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October 28, 2019

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VIA EMAIL TO PLANNING@CO.COOS.OR.US

Andrew Stamp
Land Use Hearings Officer
c/o Coos County Planning Department
225 N Adams St
Coquille, OR 97423

Re: Jordan Cove Energy Project Land Use Applications
Coos County File Nos. HBCU-19-003/FP19-003
Applicant's Second Open Record Period Submittal

Dear Mr. Stamp:

This office represents Jordan Cove Energy Project L.P. ("JCEP"), the applicant requesting approval of concurrent land use applications to construct various components of a larger project to process, liquefy, and export natural gas from the North Spit ("Project") in Coos County ("County") File Nos. HBCU-19-003/FP-19-003 ("Applications"). This letter and its enclosures constitute JCEP's second open record period submittal for the Applications. Please consider these materials before completing your recommended order for this matter.

Enclosed please find the following materials (exhibit numbering picks up with the next sequential exhibit number following JCEP's previous exhibits for the Applications):

- Exhibit 27 - Draft Environmental Impact Statement ("DEIS") issued by the Federal Energy Regulatory Commission ("FERC") dated March 2019: This report assesses the potential environmental effects of the construction and operation of the Project in accordance with the requirements of the National Environmental Policy Act. It also proposes avoidance, minimization, and mitigation measures.

- Exhibit 28 - Supplemental Response to Comments on DEIS dated September 3, 2019: This letter includes JCEP's responses filed with FERC to comments regarding the DEIS for the Project and the Pacific Connector Gas Pipeline. Some of JCEP's responses are relevant to issues raised in the County land use proceedings.

- Exhibit 29 - Consents to Applications by Oregon Department of State Lands ("DSL"): This exhibit consists of the DSL Director's signed consents to the filing of the Applications for Project components affecting submerged and submersible non-trust lands in Coos Bay owned by the State of Oregon and managed by DSL.

- Exhibit 30 - Response to FERC Environmental Information Request dated October 4, 2019: This submittal from JCEP to FERC addresses the Bureau of Land Management's questions regarding the Project's industrial wastewater pipeline.

- Exhibit 31 - Excerpts of Resource Report No. 1 (General Project Description): This report was submitted by JCEP to FERC to describe the Project. The excerpts of this report in this exhibit include Section 1.2.3 (Current LNG Terminal Proposal), which explains the new power source (direct combustion-turbine liquefaction-drive) for the gas liquefaction aspect of the Project.

- Exhibit 32 - Letter of Withdrawal dated April 12, 2019: This letter was submitted by JCEP to the Oregon Department of Energy to withdraw the application for an exemption from a site certificate for a high-efficiency cogeneration energy facility for the Project.

- Exhibit 33 - Letter from Black & Veatch dated January 11, 2016: This letter, which is from a Black & Veatch engineer, explains how the Project industrial emissions will not adversely affect airport approach surfaces.

- Exhibit 34 - Resource Report No. 9 (Air and Noise Quality): This report was submitted by JCEP to FERC to evaluate air and noise impacts caused by construction and operation of the Project and to propose measures to mitigate such impacts.

- Exhibit 35 - Letter Addressing Concrete Batch Plant dated October 28, 2019: This letter, which was prepared by the joint venture team of Kiewit, Black & Veatch, and JGC, describes and depicts the proposed concrete batch plant, its potential impacts, and measures designed to minimize and mitigate those impacts to existing surrounding uses.

- Exhibit 36 - Biological Assessment and Essential Fish Habitat Assessment revised September 2018: This report identifies the extent of effects on endangered or threatened species (including species regulated under a federal fisheries management plan) and their critical habitat and recommends measures that would avoid, reduce, or mitigate such impacts.

- Exhibit 37 - Thermal Plume Study: This exhibit consists of the study referred to as Exhibit 27 in Mr. Himes' letter.

- Exhibit 38 - Airport Imaginary Surfaces Diagram: This graphic consists of Figure 15 referenced in Mr. Himes' letter.

JCEP will offer additional argument based upon this evidence before the close of the local record. Based upon the enclosed evidence and the additional evidence and argument in the whole record, the Hearings Officer should enter an order recommending that the County Board of Commissioners approve the Applications.

I have asked County Planning staff to place a copy of this submittal into the official record for this file and to place a copy before you. JCEP reserves the right to submit additional argument and evidence in this matter consistent with the open record schedule established by the Hearings Officer and ORS 197.763.

Thank you for your careful review of this information.

Very truly yours,

Seth J. King

Encls.

cc: Jill Rolfe (via email) (w/encls.)
Steve Pfeiffer (via email) (w/encls.)
Client (via email) (w/encls.)

Federal Energy Regulatory Commission

Office of Energy Projects
Washington, DC 20426

DRAFT
ENVIRONMENTAL IMPACT STATEMENT
FOR THE
JORDAN COVE ENERGY PROJECT

Docket Nos. CP17-494-000 and CP17-495-000

FERC/DEIS-0292D

March 2019

Cooperating Agencies:

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

OFFICE OF ENERGY PROJECTS

In Reply Refer To:
OEP/DG2E/Gas Branch 3
Jordan Cove Energy Project, L.P.
Docket No. CP17-495-000
Pacific Connector Gas Pipeline, LP
Docket No. CP17-494-000
FERC/EIS-0292D

TO THE INTERESTED PARTIES:

The staff of the Federal Energy Regulatory Commission (FERC or Commission) with the participation of the cooperating agencies listed below, has prepared a draft environmental impact statement (EIS) for the Jordan Cove Liquefied Natural Gas Project proposed by Jordan Cove Energy Project L.P. (Jordan Cove) and the Pacific Connector Gas Pipeline Project proposed by Pacific Connector Gas Pipeline LP (Pacific Connector) (collectively referred to as the Jordan Cove Energy Project or Project). Under Section 3 of the Natural Gas Act (NGA), Jordan Cove requests authorization to liquefy at a terminal in Coos Bay, Oregon up to 1.04 billion cubic feet of natural gas per day for export for to overseas markets. Pacific Connector seeks a Certificate of Public Convenience and Necessity under Section 7 of the NGA to construct and operate an interstate natural gas transmission pipeline providing about 1.2 billion cubic feet per day of natural gas from the Malin hub to the Jordan Cove terminal, crossing portions of Klamath, Jackson, Douglas, and Coos Counties, Oregon.

The draft EIS assesses the potential environmental effects of the construction and operation of the Project in accordance with the requirements of the National Environmental Policy Act (NEPA). As described in the draft EIS, the FERC staff concludes that approval of the Project would result in a number of significant environmental impacts; however, the majority of impacts would be less than significant because of the impact avoidance, minimization, and mitigation measures proposed by Jordan Cove and Pacific Connector and those recommended by staff in the draft EIS.

The United States Department of the Interior Bureau of Land Management (BLM); U.S. Department of Agriculture Forest Service (Forest Service); Bureau of Reclamation (Reclamation); U.S. Department of Energy; U.S. Army Corps of Engineers; U.S. Environmental Protection Agency; U.S. Department of the Interior Fish and Wildlife Service; U.S. Department of Commerce National Oceanic and Atmospheric Administration's National Marine Fisheries Service; U.S. Department of Homeland

Security Coast Guard; the Coquille Indian Tribe; and the Pipeline and Hazardous Materials Safety Administration within the U.S. Department of Transportation participated as cooperating agencies in preparation of this EIS. Cooperating agencies have jurisdiction by law or special expertise with respect to resources potentially affected by the proposal and participate in the NEPA analysis. The cooperating agencies provided input into the conclusions and recommendations presented in the draft EIS. Following issuance of the final EIS, the cooperating agencies will issue subsequent decisions, determinations, permits or authorizations for the Project in accordance with each individual agency's regulatory requirements.

The BLM, with the concurrence of the Forest Service and Reclamation, would adopt and use the EIS to consider issuing a right-of-way grant for the portion of the Project on federal lands. Other cooperating agencies would use this EIS in their regulatory process, and to satisfy compliance with NEPA and other related federal environmental laws (e.g., the National Historic Preservation Act).

The BLM and the Forest Service would also use this EIS to evaluate proposed amendments to their District or National Forest land management plans that would make provision for the Pacific Connector pipeline. In order to consider the Pacific Connector right-of-way grant, the BLM must amend the affected Resource Management Plans (RMPs). The BLM therefore proposes to amend the RMPs to re-allocate all lands within the proposed temporary use area and right-of-way to a District-Designated Reserve, with management direction to manage the lands for the purposes of the Pacific Connector right-of-way. Approximately 885 acres would be re-allocated. District-Designated Reserve allocations establish specific management for a specific use or to protect specific values and resources. In accordance with Code of Federal Regulations (CFR) part 36 CFR 219.16, the Forest Service gives notice of its intent to consider amendments of Land and Resource Management Plans (LRMP) for the Umpqua, Rogue River and Winema National Forests. Proposed amendments of LRMPs include reallocation of matrix lands to Late Successional Reserves and site-specific exemptions from standards and guidelines and other LRMP requirements to allow construction of the Pacific Connector pipeline. Exemptions from standards and guidelines include requirements to protect known sites of Survey and Manage species, changes in visual quality objectives at specific locations, limitations on detrimental soil conditions, removal of effective shade at perennial stream crossings and the construction of utility corridors in riparian areas. Further information on Forest Service LRMP amendments is included below.

The Commission mailed a copy of the Notice of Availability of the draft EIS to federal, state, and local government representatives and agencies; elected officials; environmental and public interest groups; Indian Tribes; potentially affected landowners and other interested individuals and groups; and newspapers and libraries in the Project area. The draft EIS is only available in electronic format. It may be viewed and downloaded from the FERC's website (www.ferc.gov), on the Environmental Documents page (https://www.ferc.gov/industries/gas/enviro/eis.asp). In addition, the draft EIS may be accessed by using the eLibrary link on the FERC's website. Click on the eLibrary link (https://www.ferc.gov/docs-filing/elibrary.asp), click on General Search, and enter the docket number in the "Docket Number" field, excluding the last three digits (i.e., CP17-494 or CP17-495). Be sure you have selected an appropriate date range. For assistance, please contact FERC Online Support at FercOnlineSupport@ferc.gov or toll free at (866) 208-3676, or for TTY, contact (202) 502-8659.

Any person wishing to comment on the draft EIS may do so. Your comments should focus on the draft EIS's disclosure and discussion of potential environmental effects, reasonable alternatives, and measures to avoid or lessen environmental impacts. To ensure consideration of your comments on the proposal in the final EIS, it is important that the Commission receive your comments on or before 5:00 p.m. Eastern Time on **July 5, 2019.**

For your convenience, there are four methods you can use to submit your comments to the Commission.[1] The Commission will provide equal consideration to all comments received, whether filed in written form or provided verbally. The Commission encourages electronic filing of comments and has staff available to assist you at (866) 208-3676 or FercOnlineSupport@ferc.gov. Please carefully follow these instructions so that your comments are properly recorded.

1) You can file your comments electronically using the eComment feature on the Commission's website (www.ferc.gov) under the link to Documents and Filings. This is an easy method for submitting brief, text-only comments on a project;

2) You can file your comments electronically by using the eFiling feature on the Commission's website (www.ferc.gov) under the link to Documents and Filings. With eFiling, you can provide comments in a variety of formats by attaching them as a file with your submission. New eFiling users must first create an account by clicking on "eRegister." If you are filing a comment on a particular project, please select "Comment on a Filing" as the filing type; or

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[1] The contents of your comment including your address, phone number, e-mail address, or other personal identifying information may be made available to the public. While you may request that your personal identifying information be withheld from public view, we cannot guarantee that we will be able to do so.

3) You can file a paper copy of your comments by mailing them to the following address. Be sure to reference the Project docket numbers (CP17-494-000 and CP17-495-000) with your submission: Kimberly D. Bose, Secretary, Federal Energy Regulatory Commission, 888 First Street NE, Room 1A, Washington, DC 20426

4) In lieu of sending written or electronic comments, the Commission invites you to attend a public comment session that will be held in the Project area to receive comments on the draft EIS. The dates, locations, and times of these sessions will be provided in a supplemental notice.

Any person seeking to become a party to the proceeding must file a motion to intervene pursuant to Rule 214 of the Commission's Rules of Practice and Procedures (18 CFR 385.214). Motions to intervene are more fully described at http://www.ferc.gov/resources/guides/how-to/intervene.asp. Only intervenors have the right to seek rehearing or judicial review of the Commission's decision. The Commission grants affected landowners and others with environmental concerns intervenor status upon showing good cause by stating that they have a clear and direct interest in this proceeding which no other party can adequately represent. **Simply filing environmental comments will not give you intervenor status, but you do not need intervenor status to have your comments considered.** Subsequent decisions, determination, permits, and authorization by the cooperating agencies are subject to the administrative procedures of each respective agency.

Questions?

Additional information about the Project is available from the Commission's Office of External Affairs, at **(866) 208-FERC**, or on the FERC website (www.ferc.gov) using the eLibrary link. The eLibrary link also provides access to the texts of all formal documents issued by the Commission, such as orders, notices, and rulemakings.

In addition, the Commission offers a free service called eSubscription that allows you to keep track of all formal issuances and submittals in specific dockets. This can reduce the amount of time you spend researching proceedings by automatically providing you with notification of these filings, document summaries, and direct links to the documents. Go to www.ferc.gov/docs-filing/esubscription.asp.

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TECHNICAL ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
°F	degrees Fahrenheit
$\mu g/m^3$	micrograms per cubic meter
μPa	microPascal
AADT	average annual daily traffic
AAQS	ambient air quality standards
AASHTO	American Association of State Highway Transportation Officials
ACDP	air contaminant discharge permit
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
ACI	American Concrete Institute
AEGL	Acute Exposure Guideline Level
AIChE	American Institute of Chemical Engineers
AGPA	Alaska Gasline Port Authority
AKWA	Area of Known Wolf Activity
ALPEMA	Aluminum Plate-Fin Heat Exchanger Manufacturer's Association
AMSL	above mean sea level
ANFO	Ammonium Nitrate and Fuel Oil
ANSI	American National Standards Institute
APDBA	applicant-prepared draft biological assessment
APCO	Al Pierce Company
APE	area of potential effect
API	American Petroleum Institute
Applicants	Jordan Cove Energy L.P. and Pacific Connector Gas Pipeline L.P.
AQCR	Air Quality Control Region
AQRV	Air Quality-Related Values
ARSC	Aquatic Resources of Special Concern
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASR	Annual Species Review
ATV	all-terrain vehicle
Authorization	Section 3 Authorization
BA	biological assessment
BAC	Byram Archaeological Consulting, LLC
BBS	breeding bird survey
B.C.	British Columbia
Bcf/d	billion cubic feet per day
BCC	Birds of Conservation Concern
BCR	Bird Conservation Region
BE	Biological Evaluation
Bgs	below ground surface
BIA	U.S. Department of the Interior Bureau of Indian Affairs
BLEVE	boiling-liquid-expanding-vapor explosion
BLM	U.S. Department of the Interior Bureau of Land Management
BMP	best management practice
BO	biological opinion

BOG	boil-off gas
BPA	Bonneville Power Administration
BPVC	Boiler and Pressure Vessel Code
BST	Baker-Strehlow-Tang
BTEX	benzene, toluene, ethylbenzene, and xylene
Btu	British thermal units
Btu/ft-hr-°F	British thermal units per foot per hour per degrees Fahrenheit
BWE	ballast water exchange
BWM	Ballast Water Management
CAA	Clean Air Act
CadnaA	computer aided noise abatement
CBC	Christmas Bird Count
CBNBWB	Coos Bay-North Bend Water Board
CCPS	Center for Chemical Process Safety
CCS	carbon capture and storage
CDI	Coastal Dependent Industry
CEP	Community Enhancement Plan
CEQ	Council on Environmental Quality
Certificate	Certificate of Public Convenience and Necessity
CFD	computational fluid dynamics
CFR	Code of Federal Regulations
CH_4	methane
CHE	Coast and Harbor Engineering
CHU	critical habitat unit
CIT	Coquille Indian Tribe
CMP	Compensatory Mitigation Plan
CMZ	Channel Migration Zone
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent
Coast Guard	U.S. Department of Homeland Security Coast Guard
COE	U.S. Army Corps of Engineers
Commission	Federal Energy Regulatory Commission
Coos Tribes	Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians
COTP	Captain of the Port
Cow Creek Tribe	Cow Creek Band of Umpqua Tribe of Indians
CP	cathodic protection
CRPA	Cultural Resources Protection Agreement
CSZ	Cascadia subduction zone
CTCLUSI	Confederated Tribes of the Lower Umpqua, Coos, and Siuslaw Indians
CWA	Clean Water Act
CWD	coarse woody debris
Cy	cubic yard
CZMA	Coastal Zone Management Act
dB	decibel
dBA	A-weighted decibels
dBC	C-weight decibels
Dbh	diameter at breast height

dB_{RMS}	decibels root mean squared
DCS	distributed control system
DEA	David Evans & Associates, Inc.
DEGADIS	dense gas dispersion model
DEIS	draft environmental impact statement
DEM	digital elevation model
DHA	Department of Homeland Security
DMEF	Dredged Material Evaluation Framework
DMMU	Dredged Material Management Unit
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/FE	U.S. Department of Energy, Office of Fossil Energy
DOGAMI	Oregon Department of Geology and Mineral Industries
DP	Direct Pipe
DPS	Distinct Population Segments
Dth/d	dekatherms per day
DWSA	drinking water source area
EA	Environmental Assessment
Eagle Act	Bald and Golden Eagle Protection Act of 1940, as amended
EAR	existing access road
ECA	Emissions Control Area
ECRP	Pacific Connector's *Erosion Control and Revegetation Plan*
ECSI	Environmental Cleanup Site Information
EDRR	Early Detection Rapid Response
EEZ	economic exclusion zone
EFCC	East Fork Cow Creek
EFH	essential fish habitat
EI	environmental inspector
EIS	Environmental Impact Statement
EJSCREEN	Environmental Justice Mapping and Screening Tool
EMD	electric motor driven
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPAct	Energy Policy Act of 2005
ERMA	Extensive Recreation Management Area
ERP	emergency response plan
ESA	Endangered Species Act
ESCP	Erosion and Sedimentation Control Plan
ESD	emergency shutdown
ESU	Evolutionarily Significant Units
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
FDS	Fire Dynamics Simulator
FEED	front-end engineering design
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FGS	Fire and Gas Systems
FHWA	Federal Highway Administration
FLPMA	Federal Land and Policy Management Act of 1976

FOI	Forest Operations Inventory
Forest Service	U.S. Department of Agriculture Forest Service
Fort Chicago Holdings	Fort Chicago Holdings II US LLC
Fps	foot per second
FR	*Federal Register*
FSA	Facility Security Assessment
FSH	Forest Service Handbook
FSM	Forest Service Manual
FSP	Facility Security Plan
ft^3	cubic feet
FTA	free trade agreement
FTE	full-time equivalent
FWCA	Fish and Wildlife Coordination Act
FWS	U.S. Department of the Interior Fish and Wildlife Service
g/hp-hr	grams per horsepower per hour
GeoBOB	Geographic Biotic Observations
GHG	greenhouse gas
GIS	geographic information system
Gpm	gallons per minute
Grand Ronde Tribes	Confederated Tribes of the Grand Ronde Reservation
GRI	GRI Geotechnical and Environmental Consultants
GTN	Gas Transmission Northwest LLC
H_2S	hydrogen sulfide
HAP	Hazardous Air Pollutant
HAZID	Hazard Identification
HAZOP	hazard and operability review
HCA	high consequence area
HDD	horizontal directional drill
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HF	high-frequency
HMA	Herd Management Area
HMT	highest measured tide
Hp	horsepower
HPMP	Historic Properties Management Plan
HRA	Historical Research Associates, Inc.
HUC	Hydrologic Unit Code
Hz	hertz
I-5	Interstate 5
IM	Instruction Memorandum
IMO	International Maritime Organization
IMPLAN	Impact Analysis for Planning
INGAA	Interstate Natural Gas Association of America
IRA	Inventoried Roadless Area
IRR	Integra Realty Resources
ISA	International Society for Automation
ISO	International Organization for Standardization
ISPS Code	International Ship and Port Facility Security Code
ITA	Incidental Take Authorization
IWWP	industrial wastewater pipeline

Jordan Cove	Jordan Cove Energy Project L.P.
Jordan Cove's *Plan*	Jordan Cove's *Upland Erosion Control, Revegetation, and Maintenance Plan*
Jordan Cove's *Procedures*	Jordan Cove's *Wetland and Waterbody Construction and Mitigation Procedures*
Kcal	kilocalories
Kentuck project	Kentuck Slough Wetland Mitigation project
KO	Knockout
KOAC	known owl activity center
Km	kilometer
KOP	key observation point
kPa	kilopascals
kW	kilowatt
kW/m^2	kilowatts per square meter
L_{dn}	day-night sound level
L_{eq}	equivalent sound level
L_{max}	maximum sound level
LLA	Likely to adversely affect
LDC	local distribution company
LF	low frequency
LFL	lower flammable limit
LiDAR	light detection and ranging
LMP	Land Management Plan
LNG	liquefied natural gas
LOD	Letter of Determination
LOI	Letter of Intent
LOPA	Layer of Protection Analysis
LOR	Letter of Recommendation
LOS	level of service
LPG	liquified petroleum gasoline
LRMP	Land and Resource Management Plan
LSOG	late-successional old-growth
LSR	Late Successional Reserve
LSRA	Late-Successional Reserve Assessment
LUCS	Land Use Compatibility Statement
LUST	leaking underground storage tank
LWD	large woody debris
m^2	square meter
m^3	cubic meters
m^3/hr	cubic meters per hour
MA	Management Area
MAMU	marbled murrelet
MAOP	maximum allowable operating pressure
MARSEC	Maritime Security
MBF	thousand board feet
MBTA	Migratory Bird Treaty Act
MCE	Maximum Considered Earthquake
Mcy	million cubic yards
MF	mid-frequency

mg/l	milligram per liter
mg/d	million gallons per day
mg/kg	milligram per kilogram
MHW	mean high water
MIS	management indicator species
MLA	Mineral Leasing Act
MLLW	mean lower low water
MLRA	Major Land Resource Area
MLV	mainline block valve
Mm	millimeter
MMBF	million board feet
MMBtu/hr	million British thermal units per hour
MMcf/d	million cubic feet per day
mmhos/cm	millimhos per centimeter
MMPA	Marine Mammal Protection Act
MMTPA	million metric tons per annum
MOA	Memorandum of Agreement
MOF	material offloading facility
MOU	Memorandum of Understanding
MP	milepost
Mph	miles per hour
MPRSA	Marine Protection, Research, and Sanctuary Act
MR	Mixed Refrigerant
MRL	Mixed Refrigerant liquid
Ms	
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	mean sea level
MTBM	micro-tunnel boring machine
mtpa	metric tonnes per annum
MTSA	Maritime Transportation Security Act
MUSY	Multiple Use, Sustained Yield Act of 1960
MVA	megavolt ampere
MW	megawatt
N	equivalent energy release ratio
na	Not applicable
NAAQS	National Ambient Air Quality Standards
NAS	Non-indigenous aquatic species
NAVD88	North American Vertical Datum of 1988
NCDC	National Climatic Data Center
NCM	navigation channel mile
NE	no effect
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NF	National Forest
NFMA	National Forest Management Act
NFPA	National Fire Protection Association
NFS	National Forest System
NGA	Natural Gas Act

NHPA	National Historic Preservation Act
NJ	Not likely to jeopardize the continued existence for proposed species
NLAA	not likely to adversely affect
NMFS	National Marine Fisheries Service
NNL	National Natural Landmark
NNSR	Nonattainment New Source Review
NO	nitrogen oxide
NO_2	nitrogen dioxide
NOAA	U.S. Department of Commerce National Oceanic and Atmospheric Administration
NOI	Notice of Intent
Northwest	Northwest Pipeline GP
NO_x	oxides of nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NRF	nesting, roosting, and foraging
NRHP	National Register of Historic Places
NRIS	Natural Resource Information System
NSA	noise-sensitive area
NSHM	National Seismic Hazard Map
NSO	northern spotted owl
NSPS	New Source Performance Standards
NSR	New Source Review
NTU	nephelometric turbidity unit
NVIC	Navigation and Vessel Inspection Circular
NWFP	Northwest Forest Plan
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
NWS	National Weather Service
O_2	oxygen
O&C	Oregon and California Railroad
O&C Act	Oregon and California Revested Lands Sustained Yield Management Act of 1937
OAR	Oregon Administrative Rule
OBE	Operating Basis Earthquake
OCMP	Oregon Coastal Management Program
OCRM	National Oceanic and Atmospheric Administration Office of Coast and Ocean Resource Management
ODA	Oregon Department of Agriculture
ODE	Oregon Department of Energy
ODEQ	Oregon Department of Environmental Quality
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ODLCD	Oregon Department of Land Conservation and Development
ODNRA	Oregon Dunes National Recreation Area
ODOT	Oregon Department of Transportation
ODSL	Oregon Department of State Lands

OEP	FERC's Office of Energy Projects
OHWM	ordinary high water mark
OHV	off-highway vehicle
OHWM	ordinary high water mark
OIMB	Oregon Institute of Marine Biology
OISC	Oregon Invasive Species Council
OPRD	Oregon Parks and Recreation Department
OPS	Office of Pipeline Safety
OPUC	Oregon Public Utilities Commission
ORBIC	Oregon Biodiversity Information Center
ORS	Oregon Revised Statute
OSHA	Occupational Safety and Health Administration
OSMB	Oregon State Marine Board
OSMRE	Office of Surface Mining Reclamation Enforcement
OSWB	Oregon State Weed Board
OWRD	Oregon Water Resources Department
Pacific Connector	Pacific Connector Gas Pipeline L.P.
PAG	plant association group
PAH	polynuclear aromatic hydrocarbon
PAR	permanent access road
PBF	physical or biological features
PCB	polychlorinated biphenyl
PCT	Pacific Crest Trail
Pembina	Pembina Pipeline Corporation
PES	PES Environmental, Inc.
PFMC	Pacific Fishery Management Council
PG&E	Pacific Gas and Electric Company
PGA	peak horizontal ground acceleration
PGAM	geometric mean peak ground acceleration
PHMSA	Pipeline and Hazardous Materials Safety Administration
PI	point of intersection
PILT	Payment In Lieu of Taxes
PLF	product loading facility
Plan	*Upland Erosion Control, Revegetation, and Maintenance Plan*
PM_{10}	particulate matter with a diameter of less than 10 microns
$PM_{2.5}$	particulate matter with a diameter of less than 2.5 microns
PMD	Power Driven Machinery
PnR	Park and Ride
POD	Plan of Development
Port	Oregon International Port of Coos Bay
ppm	parts per million
ppmvd	parts per million by volume, dry basis
ppmvd @ 15 percent O_2	Parts per million by volume, dry basis, corrected to 15 percent oxygen
PPV	peak particle velocity
PRICO®	Poly Refrigerant Integrated Cycle Operation
Procedures	*Wetland and Waterbody Construction and Mitigation Procedures*
Project	Jordan Cove LNG Project and Pacific Connector Gas Pipeline Project
PSD	Prevention of Significant Deterioration

PSE	Puget Sound Energy
PSEL	plant site emission limit
PSET	Portland Sediment Evaluation Team
Psi	pounds per square inch
psig	pounds per square inch gauge
PST	Pacific Standard Time
Psu	practical salinity unit
PTS	permanent threshold shift
PVC	polyvinyl chloride
PWA	Potential Wilderness Area
R.	Range
RBC	risk-based concentration
Reclamation	U.S. Department of the Interior Bureau of Reclamation
RFP	Roseburg Forest Products
RFPD	Rural Fire Protection District
RHA	Rivers and Harbors Act
RM	river mile
RMA	Recreation Management Area
RML	rapidly moving landslide
RMP	Resource Management Plan
RMS	Riparian Management Strategy
RNA	Research Natural Area
ROD	Record of Decision
RPT	rapid phase transition
Ruby	Ruby Pipeline LLC
RV	recreational vehicle
SAFE Port Act	Security and Accountability For Every Port Act
Sandia	Sandia National Laboratories
SAP	sampling and analysis plan
SAV	submerged aquatic vegetation
SBS	Siskiyou BioSurvey, LLC
SD	scaled distance factor
SDWA	Safe Drinking Water Act
SEL_{cum}	cumulative sound exposure level
SEP	surface emissive power
SER	Significant Emission Rate
SEV	severity of ill effect
SH	State Highway
SHN	SHN Consulting Engineers & Geologists, Inc.
SHPO	State Historic Preservation Officer
SIL	significant impact level
Siletz Tribes	Confederated Tribes of the Siletz Reservation
SIS	Safety Instrumentation Systems
SLR	sea level rise
SMPE	South Mist Pipeline Extension
SMR	single mixed refrigerant
SMU	Species Management Unit
SO_2	sulfur dioxide
SOLAS	Safety of Life at Sea

SONCC	Southern Oregon/Northern California Coast
SORSC	Southwest Oregon Regional Safety Center
SOULA	Southern Oregon University Laboratory of Anthropology
SPCC	Spill Prevention, Containment, and Countermeasures
SPL	sound pressure level
SPL_{peak}	peak sound pressure level
SRMA	Special Recreation Management Area
SSA	sole or principal source aquifer
SSE	Safe Shutdown Earthquake
SSTEMP	Stream Segment Temperature Model
SSURGO	Soil Survey Geographic (Database)
STATSGO	State Soil Geographic (Database)
SVID	Shasta View Irrigation District
SVOC	semivolatile organic compound
SWMP	Storm Water Management Plan
SWPCP	Storm Water Pollution Control Plan
T.	Township
T&E	Threatened and Endangered
TACT	Typically Achievable Control Technologies
TAR	temporary access road
TCP	Traditional Cultural Property
TEMA	Tubular Exchanger Manufacturers Association
TEWA	temporary extra work area
t/hr	metric ton per hour
TMBB	temporary material barge berth
TMDL	Total Maximum Daily Load
TMP	Transportation Management Plan
TPH	total petroleum hydrocarbon
TPY	tons per year
TSS	total suspended solids
Tuscarora	Tuscarora Gas Transmission Company
TVS	total volatile solids
TWIC	Transportation Worker Identification Credential
UCSA	uncleared storage area
UDP	Unanticipated Discovery Plan
UFL	upper flammable limit
U.S.	United States
U.S.C.	United States Code
USDA	United States Department of Agriculture
USDOI	U.S. Department of the Interior
USDOT	U.S. Department of Transportation
USGCRP	United States Global Change Research Program
USGS	U.S. Geological Survey
v/c	volume-to-capacity ratio
VGP	General Permit for Discharges Incidental to the Normal Operation of Vessels
VOC	volatile organic compound
VQO	Visual Quality Objective
VRM	visual resource management

WA	Watershed Analyses
WBD	Watershed Boundary Dataset
WHPA	wellhead protection area
WNF	Winema National Forest
WRCC	Western Regional Climatic Center
WRP	Wetland Reserve Program
WSA	Waterway Suitability Assessment
WSR	Waterway Suitability Report

EXECUTIVE SUMMARY

The staff of the Federal Energy Regulatory Commission (FERC or Commission) has prepared this draft environmental impact statement (EIS) to assess the impacts of constructing and operating the Jordan Cove Liquefied Natural Gas (LNG) Project proposed by Jordan Cove Energy Project LP (Jordan Cove) and the Pacific Connector Gas Pipeline Project proposed by Pacific Connector Gas Pipeline L.P. (Pacific Connector). The purpose and need of the Jordan Cove LNG Project is to export natural gas supplies derived from existing interstate natural gas transmission systems to overseas markets. The purpose and need of the Pacific Connector Gas Pipeline Project is to connect the existing interstate natural gas transmission systems of Gas Transmission Northwest, LLC and Ruby Pipeline, LLC with the proposed LNG export terminal. Collectively, Jordan Cove and Pacific Connector are referred to as the applicants, and the projects are referred to collectively as the Project.

The purpose of this draft EIS is to inform the FERC decision-makers, the public, and the permitting agencies about the potential adverse and beneficial environmental impacts of the proposed Project and recommend mitigation measures that would reduce adverse impacts to the extent practicable. We[1] prepared this analysis based on information provided by the applicants; our independent review of this information; in consultation with federal cooperating agencies (see below); and in consideration of comments provided by state and local agencies, Indian Tribes, and individual members of the public. This draft EIS was prepared in accordance with the requirements of the National Environmental Policy Act of 1969 (NEPA) and the Commission's implementing regulations under Title 18 of the Code of Federal Regulations, Part 380 (18 CFR 380).

The FERC is the federal agency responsible for authorizing onshore LNG facilities, and is responsible for regulating the siting and construction of interstate natural gas transmission pipelines. FERC is the lead federal agency responsible for the preparation of this draft EIS. The U.S. Department of the Interior Bureau of Land Management (BLM); U.S. Department of Agriculture Forest Service (Forest Service); Bureau of Reclamation; U.S. Department of Energy; U.S. Army Corps of Engineers (COE); U.S. Environmental Protection Agency; U.S. Department of the Interior Fish and Wildlife Service; U.S. Department of Commerce National Oceanic and Atmospheric Administration's National Marine Fisheries Service; U.S. Department of Homeland Security Coast Guard (Coast Guard); the Coquille Indian Tribe; and the Pipeline and Hazardous Materials Safety Administration within the U.S. Department of Transportation are cooperating agencies for the development of this draft EIS consistent with 40 CFR 1501.6(b). A cooperating agency has jurisdiction by law or has special expertise with respect to the environment potentially affected by the Project. The cooperating agencies provided input to the conclusions and recommendations presented in the draft EIS. Following issuance of the final EIS, the cooperating agencies will issue subsequent decisions, determinations, permits or authorizations for the Project in accordance with each individual agency's regulatory requirements.

PROPOSED ACTION

On September 21, 2017, the applicants, in Docket Nos. CP17-494-000 and CP17-495-000, filed applications with the FERC pursuant to Sections 3 and 7 of the Natural Gas Act (NGA) seeking an Authorization and a Certificate of Public Convenience and Necessity to construct and operate

[1] "We," "us," and "our" refer to the environmental and engineering staff of the FERC's Office of Energy Projects.

an LNG export terminal and an interstate natural gas transmission pipeline. The LNG terminal would be located in Coos County, Oregon on the North Spit of Coos Bay and would be capable of liquefying up to 1.04 billion cubic feet of natural gas per day for export. The 200-acre LNG terminal site would include:

- an access channel from the existing Coos Bay Federal Navigation Channel to the LNG terminal;
- modifications to the existing Federal Navigation Channel;
- a marine slip containing two berths (one Production Loading Berth and one Emergency Lay Berth), a dock for tug and escort boats, and a material offloading facility (MOF);
- LNG loading platform and transfer line;
- two full-containment LNG storage tanks and associated equipment;
- five natural gas liquefaction trains;
- a pipeline gas conditioning facility;
- a temporary workforce housing facility;
- the non-jurisdictional Southwest Oregon Regional Security Center and Fire Department building; and
- other security and control facilities, administrative buildings, and other support structures.

As proposed, the LNG terminal would be called upon by about 120 LNG carriers per year.

The pipeline would originate at interconnections with existing pipeline systems in Klamath County, Oregon, and would span parts of Klamath, Jackson, Douglas, and Coos Counties, Oregon, before connecting with the LNG terminal. The approximately 229-mile-long, 36-inch-diameter pipeline would be capable of transporting up to 1.2 billion cubic feet of natural gas per day. Operating the pipeline would require the use of one compressor station (i.e., the Klamath Compressor Station) and other associated facilities including mainline block valves, pig[2] launchers and receivers, communication systems, and meter stations.

PUBLIC INVOLVEMENT

The applicants began participating in the Commission's Pre-filing Process in early 2017 (Docket No. PF17-4-000). The FERC's Pre-filing Process encourages the early involvement of interested stakeholders and responsible regulatory agencies to identify and resolve environmental issues before an application is filed with the FERC. During the Pre-filing Process, the applicants held Open Houses in Coos Bay and along the pipeline route in March of 2017 to provide the public with information about the Project and to solicit its concerns about the Project.

In June 2017, the FERC issued a *Notice of Intent to Prepare an Environmental Impact Statement for the Planned Jordan Cove LNG Terminal and Pacific Connector Pipeline Projects, Request for Comments on Environmental Issues, and Notice of Public Scoping Sessions* (NOI). The NOI was sent to affected landowners; federal, state, and local government agencies; elected officials; environmental and public interest groups; interested Indian tribes; and local libraries and newspapers. The NOI also began a 30-day scoping period. During the scoping period, the FERC along with the BLM and Forest Service, held joint public scoping sessions in Coos Bay and along the pipeline route to receive comments about the Project. Each session was attended by at least

[2] A pig is a remotely operated pipe inspection and cleaning tool.

150 people, and some sessions were attended by substantially more. During scoping, we also met with several federally recognized Indian Tribes in person and via teleconference meeting to discuss their concerns about the Project.

To date, we have received more than 9,000 comments on the Project. Most comments concern property rights, land use, purpose and need, safety and security, potential geological hazards (tsunamis and mountainous terrain), and the FERC's approach to the NEPA process. Comments from Indian Tribes expressed concern about meaningful consultation, cultural resources, environmental resources including fish (salmon) and vegetation, impacts on traditional use(s) of the land, environmental justice, cumulative impacts, and documentation of concerns in the EIS. All comments received prior to the issuance of this EIS were considered and addressed as appropriate in our analysis. Additionally, many comments raised concerns that are outside the scope of this EIS. Examples include comments concerning the public benefit or need to export LNG, unconventional natural gas production ("fracking"), induced production of natural gas, "life-cycle" cumulative environmental impacts associated with the LNG export process, and downstream greenhouse gas emissions resulting from the combustion of exported natural gas.

PROJECT IMPACTS

Constructing and operating the Project would impact geological resources, soils and sediments, water resources, wetlands, vegetation, wildlife, aquatic resources, threatened and endangered species, and other species of concern, land use, recreation, visual resources, socioeconomics, transportation, cultural resources, air quality, and noise. Our analysis also evaluates the potential for cumulative impacts on these resources.

Constructing and operating the LNG terminal would permanently impact about 200 acres of land, resulting in the loss of about 22 acres of wetlands. Coos Bay would temporarily experience increased turbidity and sedimentation due to the construction of the marine facilities. Wildlife in the vicinity of the LNG terminal, especially those species who are sensitive to noise and light would experience increased rates of stress, injury, and mortality. Areas adjacent to the Coos Bay Federal Navigation Channel would be modified, but it is suitable to support the LNG carriers that would call on the terminal. LNG carriers transiting the Federal Navigation Channel would likely cause minor delays for other marine traffic in the waterway. Vehicle traffic and associated commute times near the LNG terminal site would also increase. Permanent and temporary structures at the LNG terminal as well as LNG carrier operations in the Federal Navigation Channel would exceed FAA obstruction standards and there is a potential significant impact to the safe air operations of the Southwest Oregon Regional Airport if a resolution cannot be settled between Jordan Cove and FAA. Constructing the LNG terminal would temporarily impact the Coos Bay area short-term housing market. The LNG terminal would permanently impact the visual character of Coos Bay. The LNG terminal design accounts for possible tsunamis and includes safeguards and protections to ensure facility integrity and public safety.

Constructing the pipeline would require the temporary use of more than 4,000 acres of land. Operating the pipeline would permanently impact about 1,400 acres of land; however, many land uses including livestock grazing would not be permanently affected. The pipeline would be located across steep terrain through the Cascade Mountains, but Pacific Connector has planned accordingly for potential landslides and erosion. The pipeline would also cross over 300 waterbodies including the Coos, Rogue, and Klamath Rivers. These larger rivers would be crossed using horizontal directional drills to minimize impacts. The pipeline would also impact over 2,000 acres of forest including over 750 acres of late stage old-growth forest that provides habitat to marbled murrelet, northern spotted owl, and other federally-listed threatened and endangered species. Recreation areas crossed by the pipeline would be temporarily disturbed and use of these areas would likely find construction to be an annoyance and an inconvenience. Vehicle traffic on area roads would increase as well as demand for local services and business, but these increases would be temporary. Following construction, the primary impact of the Project would be the visible nature of the permanent pipeline easement. The visual impact of the easement would be similar to that of other utilities and roadways in the region.

ALTERNATIVES CONSIDERED

As required by NEPA and in consultation with the cooperating agencies, we identified and considered reasonable alternatives to the Project to determine if the implementation of an alternative would be preferable to the proposed action. An alternative is considered reasonable if it meets the stated purpose of the Project and is technically and economically feasible and practical. A preferable alternative would offer a significant environmental advantage over the proposed action.

In our alternatives analysis we considered the no action alternative, system alternatives, LNG terminal site alternatives, and pipeline route alternatives. The EIS evaluates all alternatives developed by staff, developed by the applicants, or suggested by stakeholders that were able to meet the Project's purpose and were feasible or practical.

Under the No Action alternative, the environmental impacts associated with constructing and operating the Project would not occur; however, equal or greater impacts could occur at other location(s) in the region as a result of another LNG export project seeking to meet the demand identified by the applicants.

The systems alternatives we considered include existing and proposed LNG terminals in Alaska, Canada, and Mexico; an LNG project currently under construction in Tacoma, Washington; an existing interstate natural gas transmission pipeline system in Oregon; and a non-jurisdictional intrastate pipeline in Coos County. Existing and proposed LNG terminals in Alaska, Canada, and Mexico are too far removed (700 to 3,000 miles) from the interconnections in Klamath County to offer a significant environmental advantage over the proposed action. The Tacoma LNG Project is designed to serve local customers and provide marine vessel fuel; it would not meet the Project's stated purpose for export. Additionally, the Tacoma LNG Project is being built on a 30-acre site and there is insufficient land available for expansion. The Northwest Pipeline interstate system and the intrastate Coos County Pipeline have insufficient capacities to replace the capacity that would be provided by the proposed pipeline. Modifications to these systems to create such capacity would result in equal or greater environmental impacts and would not offer a significant environmental advantage over the proposed action.

The LNG terminal site alternatives we considered include a site in Humboldt Bay, California; sites in Oregon and Washington; another site in Coos Bay; and an inland site east of Coos Bay. The impacts of constructing an LNG terminal and pipeline to Humboldt Bay would be comparable to that of the proposed Project. Alternative sites in Oregon and Washington would result in greater impacts on the environment. Therefore, alternative LNG terminal sites in California, Oregon, and

Washington would not offer a significant environmental advantage over the proposed action. The Coos Bay site alternative would also not offer a significant environmental advantage over the proposed action. The inland site alternative would be located at least 5 miles east of Coos Bay and would require the construction of an LNG cryogenic pipeline to the proposed marine loading facilities. Our analysis indicates that the relocation of the terminal site would reduce, but not eliminate impacts on wetlands; it would also still result in impacts on Coos Bay, and would likely increase overall impacts on the environment due to the need for an LNG cryogenic pipeline. Therefore, an inland alternative would not offer a significant environmental advantage over the proposed action.

Pipeline route alternatives considered include three major route alternatives and nine pipeline route variations. Based on our analysis as described in the draft EIS, we conclude that four route variations would be preferable to the corresponding proposed action. We are recommending that Pacific Connector incorporate the Blue Ridge Variation, the Survey and Manage Species Variation, the East Fork Cow Creek Variation, and the Pacific Crest Trail Variation into its proposed route for the Project. We have concluded that these variations would offer a significant environmental advantage over the proposed action.

CONCLUSIONS

We conclude that constructing and operating the Project would result in temporary, long-term, and permanent impacts on the environment. Many of these impacts would not be significant or would be reduced to less than significant levels with the implementation of proposed and/or recommended impact avoidance, minimization, and mitigation measures. However, some of these impacts would be adverse and significant. Specifically, we conclude that constructing the Project would temporarily but significantly impact housing in Coos Bay and that constructing and operating the Project would permanently and significantly impact the visual character of Coos Bay. Furthermore, constructing and operating the Project is likely to adversely affect 13 federally-listed threatened and endangered species including the marbled murrelet, northern spotted owl, and coho salmon. Our conclusions are based wholly or in part on the following factors:

- the Project would be constructed in compliance with all applicable federal laws, regulations, permits, and authorizations;
- the applicants would implement all best management practices, the measures described in their *Erosion Control and Revegetation Plan, Wetland and Waterbody Construction and Mitigation Procedures* and *Upland Erosion Control, Revegetation, and Maintenance Plans*, and other impact avoidance, minimization, and mitigation measures;
- the applicants' *Compensatory Wetland Mitigation Plan* would satisfy the COE's regulatory requirements to mitigate unavoidable impacts on wetlands and waters of the U.S.;
- the BLM and Forest Service's plan amendments would provide for the crossing of federal lands;
- compliance with the Endangered Species Act and the National Historic Preservation Act would be complete prior to construction;
- the LNG terminal was designed consistent with maximum tsunami run-up elevations and considered tsunami wave heights and inundation elevations;

- the LNG terminal would include protections and safeguards that ensure facility integrity and public safety;
- the Coast Guard issued a Letter of Recommendation indicating the Coos Bay Federal Navigation Channel would be considered suitable for the LNG marine traffic associated with the Project; and
- FERC's environmental and LNG engineering construction inspection programs would ensure compliance with the applicants' commitments, and the conditions of any FERC Authorization and Certificate.

In addition, we recommend that the Project-specific impact avoidance, minimization, and mitigation measures that we have developed (included in this EIS as recommendations) be attached as conditions to any Authorization and Certificate of Public Convenience and Necessity issued by the Commission for the Project.

1.0 INTRODUCTION

1.1 PROJECT SUMMARY

The staff of the Federal Energy Regulatory Commission (FERC or Commission) prepared this draft Environmental Impact Statement (EIS) to describe our assessment of the potential environmental impacts that may occur from constructing and operating the Jordan Cove Liquefied Natural Gas (LNG) Project and Pacific Connector Gas Pipeline Project.

On September 21, 2017 Jordan Cove Energy Project, L.P. (Jordan Cove) and Pacific Connector Gas Pipeline, L.P. (Pacific Connector)1 filed applications with the FERC pursuant to Sections 3 and 7 of the Natural Gas Act (NGA) to construct and operate an LNG terminal and associated pipeline facilities. A Notice of Application for the Jordan Cove and Pacific Connector Projects2 was issued by the FERC on October 5, 2017.

In FERC Docket No. CP17-495-000, Jordan Cove seeks an NGA Section 3 Authorization (Authorization) to construct and operate an LNG export terminal in Coos County, Oregon. The terminal would be capable of receiving, processing, and liquefying natural gas3 into LNG, then storing and loading the LNG onto LNG carriers. The Jordan Cove facilities could receive a maximum of 1.2 billion cubic feet per day (Bcf/d) of natural gas from the Pacific Connector pipeline and produce a maximum of 7.8 million metric tons per annum (MMTPA) of LNG.

In FERC Docket No. CP17-494-000, Pacific Connector seeks a Certificate of Public Convenience and Necessity (Certificate), under NGA Section 7, to construct and operate an approximately 229-mile-long, 36-inch-diameter natural gas transmission pipeline, crossing through Klamath, Jackson, Douglas, and Coos Counties, Oregon.4 The pipeline would transport about 1.2 Bcf/d of natural gas from interconnections with the existing Ruby Pipeline LLC (Ruby) and Gas Transmission Northwest LLC (GTN) systems5 near Malin, Oregon to the Jordan Cove terminal.

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[1] Jordan Cove and Pacific Connector are both subsidiaries of Pembina Pipeline Corporation (Pembina) of Calgary, Alberta, Canada. They are also referred to in this EIS as the applicants.

[2] Individually, the Jordan Cove proposal may be referred to in this EIS as the Jordan Cove Liquefaction Project, Jordan Cove LNG Project, LNG Project, Jordan Cove facilities, or the JCEP Project; the Pacific Connector proposal may be referenced similarly, as the Pacific Connector Pipeline Project, Pacific Connector pipeline, pipeline Project, or PCGP Project. Both proposals combined are often called the Project.

[3] Natural gas is a fossil fuel, consisting primarily of methane (CH_4), that is used for a variety of purposes, including electrical generation, home heating and cooking, fuel for motor vehicles, and other industrial/commercial applications. Natural gas is obtained from underground wells and transported from places of production to consumers mainly by way of pipelines. LNG is natural gas that has been cooled to about -260 degrees Fahrenheit (°F). As a liquid, LNG is about 600 times more dense than natural gas in a vapor state and can be stored and transported much more efficiently than the equivalent amount of gas. There are specially designed vessels (referred to as LNG carriers) that can transport LNG overseas from points of origin to customers. Exported LNG can be vaporized at receipt terminals, returned to natural gas, and then transported by pipelines to end-users.

[4] Pacific Connector also requested a blanket certificate to allow for future construction, operation, and abandonment activities under Subpart F of Title 18 Code of Federal Regulations (CFR) Part 157 of the Commission's regulations and requested a blanket certificate to provide open-access transportation services under its tariff in accordance with Subpart G of Part 284.

[5] GTN is owned by TransCanada, while Ruby is owned by Pembina.

As specified by the NGA and the Energy Policy Act of 2005 (EPAct), the FERC is responsible for authorizing onshore LNG terminals and interstate natural gas transmission facilities. EPAct also establishes the FERC as the lead federal agency responsible for coordinating applicable federal authorizations and complying with the requirements of the National Environmental Policy Act (NEPA). The FERC's regulations for implementing the elements of NEPA are at Title 18 Code of Federal Regulations (CFR) Part 380.

Consistent with federal regulations, applicable guidance, and other agreements,6 the United States (U.S.) Department of the Interior Bureau of Land Management (BLM) Oregon State Office; U.S. Department of Agriculture Forest Service (Forest Service) Pacific Northwest Region; Bureau of Reclamation (Reclamation) Klamath Basin Area Office; U.S. Department of Energy (DOE); U.S. Army Corps of Engineers (COE) Portland District; U.S. Environmental Protection Agency (EPA) Region 10; U.S. Department of the Interior Fish and Wildlife Service (FWS) Oregon Fish and Wildlife Office; U.S. Department of Commerce National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) Oregon Coast Branch; U.S. Department of Homeland Security Coast Guard (Coast Guard) Portland (Sector Columbia River); the Coquille Indian Tribe7; and the Pipeline and Hazardous Materials Safety Administration (PHMSA) within the U.S. Department of Transportation (USDOT) are cooperating agencies in the development of this EIS. Cooperating agencies have jurisdiction by law or special expertise with respect to any environmental impacts involved in a proposal. The responsibilities of cooperating agencies are summarized in 40 CFR 1501.6, the Council of Environmental Quality (CEQ) regulations for implementing NEPA.

1.1.1 Previous Proposals

Beginning in 2006, Jordan Cove and Pacific Connector sought to import LNG into a terminal at Coos Bay, Oregon, and transport natural gas through a sendout pipeline to interconnections with existing pipeline systems at the Malin hub.8 The import terminal and associated sendout pipeline

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[6] May 2002 "*Interagency Agreement on Early Coordination of Required Environmental and Historic Preservation Reviews Conducted in Conjunction With the Issuance of Authorizations to Construct and Operate Interstate Natural Gas Pipelines Certificated by the Federal Energy Regulatory Commission*", signed by the FERC, Advisory Council on Historic Preservation, CEQ, EPA, Department of the Army, Department of Agriculture, Department of Commerce, DOE, Department of the Interior, and USDOT. February 2004 "*Interagency Agreement Among the Federal Energy Regulatory Commission, United States Coast Guard, and Research and Special Programs Administration for the Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities*." June 2005 "*Memorandum of Understanding Between the United States Army Corps of Engineers and the Federal Energy Regulatory Commission Supplementing the Interagency Agreement on Early Coordination of Required Environmental and Historic Preservation Reviews Conducted in Conjunction with the Issuance of Authorizations to Construct and Operate Interstate Natural Gas Pipelines Certificated by the Federal Energy Regulatory Commission*," executed 30 June 2005.

[7] The Project would be located across ancestral territory of the Coquille Indian Tribe (CIT). Due to their continued presence in the area, their modern and historic interest throughout their five-county fee-to-trust / service area, their concern for the land, and their special expertise regarding the natural environment, the CIT are participating as a cooperating agency. The CIT manages over 10,000 acres of land, primarily as sustainable forest; and provides education assistance, health care, elder services, and housing assistance to its members. The CIT have provided a unique and invaluable perspective to the development of this EIS.

[8] The originally proposed Pacific Connector sendout pipeline (in Docket No. CP07-441-000) would have connected with the existing GTN, Pacific Gas and Electric Company, and Tuscarora pipelines near Malin, Oregon. The original Jordan Cove LNG import project was authorized by the Commission in an "Order Granting Authorizations Under Section 3 and Issuing Certificates" issued on December 17, 2009 in Docket No. CP07-444-000.

applications were authorized by the Commission with conditions; however, due to changes in the natural gas industry, the facilities were never constructed, and the Commission withdrew its previous approval for the Project.9 Although the facilities required for the import of LNG are different than those required to export LNG, the original terminal location and footprint and the pipeline route are similar to the current Project proposed in Docket Nos. CP17-494-000 and CP17-495-000.

In 2012, Jordan Cove and Pacific Connector sought to export LNG from a terminal at Coos Bay, Oregon, with an associated feeder pipeline proposed to transport natural gas from existing pipeline systems near Malin.10 In response to those applications, the Commission issued an Order Denying Applications for Certificate and Section 3 Authorization on March 11, 2016 for Docket Nos. CP13-483-000 and CP13-492-000, and upheld its decision in its Order Denying Rehearing issued December 9, 2016. However, because the denial was without prejudice, Jordan Cove and Pacific Connector were able to file new applications in Docket Nos. CP17-494-000 and CP17-495-000.

1.1.2 Proposed Action

The facilities addressed in this EIS and described further in chapter 2 are the proposed LNG and pipeline facilities identified by Jordan Cove and Pacific Connector in their respective applications, and are summarized as follows:

LNG Project Facilities:

- an access channel from the existing Coos Bay Federal Navigation Channel to the LNG terminal;
- Modifications to the marine waterway, including four dredge locations located adjacent to the Federal Navigation Channel;
- a terminal marine slip containing two berths (one Production Loading Berth and one Emergency Lay Berth), and a dock for tug and escort boats, and a material offloading facility (MOF);
- LNG loading platform and transfer line;
- LNG storage system, consisting of two full-containment storage tanks;
- five natural gas liquefaction trains;
- a pipeline gas conditioning facility;
- the workforce housing facility located at the South Dunes Site;
- Southwest Oregon Regional Security Center (SORSC); and Fire Department building; and
- other security and control facilities, administrative buildings, meteorological station, and other support structures associated with the terminal.

Pipeline Project Facilities:

- a 229-mile-long, 36-inch-diameter welded steel underground pipeline, extending between interconnections near Malin in Klamath County and the Jordan Cove LNG terminal in Coos County, Oregon;
- the Klamath Compressor Station, at the eastern end of the pipeline; and

[9] On April 16, 2012, the Commission issued an “Order Granting Rehearing in Part, Dismissing Request for Stay, and Vacating Certificate and Section 3 Authorizations” in Docket Nos. CP07-441-000 and CP07-444-000.
[10] Like the current Project, the first LNG export and feeder pipeline proposal had the Pacific Connector pipeline connecting with the existing GTN and Ruby pipelines near Malin, Oregon.

- other associated facilities (e.g., meters stations, mainline block valves, pig launchers, and communication systems).

The general location of LNG terminal and pipeline facilities are depicted in figure 1.1-1 and chapter 2.

The primary differences between the previously proposed LNG terminal facilities (in Docket No. CP13-483-000) from the currently proposed Project are as follows:

- The South Dunes Power Plant has been eliminated from the current proposal.
- The locations of the workforce housing facility, the SORSC, and the project related Fire Department have been relocated.
- New staging areas have been added at Oregon International Port of Coos Bay (Port) Laydown and Boxcar Hill sites.
- The Al Pierce Company (APCO) sites (APCO 1 and 2) would be used for some Project related dredge disposal.
- The number of LNG carriers that would visit the terminal has increased to 110 to 120 vessels per year.
- The proposal now includes the excavation of four submerged areas (removing about 700,000 cubic yards of material) lying adjacent to the existing federally-authorized Federal Navigation Channel, and dredge slurry pipelines in Coos Bay; and
- The habitat mitigation areas at West Jordan Cove and West Bridge locations have been eliminated.

The primary differences between the previously proposed pipeline Project (Docket No. CP13-492-000) from the currently proposed project are as follows:

- Multiple horizontal directional drill (HDD) crossings have been newly proposed, including an approximately 5,200-foot-long HDD crossing under Coos Bay from about mileposts (MP) 0.12[11] to 1.11.
- Multiple route modifications have been made based on detailed civil survey, project design enhancements, and landowner or land-management agency input.
- Increased compression at the Klamath Compressor Station from 41,000 horsepower (hp) to 93,300 hp.
- Elimination of the Clark's Branch Meter Station.

[11] Notice that the MPs for the current version of the Pacific Connector pipeline in Docket No. CP17-494-000 are reversed from the actual direction of natural gas. Although the natural gas would flow east (from Malin) to west (to Coos Bay) in the current Project, the MPs are numbered from west (0.0. at the Jordan Cove Meter Station) to east (MP 228.8 at the Klamath Compressor Station). The letter "R" is used with some MPs to denote re-routes adopted after the original 2007 proposed pipeline route design.


Jordan Cove Meter Station at MP 0.00
Harness Mtn. Comm Tower
Deschutes National Forest
Willamette National Forest
Blue Ridge Comm Tower
Winema National Forest
Roseburg BLM District
Umpqua National Forest
Coos Bay BLM District
Signal Tree Comm Tower
Sheep Hill MW
Starveout Creek Comm Tower
Flounce Rock Comm Tower
Rogue River National Forest
Winema National Forest
Medford BLM District
Siskiyou National Forest
Winema National Forest
Lakeview BLM District
Robinson Butte Comm Tower
USBR Klamath Basin Project
Stukel Mtn. Comm Tower
Rogue River National Forest
Klamath Compressor Station, Klamath-Eagle Meter Station, and Klamath-Beaver Meter Station at MP 228.81
Figure 1.1-1
General Location
Mileposts
Proposed PCGP Route
USBR Klamath Basin Project
BLM District Boundaries
National Forest Boundaries
Federal Lands
BLM
USFS
N
0 4 8 16
Miles

1.2 APPLICANTS' PURPOSE AND NEED

The FERC does not plan, design, build, or operate natural gas infrastructure. As an independent regulatory commission, the FERC reviews proposals developed by other entities. Accordingly, the project proponent is the source for identifying the purpose for developing and constructing a project.

In its application, Jordan Cove states the purpose of its project is to export natural gas supplies derived from existing interstate natural gas transmission systems (linked to the Rocky Mountain region and Western Canada) to overseas markets, particularly Asia.12 According to Jordan Cove, the project is a market-driven response to increasing natural gas supplies in the U.S. Rocky Mountain and Western Canada production areas, and the growth of international demand, particularly in Asia.

In its application, Pacific Connector states that the purpose of its project is to connect the existing interstate natural gas transmission systems of GTN and Ruby with the proposed Jordan Cove LNG terminal.

1.3 FEDERAL AGENCY ROLES AND RESPONSIBILITIES

NEPA requires all federal agencies to consider the environmental consequences of federal actions or undertakings. The Commission's environmental staff, in partnership with the aforementioned cooperating agencies, has prepared this EIS to comply with the requirements of NEPA. This EIS discloses and assesses the potential environmental effects that are likely to result from the construction and operation of the Project. In addition to complying with NEPA, our purposes for preparing this EIS include:

- identify and assess potential impacts on the human environment that would result from the implementation of the proposed action;
- identify and assess reasonable alternatives to the proposed action that would avoid or minimize adverse impacts on the human environment;
- identify and recommend specific mitigation measures to minimize environmental impacts; and
- facilitate public involvement in identifying significant environmental impacts on specific resources.

The information and analyses presented in this EIS are intended to support subsequent conclusions and decisions made by the Commission and the cooperating agencies. For example, the BLM would use this EIS in its assessments of amendments to the Resource Management Plan (RMP) for the Coos Bay, Roseburg, Medford, and Lakeview Districts, and the Forest Service would use this EIS in its assessments of amendments to the Land and Resource Management Plan (LRMP) for the Umpqua, Rogue River, and Winema National Forests (see figure 1.1-1). In addition, the BLM would use this EIS when considering the issuance of a Right-of-Way (ROW) Grant to Pacific Connector for a pipeline easement over federal lands, with concurrence from the Forest Service and Reclamation (as further discussed below in sections 1.3.2, 1.3.3, and 4.7). The NMFS would

[12] Note that the Commission will consider as part of its decision whether or not to authorize natural gas facilities, all factors bearing on the public interest, including the project's purpose and need. Additional information regarding the Commission's process and considerations in regard to the project's purpose and need are provided in section 1.3.1.

use this EIS when considering the issuance of an authorization pursuant to the Marine Mammal Protection Act of 1972, as amended (MMPA) section 101(a)(5) for the take of marine mammals incidental to the proposed action (as further discussed in section 1.5.1.3).

1.3.1 Federal Energy Regulatory Commission

Sections 3 and 7 of the NGA provide the Commission with the authority to regulate the siting, construction, and operation of onshore LNG terminals, and pipelines engaged in the interstate transportation of natural gas. The Commission would consider the findings in this EIS during its review of Jordan Cove's and Pacific Connector's applications. The identification of environmental impacts related to Project construction and operation, and the mitigation of those impacts, as disclosed in this EIS, would be components of the Commission's decision-making process. The Commission would issue its decision in an Order. The Commission may accept the application in whole or in part, and can attach engineering and environmental conditions to the Order that would be enforceable actions to assure that the proper mitigation measures are implemented.

Specifically, regarding whether to authorize the siting of an LNG terminal under NGA Section 3, the Commission would approve the proposal unless it finds the proposed facilities would not be consistent with the public interest. In considering whether or not to issue a Certificate to a natural gas pipeline under NGA Section 7, the Commission would balance public benefits against potential adverse consequences,13 as documented in the Order. The Commission bases its decision on technical competence, financing, rates, market demand, gas supply, environmental effects, long-term feasibility, and other issues concerning a proposed project.

1.3.2 U.S. Department of the Interior Bureau of Land Management

The Pacific Connector pipeline would cross portions of four BLM Districts: Coos Bay District (of which about 17 miles would be crossed), Roseburg District (crossing about 13 miles), Medford District (crossing about 15 miles), and Lakeview District (Klamath Falls Resource Area; crossing about 1 mile). The BLM anticipates adopting this EIS pursuant to 40 CFR 1506.3(c). The EIS will address potential impacts resulting from the pipeline route crossing BLM land, and potential impacts resulting from BLM District Plan amendment that allow the pipeline.

BLM land use planning requirements were established in Sections 201 and 202 of the Federal Land Policy and Management Act of 1976 (FLPMA, 43 United States Code [U.S.C.] 1711-1712) and the regulations in 43 CFR 1600. These laws and regulations require a unit-specific Land Management Plan (LMP) for each BLM administrative management unit (also known as Resource Management Plan [RMP]). All projects or activities on BLM land must be consistent with the governing RMP.

Representatives of the BLM have worked cooperatively with the FERC staff and Pacific Connector during pipeline route selection over BLM lands and incorporation of best management practices (BMP) to minimize environmental consequences. The BLM has determined that the Pacific Connector Pipeline Project would not be consistent with certain requirements of the RMPs of the

[13] The Commission developed a "Certificate Policy Statement" (see *Certification of New Interstate Natural Gas Pipeline Facilities*, 88 FERC ¶ 61,227 (1999), clarified in 90 FERC ¶ 61,128, and further clarified in 92 ¶ 61,094 (2000)), that established criteria for determining whether there is a need for a proposed project.

BLM Districts crossed. To address these inconsistencies, the BLM proposes to amend the RMPs of the respective BLM Districts to make provision for the Project.

For the BLM, the primary purpose of this EIS is to consider and disclose the environmental consequences of construction and operation of the Pacific Connector pipeline on BLM lands and to evaluate proposed RMP amendments. The need for this EIS arises from the BLM's obligation to respond to the application for a ROW Grant submitted by Pacific Connector. The BLM will utilize this EIS to consider Pacific Connector's ROW application and decide, with concurrence from the Forest Service and Reclamation, to grant, grant with conditions, or deny the Temporary Use Permit and the ROW Grant. The BLM is also using this EIS process to identify specific stipulations (including project design features and mitigation measures) related to resources within its respective jurisdiction for inclusion in the ROW Grant.

The BLM has identified suites of "Project Design Features" or "Project Requirements" that are deemed necessary to accomplish the management objectives and direction in the respective RMPs.14 The project design features or requirements specific to the pipeline crossing of BLM lands are included as attachments to Pacific Connector's Plan of Development (POD). There are 28 attachments to the POD; these include draft monitoring elements as needed to ensure that the wide array of actions are implemented and to assess the effectiveness of the actions relative to the management objectives and direction in the respective RMPs. Collectively, the POD is incorporated into the Project's description.

In the 2015 EIS that evaluated the Pacific Connector Project, the BLM had required a compensatory mitigation plan to offset the unavoidable adverse impacts of the Project. This offsite mitigation plan would have been included in the ROW Grant, had the grant been approved. The BLM issued new policy and agency guidance regarding the imposition of offsite compensatory mitigation on July 24, 2018 in Instruction Memorandum (IM) No. 2018-093. The policy states; "Except where the law specifically requires, the BLM must not require compensatory mitigation from public land users. While the BLM, under limited circumstances, will consider voluntary proposals for compensatory mitigation, the BLM will not accept any monetary payment to mitigate the impacts of a proposed action." The policy does not affect compensatory mitigation required under federal laws other than the FLPMA, or the ability of any state government, or other non-federal party, to require and enforce mandatory compensatory mitigation as authorized under state law. This new policy addresses compensatory mitigation and does not affect the project design features and project requirements that are contained in the POD.

The BLM will continue to coordinate with the applicant on any voluntary compensatory mitigation they may propose, and with other federal and state agencies that identify compensatory mitigation as a matter of law on lands managed by the BLM. Any compensatory mitigation that is developed as a result of this coordination would be attached to the POD and included in the ROW Grant if the grant is approved.

[14] The BLM, Forest Service, and Reclamation use the term "Project Design Features" or "Project Requirements" rather than "mitigation" to describe elements of a plan that occur within a project area and are standard requirements of a project. The BLM and Forest Service reserve the term "mitigation" to describe measures taken to reduce or compensate for otherwise unavoidable impacts. The term "mitigation" as used elsewhere in this EIS refers to the full range of activities designed to reduce adverse effects of the Project.

The BLM Oregon State Director is the authorized officer for decisions related to amendments of the respective BLM RMPs, issuance of the Temporary Use Permit, and issuance of a ROW Grant, if authorized.

1.3.3 U.S. Department of Agriculture Forest Service

The Pacific Connector pipeline route would cross portions of the Umpqua, Rogue River, and Winema National Forests (see figure 1.1-1). As a cooperating agency, the Forest Service anticipates adopting this EIS pursuant to 40 CFR 1506.3(c).

Forest Service land use planning requirements were established by the National Forest Management Act (NFMA) and the regulations in 36 CFR 219. These laws and regulations require a unit-specific LMP for each National Forest (LRMPs). All projects or activities within a National Forest must be consistent with the governing LRMP.

On December 15, 2016, the Department of Agriculture Under Secretary for Natural Resources and Environment issued a final rule that amended the 36 CFR 219 regulations pertaining to National Forest System Land Management Planning (the planning rule) (81 Federal Register [FR] 90723, 90737). The amendment to the 219 planning rule clarified the Department's direction for amending LRMPs. The Department of Agriculture Under Secretary of Natural Resources and Environment also added a requirement for amending a plan for the responsible official to consider "which substantive requirements of §§ 219.8 through 219.11 are likely to be directly related to the amendment" (36 CFR 219.13(b)(2), 81 FR at 90738). Whether a rule provision is directly related to an amendment is determined by any one of the following: the purpose for the amendment, a beneficial effect of the amendment, a substantial adverse effect of the amendment, or a lessening of plan protections by the amendment.

Representatives of the Forest Service have worked cooperatively with the FERC staff and Pacific Connector during pipeline route selection over Forest Service lands and incorporation of BMPs to minimize environmental consequences. The Forest Service has determined that the linear nature of the Pacific Connector Pipeline Project would not be consistent with certain requirements of the LRMPs of the National Forests crossed. To address these inconsistencies, the Forest Service proposes to amend the LRMPs of the respective National Forests to make provision for the Project.

For the Forest Service, the primary purpose of this EIS is to consider and disclose the environmental consequences of construction and operation of the Pacific Connector pipeline on National Forest System (NFS) lands and to evaluate proposed LRMP amendments. The Forest Service will use this EIS to assess which, if any, substantive requirements of the planning rule are likely to be directly related to the amendment. The Forest Service is also using this EIS process to identify specific stipulations (including project design features and mitigation measures) related to resources within their jurisdiction for inclusion in the ROW Grant.

The Forest Service has identified suites of "Project Design Features" or "Project Requirements" that are deemed necessary to accomplish goals and objectives of the respective LRMPs. The project design features or requirements specific to the pipeline crossing Forest Service lands are included as attachments to Pacific Connector's POD. There are 28 attachments to the POD; each of these includes draft monitoring elements to ensure that the wide array of actions are implemented and assess the effectiveness of the actions relative to the goals and objectives of the respective LRMPs. Collectively, the POD is incorporated into the project's description. The

Forest Service would require a Compensatory Mitigation Plan (CMP) be developed for implementation on lands they manage and would require that this CMP be attached to the POD. This CMP would focus on off-site actions such as reallocation of land from the Matrix land allocation to the Late Successional Reserve (LSR) land allocation, placement of large woody debris (LWD), snag creation, stand density/fuels reduction, road resurfacing and decommissioning, culvert replacement, stream crossing repairs, invasive weed control, pre-commercial thinning, fire suppression facilities development, and meadow restoration.

Although these compensatory mitigation actions required by the Forest Service (which are summarized in section 2.1.5 of this EIS and described in appendix F of this EIS) are specific in terms of activity and location, this EIS addresses them in a programmatic fashion. Many of these mitigation actions may require additional analyses and surveys to comply with NEPA and ensure consistency with LRMPs. The Forest Service anticipates that this EIS would provide the basis for tiering subsequent site-specific NEPA analyses, in accordance with the CEQ regulations at 40 CFR 1508.28(b). The Forest Service would conduct any needed supplemental environmental analysis and consultation efforts with various federal, state, and local entities, as well as tribal governments, prior to authorizing future site-specific mitigation actions described in the CMP. Environmental compliance for these mitigation actions could be concurrent with authorized project actions.

The Forest Supervisor for the Umpqua National Forest is the authorized officer for decisions related to amendments of Forest Service LRMPs and issuance of a concurrence letter for a ROW grant to BLM, if warranted.

1.3.4 U.S. Department of the Interior Bureau of Reclamation

The Pacific Connector pipeline route would cross a portion of Reclamation's Klamath Basin Project area (see figure 1.1-1). As a cooperating agency, Reclamation anticipates adopting this EIS pursuant to 40 CFR 1506.3(c). Although Reclamation's Klamath Basin Area is not subject to an LMP, the agency has also worked closely with the FERC staff and Pacific Connector to address issues related to the siting, construction, and operation of the pipeline where it would cross Reclamation lands and facilities that are part of Reclamation's Klamath Irrigation Project. These procedures are outlined in the POD, including Pacific Connector's *Klamath Project Facilities Crossing Plan* (Attachment O of the POD) and its *Winter Construction Plan for the Klamath Basin* (Appendix E.1 attached to Resource Report 1 of Pacific Connector's application to the FERC).

Reclamation and Pacific Connector have not identified specific mitigation projects at this time; therefore, Reclamation may conduct additional environmental compliance activities to meet their responsibilities under NEPA and other federal laws and regulations prior to implementation of any mitigation requirements specific to Reclamation jurisdiction. The Responsible Official for Reclamation regarding issuance of a concurrence letter for a ROW grant to the BLM, if warranted, is the Area Manager of Reclamation's Mid-Pacific Region Klamath Basin Area Office.

1.3.5 U.S. Department of Energy

The DOE's Office of Fossil Energy (DOE/FE) may adopt this EIS to consider the environmental effects associated with its decision whether to authorize the export of LNG, as proposed by Jordan Cove, to countries with which the United States does not have a free trade agreement (FTA) requiring national treatment for trade in natural gas. The purpose and need for the DOE/FE action is to respond to the application filed by Jordan Cove with the DOE/FE to export LNG to non-FTA countries. The DOE/FE must meet its obligations under Section 3 of the NGA, to authorize the import and export of natural gas, including LNG, unless it finds that the proposed import or export would not be consistent with the public interest. The DOE/FE's authority to regulate the export of the natural gas commodity arises from Section 3 of the NGA. By law, under Section 3(c) of the NGA, applications to export natural gas to countries with which the United States has FTAs that require national treatment for trade in natural gas are deemed to be consistent with the public interest and the Secretary of the DOE must grant authorization without modification or delay. In the case of applications to export LNG to non-FTA nations, NGA Section 3(a) requires the DOE/FE to conduct a public interest review and to grant the applications unless the DOE/FE finds that the proposed exports will not be consistent with the public interest. Additionally, DOE/FE must consider the environmental effects of its decisions regarding applications to export natural gas to non-FTA nations.

On September 22, 2011, Jordan Cove filed an application with the DOE/FE seeking authorization to export up to 1.2 Bcf/d of natural gas converted to LNG from its proposed terminal at Coos Bay, Oregon to FTA nations. The DOE/FE issued its *Order Granting Long-Term Multi-Contract Authorization to Export Liquefied Natural Gas by Vessel from the Jordan Cove LNG Terminal to Free Trade Agreement Nations* on December 7, 2011, in DOE/FE Docket No. 11-127-LNG (DOE/FE Order No. 3041).

On March 23, 2012, Jordan Cove filed an application with the DOE/FE, in DOE/FE Docket No. 12-32-LNG, seeking authorization to export LNG to non-FTA nations. The DOE/FE issued its *Order Conditionally Granting Long-Term Multi-Contract Authorization to Export Liquefied Natural Gas by Vessel from the Jordan Cove LNG Terminal in Coos Bay, Oregon to Non-Free Trade Agreement Nations* (DOE/FE Order No. 3413) on March 24, 2014. This Order would allow Jordan Cove to export up to the equivalent of 438 Bcf/year of natural gas, in the form of LNG, for 30 years after either the first shipment or 10 years after the date of the Order. The LNG may be exported to any country with which the United States does not have an FTA, which currently has or in the future could develop the capacity to import LNG, and with whom trade is not prohibited by United States law or policy. The authorization was conditioned on the satisfactory completion of the environmental review process in FERC Docket Nos. CP13-483-000 and CP13-492-000, to comply with NEPA, and on issuance by DOE/FE of findings of no significant impact or a record of decision pursuant to NEPA. Jordan Cove would have to also comply with all preventive and mitigation measures required by federal and state agencies for the Project. Under that conditional authorization, Jordan Cove must also file with the DOE/FE copies of executed long-term contracts for both natural gas supply and the export of LNG.

Jordan Cove submitted an amendment to its FTA application and non-FTA application on February 6, 2018 to reflect the new export capacity of the LNG terminal under the current proposal. The DOE/FE authorized Jordan Cove's amended request for export to FTA countries on July 20, 2018, reflecting a new authorized export volume of approximately 395 Bcf/year over a 30-year term, beginning on the earlier of the date of first export or 10 years from the date of the amended authorization. The DOE/FE is currently reviewing this amendment in regard to exports to non-FTA countries. If export to non-FTA countries is approved, this authorization would be considered a new authorization that supersedes the previous conditional authorization.

Because the Project may involve actions in floodplains, in accordance with 10 CFR Part 1022, *Compliance with Floodplain and Wetland Environmental Review Requirements*, this EIS includes a floodplain assessment. A floodplain statement of findings would be included in any DOE/FE determinations. Section 4.3 of this EIS discusses elements of the Project that may be within floodplains, so that the FERC, as lead federal agency, can document compliance with Executive Order (EO) 11988.[15]

1.3.6 U.S. Army Corps of Engineers

The COE exerts regulatory authorities over waters of the United States pursuant to Sections 9, 10, and 14 (i.e., Section 408) of the Rivers and Harbors Act of 1899 (RHA), Sections 404 of the Clean Water Act (CWA), and Section 103 of the Marine Protection Research and Sanctuaries Act of 1972 (MPRSA). The laws and regulations underpinning the COE's actions are further discussed below in section 1.5 and table 1.5.1-1. The agency's purpose for participating in the development of the EIS is to streamline the COE's review of the applicant's Regulatory and Section 408 application evaluation processes by working with the FERC to eliminate duplication of efforts. The EIS can reduce duplications of efforts in COE permit and permission reviews for the Project by allowing the FERC to be the lead federal agency and fulfill obligations for compliance with a variety of federal environmental laws. The COE may adopt the EIS for the purposes of exercising its regulatory authorities.

Approval from the COE is required for alterations to, or to temporarily or permanently occupy or use, any COE federally authorized civil works project pursuant to Section 408 of the RHA. Proposed alterations must not be injurious to the public interest or affect the COE project's ability to meet its authorized purpose. The Project as currently proposed may affect multiple COE civil works projects including the Coos Bay Federal Navigation Channel or other designated navigation channels (e.g., the Coos River where a proposed HDD would occur), the federal pike structure west of the proposed slip (where a rock apron is currently proposed to minimize impacts to this structure), and a 40-acre multi-use COE real estate easement located partially within the proposed LNG terminal tank site. The COE is currently reviewing the current applicant proposal to determine if these Project-related effects to the civil works projects would constitute an injury to the public interest or affect the COE project's ability to meet its authorized purpose or impair its usefulness.

The COE is currently evaluating a permit application from Jordan Cove and Pacific Connector to conduct work and/or construct structures in navigable waters of the U.S. pursuant to Section 10 of the RHA and to discharge dredged and fill material into waters of the U.S. pursuant to Section 404 of the CWA. The COE's involvement in the EIS process may assist the COE in complying with NEPA, informing the COE's public interest determination, and informing the COE's evaluation of the applicant's proposal pursuant to the CWA 404(b)(1) Guidelines.

1.3.7 U.S. Environmental Protection Agency

The EPA has responsibilities under the Clean Air Act (CAA), CWA, and MPRSA (see section 1.5.1 of this EIS for more details). The EPA shares responsibility for administering and enforcing Section 404 of the CWA with the COE and has authority to veto COE permit decisions.

[15] EO 11988, *Floodplain Management*, requires federal agencies to avoid adverse impacts associated with the occupancy and modification of floodplains, and to avoid floodplain development wherever there is a practicable alternative. The objectives of the EO include the minimization of impacts from floods resulting from agency actions, and the preservation of floodplains where possible. While the FERC, as an independent commission, is not subject to EOs, the other federal permitting agencies must confirm compliance.

In addition, Section 309 of the CAA directs the EPA to review and comment in writing on the environmental effects associated with all major federal actions. This obligation is independent of its role as a cooperating agency under NEPA regulations. Consistent with this direction, the EPA evaluates all federally issued EISs for adequacy in meeting the procedural and public disclosure requirements of NEPA.

1.3.8 U.S. Fish and Wildlife Service and National Marine Fisheries Service Review

The FWS and NMFS are charged with the protection of federally-listed threatened and endangered species as described in the Endangered Species Act (ESA) of 1973, as amended. As requested, the FWS and NMFS will consult with the lead federal agency (i.e., the FERC) for actions that may affect ESA-listed species and/or critical habitats. The FWS and NMFS also have the authority under the Fish and Wildlife Coordination Act of 1934, as amended (FWCA) to review applications for CWA Section 404 and Section 401 permits. The FWS has authority under the Bald and Golden Eagle Protection Act of 1940, as amended (Eagle Act), to protect bald and golden eagles, and to issue permits for actions that would negatively affect eagles or their nests. The FWS also has authority under the Migratory Bird Treaty Act of 1918, as amended (MBTA) to conserve migratory birds; EO 13186 encourages federal agencies to consider conservation actions for birds in the course of their operations, documented in Memoranda of Understanding (MOU). The NMFS has the authority under the Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended (MSA) and MMPA to review a project's effects on essential fish habitats (EFH) and to protect marine mammals, respectively. The process for review and potential subsequent authorizations under each law are described further in section 1.5.1.

1.3.9 U.S. Department of Homeland Security Coast Guard

The Coast Guard serves as a subject matter expert for and providing recommendations on the maritime safety and security aspects of the Project. The Coast Guard does not issue a permit, license, order, or record of decision in this context, but is responsible for assessing the suitability of the waterway and issuing a Letter of Recommendation (LOR).

The Coast Guard exercises regulatory authority over LNG facilities that affect the safety and security of port areas and navigable waterways under EO 10173; the Magnuson Act; the Ports and Waterways Safety Act of 1972, as amended; and the Maritime Transportation Security Act of 2002. The Coast Guard is responsible for matters related to navigation safety, vessel engineering and safety standards, and all matters pertaining to the safety of the facilities or equipment located in or adjacent to navigable waters up to the last valve immediately before the LNG storage tanks. The Coast Guard also has authority for LNG facility security plan review, approval, and compliance verification, and siting as it pertains to the management of vessel traffic in and around the LNG facility. As required by its regulations, the Coast Guard is responsible for issuing an LOR as to the suitability of the waterway for LNG marine traffic.

On June 14, 2005, the Coast Guard issued a Navigation and Vessel Inspection Circular (NVIC), *Guidance on Assessing the Suitability of a Waterway for Liquefied Natural Gas (LNG) Marine Traffic* (NVIC 05-05). The purpose of the NVIC 05-05 is to provide Coast Guard Captains of the Port (COTPs)/Federal Maritime Security Coordinators, members of the LNG industry, and port stakeholders with guidance on assessing the suitability of a waterway for LNG marine traffic that takes into account conventional navigation safety/waterway management issues contemplated by the existing Letter of Intent (LOI)/LOR process. In addition, maritime security implications were also considered. In accordance with this guidance, each LNG project applicant is to submit a Waterway Suitability Assessment (WSA) to the cognizant COTP. On December 22, 2008, the Coast Guard published a second NVIC, *Guidance Related to Waterfront Liquefied Natural Gas (LNG) Facilities* (NVIC 05-08; Coast Guard 2008). The purpose of NVIC 05-08 was to revise the format of the LOR to conform to its intended effect of being a recommendation of the waterway suitability to the FERC. NVIC 05-08 is further discussed in section 4.13. On January 24, 2011, the Coast Guard published a third NVIC: *Guidance Related to Waterfront Liquefied Natural Gas (LNG) Facilities* (NVIC 01-2011). The purpose of NVIC 01-2011 was to revise the format of the LOR to conform to its intended effect of being a recommendation to the FERC as to the suitability of the waterway. In this NVIC, the Coast Guard has added guidance on release of the LOR and message management and provided an updated template for the LOR analysis.

The WSR for the Jordan Cove LNG Project was issued pursuant to NVIC 05-05. The final review and LOR were issued pursuant to NVIC 05-08, which replaced NVIC 05-05. NVIC 05-08 eliminated the term WSR and replaced it with "Letter of Recommendation (LOR) Analysis." For the purpose of clarity, the WSR is equivalent to the LOR Analysis. Section 813 of the Coast Guard Authorization Act of 2010 requires the Coast Guard to consider recommendations made by the States prior to making a recommendation to the FERC on the suitability of the waterway for marine traffic associated with an LNG facility. Although this law was effective after the WSR and LOR were issued, the Oregon Department of Energy (ODE) (as lead State agency) was an active participant in the WSA validation committee and concurred with the verbiage of the WSR and LOR.

On January 13, 2014, Jordan Cove forwarded its most recent annual review of the WSA to the Coast Guard, who responded on February 14, 2014, with the following statement: "we have no objection to your conclusion that the minor changes do not change the risk associated with the waterway or the facility as originally evaluated in your 2007 WSA." On February 27, 2014, the Coast Guard accepted the annual review of the WSA for the Jordan Cove LNG Project. On January 23, 2017, the Coast Guard accepted the Project's existing WSA as it relates to the new proposed project and stated that a new "Follow-On" WSA is not required.[16] On May 10, 2018, a revised LOR was issued, in which the Coast Guard stated that "the Coos Bay Channel be considered suitable for accommodating the type and frequency of LNG marine traffic associated with this project."

1.3.10 U.S. Department of Transportation

The USDOT has prescribed the minimum federal safety standards for LNG facilities in compliance with 49 U.S.C. 60101. Those standards are codified in 49 CFR 193 and apply to the siting, design, construction, operation, maintenance, and security of LNG facilities. The National Fire Protection Association (NFPA) Standard 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (2001 ed.), is incorporated into these requirements by reference, with regulatory preemption in the event of conflict. In accordance with the 2004 Interagency Agreement, the USDOT participates as a cooperating agency on the safety and security review of waterfront import/export LNG facilities. The USDOT does not issue a permit or license but, as a cooperating agency, assists FERC staff in evaluating whether an applicant's proposed siting criteria meets the USDOT requirements in Part 193, Subpart B. On August 31, 2018, the USDOT

[16] The WSA is considered Sensitive Security Information and is therefore not publicly releasable. Public documents related to the Coast Guard's determination can be found in appendix B of this EIS.

and FERC signed a new MOU to improve coordination throughout the LNG permit application process for FERC jurisdictional LNG facilities. Under the 2018 MOU, the USDOT will issue a Letter of Determination (LOD), determining whether a proposed LNG facility will be capable of complying with Part 193, Subpart B, Siting (see section 4.13 of this EIS). The LOD is provided to the Commission for consideration in its decision on the Project application. The USDOT also has the authority to enforce safety regulations and standards related to the design, construction and operation of natural gas pipelines, under the Natural Gas Pipeline Safety Act. The USDOT would also monitor the construction and operation of the natural gas facilities to determine compliance with its design and safety standards.

1.3.11 Federal Aviation Administration (FAA)

The FAA is a federal agency under the USDOT, which has the authority to regulate all aspects of civil aviation. The FAA is responsible for enforcing the elements of 14 CFR 77 (i.e., Objects Affecting Navigable Airspace), which would include an assessment of whether the proposed project could represent a hazard to aircraft at the Southwest Oregon Regional Airport.

1.4 PUBLIC REVIEW AND COMMENTS

On January 23, 2017 Jordan Cove and Pacific Connector filed a request to implement the Commission's Pre-filing Process for the Jordan Cove liquefaction and LNG export proposal, and the associated Pacific Connector supply pipeline. The FERC established the Pre-filing Process to encourage early involvement of interested stakeholders, facilitate interagency cooperation, and identify and resolve environmental issues before an application is filed with the FERC and facility locations are formally proposed. The FERC granted this request to use the Pre-filing Process on February 10, 2017 and established pre-filing Docket Nos. PF17-4-000 for the Projects.

Prior to and during the Pre-filing Process, Jordan Cove and Pacific Connector (Applicants) contacted federal, state, and local agencies to inform them about their respective projects and discuss project-specific issues and concerns. The applicants initiated contact with potentially affected landowners prior to entering the FERC Pre-filing Process. These initial contacts were in the form of a letter describing each applicant's project and seeking permission to conduct environmental and cultural resource surveys on landowner property. Jordan Cove held an Open House meeting in North Bend on March 21, 2017. Pacific Connector held additional Open House meetings in Canyonville, Medford, and Klamath Falls during the week of March 22, 2017. These Open House meetings were advertised to the public through notices published in local newspapers. The FERC staff attended these Open House meetings and were available to answer questions from the public regarding the FERC and NEPA process.

On June 9, 2017, the FERC issued a *Notice of Intent to Prepare an Environmental Impact Statement for the Planned Jordan Cove LNG Terminal and Pacific Connector Pipeline Projects, Request for Comments on Environmental Issues, and Notice of Public Scoping Sessions* (Notice of Intent, or NOI). The NOI was sent to affected landowners; federal, state, and local government agencies; elected officials; environmental and public interest groups; interested Indian tribes; and local libraries and newspapers. The NOI described the Project; listed currently identified environmental issues; outlined the proposed actions of the DOE, BLM, and Forest Service; discussed the scoping and environmental review process; announced the date, location, and time of four public scoping meetings; and explained how the public could participate and comment.

During the week of June 27, 2017, the FERC, BLM, and Forest Service held joint public scoping sessions in Coos Bay, Roseburg, and Klamath Falls to receive comments about the Project, which were recorded by a court reporter.[17]

Throughout the Pre-filing Review Process, we received comments on a wide variety of environmental issues. Between February 10, 2017 (when pre-filing was initiated) and July 10, 2017 (i.e., the end of the announced scoping period), we received more than 5,100 comments. These comments were provided via 1,174 discrete comment letters/documents; this included 1,028 letters from individuals, 55 letters from non-governmental organizations, 1 letter from a federal agency, 16 letters from state and local agencies, 64 letters from private companies, 2 letters from members of the U.S. Congress, and 8 letters from federally recognized Tribes. We also received 462 form letters during this time. In addition, between July 10, 2017, and issuance of this EIS, the FERC received more than 3,700 additional comments contained within over 700 discrete documents, and an additional 14 form letters. All comments received prior to the writing of this EIS were considered. The analysis in this EIS addresses all relevant environmental topics raised during scoping.

Table 1.4-1 categorizes the relevant environmental issues raised in letters to the FERC and considered in this EIS. The table does not account for the out-of-scope issues (as discussed below) and general environmental concerns or non-specific comments. The most frequently expressed comments concerned property rights, land use, purpose and need, safety and security; potential geological/topographical hazards, and the FERC's approach to the NEPA process (e.g., length of scoping periods, number of public meetings, etc.).

TABLE 1.4-1

Environmental Issues Identified During the Pre-filing Public Scoping Process for the Jordan Cove and Pacific Connector Projects

Specific Issue/Comment	EIS Section Where Comments are Addressed
Purpose and Need, and FERC Process/NEPA Process/State Process .	1.0
Comments about scoping period and meeting locations.	
Project Description	**2.0**
Life of Project, decommissioning	
Concerns over temporary work areas (TEWAs), uncleared storage areas	
BLM, Forest Service, and FERC process	
Alternatives	**3.0**
Comments urging that investments be redirected towards renewable, domestic energy sources such as wind, solar and wave power.	
Request rigorous analysis of pipeline route alternatives (evaluate more than action/no-action)	
Geologic Hazards	**4.1**
Regional seismic activity (earthquake and/or tsunami) on the export terminal or pipeline.	
Soils and Minerals	**4.2**
Concerns over erosion of sensitive soils.	
Sedimentation of streams as a result of soil disruption	
Soil and slope stability along the pipeline route.	

[17] Transcripts of all of the public scoping meetings for this Project were placed into the FERC public record for the proceedings.

TABLE 1.4-1 (continued)

Environmental Issues Identified During the Pre-filing Public Scoping Process for the Jordan Cove and Pacific Connector Projects

Specific Issue/Comment	EIS Section Where Comments are Addressed
Water Resources	**4.3**
Effects of construction and operation of the project elements, including export terminal facilities and pipeline crossings, on surface water and groundwater, including drinking water and salmon spawning habitat, and especially that of the Rogue River.	
Concerns over horizontal directional drilling under streams and rivers along the pipeline route.	
Concerns over hydrostatic testing of the pipeline.	
Wetlands and Riparian Areas	**4.3**
Effects on sensitive wetlands in the vicinity of the export terminal and pipeline.	
Biological Resources	**4.4, 4.5, and 4.6**
Effects on threatened and endangered species.	
Effects on fisheries and EFH.	
Effects on wildlife habitat, including connectivity.	
Effects on pipeline construction on forestlands, including sensitive forest types.	
Introduction and propagation of noxious weeds in the pipeline ROW.	
Land Use and Recreation	**4.7 and 4.8**
Location of access roads, hydrostatic test locations, uncleared storage areas, cleared areas.	
Effects on recreational opportunities, recreation-based tourism.	
Comments supporting and opposing the use of federal lands for the pipeline corridor.	
Comments making specific pipeline alignment adjustments (generally to avoid private properties, also to avoid resources.	
Concerns over BLM and Forest Service LMP revisions.	
BLM and Forest Service Plan Revisions, and associated mitigation/restoration requirements	
Visual Resources	**4.8**
Concerns over specific views, typically from private properties.	
Socioeconomics	**4.9**
Opposition to use of eminent domain to acquire pipeline easements, especially when some land uses would not be allowed or practicable once the pipeline is installed.	
Comments supporting and opposing the creation of local jobs; reconcile with environmental effects and safety risks involved.	
Effects on the local economy, including anticipated drop in tourism (fishing, birding).	
Concerns over application of eminent domain.	
Concerns over decreased property values.	
Transportation	**4.10**
Effects and risks of proximity to the Southwest Oregon Regional Airport.	
Cultural Resources	**4.11**
Effects on tribal lands and lands traditionally used by tribal members, especially fishing.	
Request outreach to the tribes.	
Air Quality and Noise	**4.12**
Effects on climate change.	
Concerns over operations emissions of the LNG carriers and terminal on local communities (respiratory health).	
Safety and Security/Public Health/Monitoring and Accountability/Siting	**4.13**
Risk of catastrophic events, either accidental, intentional (terrorism) or as a result of a natural disaster on the export terminal, LNG carriers or the pipeline.	

TABLE 1.4-1 (continued) **Environmental Issues Identified During the Pre-filing Public Scoping Process for the Jordan Cove and Pacific Connector Projects**	
Specific Issue/Comment	**EIS Section Where Comments are Addressed**
Availability and readiness of emergency response personnel in the event of a catastrophic incident, especially in remote areas.	
Concerns over the health effects of spilled or leaked gas on nearby communities.	
Emergency response planning (tsunami, earthquake).	
Concerns over pipeline weakness, potential for leak or explosion leading to wildfire.	
Concerns over rural pipeline safety, including non-odorized gas and construction standards.	
Monitoring and mitigation; accountability and responsibility.	
Cumulative Impacts	**4.14**
Effects of increased marine traffic.	
Effects from other energy projects.	

The BLM and Forest Service also reviewed the results of scoping to identify any concerns specific to their proposed plan amendments and mitigation actions. Comments were received that addressed concerns about the Forest Service planning regulations that govern amending LRMPs as well as the need for further detail on proposed BLM plan amendments. Comments were also received that identified concerns regarding the proposed mitigation actions of the BLM and Forest Service and the need for additional alternatives that would avoid impacts to areas such as LSRs and riparian areas. These issues are addressed in more detail in a scoping report prepared by the BLM and Forest Service in appendix F.8 (Federal Lands Review) of this EIS.

Numerous citizens and organizations raised issues that are outside the scope of this EIS. Examples of out-of-scope issues include comments regarding the public benefit or need to export LNG; horizontal hydraulic drilling through shale formations during exploration for natural gas (often referred to as "fracking"); induced production of natural gas; "life-cycle" cumulative environmental impacts associated with the entire LNG export process; downstream greenhouse gas emissions resulting from the combustion of exported gas; the concept of a "programmatic" EIS to cover LNG export terminals throughout the United States; and administrative information technology system operations at the FERC. These issues are not addressed in this EIS.

1.5 PERMITS, APPROVALS, AND CONSULTATIONS

1.5.1 Federal Environmental Laws, Regulations, Permits, Approvals, and Consultations

In addition to the NGA, EPAct, and NEPA, the FERC and cooperating agencies are required to comply with other federal laws and regulations that involve consideration of the Project's potential effect on a range of environmental resources (see table 1.5.1-1). This includes, but is not limited to, compliance with the CAA, CWA, Coastal Zone Management Act (CZMA), ESA, MSA, MMPA, MBTA, and the National Historic Preservation Act (NHPA).

As the lead federal agency for the Project, the FERC has taken on the lead role for consultation under these statutes for itself and in collaboration with the cooperating agencies. The BLM will make its determinations in accordance with the FLPMA, NFMA, and Mineral Leasing Act (MLA), as it relates to the Pacific Connector's ROW Grant application to cross federal lands, with concurrence necessary from the Forest Service and Reclamation (see section 1.3). Some federal permits or approvals, such as Section 401 of the CWA, the CAA, and the CZMA, have been delegated to state agencies, as discussed below.

In accordance with Section 313(d) of the EPAct, the FERC is required to keep a complete consolidated record of all actions or decisions made by agencies undertaking federal authorizations. On October 19, 2006, in Order No. 687, the FERC issued implementing regulations regarding the maintenance of a consolidated record.

Table 1.5.1-1 lists the major federal, state, and local permits, approvals, and consultations identified for the Project.

TABLE 1.5.1-1

Major Permits, Approvals, and Consultations for the Jordan Cove & Pacific Connector Project

Agency	Authority/Regulation/ Permit	Agency Action	Initiation of Consultations and Permit Status
FEDERAL			
FERC	Sections 3 and 7 of the NGA Section 311 of the EPAct	Order Granting Section 3 Authorization and Issuing Certificate of Public Convenience and Necessity.	Jordan Cove and Pacific Connector filed applications with the FERC on September 21, 2017. In September 2017, Pacific Connector filed an application with the FERC under Section 7 of the NGA. The FERC's decision is pending.
Forest Service	MLA	Concur with ROW Grant.	Pending. The Forest Service letter on concurrence of the ROW grant is pending until after issuance of the FEIS and preparation of a Record of Decision (ROD).
	36 CFR 219 Subpart B 36 CFR 218 Subpart A and B	Amend Land and Resource Management Plans (LRMP).	Pending. The Forest Service proposed decision(s) on plan level amendments of LRMPs are subject to Administrative Review Regulations at 36 CFR 219 Subpart B. Decisions by the Forest Service to approve project-specific plan amendments are subject to the Administrative Review Process of 36 CFR 218 Subpart A and B. A final decision will follow consideration and resolution of any administrative reviews.
BLM	Section 28 of MLA	Issue ROW Grant for crossing federal lands.	Pending. The BLM decision on the ROW grant will follow BLM and Forest Service decisions on LRMP amendments and receipt of Letters of Concurrence from the Forest Service and Reclamation.

TABLE 1.5.1-1 (continued)

Major Permits, Approvals, and Consultations for the Jordan Cove & Pacific Connector Project

Agency	**Authority/Regulation/ Permit**	**Agency Action**	**Initiation of Consultations and Permit Status**
	Federal Land Policy and Management Act of 1976, as amended	Resource Management Plan (RMP) Amendments.	Pending. BLM's proposed decision(s) on amendments of RMPs are subject to Protest following completion of the FEIS. A final decision will follow consideration and resolution of any Protests.
Bureau of Reclamation	MLA	Concur with issuance of the ROW Grant	Pending.
DOE	Section 3 of the NGA	Long-Term authority to export LNG to Free Trade Agreement (FTA) Nations	FTA authorization granted December 7, 2011 (DOE/FE Order No. 3041). DOE authorized amendment to FTA authorization on July 20, 2018 (DOE/FE Order No. 3041-A).
	Section 3 of the NGA	Long-Term conditional authority to export LNG to Non-FTA Nations.	Conditional non-FTA authorization issued on March 24, 2014; subject to satisfactory completion of NEPA review and related conditions. DOE is currently reviewing the amendment request with respect to the non-FTA application.
COE	Section 10 and 408 of the RHA	Process permit applications for structures or work in or affecting navigable waters of the United States. Approval of requests to alter COE civil works projects.	Pending. The applicants requested COE initiate the project's review per the RHA and have submitted both regulatory and Section 408 applications to the COE. The applicants are continuing to work with the COE to provide supplemental information regarding the RHA review.
	Section 404 of the CWA	Process permit application for the discharge of dredged or fill material into waters of the United States.	Pending. The applicants requested the COE initiate the Project's review per the CWA and have submitted a regulatory application to the COE. The applicants are continuing to work with the COE to provide supplemental information regarding the CWA review
EPA	Section 404 of the CWA	Co-administers CWA 404 program with the COE. EPA retains veto authority for wetland permits issued by the COE.	Pending.
	Section 309 of the CAA	Reviews and evaluates EIS for adequacy in meeting the procedural and public disclosure requirements of NEPA.	Pending.
FWS	Section 7 of the ESA		Pending. The FERC is preparing a biological assessment (BA) that will be submitted to the FWS and NMFS.
	FWCA	Provide comments to prevent loss of and damage to wildlife resources.	Pending. FWS generally addresses FWCA issues via comments on the FERC NEPA and COE 404 permit processes.

TABLE 1.5.1-1 (continued)

Major Permits, Approvals, and Consultations for the Jordan Cove & Pacific Connector Project

Agency	Authority/Regulation/ Permit	Agency Action	Initiation of Consultations and Permit Status
	MBTA Executive Order 13186	Consultation regarding compliance with the MBTA.	Pending. The applicants are currently consulting with the FWS regarding the projects requirements under the MBTA.
	Eagle Act	Coordination regarding compliance with the Eagle Act	Pending. The applicants will consult with the FWS regarding the project's requirements under the Eagle Act. Jordan Cove and Pacific Connector would apply for an Eagle Act permit if needed.
NMFS	Section 7 of the ESA	Provide a BO if the Project is likely to adversely affect federally listed threatened or endangered aquatic species or their habitat.	Pending. The FERC is preparing a BA that will be submitted to the FWS and NMFS.
	MMPA	Authorize, upon request, take of marine mammals incidental to otherwise lawful activities, subject to mitigation monitoring and reporting requirements.	Pending. The applicants have indicated that a MMPA Incidental Take Authorization (ITA) request will be filed with the NMFS.
	MSA	Provide conservation recommendations if the Project would adversely impact EFH.	Pending. EFH will be addressed in the FERC BA.
Coast Guard	Ports and Waterway Safety Act	Captain of the Port (COTP) issues a Letter of Recommendation (LOR) recommending the suitability of the waterway for LNG marine traffic.	Jordan Cove submitted LOI on January 9, 2017. Coast Guard issued LOR on May 10, 2018.
		Review Emergency Manual.	Pending. Must be completed prior to receiving first LNG carrier.
		Review Operations Manual.	Pending. Must be completed prior to receiving first LNG carrier.
		Establish safety and security zones for LNG vessels in transit and while docked.	Pending.
	Maritime Transportation Security Act	Review and Approve Facility Security Plan.	Pending. Must be completed 60 days prior to receiving first LNG carrier at the facility
	Navigation and Vessel Inspection Circular – Guidance related to Waterfront LNG Facilities	Develop LNG Vessel Transit Management Plan.	Pending. Must be completed prior to receiving first LNG carrier.
		Validate WSA and produce LOR and LOR Analysis.	Issued LOR and LOR Analysis on May 10, 2018.
USDOT; PHMSA	Natural Gas Pipeline Safety Act	Administer national regulatory program to ensure the safe transportation of natural gas and issue LOD on the project's compliance with the siting requirements of 49 CFR 193.	Pending. Applicants met with PHMSA in November 2017 to review their technical design package. In June 2018, PHSMA determined that the Project's design spill determination methodology meets the requirements of 49 CFR 193. LOD is pending. Anticipated prior to FEIS.

TABLE 1.5.1-1 (continued)

Major Permits, Approvals, and Consultations for the Jordan Cove & Pacific Connector Project

Agency	Authority/Regulation/ Permit	Agency Action	Initiation of Consultations and Permit Status
U.S. Department of Defense (DOD)	Section 311(f) of the EPAct and Section 3 of the NGA Memorandum of Understanding (MOU) between the FERC and DOD	Consult with the Secretary of Defense to determine whether an LNG facility would affect the training or activities of an active military installation.	In November 2012, the DOD indicated that the previously proposed project would have minimal impacts on military operations in the area. In December 2017, the DOD indicated that because it had previously reviewed the last proposal, it has “no issues” concerning the current Project.
DOE, Bonneville Power Administration (BPA)	Land Use Agreement for electric transmission line crossings	Permit review.	Pending.
USDOT, FAA	18 CFR Subchapter E Federal Aviation Regulations (FAR) Part 77 IAW FAA Order 7400.2G, 6-1-6	Aeronautical Study of Objects Affecting Navigable Airspace. Feasibility Study for Hazard Determination.	Pending. The FAA has issues a Notice of Presumed Hazard. Jordan Cove is currently consulting with the FAA regarding the potential for aeronautical operations to be impacted by the LNG terminal.
ACHP	Section 106 of the NHPA	Opportunity to comment on the undertaking.	Pending.
Federal Communication Commission	License for fixed microwave stations and service	Review proposals for new or additions to existing communication towers.	Pending.
U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)	Farmland Protection Policy Act	Determine if the Project would result in the permanent conversion of prime farmland.	Pending.
U.S. Department of the Treasury, Bureau of Alcohol, Tobacco, and Firearms	Explosives User Permit	Issue permit to purchase, store, and use explosives during project construction.	Pending. Permits to be obtained by Jordan Cove and Pacific Connector, as necessary, before construction.
STATE – OREGON			
Oregon Department of Geology and Mineral Industries (DOGAMI)	Building Code Section 1802.1 Oregon Revised Statute (ORS) 455.446	Review of structural designs in tsunami zones. Review of geotechnical investigations for geological hazards.	Pending.
Oregon Department of Agriculture (ODA)	Oregon Endangered Species Act Oregon Senate Bill 533 and ORS 564	Consult on Oregon listed plant species, and ODA would review botanical survey reports covering non-federal public lands prior to ground-disturbing activities where state listed botanical species are likely to occur.	Pending.
Oregon Department of Consumer and Business Services – Building Code Division	ORS 455.446	Site-specific exemption approval under the state building code,	Pending.

TABLE 1.5.1-1 (continued)

Major Permits, Approvals, and Consultations for the Jordan Cove & Pacific Connector Project

Agency	**Authority/Regulation/ Permit**	**Agency Action**	**Initiation of Consultations and Permit Status**
ODE	State Authorities under Section 311 of the EPAct	Furnish an advisory report on state safety and security issues to the FERC regarding the Jordan Cove LNG terminal proposal and conduct operational safety inspections if the facility is approved and built.	Pending.
Oregon Department of Environmental Quality (ODEQ)	Water Quality Certification Section 401 of the CWA	Issue a license or permit to achieve compliance with state water quality standards.	Applicants submitted their CWA Section 401 application package to the ODEQ on April 6, 2018. On September 25, 2018, the applicants requested that the 401 application be withdrawn and resubmitted to allow ODEQ additional time to consider the request. Processing of the permit is pending.
	Section 402 of CWA	Issue National Pollutant Discharge Elimination System (NPDES) permits for discharge of stormwater.	NPDES permit for storm water issued in July 2015 and expires in June 2020
	Ballast Water Management	Review liabilities and offences connected to shipping and navigation.	Pending.
	CAA – Title V	Issue Title V Air Quality Operating permit. Issue Title V Acid Rain permit. Enforce Greenhouse Gas (GHG) Reporting Requirements.	Permit application to be filed by Pacific Connector one year after beginning operations of the Klamath Compressor Station.
	Prevention of Significant Deterioration CAA	Review Best Available Control Technologies to minimize discharges from new major sources, and review air quality analyses to ensure compliance with National Ambient Air Quality Standards.	Pending.
	Hazardous Waste Activity ORS 466 Oregon Administrative Rule (OAR) 340-102	Review plans for storage and management of hazardous waste	Pending.
Oregon Department of Fish and Wildlife (ODFW)	Fish and Wildlife Coordination Act and the Oregon Endangered Species Act under ORS 496, 506, and 509 OAR 635	Consult on sensitive species and habitats that may be affected by the Project and, in general, regarding conservation of fish and wildlife resources.	Pending.
	Fish and Wildlife OAR 345-22 & 60	Consult on and approve fish and wildlife mitigation plan.	Pending.
	Oregon Fish Passage Law ORS 509.-585 OAR 635-412-5 to 40	Review stream crossing plans for consistency with Oregon Fish Passage Law and screening criteria.	Pending.
	In-Water Blasting ORS 509-140, et al. OAR 635-425 to 50	Consider issuance of in-water blasting permits.	Pending.

TABLE 1.5.1-1 (continued)

Major Permits, Approvals, and Consultations for the Jordan Cove & Pacific Connector Project

Agency	Authority/Regulation/ Permit	Agency Action	Initiation of Consultations and Permit Status
Oregon Department of Forestry (ODF)	Easement on State lands Oregon Forest Practices Act OAR 629 ORS 477 ORS 527	Management of State Forest lands for Greatest Permanent Value, develops Forest Management Plans, stewardship under State's Land Management Classification System, monitors harvests of timber on private lands, and protects non-federal public and private lands from wildfires.	Pending.
Oregon Department of Land Conservation and Development (ODLCD)	CZMA 15 CFR Part 930 ORS 196.435	Determine consistency with CZMA program policies.	Pending.
Oregon Department of Transportation (ODOT)	Section 303(c) DOT Act 49 CFR 303 OAR 734-030(4) OAR 734-051-4020	Review and approve traffic management plans	Pending. A draft traffic impact analysis was provided to ODOT, Coos County, and City of North Bend on December 4, 2017 by the applicants. ODOT and North Bend provided comments on December 21, 2017. The applicants continue to work with ODOT.
	State Highway ROW ORS 374-305 OAR 734- 55	Permits to be issued from each ODOT District Office to allow construction within State Highway ROW and use of State Highways for Project access, and where utilities would cross over, under, or run parallel to ODOT ROWs.	Pending. Applications for ODOT Approach and Utility Permits to be submitted with enough advance notice (which could be up to 12 months or more depending on individual District requirements) prior to construction activities to ensure adequate time to review the specific proposals.
Oregon Department of State Lands (ODSL)	Submerged and Submersible Land Easement OAR 141-122	Grant submerged land easements.	Pending.
	Lease and Registrations OAR 141-082	Issue wharf registrations	Pending.
	Sand and Gravel Lease/License OAR 141-014	Issue licenses or leases for removal of state-owned materials.	Pending.
	Joint Removal-Fill Law ORS 196-795-990 OAR 141-85	Approve removal or fill of material in waters of the state.	Pending.
	Special Use Permits OSAR 141-125	Allow work within state-owned lands	Pending.
	Compensatory Wetland Mitigation Rules OAR 141-85-121	Review and approve wetland mitigation plans.	Pending.
Oregon Water Resources Department (OWRD)	New Water Rights ORS 537 OAR 690-310	Issue permits to appropriate surface water and groundwater.	Pending.
	Temporary Water Use ORS 537 OAR 690-340	Issue limited licenses for temporary use of surface waters.	Pending.

TABLE 1.5.1-1 (continued)

Major Permits, Approvals, and Consultations for the Jordan Cove & Pacific Connector Project

Agency	Authority/Regulation/ Permit	Agency Action	Initiation of Consultations and Permit Status
Oregon Public Utilities Commission (OPUC)	OAR 860-031	Authorize intrastate electric transmission lines. Inspect the natural gas facilities for safety.	Pending Pacific Connector's submittal of appropriate applications to OPUC.
State Historic Preservation Office (SHPO)	Section 106 of the NHPA 36 CFR 800 ORS 338-920	Review cultural resources reports and comments on recommendations for National Register of Historic Places eligibility and project effects. Issue permits for excavation of archaeological sites on non-federal lands.	Pending. SHPO wrote letters to the FERC on June 21, 2017, January 18 and September 24, 2018, commenting on reports submitted by the applicants.
LOCAL – COUNTIES and CITIES			
Various County Permits	Coos County Zoning and Land Development Ordinance, Coos County Comprehensive Plan, and Coos Bay Estuary Management Plan (CBEMP) Douglas County Comprehensive Plan and Douglas County Land Use and Development Ordinance Jackson County Comprehensive Plan and Jackson County Land Development Ordinance Jackson County Comprehensive Plan and Jackson County Land Development Ordinance Klamath County Land Development Code Various Road Crossing; Grading; and Solid Waste Disposal North Bend Comprehensive Plan North Bend City Code	Issue Conditional Use Permits. Zoning Changes and Verifications. Issue Land Use Compatibility Statement under Statewide Planning Goals.	Pending.

1.5.1.1 Endangered Species Act

Section 7 of the ESA, as amended, states that "Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act," and any project authorized, funded, or conducted by a federal agency should not "jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined...to be critical". The lead federal agency, or the applicant as a non-federal party, is required to consult with the FWS and the NMFS to determine whether any federally listed or proposed endangered or threatened species or their designated critical habitat occur in the vicinity of the Project. If, upon review of existing data, or data provided by the applicant, one (or both) of the Services find that any federally listed species or critical habitats may be affected by the Project, the FERC is required to prepare a biological assessment (BA) to identify the nature and extent of adverse effects, and to recommend measures that would avoid, reduce, or mitigate effects on habitats and/or species. The FERC's request for consultation with the BA begins the consultation process. The consultation process concludes with the issuance of a biological opinion(s) as to whether or not the proposed action may result in jeopardy to the species or adverse modification to critical habitat. If the determination is no jeopardy/adverse modification, an incidental take statement is included when needed. An incidental take statement would contain reasonable and prudent measures necessary or appropriate to minimize the proposed action's impact and terms and conditions that must be complied with by the federal agency(s) and applicants. See section 4.6 of this EIS, as well as the pending BA, for further information regarding the Project's effects on federally listed species and protected habitats.

1.5.1.2 Magnuson-Stevens Fishery Conservation and Management Act

The MSA, as amended by the Sustainable Fisheries Act of 1996, established procedures designed to identify, conserve, and enhance EFH for those species regulated under a federal fisheries management plan. The MSA requires federal agencies to consult with the NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. Although absolute criteria have not been established for conducting EFH consultations, the NMFS recommends consolidated EFH consultations with interagency coordination procedures required by other statutes, such as NEPA, the Fish and Wildlife Coordination Act, or the ESA to reduce duplication and improve efficiency.

See sections 4.5 and 4.6 of this EIS for further information regarding the Project's effects on EFH.

1.5.1.3 Marine Mammal Protection Act

All marine mammals are protected under the MMPA. This act was amended by the U.S. Congress in 1994. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.) direct the Secretary of Commerce (as delegated to the NMFS) to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings are made and either regulations are issued or, if the taking is limited to harassment, a notice of a proposed authorization is provided to the public for review (note that the FWS has jurisdiction over some species of marine mammals, but none within Oregon).

An authorization for incidental takings shall be granted if the NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. The NMFS has defined "negligible impact" in 50 CFR 216.103 as an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival.

The MMPA states that the term "take" means to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as: any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild (Level A harassment); or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B harassment).

The NMFS may use relevant portions of this EIS during its review and may adopt measures to protect marine mammals outlined in this EIS. It may also require additional mitigation, monitoring, and reporting measures to ensure that the taking results in the least practicable adverse impact on affected marine mammal species or stocks. The public would have an opportunity to comment to the NMFS in response to its publication of a notice of proposed Incidental Take Authorization (ITA), or in response to its publication of a notice of proposed rule.

See sections 4.5 and 4.6 of this EIS for further information regarding the Project's effects on marine mammals.

1.5.1.4 National Historic Preservation Act

Section 101(d)(6) of the NHPA states that properties of traditional religious and cultural importance to Indian tribes[18] may be determined eligible for the National Register of Historic Places (NRHP). In carrying out our responsibilities under Section 106 of the NHPA, the FERC consulted on a government-to-government basis with Indian tribes that may attach religious and cultural importance to properties in the area of potential effect (APE), in accordance with the implementing regulations at 36 CFR 800.2(c)(2)(ii). Those consultations with tribes are detailed in section 4.11.1.2 of this EIS. The BLM and Forest Service are proposing to amend their respective LMPs to make provision for the pipeline, Reclamation must concur with the BLM ROW Grant to allow the pipeline to cross lands and facilities related to the Klamath Project, and the COE is considering issuing permits under the RHA and CWA, and these other federal agencies may consult separately, under their responsibilities, with affected Indian tribes on those actions.

Section 106 of the NHPA requires that federal agencies take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment. Historic properties include prehistoric or historic sites, districts, buildings, structures, objects, landscapes, or properties of traditional religious or cultural importance listed on or eligible for listing on the National Register of Historic Places (NRHP). Jordan Cove and Pacific Connector, as non-federal parties, can provide cultural resources data, analyses, and recommendations to the FERC, as allowed by the regulations for implementing Section 106. However, the FERC remains responsible for all findings and determinations.

The FERC is responsible under Section 106 and its implementing regulations, to consult with the Oregon State Historic Preservation Office (SHPO), identify historic properties within the APE, and make determinations of NRHP eligibility and project effects, on behalf of all the federal

[18] Indian tribes are defined in 36 CFR 800.16(m) as: "an Indian tribe, band, nation, or other organized group or community, including a Native village, Regional Corporation, or Village Corporation, as those terms are defined in Section 3 of the Alaska Native Claims Settlement Act (43 U.S.C. 1602), which is recognized as eligible for the special programs and services provided by the United States to Indians because of their special status as Indians."

cooperating agencies. Section 4.11 of this EIS summarizes the status of our compliance with the NHPA.

1.5.1.5 Rivers and Harbors Act

Section 10 of the RHA prohibits the unauthorized obstruction or alteration of any navigable water of the United States. This section provides that the construction of any structure in or over any navigable water of the United States, or the accomplishment of any other work affecting the course, location, condition, or physical capacity of such waters is unlawful unless the work has been authorized by the COE.

1.5.1.6 Clean Water Act

The CWA establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Section 404 of the CWA outlines procedures by which the COE can issue permits (after notice and opportunity for public hearings) for the discharge of dredged or fill material into waters of the United States at specified disposal sites.[19] The EPA has the authority to review and veto COE decisions on Section 404 permits. The FWS and NMFS use their Fish and Wildlife Coordination Act authorities to review and comment during the 404 permitting process. The authority to issue Water Quality Certifications pursuant to Section 401 of the CWA and National Pollutant Discharge Elimination System (NPDES) permits pursuant to Section 402 of the CWA has been delegated to the ODEQ (see section 1.5.2.4).

See section 4.3 of this EIS for further information regarding water quality issues.

1.5.1.7 Clean Air Act

The primary objective of the CAA as amended, is to establish federal standards for various pollutants from both stationary and mobile sources, and to provide for the regulation of polluting emissions via state implementation plans. In addition, the CAA was established to prevent significant deterioration in certain areas where air pollutants exceed national standards and to provide for improved air quality in areas that do not meet federal standards (non-attainment areas).

The EPA has regulatory authority under the CAA. Section 309 of the CAA directs the EPA to review and comment in writing on environmental effects associated with all major federal actions. The EPA has delegated permitting authority under the CAA to the ODEQ. Emissions from all phases of construction and operation of the proposed LNG terminal and pipeline would be subject to applicable federal and state air regulations.

See section 4.12.1 of this EIS for further information regarding air quality issues.

[19] For activities involving CWA Section 404 discharges, a permit will be denied by the COE if the associated discharge does not comply with the EPA's 404(b) (1) Guidelines. The Guidelines are binding regulations and provide substantive environmental standards by which all Section 404 permit applications are evaluated. The Guidelines specifically require that "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse effects." The burden of proving no practicable alternative exists is the sole responsibility of the applicant.

1.5.1.8 Coastal Zone Management Act

In 1972, Congress passed the CZMA to "preserve, protect, develop, and where possible, to restore or enhance, the resources of the nation's coastal zone for this and succeeding generations" and to "encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve wise use of the land and water resources of the coastal zone".

Section 307 (c)(3)(A) of the CZMA states that "any applicant for a required federal license or permit to conduct an activity, in or outside the coastal zone, affecting any land or water use or natural resource of the coastal zone of that state shall provide a certification that the proposed activity complies with the enforceable policies of the state's approved program and that such activity will be conducted in a manner consistent with the program." In order to participate in the coastal zone management program, a state is required to prepare a program management plan for approval by the NOAA Office of Coast and Ocean Resource Management (OCRM). Once the OCRM has approved a plan and its enforceable program policies, a state program gains "federal consistency" jurisdiction. This means that any action requiring a federally issued licenses or permits that takes place within a state's coastal zone must be found to be consistent with state coastal policies before the action authorized by the federal license or permit can occur.

All components of the Project from MP 0.0 to approximately MP 53.2 are within the designated Oregon coastal zone and are subject to federal CZMA review. The ODLCD is the state's designated coastal management agency and has established the Oregon Coastal Management Program (OCMP). The program's mission is to work in partnership with coastal local governments, state and federal agencies, and other stakeholders to ensure that Oregon's coastal and ocean resources are managed, conserved, and developed consistent with statewide planning goals. To accomplish this mission, the program combines various state statutes for managing coastal lands and waters into a single, coordinated package. These include: (1) the 19 Statewide Planning Goals, which are Oregon's standards for comprehensive land use planning; (2) city and county comprehensive land use plans; and (3) state agencies and natural resource laws such as the Oregon Beach Bill and the Removal-Fill Law. Under the provisions of the CZMA, Jordan Cove and Pacific Connector must provide a certification to the FERC, COE, and the ODLCD that their projects comply with and would be conducted in a manner consistent with the state's approved management program (15 CFR 930.50 Subpart D).

See section 4.7 of this EIS for further information regarding the FERC's compliance with the CZMA.

1.5.1.10 Migratory Bird Treaty Act

The MBTA protects 1,027 species (50 CFR §10.13). Intentional destruction or disturbance of active migratory bird nests, or any eggs or young contained within it, without authorization, is a violation of the MBTA.

EO 13186 encourages federal agencies to find ways to conserve birds protected under MBTA, especially those of greatest conservation concern, in the course of conducting agency activities. On March 30, 2011 the FERC and FWS entered into an MOU that focuses on migratory birds and strengthening conservation through enhanced collaboration between the agencies. This voluntary MOU does not waive legal requirements under the MBTA, Eagle Act, ESA, or any other statutes, and does not authorize the take of migratory birds. Under the MOU, the FERC would promote the applicants' use of BMPs to avoid and minimize impacts on birds to the extent practicable during project implementation.

See sections 4.5 and 4.6 of this EIS for further information regarding the migratory bird species that inhabit the Project area, as well as measures the applicants would implement to avoid, reduce, or mitigate effects on migratory birds.

1.5.1.11 Bald and Golden Eagle Protection Act (Eagle Act)

The Eagle Act prohibits the "take" of bald and golden eagles, including their parts, nests, or eggs, without a permit. "Take" is defined as "pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb."

Activities that may affect an eagle's ability to forage, nest, roost, breed, or raise young, constitute 'disturbance' and require a permit; habitat manipulation in this project might result in disturbance and require a permit. The FWS can issue permits for non-purposeful take under the Eagle Act and encourages applicants to coordinate early to avoid and minimize impacts to bald and golden eagles that may be in the vicinity of the project.

See section 4.6 of this EIS for further information regarding bald and golden eagles that inhabit the Project area, as well as measures the applicants would implement to avoid, reduce, or mitigate effects on bald and golden eagles as required by the Eagle Act.

1.5.2 State Agency Permits and Approvals

In addition to the federal permitting authorities that have been delegated to the states, as discussed above, various Oregon laws pertain to the Project. Permits, authorizations, and consultations with state agencies relevant to the Project are listed in table 1.5.1-1.

The FERC encourages cooperation between applicants and state and local authorities, but this does not mean that state and local agencies (through application of state and local laws) may prohibit or unreasonably delay the construction or operation of facilities approved by the FERC. Any state or local permits issued with respect to FERC regulated facilities must be consistent with the conditions of any Certificate the FERC may issue.[20]

1.5.2.1 Oregon Department of Geology and Mineral Industries (DOGAMI)

The mission of the DOGAMI is to provide earth science information for the citizens of Oregon. DOGAMI identifies and quantifies natural hazards, and works to minimize potential effects of earthquakes, landslides, and tsunamis. Its administrative rule at OAR 632 includes the identification of Tsunami Inundation Zones under Division 5. The agency is also the steward of Oregon's mineral resources, and it regulates mining activities, and oil and gas exploration and production on non-federal lands.

[20] *See* 15 U.S.C. § 717r(d) (state or federal agency's failure to act on a permit considered to be inconsistent with Federal law); *see also Schneidewind v. ANR Pipeline Co*., 485 U.S. 293, 310 (1988) (state regulation that interferes with FERC's regulatory authority over the transportation of natural gas is preempted) and *Dominion Transmission, Inc. v. Summers,* 723 F.3d 238, 245 (D.C. Cir. 2013) (noting that state and local regulation is preempted by the NGA to the extent it conflicts with federal regulation, or would delay the construction and operation of facilities approved by the Commission).

1.5.2.2 Oregon Department of Agriculture (ODA)

The ODA maintains the state list of endangered and threatened plant species, in accordance with Oregon Administrative Rule (OAR) Chapter 603, Division 73, and reviews reports of botanical surveys under Oregon Senate Bill 533 and its corresponding Oregon Revised Statute (ORS) 564. These state laws and regulations require surveys for state listed species on non-federal public lands prior to ground-disturbing activities, unless habitat for the species does not exist in the Project area. Furthermore, the ODA Noxious Weed Control Program and the Oregon State Weed Board maintain the State Noxious Weed List for the State of Oregon.

1.5.2.3 Oregon Department of Energy (ODE)

According to the EPAct, the Governor of a state in which an LNG terminal is proposed is to designate an appropriate state agency to consult with the Commission. That state agency should provide the FERC with an advisory report on state and local safety concerns, within 30 days of the FERC's notice of an application for an LNG terminal, for the Commission to consider prior to making a decision. The ODE has been designated by the Governor of Oregon as the state agency to coordinate the review of proposed LNG projects by other state agencies and consult with the FERC.

1.5.2.4 Oregon Department of Environmental Quality (ODEQ)

The ODEQ is responsible for protecting and enhancing Oregon's water and air quality, managing the proper disposal of hazardous and solid waste, overseeing clean-ups of spills or releases of hazardous materials, and enforcing Oregon's environmental laws and regulations. The agency's duties to regulate sewage treatment and disposal systems are found in ORS Chapter 454, for solid waste management in Chapter 459, hazardous materials in Chapters 465 and 466, air and water quality in Chapter 468, and ballast water in Chapter 783. The EPA has delegated authority to the ODEQ under both the CWA and CAA.

Under its delegated responsibilities required by the CAA, the ODEQ administers the Title V Air Permit program and the acid rain program, and issues air contaminant discharge permits (ACDP). The agency is also responsible for enforcing greenhouse gas (GHG) reporting requirements, and collecting data on GHG emissions for certain facilities that hold Title V or ACDP operating permits. In addition, ODEQ makes determinations about the Prevention of Significant Deterioration (PSD) of air quality from new major sources or major modifications at existing sources, and reviews air quality analyses completed to comply with National Ambient Air Quality Standards (NAAQS).

1.5.2.5 Oregon Department of Fish and Wildlife (ODFW)

The OODFW is responsible for keeping the state sensitive fish and wildlife list and developing the state's Wildlife Diversity Plan. The purpose of the Fish and Wildlife Habitat Mitigation Policy (OAR 345-22-60) developed by the ODFW is to apply consistent goals and standards to mitigate effects on fish and wildlife habitat caused by land and water development actions. The policy provides goals and standards for general application to individual development actions, and for the development of more detailed policies for specific classes of development actions or habitat types. In implementing this policy, the ODFW will recommend or require mitigation for losses of fish and wildlife habitat resulting from development actions; priority is given to native species.

ORS 509.585 (Oregon Fish Passage Law) applies to all project components that cross waters of the state where native migratory fish species are or were historically present. The ODFW would also review fish screening at water intakes under ORS 498-306. Under ORS 509 and OAR 635, the ODFW has responsibilities for review of stream crossing plans to provide for passage of native migratory fish.

OAR 635-425-000 through 635-425-0050 requires in-water blasting permits to be issued by ODFW for locations where explosives may be used to cross streams. While, in general, in-water blasting is discouraged, unless it is the only practicable method for accomplishing project goals, the ODFW may issue a permit if it contains conditions for preventing injury to fish and wildlife and their habitats.

1.5.2.6 Oregon Department of Forestry (ODF)

The ODF manages State Forests for the Greatest Permanent Value. The ODF has created a Forest Management Plan to provide strategic direction and guide management activities. Part of the plan is to identify multi-purpose objectives, and protect sensitive resources according to the state's Land Management Classification System. The ODF also monitors the commercial harvest of forest products from private timber lands, according to the Oregon Forest Practices Act. The ODF is responsible for protection of non-federal and private forest lands from wildfires.

Pacific Connector would be required to submit a Notification to the ODF. The Notification serves three purposes: notification of a forest operation, a request for a Permit to Use Fire or Power Driven Machinery, and notice to the Department of Revenue of timber harvest. A separate notification should be filed for each county and timber owner affected by the Project. All notifications require a 15-day waiting period before activity may begin unless a waiver is requested. Also, any action that would result in the conversion of forestland to other land uses or practices not in statute or rule would require the submission of a Plan for Alternate Practice and written approval from the State Forester.

1.5.2.7 Oregon Department of Land, Conservation, and Development (ODLCD)

The ODLCD assists communities and citizens in improving the built and natural environment. Under Oregon's statewide land use planning program, the ODLCD provides protection for farm and forest lands, conservation of natural resources, plans for orderly development, and coordinates among local governments. Comprehensive land use planning coordination is required under ORS 197. All cities and counties in Oregon have adopted plans that meet state standards and adhere to 19 Statewide Planning Goals and Guidelines.

In addition, NOAA has delegated to the state of Oregon the finding of consistency with the CZMA. In accordance with ORS 196.435, the ODLCD's Ocean and Coastal Services Division has been designated the state's coastal zone management agency and administers the CZMA federal consistency review program. Applicants for certification of CZMA consistency are encouraged by the ODLCD to obtain state and local permits and other authorizations required by enforceable policies. The requirements of the CZMA are applicable to NPDES permits and must be included in the NPDES permit for the Jordan Cove industrial wastewater treatment facility.

1.5.2.7 Oregon Department of Transportation (ODOT)

The ODOT has the responsibility to preserve the operational safety, integrity, and function of the state's highway facilities. The ODOT must also ensure that improvements to the highway system can be accomplished without undue effects or damage to utilities within the highway ROW. Construction that may affect the state ROW is subject to ORS 374.305, under which no person, firm, or corporation may place, build, or construct on any state highway ROW, approach road, structure, pipeline, ditch, cable or wire, or any other facility, thing, or appurtenance without first obtaining written permission from the ODOT. A permit from the ODOT is required for any work on a highway that is part of the state highway system, including but not limited to interstate highways, other highways on the National Highway System, and routes on the federal-aid highway system.

1.5.2.8 Oregon Department of State Lands (ODSL)

Under Oregon's Removal-Fill Law, permits are issued by the ODSL for projects requiring the removal or fill of 50 cubic yards or more of material in waters of the state; the removal or fill of any material regardless of the number of cubic yards affected in a stream designated as essential salmon habitat; and the removal or fill of any material from the bed and banks of scenic waterways regardless of the number of cubic yards affected.

An application to the ODSL should demonstrate independent utility, identify best use of waters, and outline measures to minimize effects on water resources. To meet the requirements of OAR Division 85, compensatory mitigation should be offered to replace all lost functions and values of wetlands and waterbodies effected by a project.

1.5.2.9 Oregon Water Resources Department (OWRD)

The mission of the OWRD is to address the state's water supply needs through the restoration and protection of stream flows and watersheds. The OWRD is charged with administering state laws and regulations governing surface and groundwater resources, such as the Ground Water Act under ORS 537-505. Its core functions include collecting water resources data and enforcing water rights, under OAR Chapter 690. All water is publicly owned in Oregon, and users must obtain a permit or water right from OWRD, including water withdrawals from underground wells, streams, or lakes. OWRD also maintains a database of water well locations, and a database for stream flows and lake levels. The applicants utilized the OWRD database for their application to the FERC.

1.5.2.8 Oregon State Historic Preservation Office (SHPO)

The FERC, as the lead federal agency, on behalf of the federal cooperating agencies, is consulting with the Oregon SHPO regarding the identification of historic properties and determination of Project-related effects, in accordance with 36 CFR 800, in order to comply with Section 106 of the NHPA. The SHPO also has authorities under ORS 358-920 to issue permits for cultural resources surveys on non-federal public land, and for the excavation of archaeological sites on non-federal lands. Jordan Cove and Pacific Connector would obtain applicable permits from the SHPO prior to conducting other archaeological work related to the Project.

2.0 DESCRIPTION OF THE PROPOSED ACTION

As described herein, Jordan Cove proposes to construct and operate an LNG production, storage, and export facility in Coos County, Oregon. Pacific Connector also proposes to construct and operate an interstate natural gas transmission pipeline and associated facilities in Coos, Douglas, Jackson, and Klamath Counties, Oregon. The proposed action also includes amendments to BLM and Forest Service LMPs. The proposed amendments and associated mitigation actions are described in sections 2.1.3, 2.1.4, and 2.1.5 below.

2.1 PROJECT OPERATIONAL COMPONENTS

2.1.1 Jordan Cove LNG Project

The Jordan Cove LNG export terminal would be located on the bay side of the North Spit of Coos Bay, Oregon. The general location of the terminal and associated temporary construction work areas including marine facilities and mitigation sites is shown on figure 2.1-1. The primary components of the LNG terminal include five liquefaction trains[21], two full-containment LNG storage tanks, vessel loading facilities, a vessel slip, and a marine access channel. The terminal site would also include a connection to the Pacific Connector pipeline and a gas conditioning facility. Jordan Cove is proposing five mitigation sites (i.e., the Kentuck project; the Eelgrass Mitigation site; and the Lagoon, Panhandle, and North Bank upland wildlife habitat mitigation sites). As shown on figure 2.1-2, portions of the terminal site are referred to as Ingram Yard which would contain the main terminal facilities; South Dunes, which would contain the SORSC, administration building, and temporary workforce housing and laydown areas; and an access and utility corridor between the Ingram Yard and South Dunes. Components that make up the proposed LNG terminal are described below, and the location of specific components are shown on figure 2.1-3.

The proposed LNG terminal site is within a potential tsunami inundation zone, and Jordan Cove has incorporated measures into the proposed facility design to account for potential tsunami inundation. Measures include elevating some site components and protecting some site components with berms or wall. Details are discussed as appropriate within this EIS.

2.1.1.1 Gas Conditioning

Natural gas would require conditioning prior to liquefaction to remove components that could freeze out and clog the liquefaction equipment or would otherwise be incompatible with the liquefaction process such as mercury, hydrogen sulfide, carbon dioxide (CO_2), water, and heavy hydrocarbons that would freeze during the liquefaction process. Heavy hydrocarbons removed would be blended into the fuel gas stream, so no on-site storage or disposal would be required.

[21] A liquefaction train consists of all components of the liquefaction process arranged in a linear relationship.

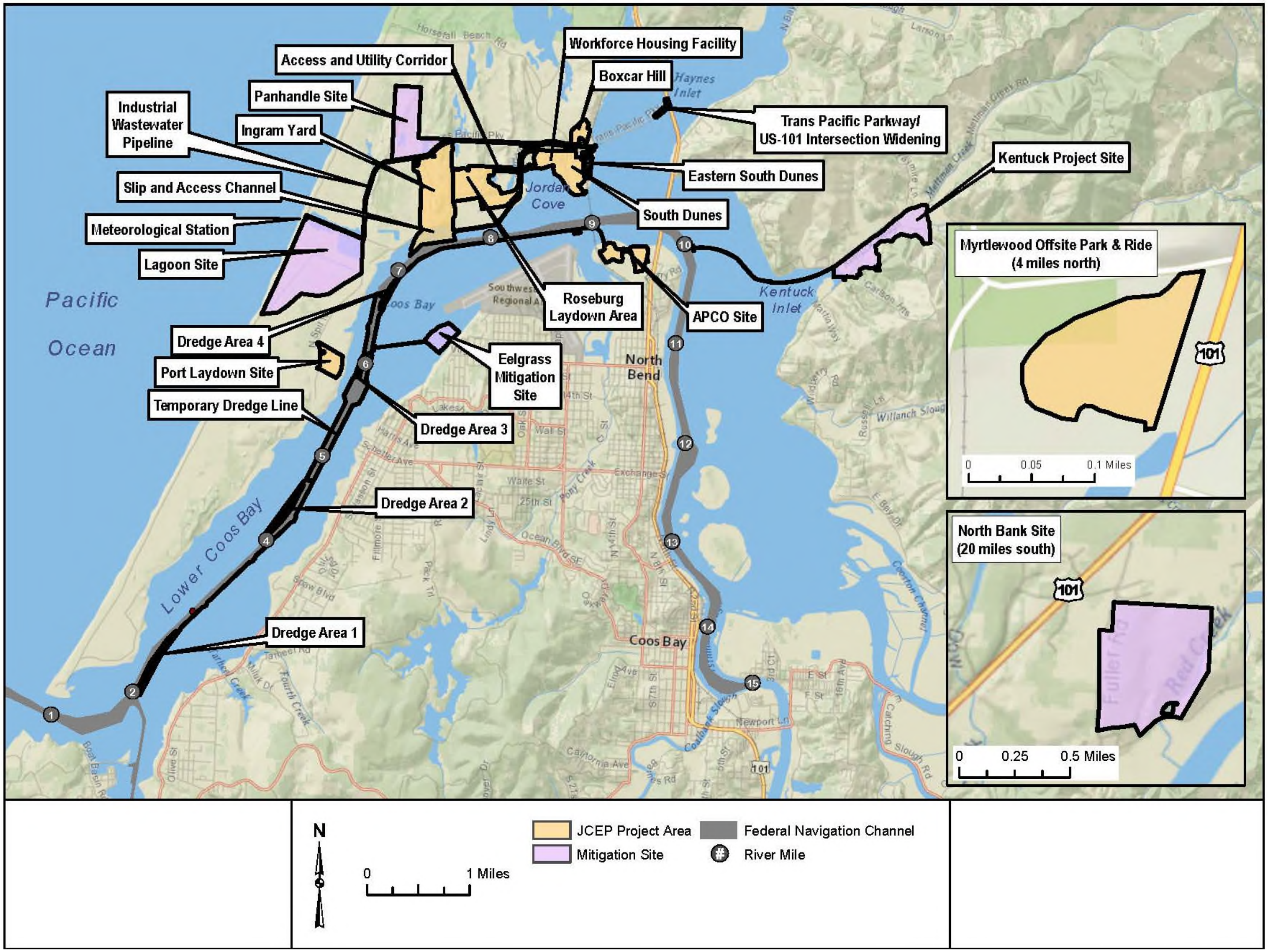

Figure 2.1-1
Jordan Cove LNG Project General Location

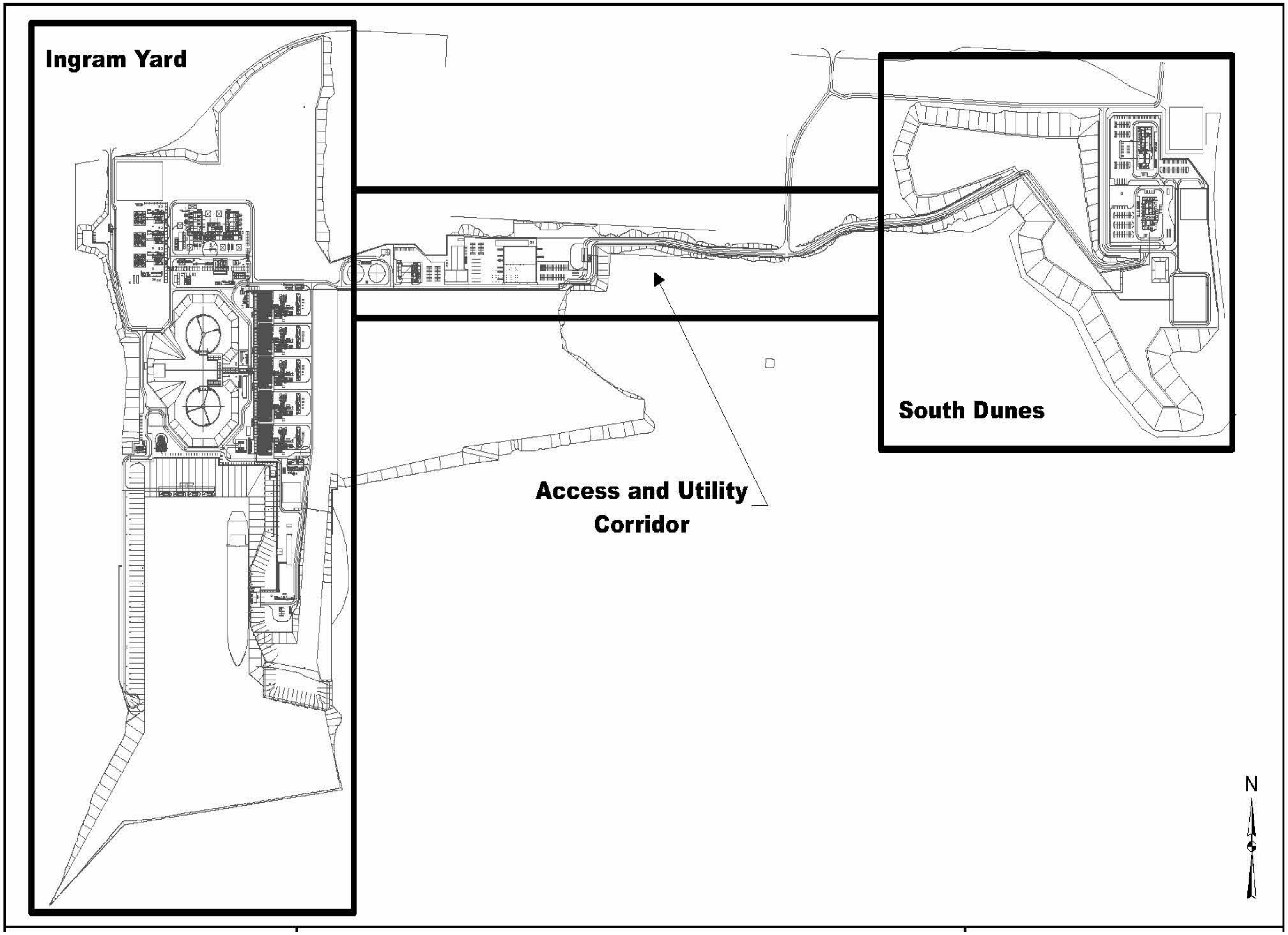

Figure 2.1-2
LNG Terminal Facilities

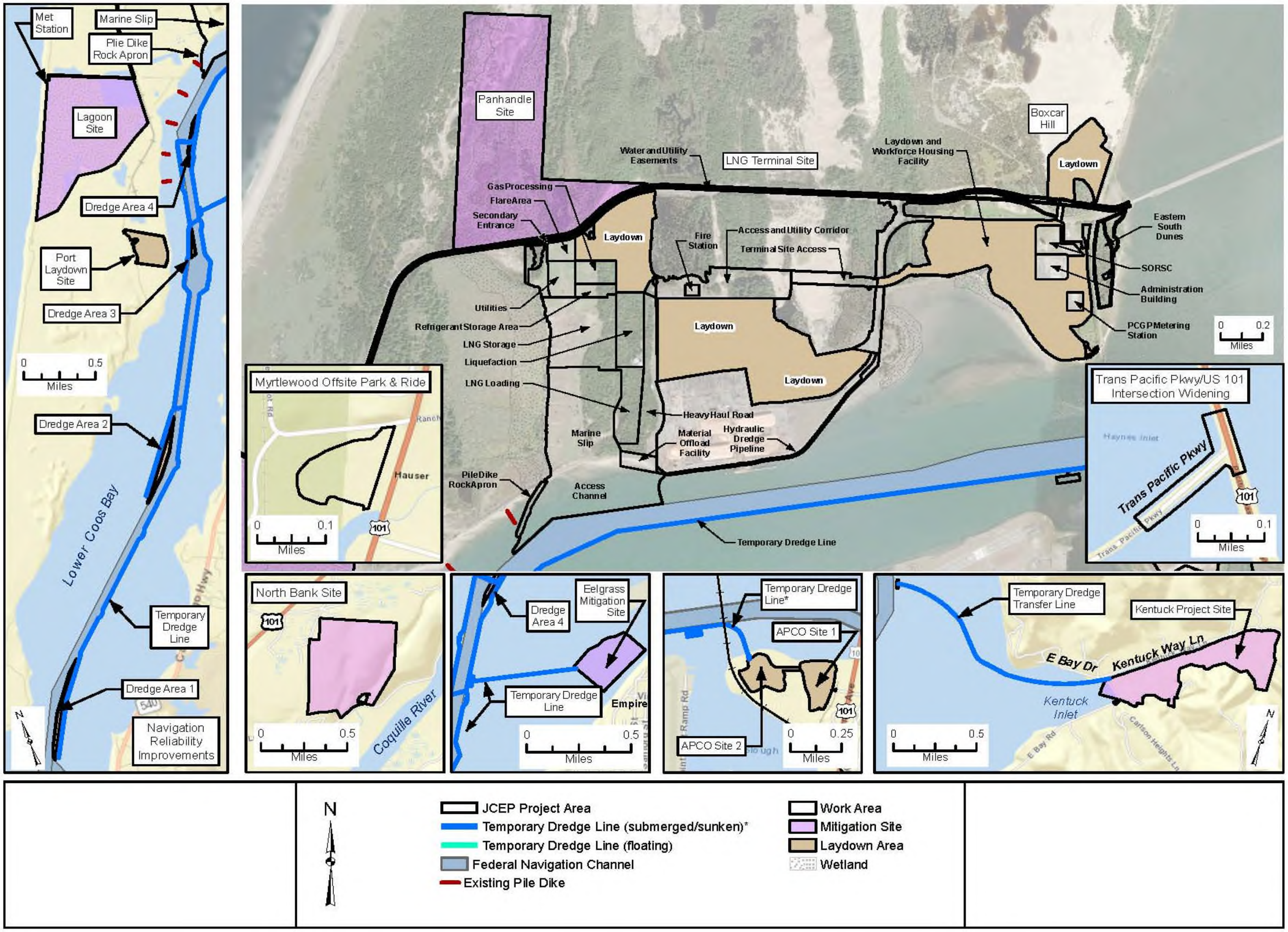

Figure 2.1-3
Jordan Cove LNG Project Detail

2.1.1.2 Liquefaction

The liquefaction trains would use Black & Veatch proprietary Poly Refrigerant Integrated Cycle Operation (PRICO®) LNG technology, each with a maximum annual capacity of 1.56 metric tonnes per annum (mtpa), for a total annual capacity of 7.8 mtpa for export. Gas delivered from the conditioning units would be divided equally among the five liquefaction trains where it would be turned into liquid by cooling to approximately -260°F. Upon leaving the LNG trains the produced LNG would be conveyed to the LNG storage tanks.

2.1.1.3 LNG Storage Tanks

The terminal would include two full-containment storage tanks, each designed to store 160,000 cubic meters (m^3) (1,006,000 barrels) of LNG at an approximate temperature of -260 degrees Fahrenheit (°F) at atmospheric pressure. Each storage tank would consist of a nine percent nickel inner steel container and a secondary concrete outer container wall with a steel vapor barrier, and would be designed so that both the primary inner container and the secondary outer concrete shell are capable of independently containing the entire volume of stored LNG.

The base elevation of the LNG storage tanks would be at about +27 feet above mean sea level (MSL). The top of the tanks (dome) would be about 180 feet above grade, and the diameter of the outer tank would be about 267 feet wide. Jordan Cove proposes to enclose the LNG storage tanks within an earthen berm that would be about +46 feet high. The berm would be designed to contain the contents of one 160,000 m^3 storage tank.

Each LNG storage tank would be built on a shallow mat foundation. Cellular glass insulation would be incorporated into the foundation and a glass wool blanket would be installed on the inner tank. The remainder of the annular space between the outer tank and inner tank would be filled with expanded perlite to keep the stored LNG at a temperature of approximately -260°F while maintaining the outer container at near ambient temperature. The LNG storage tanks would have top connections only with piping that would allow top and bottom filling. Top filling would be done via a spray device or a splash plate while bottom loading would be achieved via a standpipe to allow mixing of incoming LNG as it combines with the LNG inventory within the LNG storage tanks. A conceptual design drawing of a typical full containment LNG storage tank is illustrated in figure 2.1-4.

2.1.1.4 Terminal Access, Utility Corridor, and Parking

The feed gas supply pipeline and other utilities including power, water supply, and communications would be located in an approximately one-mile-long corridor connecting the South Dunes and Ingram Yard. The corridor would also provide temporary and permanent access to the LNG terminal site. Paved access between the South Dunes portion of the site and the western portion of the access and utility corridor would be via the existing Jordan Cove Road. A two-lane access road would be installed to the northwest of Ingram Yard to provide emergency, marine terminal, and occasional maintenance access from the Trans-Pacific Parkway.

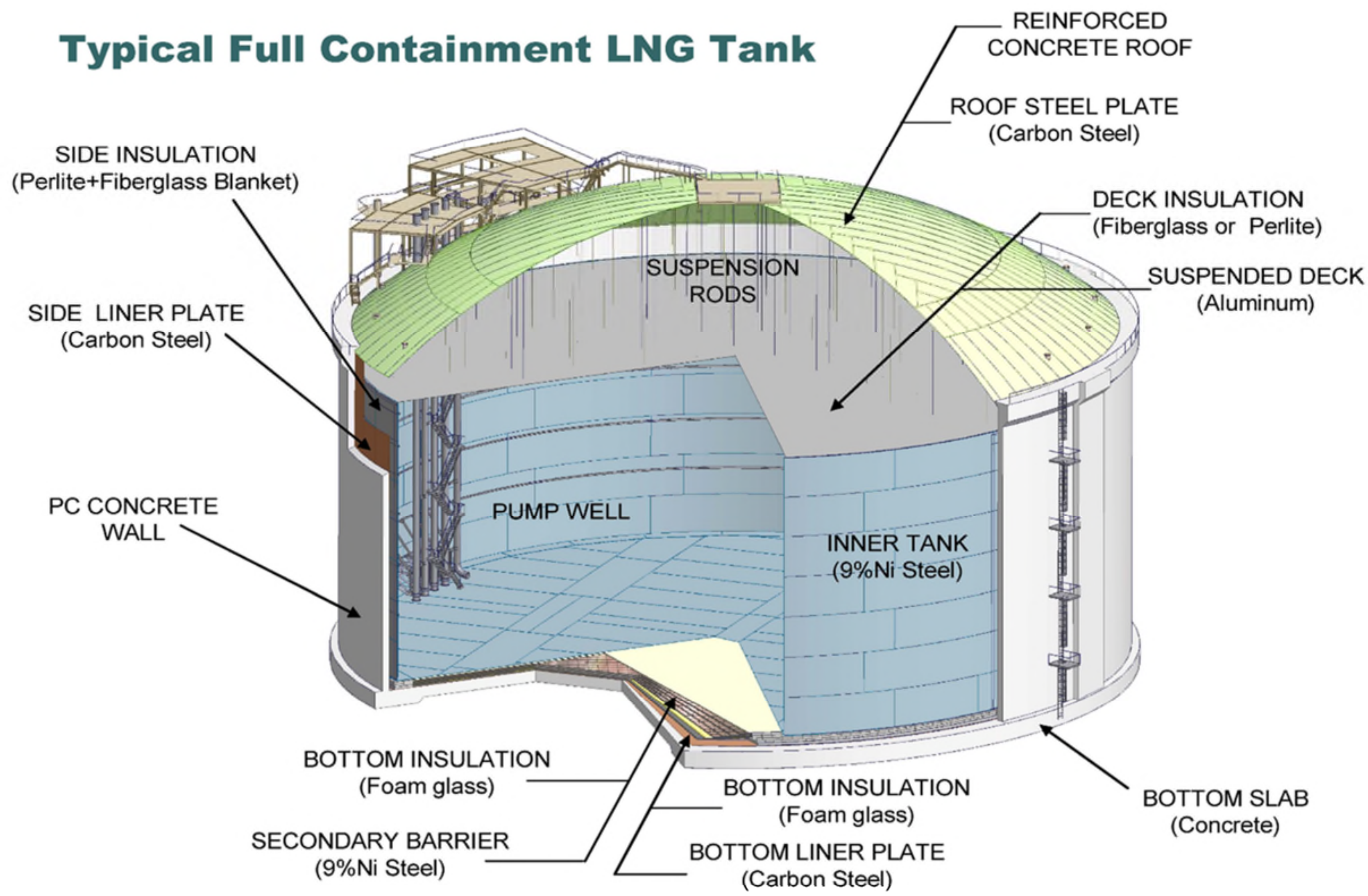

Figure 2.1-4

Typical Full Containment LNG Storage Tank

2.1.1.5 Other Terminal Support Systems

The LNG terminal operation would require installation of several other systems within the LNG terminal site, as described below.

Vapor Handling System

The liquefaction and vessel loading processes would result in the creation of miscellaneous LNG vapors, which would be recovered and directed into a vapor handling system and recycled into the liquefaction process.

Ground Flares

The LNG terminal would have three separate flare systems for occasional pressure relief or plant protection conditions: one flare system for warm (or wet) reliefs, one for cold cryogenic (or dry) reliefs, and one for low-pressure cryogenic reliefs from the marine loading system. The warm and cold flares would both be combined within a shared multi-point ground flare, while the marine flare would be within an enclosed cylindrical ground flare. The multi-point ground flare systems would be located at the northern end of the LNG terminal site and the enclosed ground flare would be located north of the marine vessel slip. The flare systems would only be used during plant-protection situations, maintenance activities, cases of purging and gassing-up an LNG carrier, and initial commissioning/start-up.

During initial commissioning and startup flaring would occur for approximately 1 week, at 10 to 20 percent of the flare design capacity. For dryout and cooldown, flaring would occur for approximately 2 weeks at less than about 20 percent of the flare design capacity. When each subsequent liquefaction train is started, flaring may occur for approximately 2 hours, and each train would be staggered by about 1 month between startups. Flaring during other commissioning activities would occur intermittently but would consist of individual pieces of equipment being isolated with very small volumes flared compared to the flare design capacity until the system is depressurized.

Instrumentation and Process Control System

The facility would be operated through a distributed control system (DCS) that would include control panels and numerous field-mounted instruments connected to remote input/output cabinets that would interface with the central control room. In addition, independent Safety Instrumented Systems (SIS) and Fire and Gas Systems (FGS) would monitor hazardous conditions and provide emergency shutdown capability.

Electrical Systems

Electrical power to the LNG terminal would be supplied via two 30-megawatt (MW) steam turbine generators and one spare 30 MW steam turbine generator, with the steam generated by heat recovery from gas turbine operation. A black-start auxiliary boiler would be used to generate steam for power when gas turbines are not in operation. The system would also include two standby diesel generators for the LNG facility and two for the SORSC.

Lighting System

Twenty-four-hour facility lighting would be required for security and personnel safety during operation of the LNG terminal. A final lighting plan, including lighting of the LNG storage tanks, would be developed during detailed LNG terminal design; however, Jordan Cove states that only lighting required for operation and maintenance, safety, security, and meeting FAA requirements would be used on the LNG storage tanks.

Water Systems

Jordan Cove would design and construct a stormwater management system to gather runoff from impervious surfaces within the terminal and direct the flow to designated areas for disposal. Stormwater collected in areas that are potentially contaminated with oil or grease would be pumped or would flow to oily water collection sumps before discharging to the industrial wastewater pipeline. No untreated stormwater would be allowed to enter federal or state waters.

Sanitary waste would either be directed to a holding tank and disposed of by a sanitary waste contractor as necessary or would be treated by a packaged treatment system and directed to an existing industrial wastewater pipeline (IWWP).

During construction of the Jordan Cove LNG Project, an existing industrial wastewater pipeline would be abandoned, replaced, and relocated. The new replacement pipeline would consist of 16-inch-diameter slip joint polyvinyl chloride (PVC). It would run for about two miles from the South Dunes portion of the site along the shoulder of the Trans-Pacific Parkway within an easement owned by the Port to connect with the existing outfall pipe west of the Weyerhaeuser lagoon on the North Spit (see figure 2.1-5).

Jordan Cove proposes to use raw water from the existing Coos Bay North Bend Water Board (CBNBWB) raw water pipeline for construction water needs, including hydrostatic testing of the LNG storage tanks. Following testing and ODEQ approval, the water would be locally discharged to the stormwater system for infiltration or discharged into the IWWP according to the applicable NPDES permit requirements.

An interconnect to the CBNBWB potable water pipeline would be used for all normal operational water needs in the LNG terminal, which includes fire water makeup, utility water used for such items as equipment and area cleaning, and potable water required to supply buildings and eyewash/safety shower stations. In addition, the raw water pipeline tap at the LNG terminal site would remain connected after construction, but there are no normal operational uses anticipated for this raw water supply. The water pipelines and proposed taps are shown on figure 2.1-5.

During construction of the terminal, Jordan Cove would use approximately 595.5 million gallons of water for various activities, including hydrostatic testing. During terminal operations, about 71.5 million gallons of water would be consumed annually. Water usage and impacts are more fully discussed in section 4.3 of this EIS.

The LNG terminal would include a fire suppression system with the main fire water supply for the system provided by two aboveground firewater storage tanks located in the access and utility corridor. Water supply for the two tanks would be potable water obtained from CBNBWB. Each tank would hold a minimum usable capacity of 3,240,000 gallons. This would supply approximately 4 hours of firefighting water. The fire water systems would also include stationary fire water pumps, fire hydrant mains, fixed water spray systems, automatic sprinkler extinguishing systems, high expansion foam system, and remotely controlled monitored spray systems. The fire water supply would also be used to provide water for on-site firefighting trucks.

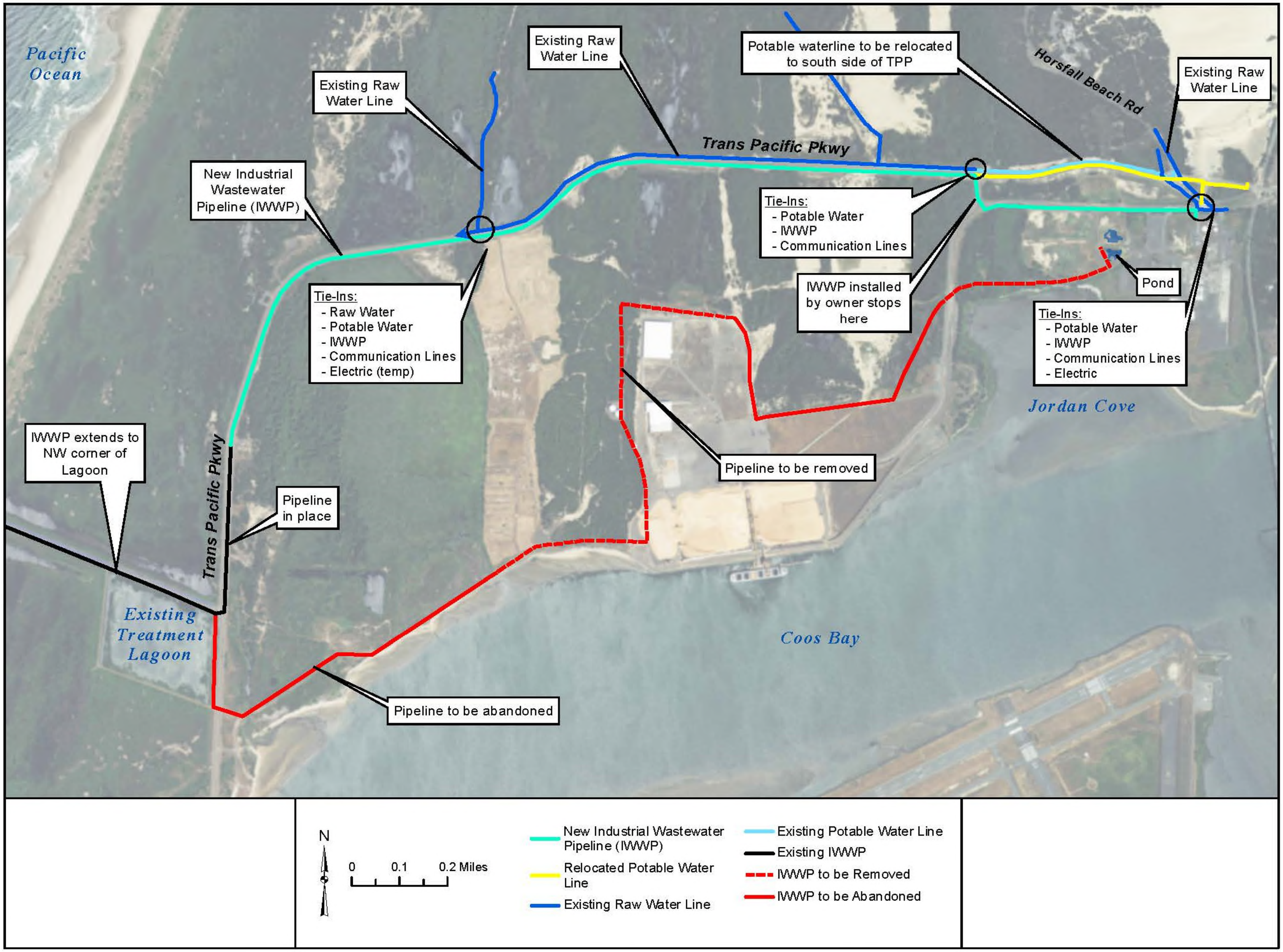

Figure 2.1-5
Industrial Wastewater Pipeline, Water Pipelines Relocation, and Utility Tie-Ins

Support Buildings

The LNG terminal would include buildings to house LNG process equipment, administration and office space, warehouse and receiving, guard houses and security, tugboat storage, and chemical and material storage. Support buildings would also include the non-jurisdictional SORSC and fire department building (see section 2.2). The SORSC would be located adjacent to the LNG terminal administration building on the South Dunes portion of the site. The fire department building would be located in the access and utility corridor.

2.1.1.6 Marine Waterway including Proposed Modifications to the Marine Waterway[23]

The Coast Guard defines the waterway for LNG marine traffic as extending from the outer limits of the United States territorial waters 12 nautical miles off the coast of Oregon, and 7.5 nautical miles up the Federal Navigation Channel to the LNG terminal site (figure 2.1-6). The Federal Navigation Channel extends from the mouth of Coos Bay to the city of Coos Bay Docks at about river mile (RM) 15.1. Jordan Cove would dredge four areas abutting the current boundary of the navigation channel between RM 2 to RM 7 (figure 2.1-1). Dredging could potentially modify the physical morphology of the channel, by widening four turns along the channel, to allow for more efficient transit of LNG carriers. These proposed dredging actions would not result in a change in the overall depth of the Federal Navigation Channel (only a widening of four turns along the channel). The COE is currently evaluating if the dredging of these four turns would alter the Federal Navigation Channel. The four dredging actions are summarized below.

- **Enhancement #1 – Coos Bay Inside Range channel and right turn to Coos Bay Range:** To reduce constriction to vessel passage at the inbound entrance to Coos Bay Inside Range. Widen channel from the current 300 feet to 450 feet, and lengthen the total corner cutoff on the Coos Bay Range side from the current 850 feet to about 1,400 feet.
- **Enhancement #2 – Turn from Coos Bay Range to Empire Range channels:** Widen the turn area from the Coos Bay Range to the Empire Range from current 400 feet to 600 feet and lengthen the total corner cutoff area from the current 1,000 feet to about 3,500 feet.
- **Enhancement #3 – Turn from the Empire Range to Lower Jarvis Range channels:** Add a corner cut on the west side in this area that would be about 1,150 feet wide to provide additional room for vessels to make this turn.
- **Enhancement #4 – Turn from Lower Jarvis Range to Jarvis Turn Range channels:** Widen turn area from current 500 feet to 600 feet and lengthen total corner cutoff area from the current 1,125 feet to about 1,750 feet, to allow vessels to begin a turn in this area earlier.

In addition, Jordan Cove would install five meteorological ocean data collection buoys to aid navigation within the waterway, by measuring wind speed and direction, current speed and direction, as well as tide height. Jordan Cove intends to replace three existing buoys with the new buoys (one located in the Pacific Ocean near the bay entrance, and one within Coos Bay along the LNG carrier route), and two new buoys located near the access channel.

[23] The proposed modifications to the marine waterway (i.e., dredging at four points along the Federal Navigation Channel) are referred to as "marine waterway modifications" or "navigation channel modifications" in this EIS.

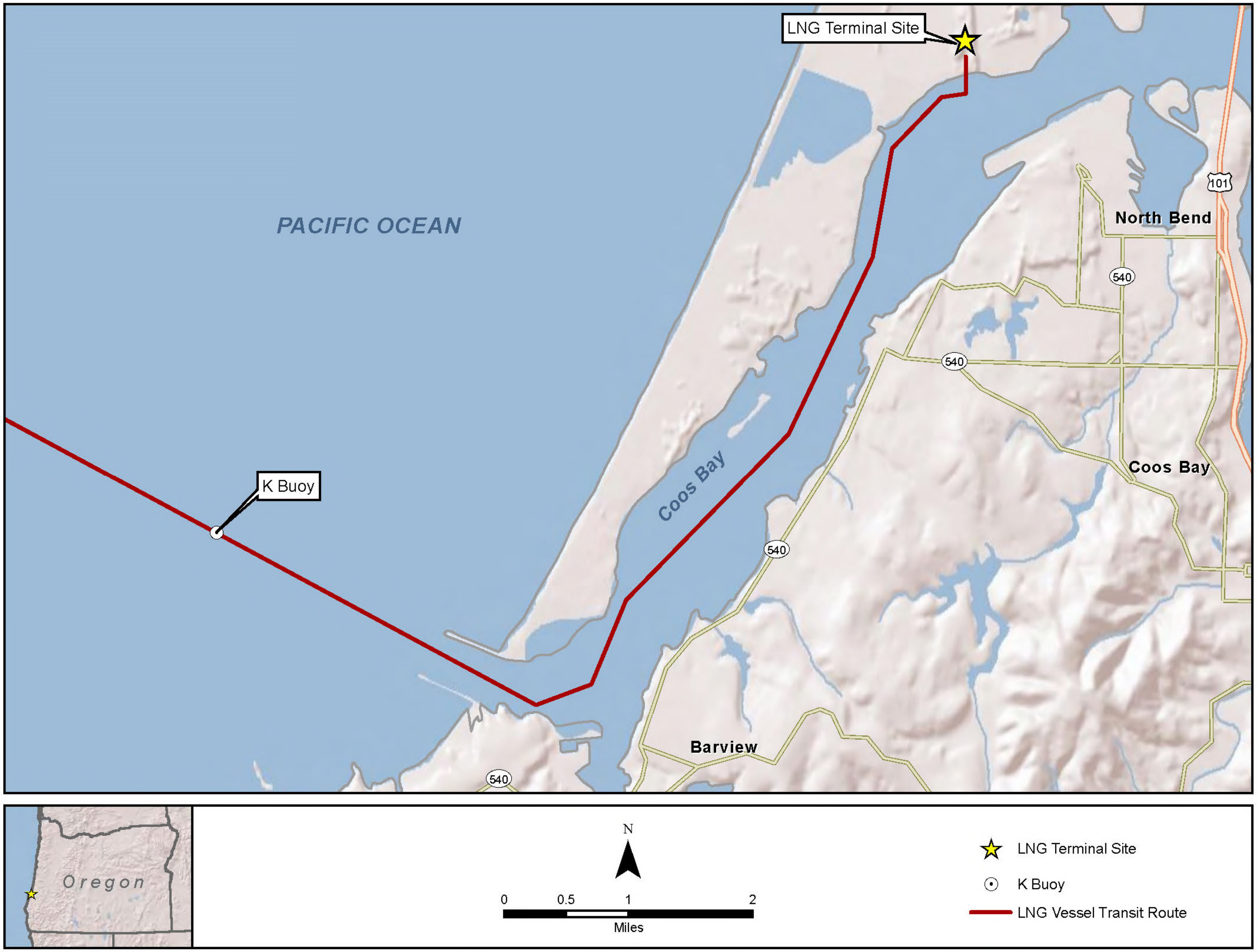

Figure 2.1-6
Proposed LNG Carrier Transit Route

2.1.1.7 Marine Access and Facilities

Access Channel

Jordan Cove would construct an access channel to connect the terminal to the Federal Navigation Channel (figure 2.1-7).[24] The access channel would begin at the confluence between the Jarvis Turn and the Upper Jarvis Range at about navigation channel mile (NCM) 7.5, and would be about 2,200 feet wide at the navigation channel and about 780 feet wide at the terminal. The distance from the north edge of the navigation channel to the mouth of the terminal would be about 700 feet. The walls of the access channel would be sloped to meet the existing bottom contours at an angle of 3 feet horizontal to one foot vertical (3:1). The access channel would be approximately 45 feet deep and would cover about 22 acres below the highest measured tide elevation of 10.3 feet (North American Vertical Datum of 1988 [NAVD88]).

Terminal Slip

Jordan Cove would construct a marine slip to support vessel operations at the north end of the access channel. This would be a single use slip that would be sized to provide flexibility to safely maneuver an LNG carrier from the access channel into the slip when another LNG carrier is already berthed on the east or west sides. The slip would also be sized to allow for tugs to move a temporarily disabled LNG carrier away from the loading berth on the east side of the slip to the emergency lay berth on the west side of the slip if necessary. The slip would be bounded on the east and west sides by sheet pile walls, creating a vertical face to support mooring structures. The northern side of the slip would be sloped to meet the existing bottom contours at an angle of 3 feet horizontal to one foot vertical (3:1). The minimum water depth within the slip would be -45 feet (NAVD88) in order to maintain at least 10 percent under-keel clearance when the ships are in dock. A berm/tsunami wall would also be constructed between the western edge of the slip and Henderson Marsh to approximate elevation +34.5 feet to increase tsunami resistance (figure 2.1-7).

Material Offloading Facility

The material offloading facility (MOF) would be constructed to receive components of the LNG terminal that are too large or heavy to be delivered by road or rail. The MOF would cover about 3 acres on the southeast side of the slip (see figure 2.1-7). The MOF would be constructed using the same sheet pile wall system as the LNG loading berth to an elevation approximately +13.0 feet (NAVD88). Following construction, the MOF would be retained as a permanent feature of the LNG terminal to support maintenance and replacement of large equipment components.

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[24] The access channel and a portion of the marine slip would be within state waters managed by the ODSL. Jordan Cove would construct the access channel and would transfer responsibility for maintenance to the Oregon International Port of Coos Bay (Port) following construction. The Port has already obtained an easement from ODSL for operation and maintenance of the access channel and the in-water portion of the slip. Jordan Cove would reimburse the Port for costs associated with its operation and maintenance of the access channel and slip.

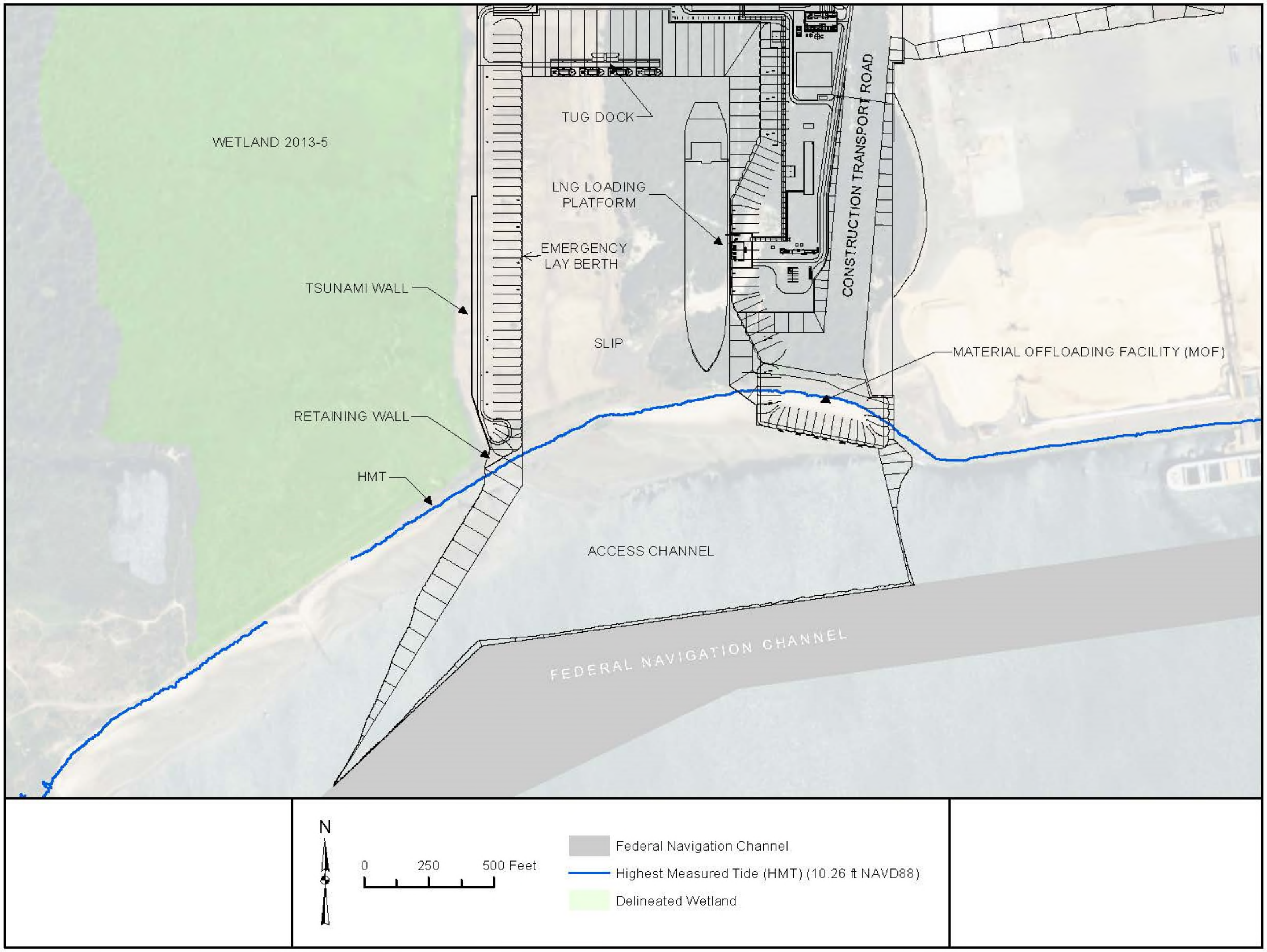


Figure 2.1-7
Plot Plan of the Marine Facilities

LNG Carrier Loading Berth and Product Loading Facility

An LNG carrier loading berth would occupy the eastern side of the slip. A profile of the loading berth is provided in figure 2.1-8. The loading berth would be constructed of steel sheet piles that support surface structures (the loading area) and provide the foundation for the breasting and mooring structures. The berth support wall would extend from the bottom of the slip (elevation approximately -45 feet) to approximate elevation +34.5 feet (NAVD88).[25]

The product loading facility (PLF), or LNG loading platform, would be a pile-supported concrete slab that provides structural support to the marine loading arms, terminal gangway, and other ancillary equipment at the berth. The PLF would be constructed on top of the sheet pile wall at approximate elevation +34.5 feet (NAVD88), with a foundation of reinforced concrete supported by steel pilings.

Emergency Lay Berth

An emergency vessel lay berth on the west side of the slip would be constructed to safely moor a temporarily non-operational LNG carrier (figure 2.1-7). This berthing facility would be supported by the west side sheet pile wall with a top-of-wall elevation of approximately +20 feet (NAVD 88). Support infrastructure would include an access road from the tug berth area, duct bank with cabling for powering the mooring hooks and capstans, and lighting of the ship access area.

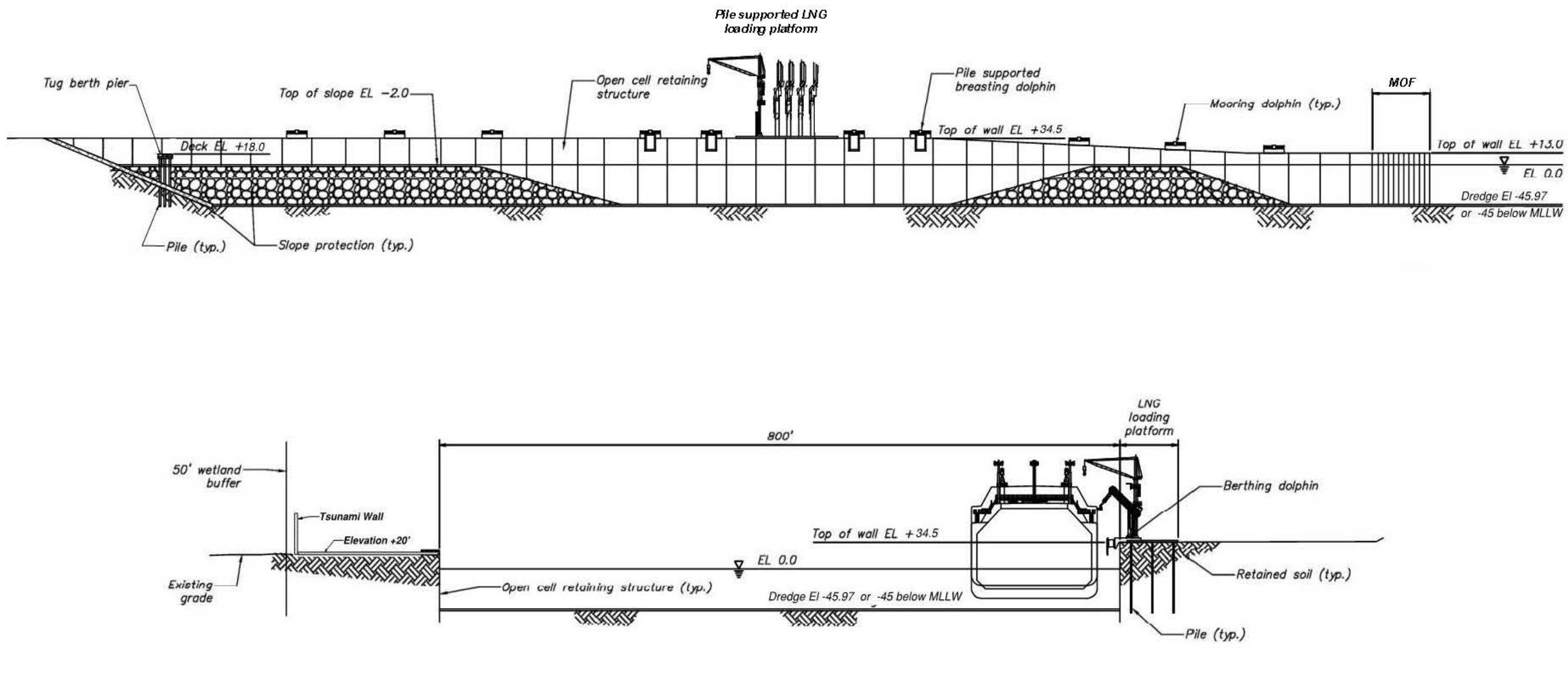
Tug and Escort Boat Berth

A berth, also referred to as a tug dock, would be constructed on the north side of the marine slip (figure 2.1-7) to accommodate up to four tugboats, two sheriff's escort boats, and six other visitor boats with similar characteristics as the sheriff's boats. This dock would be about 470 feet long and 18 feet wide and would be precast concrete supported by steel piles. The tug dock would be accessible from land by a pile-founded trestle. Included as part of the dock would be two boat houses. North of the dock would be a tug operator building.

LNG Marine Traffic

Section 2.1.1.6 defines the extent of the marine waterway. For the analysis in this EIS, and the corresponding BA and EFH Assessment specific to species covered by the ESA and MSA, we also considered impacts from LNG carrier marine traffic extending out to the edge of the Outer Continental Shelf. Jordan Cove estimated that it would take an LNG carrier between 1.5 hours (at 6 knots) and 2 hours (at 4 knots) to travel through the waterway from Buoy "K" to the terminal (a description of the LNG carriers is provided in section 2.2.1.). An additional 90 minutes would be necessary for the LNG carrier to be turned in the access channel and parked at the terminal berth, with the assistance of tug boats. The entire round-trip transit time for a single LNG carrier to travel from Buoy K through the waterway, turn and dock at the berth, take on a full cargo of LNG, and then exit the terminal slip and travel through the waterway back out to the open ocean past Buoy K would be about 22 hours.

[25] The slip and berth would be designed to accommodate LNG carriers as large as 217,000 m^3 in capacity.



All elevations are to the NAVD88 datum

NOT TO SALE

Figure 2.1-8
Profile of Marine Berth

Rock Apron

The COE expressed concern that erosion resulting from the Jordan Cove LNG Project's operation could result in impacts on Pile Dike 7.3 (located immediately west of the access channel) as well as the Project's slip. As a result, Jordan Cove would construct a rock apron west of the access channel to arrest slope migration, or equilibration, before it can progress to a condition that could potentially negatively impact Pile Dike 7.3 or the proposed slip. The design involves a 50-foot-wide by 3-foot-thick by approximately 1,100-foot long rock apron set back approximately 20 feet from the top (slope catch point) of the access channel side slope. The size of rock to be used is well graded 6-inch to 22-inch angular stone with a median size of 14 inches. The rock apron design also includes an approximately 100-foot-long extension of the slip's sheetpile bulkhead at the northwest corner of the access channel to minimize slope cut-back at this location. Total required rock volume is approximately 6,500 cy.

2.1.1.8 Dredged and Excavated Material Disposal

Dredging for the Marine Facilities

Dredging for the marine facilities, including the marine waterway modifications, would generate about 6.32 million cubic yards (mcy) of dredged and excavated material (see table 2.1.1.8-1). Of this, about 3.6 mcy would be dry excavated and then dredged in the fresh water pocket in the slip area and access channel behind an earthen berm that would remain in place to separate work prior to dredging activities in the bay. The remainder of the dredge material would be removed during open water dredging while exposed to the bay and Federal Navigation Channel.

TABLE 2.1.1.8-1

Materials Excavated and Dredged During Construction of LNG Terminal Marine Facilities

Area	Construction Phase	Volume (mcy)	Disposal Location
Slip	Excavation and Dredge Behind Berm	3.6	Ingram Yard, Corridor, South Dunes, Roseburg site
Slip	Salt Water Dredge	0.2	Ingram Yard, Corridor, South Dunes, Roseburg site
Protective Berm	Upland Excavation	0.03	Ingram Yard, Corridor, South Dunes
Protective Berm	Salt Water Dredge	0.5	Ingram Yard, Corridor, South Dunes, Kentuck Project
Access Channel	Upland Excavation	0.004	Ingram Yard, Corridor, South Dunes, Roseburg site
Access Channel	Salt Water Dredge	1.4	Ingram Yard, Corridor, South Dunes, Roseburg site
Marine Waterway Modifications	Salt Water Dredge	0.59	APCO Sites 1 and 2
	Total:	**6.32**	

Most of the material excavated and dredged during construction of the marine facilities would be used to raise the elevation of the terminal facilities above the tsunami inundation zone. Ingram Yard, the access and utility corridor, and the South Dunes portions of the site, including temporary use areas (see section 2.1.1.10), would receive material to raise their respective site elevations. Some material would also be deposited at the adjacent Roseburg Forest Products property, and at the Kentuck project mitigation site. Material dredged for the marine waterway modifications would be deposited at Al Pierce Company (APCO) Sites 1 and 2.

Dredging for the Marine Waterway Modifications

Approximately 590,000 cy of material would be excavated/dredged to complete the marine waterway modifications. Storage of the dredge material would be distributed between the APCO 1 and APCO 2 upland disposal sites (see figure 2.1-1), or placed entirely at APCO Site 2 if shown to be feasible.

Operational Maintenance Dredging

Jordan Cove proposes to conduct maintenance dredging about every 3 years with about 115,000 cy of material removed per dredging interval for the first 12 years of operation, and after that maintenance dredging could be done about every 5 years with up to 160,000 cy of materials removed during each dredging event.[26] For the marine waterway modification projects within the channel, maintenance dredging would also be conducted about every 3 years with about 27,900 cy of materials removed during each dredging event. Jordan Cove proposes to distribute maintenance dredge material between the upland APCO Sites 1 and 2 (see figure 2.1-3). Jordan Cove would be required to acquire a new permit from the COE if future dredge materials could not be distributed at the upland APCO Sites 1 and 2, due to unforeseen future conditions.

2.1.1.9 Mitigation Areas

Jordan Cove and Pacific Connector have identified several mitigation areas that are directly related to the proposed Project. These areas and associated mitigation actions are not under the jurisdiction of the Commission; however, because they are directly related to the proposed Project, we include them in this EIS where appropriate. Jordan Cove and Pacific Connector propose to mitigate the loss of wetlands that would result from both the Jordan Cove LNG and Pacific Connector Pipeline Projects through the Kentuck project (i.e., wetland impacts include permanent and temporary impacts and loss of aquatic resource types, functions and values; see section 4.3). The Kentuck project would cover about 140 acres on the eastern shore of Coos Bay at the mouth of Kentuck Slough (see figures 2.1-1 and 2.1-3). Formerly, this property was the Kentuck Golf Course, but it is currently owned by Jordan Cove. On August 30, 2016, the Coos County Board of County Commissioners granted Jordan Cove's request for a conditional use permit to allow for mitigation and restoration within this property.

Jordan Cove proposes to mitigate for the loss of aquatic vegetation via an eelgrass restoration program in Coos Bay, near the Southwest Oregon Regional Airport in North Bend, including establishing new eelgrass beds (see figures 2.1-1 and 2.1-3). Additional information about wetland impacts and mitigation is presented in section 4.3.3.

Jordan Cove developed three upland mitigation sites per recommendations from the ODFW in response to the mitigation policy set forth in OAR 635-415-0000 through 0025. The proposed upland habitat mitigation sites include the Panhandle site, the Lagoon site, and the North Bank site. The Panhandle site is approximately 133 acres and is located north of Trans-Pacific Parkway. The Lagoon site is approximately 320 acres and is located adjacent to the meteorological station. The North Bank site is approximately 156 acres and is located on the north bank of the Coquille River adjacent to the Bandon Marsh National Wildlife Refuge (NWR).

[26] Proposed maintenance dredge frequency and volume is based on a sedimentation study conducted by Jordan Cove and summarized in Jordan Cove's *Dredged Material Management Plan* filed as Appendix N.7 in Resource Report 7 as part of its September 2017 application to FERC.

2.1.1.10 Temporary Construction Use Areas

During construction of the LNG terminal, temporary use areas outside of the footprint of the permanent LNG terminal, would be required for equipment and material staging, dredge material disposal and transport, workforce housing, workforce parking, and road improvement. These facilities and their locations are shown on figures 2.1-1 and 2.1-3, and summarized below.

Laydown Yards

Jordan Cove would use several construction laydown areas immediately adjacent to the LNG terminal site, including at the north side of the Ingram Yard, within the Roseburg Forest Products property east of marine terminal facilities, and within the South Dunes portion of the site (figure 2.1-3). Jordan Cove would also use one laydown yard (Boxcar Hill) on the north side of the Trans-Pacific Parkway just north of the South Dunes portion of the site, one laydown yard (Port Laydown Site) within Port property about 2 miles south of the LNG terminal site, and two laydown yards across Coos Bay on North Point in North Bend (APCO Sites 1 and 2) (figures 2.1-1 and 2.1-3). The laydown yards would be used during construction to house construction offices, workforce lunchrooms, warehousing, equipment maintenance, and laydown of materials after delivery to the site.

Dredge Pipelines

During construction of the marine slip and access channel, a slurry pipeline and return water pipeline would be laid across the Roseburg Forest Products tract to the South Dunes portion of the site. A temporary dredge pipeline would also be laid adjacent to the Federal Navigation Channel (via a floating or submerged pipe) to transport dredge material from the four marine waterway modification sites to the APCO Sites 1 and 2, and a temporary dredge line would be laid between the Federal Navigation Channel and the Kentuck project site to transfer dredge material from marine transport barges to the disposal sites.

Workforce Housing

Jordan Cove proposes to construct a temporary workforce housing facility within the South Dunes portion of the LNG terminal site that could accommodate common facilities and 200 to 700 beds. Parking would be provided on-site, and shuttle buses would be provided to and from local communities to reduce traffic on the road network after working hours. After completion of construction and commissioning activities the entire facility would be decommissioned and removed from the site.

Off-Site Parking

To reduce construction traffic along U.S. Highway 101, Jordan Cove would establish a park-and-ride facility at the vacated Myrtlewood RV park near the community of Hauser, north of the U.S. Highway 101 McCullough Bridge (figures 2.1-1 and 2.1-3).[27] Jordan Cove would also provide dedicated buses to and from private RV parks, subject to demand, where those parks could house a large number of construction personnel. After construction of the terminal is completed, the off-site parking lot would be restored to pre-construction condition and use.

[27] Jordan Cove has indicated that they are working with local developers to identify a second park-and-ride that would be used for the Project. However, at this time the only park-and-ride that has been identified and filed with the FERC is the Myrtlewood RV park-and-ride.

2.1.2 Pacific Connector Pipeline and Associated Aboveground Facilities

The 36-inch-diameter, Pacific Connector natural gas pipeline would extend for about 229 miles across Klamath, Jackson, Douglas, and Coos Counties, Oregon and terminate at the proposed LNG export facility in Coos County (figure 1.1-1 in chapter 1). As identified in table D-1 in appendix D, the pipeline would be located adjacent to, but separated from, existing rights-of-way including powerlines, roads, and other pipelines for about 97.7 miles (43 percent).

The pipeline would have a design capacity of 1.2 Bcf/d of natural gas, with a maximum allowable operating pressure (MAOP) of 1,600 pounds per square inch gauge (psig).[28] The pipeline (and aboveground facilities) would be designed, constructed, tested, operated, and maintained to conform with USDOT requirements found in 49 CFR Part 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Safety Standards*; the FERC requirements at 18 CFR 380.15, *Site and Maintenance Requirements*; and other applicable federal and state regulations. The location of the proposed pipeline Project facilities is shown on detailed maps included in appendix C and described below.

2.1.2.1 Aboveground Pipeline Facilities

New aboveground facilities would include one compressor station, 3 meter stations, 5 pig launcher/receiver assemblies, 17 mainline valves (MLV), and 15 communication towers (table 2.1.2.1-1).

TABLE 2.1.2.1-1

Pacific Connector Aboveground Facilities

Facility	MP	Operational Acres a/	County	Ownership/ Jurisdiction
Jordan Cove Meter Station, MLV #1, Pig Receiver, and Communication Tower	0.0	1.7	Coos	Private
MLV #2 (Boone Creek Road)	15.1	0.1	Coos	Private
MLV #3 (Myrtle Point Stikum Road)	29.5	0.1	Coos	Private
MLV #4 and Communication Tower (Deep Creek Spur)	48.6	0.1	Douglas	BLM
MLV #5 (South of Olalla Creek)	59.6	0.1	Douglas	Private
MLV #6 and Launcher/Receiver (Myrtle Creek)	71.5	0.5	Douglas	Private
MLV #7 (Pack Saddle Road)	80.0	0.1	Douglas	BLM
MLV #8 (Highway 227)	94.7	0.1	Douglas	Private
MLV #9 (BLM Road 33-2-12)	113.7	0.1	Jackson	Private
MLV #10 and Communication Tower (Shady Cove)	122.2	0.1	Jackson	Private
MLV #11, Communication Tower, and Launcher/Receiver (Butte Falls)	132.5	0.3	Jackson	Private
MLV #12 (Heppsie Mountain Quarry Spur)	150.7	0.1	Jackson	BLM
MLV #13 (Clover Creek Road)	169.5	0.1	Klamath	Private
MLV #14 and Launcher/Receiver (Keno)	187.4	0.4	Klamath	Private
MLV #15 and Communication Tower	196.5	0.1	Klamath	Private
MLV #16 and Communication Tower	211.6	0.1	Klamath	Private
Klamath Compressor Station, Klamath-Beaver and Klamath-Eagle Meter Stations, MLV #17, Pig Launcher, and Communications Tower	228.8	21.4	Klamath	Private
Blue Ridge Communication Tower	Approx. 20	0.2	Coos	BLM
Signal Tree Communication Tower	Approx. 45	0.2	Coos	BLM

[28] On October 5, 2018, Pacific Connector notified the Commission that it would use thicker pipe than initially proposed in order to increase the design pressure from 1,600 psig to 1,950 psig and allow for possible increased volume in the future, however the proposed MAOP remains at 1,600 psig. Any addition or change to the proposed psig would require additional review and approval from the FERC, and is not covered within the scope of the EIS.

TABLE 2.1.2.1-1 (continued)

Pacific Connector Aboveground Facilities

Facility	MP	Operational Acres a/	County	Ownership/ Jurisdiction
Sheep Hill Communication Tower	Approx. 70	0.2	Douglas	Private
Harness Mountain Communication Tower	Approx. 75	0.0	Douglas	Private
Starveout Communication Tower	Approx. 115	0.2	Douglas	Private
Flounce Rock Communication Tower	Approx. 123	0.2	Jackson	BLM
Robinson Butte Communication Tower	Approx. 159	0.2	Jackson	Forest Service
Stukel Mountain Communication Tower b/	Approx. 209	0.2	Klamath	BLM

a/ Values are rounded to the nearest tenth of an acre.
b/ Assumes that existing BLM communication Site Plan is sufficient. If not, supplemental environmental compliance may be required.

Meter Stations

The Jordan Cove Meter Station would be located within the South Dunes portion of the terminal. The meter station would be comprised of one building which would house gas chromatographs, moister analyzer, communication equipment, and flow computer. A canopy would also be installed to cover the control valves and ultrasonic meters. The Jordan Cove Meter Station would also include an MLV, a pig launcher/receiver, and a 140-foot-high steel communication tower. The station would be enclosed by a 7-foot-high chain-link fence, and the interior of the yard would be graveled.

The Klamath-Beaver and the Klamath-Eagle Meter Stations would be co-located within the fenced boundaries of the Klamath Compressor Station at about MP 228.8. The Klamath-Beaver Meter Station would include an interconnection with the existing GTN pipeline system; while the Klamath-Eagle Meter Station would serve as the interconnect with the existing Ruby pipeline system.

Klamath Compressor Station

The Klamath Compressor Station would be located approximately 1.8 miles northeast of the town of Malin, at the eastern terminus of the Pacific Connector pipeline, and would be accessible from Malin Loop and Morelock Roads. The station would include the Klamath-Eagle and Klamath-Beaver Meter Stations and would be located adjacent to the existing GTN Malin/Tuscarora Gas Transmission Company (Tuscarora) Meter Station and the Ruby Turquoise Flats facility.

The compressor station would include 62,200 International Organization for Standardization (ISO) hp of new compression and a 31,100 ISO hp standby compressor unit, consisting of turbine-driven, natural gas fired centrifugal compressor units. Other facilities would include an inlet filter/separator, lube oil cooler, inlet air silencer/cleaner, exhaust system, and gas coolers. The compressor building would include skid-mounted fuel gas conditioning, measuring, and regulation equipment. Related suction and discharge headers and piping would be installed between the pipeline and the compressor units. Other buildings inside the station would include a control room/ancillary equipment building and unit valve skid buildings. The ancillary equipment building would include an air compressor system, hot water boiler, and back-up generator. A high-pressure vent system with a silencer would be installed to allow the compressor to be blown down. There would also be a small office in one of the buildings and the station would contain aboveground pig launcher/receiver equipment, an MLV, and a 140-foot-high communication tower. The compressor station would be secured by a 7-foot-high chain-link fence.

The Klamath Compressor Station would be utilized as a maintenance base for operation of the pipeline facilities. The station would not be manned 24 hours per day, but would have emergency pipe, spare parts, and equipment and tools stored on site.

Mainline Block Valves

Pacific Connector would install 17 MLVs along its pipeline in compliance with USDOT requirements (CFR 192.179) (see table 2.1.2.1-1). The MLVs would be within the construction and operational right-of-way for the pipeline, except for the MLVs at meter stations, the compressor station, and that include pig launchers and receivers. Five of the MLVs would be automated to allow remote operation, which would require a 40-foot communication tower to be installed within the facility's fenced footprint.

Pig Launchers/Receivers

Pig launchers and receivers would allow Pacific Connector to maintain the interior of its pipeline using remotely operated pipe inspection and cleaning tools (known as "pigs"). A pig launcher would be located within the proposed Klamath Compressor Station, and a pig receiver would be installed at the proposed Jordan Cove Meter Station. There would also be pig launcher and receivers at MLVs #6, #11, and #14. The pig launcher and receiver facilities would be fenced at all locations.

Gas Control Communications

The meter stations and compressor station would require a communications link with the gas control monitoring system. New radio towers are proposed at the Jordan Cove Meter Station, the Klamath Falls Compressor Station, and at five MLVs. Pacific Connector has conducted initial communications studies and determined that leased space on eight existing communication towers would also be needed for gas control communications (see table 2.1.2.1-2 and figure 1.1-1). For the five locations on federal lands, Pacific Connector prepared a *Communication Facilities Plan* (dated January 2013) as part of its POD.

TABLE 2.1.2.1-2

Proposed and Existing Gas Control Communication Towers

Facility	County	Landowner	Tower Height (ft)	Operational Acres a/
Proposed New Towers Within Proposed Aboveground Facility Sites				
Jordan Cove Meter Station b/	Coos	Private (Pacific Connector)	140	1.7 c/
MLV #4	Douglas	BLM	40	0.1
MLV #10	Jackson	Private	40	0.1
MLV #11, Launcher/Receiver (Butte Falls)	Jackson	Private	40	0.3
MLV #15 (Klamath River)	Klamath	Private	40	0.1
MLV #16 (Hill Road)	Klamath	Private	40	0.1
Klamath Compressor Station	Klamath	Private (Pacific Connector)	140	17
Existing Communication Tower Sites d/				
Blue Ridge	Coos	BLM (Coos District)	170	0.2
Signal Tree (Kenyon Mt.)	Coos	BLM (Coos District)	120	0.2
Sheep Hill	Douglas	Private	125	0.2
Harness Mountain e/	Douglas	Private (Northwest Pipeline)	150	0.0
Starveout Communication	Jackson	Private	115	0.2
Flounce Rock	Jackson	BLM (Medford District)	120	0.2

TABLE 2.1.2.1-2 (continued)

Proposed and Existing Gas Control Communication Towers

Facility	County	Landowner	Tower Height (ft)	Operational Acres a/
Robinson Butte	Jackson	Forest Service (Rogue River National Forest)	125	0.2
Stukel Mountain	Klamath	BLM (Lakeview District)	100	0.2

a/ Acreages are rounded to the nearest 0.1 acre.
b/ A tower at this site would only be necessary if Pacific Connector is unable to mount an antenna on one of the structures within the LNG terminal site.
c/ The towers at meter or compressor stations and MLVs would be within the fenced operational area of the facilities.
d/ Space would be leased on an existing tower, or a new tower and equipment building installed if lease space is not available. Operational acres column assumes worst case.
e/ Communication equipment would be installed on an existing tower.

2.1.3 BLM and Forest Service Land Management Plan Amendment Actions

2.1.3.1 Proposed Amendments of the BLM Districts RMPs

Approximately 46.9 miles of the proposed Pacific Connector pipeline route would cross federal land administered by BLM Coos Bay, Roseburg, and Medford Districts and the Klamath Falls Field Office of the Lakeview District.

Similar to a county zoning ordinance, projects or activities that occur on BLM lands must be consistent with the respective RMP where the project or activity occurs. The proposed Right-of-Way for the Project on BLM-managed lands would not conform to the Southwestern Oregon RMP and the Northwestern and Coastal RMP (RMPs for Western Oregon). The RMPs for Western Oregon allow for the construction of linear rights-of-way within the LSR "as long as northern Spotted Owl (NSO) nesting-roosting habitat continues to support nesting and roosting at the stand level, and NSO dispersal habitat continues to support movement and survival at the landscape level," and construction of linear rights-of-way "as long as the occupied stand continues to support marbled murrelet nesting" (BLM 2016b: 71; BLM 2016a: 65). BLM staff initially evaluated that the proposed right-of-way would cross approximately 268 acres of LSR and approximately 116 acres of known or presumed occupied marbled murrelet (MAMU) habitat and/or NSO nesting-roosting habitat within LSR. Additional analysis concluded that the clearing and removal of vegetation required within the LSR for the proposed Project would likely result in some NSO habitat no longer continuing to support nesting and roosting at the stand level, and some MAMU habitat no longer continuing to support nesting at the stand level.

BLM management direction in the RMPs for Western Oregon specific to wildlife prohibits activities that "*disrupt marbled murrelet nesting at occupied sites ... within all land use allocations within 35 miles of the Pacific Coast and... within reserved land use allocation between 35-50 miles of the Pacific Coast*" (BLM 2016b:118; BLM 2016a: 98). BLM staff concluded that construction of the Project would likely result in disruption of MAMU nesting at some occupied sites within these two discrete geographic ranges.

In order to consider the Right-of-Way Grant, the BLM must address these inconsistencies by amending the affected RMPs to make provisions for the Project. BLM therefore proposes to amend the RMPs to re-allocate all lands within the proposed temporary use area and right-of-way to a District-Designated Reserve, with management direction to manage the lands for the purposes of the Pacific Connector Gas Pipeline Right-of-Way. Approximately 885 acres would be re-allocated. District-Designated Reserve allocations establish specific management for a specific use or to protect specific values and resources. Other uses that are compatible with the purpose of the District-Designated Reserve may be authorized.

District-Designated Reserve is an existing land use allocation in both the Northwestern and Coastal Oregon RMP and the Southwestern Oregon RMP. Under these RMPs, District-Designated Reserves encompass a wide variety of lands, including constructed facilities, infrastructure, roads, communication sites, seed orchards, quarries, lands biologically or physically unsuitable for timber production, Areas of Critical Environmental Concern (ACEC), and lands managed for their wilderness characteristics. District-Designated Reserves are reserved from sustained-yield timber production in order to manage them for another set of specific values and resources. Within the District-Designated Reserve, the BLM would maintain the values and resources necessary for construction, operation, maintenance, and decommissioning of the proposed Project.

Specifically, BLM proposes to add the following text to the RMPs for Western Oregon (BLM 2016a:59; BLM 2016b: 57):

<u>District-Designated Reserve – Pacific Connector Gas Pipeline</u>

Management Objectives

- See *District-Designated Reserves* management objectives.
- Maintain the values and resources for which the BLM has granted the right-of-way for the Pacific Connector Gas Pipeline Project.

Management Direction

- Allow the construction, operation, maintenance, and decommissioning of the Pacific Gas Connector Pipeline, notwithstanding the restrictions and requirements of management direction described for resource programs.

The Project-specific amendment would not change RMP requirements for other projects or authorize any other actions. Therefore, resource impacts of the proposed plan amendments are those associated with construction, operation, maintenance and decommissioning of the proposed pipeline. With this amendment, the granting of a ROW on BLM-managed lands for the Pacific Connector Project would conform to the Southwestern Oregon Record of Decision and Resource Management Plan (BLM 2016b) and the Northwestern and Coastal Oregon ROD and RMP (BLM 2016a).

Amendment Approaches Considered

Four different approaches were considered to address the identified plan conformance issues. Three were evaluated and determined to have resource and management impacts beyond those associated with the direct, indirect, induced and cumulative effects of construction, operation, maintenance, and decommissioning the proposed Project.

<u>Change Management Direction for LSR, NSO, and MAMU to Accommodate Rights-of-Way</u>

The BLM considered eliminating the requirement that rights-of way maintain NSO nesting-roosting habitat function and continue to support MAMU nesting in occupied stands within LSR at the stand level and removing the prohibition on activities that disrupt MAMU nesting at occupied sites within 35 miles of the Pacific coast. Similar rights-of-way that may be proposed in the future would conform with plan direction for LSR, NSO, and MAMU.

No projects of a similar nature have been proposed. However, this approach would reduce protections for LSR, NSO, and MAMU provided by the RMPs for Western Oregon throughout the LSR land use allocation and in all allocations within 35 miles of the Pacific coast, and could substantially alter the effects analysis conducted by the BLM for NSO and MAMU in the two RMPs for western Oregon. This alternative could trigger re-initiation of ESA consultation on BLM RMPs for western Oregon.

This amendment approach would generate environmental effects beyond those associated with the construction, operation, maintenance, and decommissioning of the proposed Project pipeline and is beyond the scope of the application submitted by the proponent and currently under consideration by the BLM. For these reasons, the BLM determined that this amendment approach would not meet the BLM's purpose and need. This amendment approach was not analyzed in further detail.

<u>Change Management Direction for LSR, NSO, and MAMU at Specific Locations</u>

The BLM considered amendments to the RMPs for Western Oregon to specifically exempt the proposed Project from management direction for LSR, NSO, and MAMU in with known conformance problems (known MAMU occupied stands, existing MAMU nesting habitat, and existing NSO nesting-roosting habitat). This amendment approach would not create environmental effects beyond those associated with construction, operation, maintenance, and decommissioning of the proposed Project. However, unanticipated or currently unknown conformance problems, such as newly identified MAMU occupied stands, could arise which would require additional amendments and supplemental analysis following completion of the FERC-prepared EIS.

This amendment approach presents a risk that could require additional amendments and supplemental analysis, and would result in identical environmental effects if the proposed Project right-of-way is granted. For these reasons, the BLM determined that this amendment approach is substantially similar to the proposed action and would not fulfill the BLM's commitment as a cooperating agency in the preparation of the EIS should supplemental analysis be required. This amendment approach was not analyzed in further detail.

<u>Designate All Lands within the Proposed Right-of-Way as a Right-of-Way Corridor</u>

Designation of a Right-of-Way Corridor under 43 CFR 2806 would be for the purpose of construction, operation, maintenance, and decommissioning of the proposed Project. Designated Rights-of-Way Corridors are typically 1,000 to 2,000 feet in width and designed to encourage co-location of additional facilities in the future. Designating a Right-of-Way Corridor would require an analysis of reasonably foreseeable projects that could be co-located in the future and could substantially alter the effects analysis conducted by the BLM for NSO and MAMU in the two RMPs for western Oregon. This amendment approach could trigger re-initiation of ESA consultation on BLM RMPs for Western Oregon.

This amendment approach would generate environmental effects beyond those associated with the construction, operation, maintenance, and decommissioning of the proposed Project pipeline and is beyond the scope of the application submitted by the proponent and currently under consideration by the BLM. For these reasons, the BLM determined that this amendment approach would not meet the BLM's purpose and need. This amendment approach was not analyzed in further detail.

2.1.3.2 Proposed Amendments of National Forest LRMPs

Approximately 30.6 miles of the Pacific Connector pipeline route would cross NFS lands administered by the Umpqua, Rogue River, and Winema National Forests (see figure 1.1-2). NFS lands are managed according to current LRMPs. Similar to a county zoning ordinance, projects or activities that occur on NFS lands must be consistent with the respective LRMP where the project or activity occurs. As proposed, the Pacific Connector Pipeline Project would not be consistent with certain provisions of the affected Forest Service LRMPs. Before the Forest Service can consent to the BLM Right-of-Way Grant application, the Forest Service must amend the affected LRMPs to make provisions for the Pacific Connector Project. With the exception of amendments to reallocate Matrix lands to LSR, the LRMP amendments described below are specific to the Pacific Connector Pipeline Project. The project-specific amendments would not change LRMP requirements for other projects or authorize any other actions. With these amendments, the Pacific Connector Pipeline Project would be a conforming use of the affected National Forests.

In addition to the proposed amendments specific for each National Forest described in the sections below, table 2.1.3.2-1 describes the proposed amendments that would apply to all three National Forests.

TABLE 2.1.3.2-1

Forest Service LRMP Amendments Associated with the Pacific Connector Pipeline Project that Apply to the Umpqua, Rogue River, and Winema National Forests

Amendment #	Amendment	Description
FS-1	Project-Specific Amendment to Exempt Management Recommendations for Survey and Manage Species on the Umpqua, Rogue River and Winema National Forests:	These National Forest LRMPs would be amended to exempt certain known sites within the area of the proposed Pacific Connector right-of-way grant from the Management Recommendations required by the 2001 "Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines. For known sites within the proposed right-of-way that cannot be avoided, the 2001 Management Recommendations for protection of known sites of Survey and Manage species would not apply. For known sites located outside the proposed right-of-way but with an overlapping protection buffer only that portion of the buffer within the right-of-way would be exempt from the protection requirements of the Management Recommendations. Those Management Recommendations would remain in effect for that portion of the protection buffer that is outside of the right of way. The proposed amendment would not exempt the Forest Service from the requirements of the 2001 Survey and Manage Record of Decision, as modified, to maintain species persistence for affected Survey and Manage species within the range of the northern spotted owl. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The amendment would provide an exception from these standards for the Pacific Connector Project and include specific mitigation measures and project design requirements for the project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.9(a)(2)(ii) – [the plan must include plan components to maintain or restore] "Rare aquatic and terrestrial plant and animal communities." § 219.9(b)(1) – "The responsible official shall determine whether or not the plan components required by paragraph (a) provide ecological conditions necessary to: …maintain viable populations of each species of conservation concern within the plan area."

2.1.3.3 Proposed Amendments Specific to the Umpqua National Forest LRMP

The Forest Service proposes to amend the Umpqua National Forest LRMP. The proposed amendments are described in table 2.1.3.3-1.

TABLE 2.1.3.3-1

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Umpqua National Forest

Amendment #	Amendment	Description
UNF-1	Project-Specific Amendment to Allow Removal of Effective Shade on Perennial Streams:	The Umpqua National Forest LRMP would be amended to exempt the Standards and Guidelines for Fisheries (Umpqua National Forest LRMP, page IV-33, Forest-Wide) to allow the removal of effective shading vegetation where perennial streams are crossed by the Pacific Connector right-of-way. This change would potentially affect an estimated total of three acres of effective shading vegetation at approximately five perennial stream crossings in the East Fork of Cow Creek subwatershed from pipeline mileposts (MP) 109 to 110 in Sections 16 and 21, T.32S., R.2W., W.M., OR. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(3)(i) – The plan must include plan components "to maintain or restore the ecological integrity of riparian areas in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity."
UNF-2	Project-Specific Amendment to Allow the Pacific Connector Pipeline Project in Riparian Areas	The Umpqua National Forest LRMP would be amended to change prescriptions C2-II (LRMP IV-173) and C2-IV (LRMP IV-177) to allow the Pacific Connector pipeline route to run parallel to the East Fork of Cow Creek for approximately 0.1 mile between about pipeline MPs 109.5 and 109.6 in Section 21, T.32S., R.2W., W. M., OR. This change would potentially affect approximately one acre of riparian vegetation along the East Fork of Cow Creek. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(3)(i) – The plan must include plan components "to maintain or restore the ecological integrity of riparian areas in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity"
UNF-3	Project-Specific Amendment to Exempt Limitations on Detrimental Soil Conditions within the Pacific Connector Right-of-Way in All Management Areas:	The Umpqua National Forest LRMP would be amended to exempt limitations on the area affected by detrimental soil conditions from displacement and compaction within the Pacific Connector right-of-way. Standards and Guidelines for Soils (LRMP page IV-67) requires that not more than 20 percent of the project area have detrimental compaction, displacement, or puddling after completion of a project. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(2)(ii) – [The plan must include plan components to maintain or restore] "soils and soil productivity, including guidance to reduce soil erosion and sedimentation."

TABLE 2.1.3.3-1 (continued)

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Umpqua National Forest

Amendment #	Amendment	Description
UNF-4	Reallocation of Matrix Lands to LSR	The Umpqua National Forest LRMP would be amended to change the designation of approximately 585 acres from Matrix land allocations to the LSR land allocation in Sections 7, 18, and 19, T.32S., R.2W.; and Sections 13 and 24, T.32S., R.3W., W.M., OR. This change in land allocation is proposed to partially mitigate the potential adverse impact of the Pacific Connector Pipeline Project on LSR 223 on the Umpqua National Forest. This is a plan level amendment that would change future management direction for the lands reallocated from Matrix to LSR. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(1)(i) – [the plan must include plan components to maintain or restore] "Interdependence of terrestrial and aquatic ecosystems in the plan area." § 219.8(b)(1) – [the plan must include plan components to guide the plan area's contribution to social and economic sustainability] "Social, cultural and economic conditions relevant to the area influenced by the plan." § 219.9(b)(1) "The responsible official shall determine whether or not the plan components required by paragraph (a) of this section provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area," and § 219.9(a)(2)(ii) – [the plan must include plan components to maintain or restore] "Rare aquatic and terrestrial plant and animal communities."

If any of the proposed amendments to the Umpqua National Forest LRMP described above are determined to be "directly related" to a substantive rule requirement, the Responsible Official must apply that requirement within the scope and scale of the proposed amendment and, if necessary, make adjustments to the proposed amendment to meet the rule requirement (36 CFR 219.13 (b)(5) and (6)).

2.1.3.4 Proposed Amendments Specific to the Rogue River National Forest LRMP

The Forest Service proposes to amend the Rogue River National Forest LRMP. The proposed amendments are described in table 2.1.3.4-1.

TABLE 2.1.3.4-1

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Rogue River National Forest

Amendment #	Amendment	Description
RRNF-2	Project Specific Amendment of Visual Quality Objectives (VQO) on the Big Elk Road:	The Rogue River National Forest LRMP would be amended to change the VQO where the Pacific Connector pipeline route crosses the Big Elk Road at about pipeline MP 161.4 in Section 16, T.37S., R.4E., W.M., OR, from Foreground Retention (Management Strategy 6, LRMP page 4-72) to Foreground Partial Retention (Management Strategy 7, LRMP page 4-86) and allow 10-15 years for the amended VQO to be attained. The existing Standards and Guidelines for VQO in Foreground Retention where the Pacific Connector pipeline route crosses the Big Elk Road require that VQOs be met within one year of completion of the project and that management activities not be visually evident. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment that would apply only to the Pacific Connector Pipeline Project in the vicinity of Big Elk Road and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.10(a)(1) – […the responsible official shall consider: …] "(1) Aesthetic values,… scenery,... viewsheds...". § 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities,…and scenic character…"
RRNF-3	Project-Specific Amendment of VQO on the Pacific Crest Trail:	The Rogue River National Forest LRMP would be amended to change the VQO where the Pacific Connector pipeline route crosses the Pacific Crest Trail at about pipeline MP 168 in Section 32, T.37S., R.5E., W.M., OR, from Foreground Partial Retention (Management Strategy 7, LRMP page 4-86) to Modification (USDA Forest Service Agricultural Handbook 478) and to allow 15-20 years for amended VQOs to be attained. The existing Standards and Guidelines for VQOs in Foreground Partial Retention in the area where the Pacific Connector pipeline route crosses the Pacific Crest Trail require that visual mitigation measures meet the stated VQO within three years of the completion of the project and that management activities be visually subordinate to the landscape. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment that would apply only to the Pacific Connector Pipeline Project in the vicinity of the Pacific Crest Trail and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.10(a)(1) – […the responsible official shall consider: …] "(1) Aesthetic values,… scenery,... viewsheds...". § 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities,…and scenic character…"

TABLE 2.1.3.4-1 (continued)

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Rogue River National Forest

Amendment #	Amendment	Description
RRNF-4	Project-Specific Amendment of Visual Quality Objectives Adjacent to Highway 140:	The Rogue River National Forest LRMP would be amended to allow 10-15 years to meet the VQO of Middleground Partial Retention between Pacific Connector pipeline MPs 156.3 to 156.8 and 157.2 to 157.5 in Sections 11 and 12, T.37S., R.3E., W.M., OR. Standards and Guidelines for Middleground Partial Retention (Management Strategy 9, LRMP Page 4-112) require that VQOs for a given location be achieved within three years of completion of the project. Approximately 0.8 miles or 9 acres of the Pacific Connector right-of-way in the Middleground Partial Retention VQO visible at distances of 0.75 to 5 miles from State Highway 140 would be affected by this amendment. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment that would apply only to the Pacific Connector Pipeline Project in Sections 11 and 12, T.37S., R.3E., W.M., OR, and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.10(a)(1) – […the responsible official shall consider: …] "(1)Aesthetic values,… scenery,... viewsheds...". § 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities, . . . and scenic character...".
RRNF-5	Project-Specific Amendment to Allow the Pacific Connector Pipeline Project in Management Strategy 26, Restricted Riparian Areas:	The Rogue River National Forest LRMP would be amended to allow the Pacific Connector right-of-way to cross the Restricted Riparian land allocation. This would potentially affect approximately 2.5 acres of the Restricted Riparian Management Strategy at one perennial stream crossing on the South Fork of Little Butte Creek at about pipeline MP 162.45 in Section 15, T.37S., R.4E., W.M., OR. Standards and Guidelines for the Restricted Riparian land allocation prescribe locating transmission corridors outside of this land allocation (Management Strategy 26, LRMP page 4-308,). The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a site-specific amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(3)(i) – The plan must include plan components "to maintain or restore the ecological integrity of riparian areas in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity"
RRNF-6	Site-Specific Amendment to Exempt Limitations on Detrimental Soil Conditions within the Pacific Connector Right-of-Way in All Management Areas:	The Rogue River National Forest LRMP would be amended to exempt limitations on areas affected by detrimental soil conditions from displacement and compaction within the Pacific Connector right-of-way in all affected Management Strategies. Standards and Guidelines for detrimental soil impacts in affected Management Strategies require that no more than 10 percent of an activity area should be compacted, puddled or displaced upon completion of project (not including permanent roads or landings). No more than 20 percent of the area should be displaced or compacted under circumstances resulting from previous management practices including roads and landings. Permanent recreation facilities or other permanent facilities are exempt (RRNF LRMP 4-41, 4-83, 4-97, 4-123, 4-177, 4-307). The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(2)(ii) – [The plan must include plan components to maintain or restore] "soils and soil productivity, including guidance to reduce soil erosion and sedimentation."

TABLE 2.1.3.4-1 (continued)

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Rogue River National Forest

Amendment #	Amendment	Description
RRNF-7	Reallocation of Matrix Lands to LSR	The Rogue River National Forest LRMP would be amended to change the designation of approximately 522 acres from Matrix land allocations to the LSR land allocation in Section 32, T.36S., R.4E. W.M., OR. This change in land allocation is proposed to partially mitigate the potential adverse impact of the Pacific Connector Pipeline Project on LSR 227 on the Rogue River National Forest. This is a plan level amendment that would change future management direction for the lands reallocated from Matrix to LSR. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(1)(i) – [the plan must include plan components to maintain or restore] "Interdependence of terrestrial and aquatic ecosystems in the plan area." § 219.8(b)(1) – [the plan must include plan components to guide the plan area's contribution to social and economic sustainability] "Social, cultural and economic conditions relevant to the area influenced by the plan." § 219.9(b)(1) "The responsible official shall determine whether or not the plan components required by paragraph (a) of this section provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area", and § 219.9(a)(2)(ii)– [the plan must include plan components to maintain or restore: …] "(ii) Rare aquatic and terrestrial plant and animal communities".

If any of the proposed amendments to the Rogue River National Forest LRMP described above are determined to be "directly related" to a substantive rule requirement, the Responsible Official must apply that requirement within the scope and scale of the proposed amendment and, if necessary, make adjustments to the proposed amendment to meet the rule requirement (36 CFR 219.13 (b)(5) and (6)).

2.1.3.5 Proposed Amendments Specific to the Winema National Forest LRMP

The Forest Service proposes to amend the Winema National Forest LMRP. The proposed amendments are described in table 2.1.3.5-1.

TABLE 2.1.3.5-1

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Winema National Forest

Amendment #	Amendment	Description
WNF-1	Project -Specific Amendment to Allow Pacific Connector Pipeline Project in Management Area 3:	The Winema National Forest LRMP would be amended to change the Standards and Guidelines for Management Area 3 (MA-3) (LRMP page 4-103-4, Lands) to allow the 95-foot-wide Pacific Connector pipeline project in MA-3 from the Forest Boundary in Section 32, T.37S., R.5E., W.M., OR, to the Clover Creek Road corridor in Section 4, T.38S, R.5. E., W.M., OR. Standards and Guidelines for MA-3 state that the area is currently an avoidance area for new utility corridors. This proposed Pacific Connector Pipeline Project is approximately 1.5 miles long and occupies approximately 17 acres within MA-3. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.10(a)(1) – [the responsible official shall consider] "Aesthetic values,… scenery,... viewsheds...". § 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities,…and scenic character…"

TABLE 2.1.3.5-1 (continued)

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Winema National Forest

Amendment #	Amendment	Description
WNF-2	Project-Specific Amendment of VQO on the Dead Indian Memorial Highway:	The Winema National Forest LRMP would be amended to allow 10-15 years to achieve the VQO of Foreground Retention where the Pacific Connector right-of-way crosses the Dead Indian Memorial Highway at approximately pipeline MP 168.8 in Section 33, T.37S., R.5E., W. M., OR. Standards and Guidelines for Scenic Management, Foreground Retention (LRMP 4-103, MA 3A, Foreground Retention) requires VQOs for a given location be achieved within one year of completion of the project. The Forest Service proposes to allow 10-15 years to meet the specified VQO at this location. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment that would apply only to the Pacific Connector Pipeline Project in the vicinity of the Dead Indian Memorial Highway and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.10(a)(1) – […the responsible official shall consider: …] "(1) Aesthetic values,… scenery,... viewsheds...". § 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities,… and scenic character…".
WNF-3	Project -Specific Amendment of VQO Adjacent to the Clover Creek Road:	The Winema National Forest LRMP would be amended to allow 10-15 years to meet the VQO for Scenic Management, Foreground Partial Retention, where the Pacific Connector right-of-way is adjacent to the Clover Creek Road from approximately pipeline MP 170 to 175 in Sections 2, 3, 4, 11, and 12, T.38S., R.5E., and Sections 7 and 18, T.38S., R.6E., W.M., OR. This change would potentially affect approximately 50 acres. Standards and Guidelines for Foreground Partial Retention (LRMP, page 4-107, MA 3B) require that VQOs be met within three years of completion of a project. The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment that would apply only to the Pacific Connector Pipeline Project in the vicinity of Clover Creek Road and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.10(a)(1) – […the responsible official shall consider: …] "(1) Aesthetic values,… scenery,... viewsheds...". § 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities,…and scenic character…".
WNF-4	Project -Specific Amendment to Exempt Limitations on Detrimental Soil Conditions within the Pacific Connector Right-of-Way in All Management Areas:	The Winema National Forest LRMP would be amended to exempt restrictions on detrimental soil conditions from displacement and compaction within the Pacific Connector right-of-way in all affected management areas. Standards and Guidelines for detrimental soil impacts in all affected management areas require that no more than 20 percent of the activity area be detrimentally compacted, puddled, or displaced upon completion of a project (LRMP page 4-73, 12-5). The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(2)(ii) – [The plan must include plan components to maintain or restore…] "Soils and soil productivity, including guidance to reduce soil erosion and sedimentation"

TABLE 2.1.3.5-1 (continued)

LRMP Amendments Associated with the Pacific Connector Pipeline Project Specific to the Winema National Forest

Amendment #	Amendment	Description
WNF-5	Project-Specific Amendment to Exempt Limitations on Detrimental Soil Conditions within the Pacific Connector Right-of-Way in Management Area 8:	The Winema National Forest LRMP would be amended to exempt restrictions on detrimental soil conditions from displacement and compaction within the Pacific Connector right-of-way within the Management Area 8, Riparian Area (MA-8). This change would potentially affect approximately 0.5 mile or an estimated 9.6 acres of MA-8. Standards and Guidelines for Soil and Water, MA-8 require that not more than 10 percent of the total riparian zone in an activity area be in a detrimental soil condition upon the completion of a project (LRMP page 4-137, 2). The amendment would provide an exception from these standards for the Pacific Connector Pipeline Project and include specific mitigation measures and project design requirements for the project. This is a project-specific plan amendment applicable only to the Pacific Connector Pipeline Project and would not change future management direction for any other project. The 36 CFR 219 planning rule requirements that are likely to be directly related to this amendment include: § 219.8(a)(2)(ii) – [The plan must include plan components to maintain or restore…] "Soils and soil productivity, including guidance to reduce soil erosion and sedimentation".

If any of the proposed amendments to the Winema National Forest LRMP described above are determined to be "directly related" to a substantive rule requirement, the Responsible Official must apply that requirement within the scope and scale of the proposed amendment and, if necessary, make adjustments to the proposed amendment to meet the rule requirement (36 CFR 219.13 (b)(5) and (6)).

2.1.4 Mitigation Actions Specific to the Right-of Way Grant on Federal Lands

Representatives of the BLM, Forest Service, and Reclamation have worked cooperatively with the FERC staff and the Project proponent to incorporate BMPs, project design features, and project requirements which would avoid, minimize, rectify, reduce, or eliminate environmental consequences (40 CFR 1502.14(f) and 1508.20(a-d)). The agencies deem these BMPs, project design features, or project requirements necessary to meet the respective regulatory requirements, accomplish the goals and objectives of their respective management plans, and to prevent unnecessary and undue environmental degradation. The BMPs, project design features, or requirements specific to the authorized use of BLM, NFS, and Reclamation lands are included as attachments to the applicant's POD. There are 28 appendices in the POD; they include draft monitoring elements to ensure that the wide array of actions are implemented and assess consistency of the actions relative to the goals and objectives of the respective LMPs. Collectively, the POD is incorporated into the Project's description, and is summarized in section 2.6.3 below.

In addition to the POD, the Forest Service has identified compensatory mitigation requirements. Additional detail is provided in section 2.1.5 below and in appendix F.

Under existing authorities and policy, the BLM may not specify compensatory mitigation specific to its lands or facilities; however, the BLM may incorporate the compensatory mitigation requirements of other agencies into the Right-of-Way Grant.

Reclamation has not identified any off-site compensatory mitigation measures specific to its lands or facilities.

2.1.5 Mitigation Plan Specific to NFS Lands

These compensatory mitigation actions are addressed programmatically in this EIS and may require additional analyses and surveys to comply with NEPA. The Forest Service anticipates this EIS would provide the basis for tiering subsequent site-specific NEPA analyses, in accordance with the CEQ regulations at 40 CFR 1508.28(b). As applicable, the Forest Service would conduct supplemental environmental analysis and consultation efforts with various federal, state, and local entities, as well as tribal governments, prior to authorizing future site-specific mitigation actions described in the CMP. The public would have the opportunity to comment on specific project proposals at that time. Subsequent environmental analysis for mitigation actions would not preclude the BLM from issuing authorizations necessary for construction and operation of the proposed pipeline project.

Forest Service interdisciplinary teams have developed a CMP for the Pacific Connector Pipeline Project specific to the national forests that would be impacted by the proposed project. The CMP is based on the respective LRMPs, the recommendations of the (2011) NSO recovery plan, the recommendations of the final Southern Oregon/Northern California Coast (SONCC) Coho Salmon Recovery Plan (2014), applicable Late Successional Reserve Assessments, and fifth-field Watershed Analyses (WA) for watersheds where impacts of the Pacific Connector Pipeline Project would occur. Members of the interagency team used professional judgment and knowledge of the affected landscapes to develop the mitigation actions described below. Mitigation measures reduce or compensate for environmental consequences of an action. Off-site mitigation is a supplemental mitigation to address important LRMP management objectives and standards and guidelines that cannot be fully mitigated on-site. Proposed mitigation actions are intended to be responsive to LRMP objectives that include:

- Compliance with the Aquatic Conservation Strategy;
- Habitat for Threatened or Endangered (T&E) species including the NSO and coho salmon;
- Mitigation of impacts and compliance with standards and guidelines for LSRs;
- Compliance with National Forest Management Act 2012 planning rule sustainability criteria at 36 CFR §§ 219.8 through 219.11; and
- Specific resource issues as they occur by watershed.

A central provision of the Forest Service CMP is that it is to remain adaptable to new information and changed conditions.

Table 2.1.5-1 describes the individual mitigation projects related to LRMP management goals and objectives on NFS lands that are included in the proposed action. These projects would be implemented by the Forest Service as a subsequent phase of the Pacific Connector Project with funding provided by the applicant. The applicant is also responsible for providing funding to Forest Service for planning efforts related to these mitigation actions.

TABLE 2.1.5-1

Mitigation Projects to Address LRMP Objectives on NFS Lands

Unit	Watershed	Mitigation Group	Project Type	Project Name	Quantity a/	Unit
Umpqua National Forest	Days Creek - South Umpqua	Stand Density Fuel Break	Fuels Reduction	Days Creek - South Umpqua Matrix Integrated Fuels Reduction	194	acres
		Stand Density Fuel Break	Fuels Reduction	Days Creek - South Umpqua LSR Integrated Fuels Reduction	254	acres
		Terrestrial Habitat Improvement	Snag Creation	Days Creek - South Umpqua LSR Snag Creation	32	acres
		Terrestrial Habitat Improvement	Snag Creation	Days Creek - South Umpqua Matrix Snag Creation	14	acres
		Terrestrial Habitat Improvement	Lupine Meadow Restoration	Upper Cow Creek Lupine Meadow Restoration	23	acres
	Elk Creek - South Umpqua	Aquatic and Riparian Habitat	Fish Passage	Elk Creek Fish Passage Culverts	5	sites
		Road sediment reduction	Road Storm-proofing	Elk Creek Road Storm-proofing	9.2	miles
		Road sediment reduction	Road Decommissioning	Elk Cr. Road Decommissioning	5.9	miles
		Stand Density Fuel Break	Fuels Reduction	Elk Creek Matrix Integrated Fuels Reduction	176	acres
		Stand Density Management	Commercial Thinning	Elk Creek LSR Enhancement	91	acres
		Stand Density Management	Off-site Pine Removal	Elk Creek LSR Off-site Pine Removal	300	acres
		Terrestrial Habitat Improvement	LWD Upland Placement	Elk Creek LSR LWD Placement	99	acres
		Terrestrial Habitat Improvement	Lupine Meadow Restoration	Elk Creek LSR Lupine Meadow Restoration	101	acres
		Terrestrial Habitat Improvement	Noxious Weed Treatment	Elk Creek Roadside Noxious Weeds	6.7	miles
		Terrestrial Habitat Improvement	Snag Creation	Elk Creek LSR Snag Creation	68	acres
		Fire Suppression	Water Source Improvement	Elk Creek Pump Chance	2	sites
	Evans Creek	Stand Density Fuel Break	Road Shaded Fuel Break	Evans Cr LSR Road Shaded Fuel Break	63	acres
	Trail Creek	Road sediment reduction	Road Decommissioning	Trail Creek Road Decommissioning	0.3	miles
		Road sediment reduction	Road Storm-proofing	Trail Creek Storm-proofing	2.2	miles
		Stand Density Fuel Break	Fuels Reduction	Trail Creek Matrix Integrated Fuels Reduction	500	acres
		Stand Density Fuel Break	Road Shaded Fuel Break	Trail Creek LSR Road Shaded Fuel Break	175	acres
		Terrestrial Habitat Improvement	Snag Creation	Trail Creek Matrix Snag Creation	109	acres
		Stand Density Management	Pre-commercial	Trail Creek LSR PCT Enhancement	112	acres
	Upper Cow Creek	Aquatic and Riparian Habitat	Fish Passage	Upper Cow Creek Fish Passage Culverts	6	sites
		Fire Suppression	Water Source Improvement	Upper Cow Creek Pump Chance	1	site
		Road Sediment Reduction	Road Closure	Upper Cow Creek Road Closure	1.2	miles
		Road Sediment Reduction	Road Decommissioning	Upper Cow Creek Road Decommissioning	1.0	miles
		Stand Density Fuel Break	Fuels Reduction	Upper Cow Creek LSR Integrated Fuels Reduction	632	acres
		Stand Density Fuel Break	Fuels Reduction	Upper Cow Creek Matrix Integrated Fuels Reduction	730	acres
		Stand Density Fuel Break	Road Shaded Fuel Break	Upper Cow Creek LSR Road Shaded Fuel Break	378	acres
		Stand Density Management	Commercial Thin	Upper Cow Creek LSR Enhancement	197	acres

TABLE 2.1.5-1 (continued)

Mitigation Projects to Address LRMP Objectives on NFS Lands

Unit	Watershed	Mitigation Group	Project Type	Project Name	Quantity a/	Unit
		Stand Density Management	Pre-commercial Thinning	Elk Creek LSR PCT Enhancement	116	acres
		Terrestrial Habitat Improvement	LWD Upland Placement	Upper Cow Creek LSR LWD Placement	65	acres
		Terrestrial Habitat Improvement	Snag Creation	Upper Cow Creek LSR Snag Creation	90	acres
		Terrestrial Habitat Improvement	Snag Creation	Upper Cow Creek Matrix Snag Creation	11	acres
		Reallocation of Matrix Lands to LSR	Land Re-Allocation from Matrix to LSR	LRMP Amendment UNF 4 LSR 223 Reallocation	585	acres
Rogue River National Forest	Little Butte Creek	Aquatic and Riparian Habitat	LWD In-stream	South Fork Little Butte Creek. LWD	1.5	mile
		Aquatic and Riparian Habitat	Stream Crossing Repair	Little Butte Creek Stream Crossing Decommissioning	32	sites
		Road sediment reduction	Road Decommissioning	Little Butte Creek Road Decommissioning	57.5	miles
		Stand Density Fuel Break	Pre-commercial Thinning	Little Butte Creek LSR Pre-commercial Thin	618	acres
		Terrestrial Habitat Improvement	Habitat Planting	Little Butte Creek Mardon Skipper Butterfly	20	acres
		Terrestrial Habitat Improvement	LWD Upland Placement	Little Butte Creek LSR LWD Placement	511	acres
		Terrestrial Habitat Improvement	Snag Creation	Little Butte Creek LSR Snag Creation	622	acres
		Reallocation of Matrix Lands to LSR	Land Reallocation from Matrix to LSR	LRMP Amendment RRNF 7, LSR 227 Reallocation	25	acres
	Big Butte Creek	Reallocation of Matrix Lands to LSR	Land Reallocation from Matrix to LSR	LRMP Amendment RRNF 7, LSR 227 Reallocation	497	acres
Winema National Forest	Spencer Creek	Aquatic and Riparian Habitat	Riparian Planting	Spencer Creek Riparian Planting	0.5	miles
		Aquatic and Riparian Habitat	Fencing	Spencer Creek Fencing	6.5	miles
		Aquatic and Riparian Habitat	LWD In-stream	Spencer Creek In-stream LWD	1.0	miles
		Aquatic and Riparian Habitat	Stream Crossing Repair	Spencer Creek Ford Hardening and Interpretive Sign	1	sites
		Aquatic and Riparian Habitat	Stream Crossing Repair	Spencer Creek Stream Crossing Decommissioning	25	sites
		Road sediment reduction	Road Decommissioning	Spencer Creek Road Decommissioning	29.2	miles
		Visuals	Stand Density Reduction	Clover Creek Visual Management.	114	acres

a/ Acres are rounded to the nearest whole acre and miles to the nearest tenth of a mile.

These mitigation actions would be a condition of the Forest Service letter of concurrence and would be included in the Right-of-Way Grant, if one were issued for this project. Implementation and funding of these actions would be carried out through negotiated agreements between the Forest Service and the applicant. A more detailed description of these mitigation actions is included in appendix F of this EIS.

2.1.6 Right-of-Way Grant to Cross Federal Lands

Pursuant to the Mineral Leasing Act of 1920 and in accordance with federal regulation 43 CFR Part 2880, the Pacific Connector Pipeline Project must secure a Right-of-Way Grant from the BLM to cross BLM, NFS, and Reclamation lands. Pacific Connector has applied to the BLM for a

Right-of-Way Grant to cross federal lands. The BLM proposes to consider issuance of a Right-of-Way Grant that provides terms and conditions for construction and operation of the Pacific Connector Project on federal lands in response to the proponent's application. Issuance of the Right-of-Way Grant must be in accordance with 43 CFR Parts 429, 2800, and 2880 and relevant BLM manual and handbook direction. In making this decision, the BLM would consider several factors including conformance with BLM RMPs and impacts on resources and programs. Following adoption of this EIS and receipt of concurrence from the Forest Service and Reclamation, the BLM would issue a Record of Decision that documents the agency's decision whether to amend the BLM RMPs and issue the Right-of-Way Grant. The Right-of-Way would incorporate the stipulations, project design features and mitigation, including compensatory mitigation specified by the concurring agencies.

This Right-of-Way Grant would be in addition to any authorization for the Project issued by the FERC. The Right-of-Way Grant, if approved, would be authorized by issuance of a Temporary Use Permit for up to three years for the pipeline clearing and construction, which would terminate upon completion of construction, and issuance of a Right-of-Way Grant for ongoing pipeline operations and maintenance for a 30-year term. The Temporary Use Permit contains the specific temporary construction and work areas necessary to build the Project. Once the Project is constructed and in operation, the Right-of-Way Grant would be modified to reflect the final location of the Project and the associated 50-foot-wide maintenance corridor29 plus any roads on federal lands or under federal easements that are necessary for operations.

2.1.7 Mitigation on Non-Federal Lands

Both Jordan Cove and Pacific Connector are currently developing mitigation plans to address environmental impacts occurring on non-federal lands as part of their proposed action. Currently, these mitigation plans include the CMP for wetland impacts (see section 4.3), as well as the avoidance and minimization plans included in the POD30 (though initially developed for federally-managed lands, most of the POD attachments apply to non-federal lands as well). Mitigation and BMPs are discussed in conjunction with the respective affected resources in chapter 4 of this EIS.

2.2 NON-JURISDICTIONAL FACILITIES

Under the NGA, the FERC is required to consider, as part of a decision to authorize jurisdictional facilities, all facilities that are directly related to a proposed project where there is sufficient federal control and responsibility to warrant environmental analysis as part of NEPA environmental review for the Project. Some proposed projects have associated facilities that do not come under the jurisdiction of the Commission. These "non-jurisdictional" facilities may be integral to the need for the proposed facilities, or they may be merely associated as minor components of the jurisdictional facilities that would be constructed and operated as a result of authorization of the proposed facilities. Non-jurisdictional actions associated with the Project were identified in

[29] In this EIS, the 50-foot-wide corridor may be referred to as the "operational maintenance corridor," "permanent maintenance corridor," "permanent pipeline easement," "permanent pipeline right-of-way," or similar, depending on the resource discussion and context. On all federal lands, the 50-foot-wide corridor would be based on a 30-year Right-of-Way with the federal land managing agencies, and would not constitute a permanent easement on federal lands.

[30] The POD was filed with the FERC as Appendix F.1 in Resource Report 1 as part of Pacific Connector's application on September 23, 2017.

association with both the LNG facility and the pipeline, as described below. Available environmental data further characterizing the impacts of the non-jurisdictional facilities is provided in our cumulative impacts analysis (section 4.14).

2.2.1 LNG Carriers

LNG exported from the Jordan Cove terminal to overseas markets would be transported in vessels specially designed and built for that task (i.e., LNG carriers). Jordan Cove expects that its terminal would be visited by about 100 to 120 LNG carriers per year. These carriers would be loaded with LNG at the terminal and deliver the cargo to customers, most likely around the Pacific Rim. LNG carriers would be under the ownership and control of third parties, not Jordan Cove, and would not be regulated by the FERC. The third-party owners and operators of the LNG carriers would have agreements with Jordan Cove for the transportation of the LNG to designated ports or customers. We do not have any information about the exact carriers that would be used to transport the LNG from the terminal; however, the slip and berth would be designed to accommodate LNG carriers as large as 217,000 m3 in capacity. Neither do we know the exact destinations for the LNG cargo nor the specific routes across the Pacific Ocean to customers that would be taken by LNG carriers, outside of the waterway within 12 miles of the Oregon Coast.

2.2.2 Southwest Oregon Regional Safety Center

Jordan Cove would construct the SORSC, a non-jurisdictional multi-organizational office complex, in the South Dunes area of the LNG terminal site. The SORSC would house the Jordan Cove Security Center, Coos County Dispatch Center, Coos County Emergency Operations Center, and offices for various businesses and agencies.

2.2.3 Fire Department

Jordan Cove would construct a stand-alone fire department building located in the access and utility corridor adjacent to the fire water tanks. This building would house the Jordan Cove Fire Department chief and staff.

2.2.4 Trans-Pacific Parkway/U.S. 101 Intersection Widening

Jordan Cove would add a turning lane to the Trans-Pacific Parkway (approximately 600 feet in length) to manage traffic entering U.S. Highway 101 from the west, and the addition of an automated traffic control signal. Approximately 1,150 wood piles would be installed along the road as part of this road-widening effort. The general location of the intersection is shown on figures 2.1-1 and 2.1-3.

2.2.5 Utility Connections for the Pipeline Facilities

All of the aboveground pipeline facilities would require either electrical power and/or telephone service. At the Klamath Compressor Station, electricity would be supplied by Pacific Power, which would require upgrades to an existing substation and distribution line immediately adjacent to the compressor station. New disturbance would be limited to the extension of three-phase distribution onto the compressor station property, and Pacific Connector states that Pacific Power does not anticipate disturbance would be required in new areas outside of the existing road right-of-way or existing Pacific Power right-of-way or fenced facilities. Water would be provided from water wells located on property owned by Pacific Connector, immediately adjacent to the compressor station. Telecommunications would be provided by Cal-Ore, which would require a short tie-in from the existing service available immediately adjacent to the compressor station.

For the Jordan Cove Meter Station, Pacific Power would supply electricity through a connection to an existing powerline located adjacent to the Trans Pacific Lane southwest of Ingram Yard. Telecommunications would be supplied from three existing networks, ORCA Communications, LS Networks, and Frontier Communications, through extensions of fiber optic and cable that would be installed to the SORSC proposed by Jordan Cove.

Pacific Connector has located its automated mainline valve facilities near available electrical power facilities such that only short tie-ins would be required. If it were to become necessary, in lieu of purchased power, thermal power generation equipment would be installed to provide electricity for the minimal power requirement at these sites.

2.3 LAND REQUIREMENTS

2.3.1 Jordan Cove LNG Terminal Facilities

The Jordan Cove LNG Project would require the use of about 1,355 acres of land. When complete, the Jordan Cove LNG terminal would occupy about 197 acres. Jordan Cove owns about 295 acres at the terminal site and would acquire the use of the remaining area (e.g., via easements or lease). Table 2.3.1-1 lists the land requirements for the Jordan Cove LNG terminal facilities.

TABLE 2.3.1-1

Land Requirements for the Jordan Cove LNG Project a/

Facilities	Acres Required During Construction b/	Acres Required During Operation b/
JURISDICTIONAL FACILITIES		
Total for Jurisdictional Facilities	202.6	197.1
NON-JURISDICTIONAL FACILITIES		
Southwest Oregon Regional Safety Center	5.4	5.4
Fire Department	0.8	0.8
Total for Non-Jurisdictional Facilities	**6.2**	**6.2**
TEMPORARY CONSTRUCTION AREAS		
Total for Temporary Construction Areas	**368.1**	**0**
MITIGATION SITES		
Eelgrass Mitigation Area and Dredge Line	33.4	0
Kentuck Project and Dredge Line	135.6	0
Panhandle Site	132.6	0
Lagoon Site	320.3	0
North Bank Site	156.1	0
Total for Mitigation Sites	**778.0**	**0.0**
GRAND TOTAL	**1,355.1**	**203.3**

a/ This table lists the acres of land that would be encompassed by Project components or mitigation areas, but may not directly relate to areas that would experience direct effects (e.g., the entire footprint of each of the mitigation areas may not experience direct effects such as clearing, but are included in this table to disclose the scope of the projects footprint). See chapter 4 for the acres of land and resources that would be affected by the Project.
b/ Columns may not sum correctly due to rounding.

2.3.2 Pacific Connector Pipeline and Associated Aboveground Facilities

Constructing and operating the Pacific Connector pipeline would require the use of about 4,946 acres of land, and about 1,403 acres of land, respectively. Table 2.3.2-1 lists the land requirements for the Pacific Connector Pipeline Project.

TABLE 2.3.2-1

Land Requirements for the Pacific Connector Pipeline Project a/

Project Component	Land Required During Construction (acres) b/	Land Required During Operation (acres) b/
Pipeline Right-of-Way	2,582.0	1,373.7 c/
Temporary Extra Work Areas	922.6 d/	0
Uncleared Storage Areas	676.4	0
Rock Source & Disposal Sites e/	41.2 e/	0
Contractor and Pipe Storage Yards	674.2	0
Access Roads	28.5 f/	2.2
Aboveground Facilities	21.4 g/	27.0 g/
Totals	**4,946.4**	**1,402.9**

a/ This table lists the acres of land that would be encompassed by Project components or designations (e.g., permanent easements), but may not directly relate to areas that would experience direct effects (e.g., the entire permanent easement would not be cleared during operation). See chapter 4 for the acres of land and resources that would be affected by the Project.
b/ Columns may not sum correctly due to rounding.
c/ 50-foot-wide permanent pipeline easement (on federal lands, 30-year maintenance corridor).
d/ Includes TEWAs, existing quarries, rock sources, and disposal areas that may be used as permanent storage areas. These areas would not be used during operation of the Project, and therefore are not included in the operational total.
e/ Includes rock source and disposal sites that would remain disturbed following construction but would not be used during operation of the Project and therefore are not included in the operational total.
f/ Road improvements would remain following construction, but these roads would not be used for operation of the Project and therefore are not included in the operational total.
g/ Construction impacts associated with the aboveground facilities are included in the construction land requirement for the pipeline right-of-way and TEWAs except the potential off-right-of-way communication tower sites and the Klamath Compressor station, which are included here. Portions of aboveground facilities that fall within the permanent pipeline easement are included under Pipeline Right-of-Way.

For private and non-federal lands crossed by the pipeline, Pacific Connector would need to negotiate a mutually agreed upon easement for its pipeline with the affected landowners. The agreement between Pacific Connector and the landowner would specify compensation for the easement, compensation for damage to property and loss of use during construction, and loss of renewable and nonrenewable or other resources. The agreement would also specify uses of the permanent right-of-way after construction. If the company is unable to reach an agreement with a landowner, and if the Project is authorized by the FERC, the Certificate would convey the right of eminent domain under section 7h of the NGA. In these situations, Pacific Connector could initiate condemnation proceedings, and the value of the easement and the amounts for compensatory damages would be determined by a local, state, or district court.

2.3.2.1 Pipeline

Construction Right-of-Way

As illustrated in figure 2.3-1, Pacific Connector would generally construct the pipeline using a 95-foot-wide right-of-way. Pacific Connector would also use, as necessary, temporary extra work areas (TEWAs) to accommodate construction across waterbodies, roads, steep terrain, dense forest, and other areas of concern.[31] Where feasible (i.e., where topographic conditions allow) through forested and scrub-shrub wetlands as well as stream crossings, the construction right-of-way would be narrowed to 75 feet in width to minimize impacts on these resources and be consistent with the FERC's *Procedures* (Section VI.A.3). See additional discussion in section 4.3 of this EIS.

[31] About 42 acres of the TEWAs would be existing quarries, rock sources, or rock disposal areas that would be permanent storage areas for excess rock, and these areas would remain as exposed rock sites following construction.

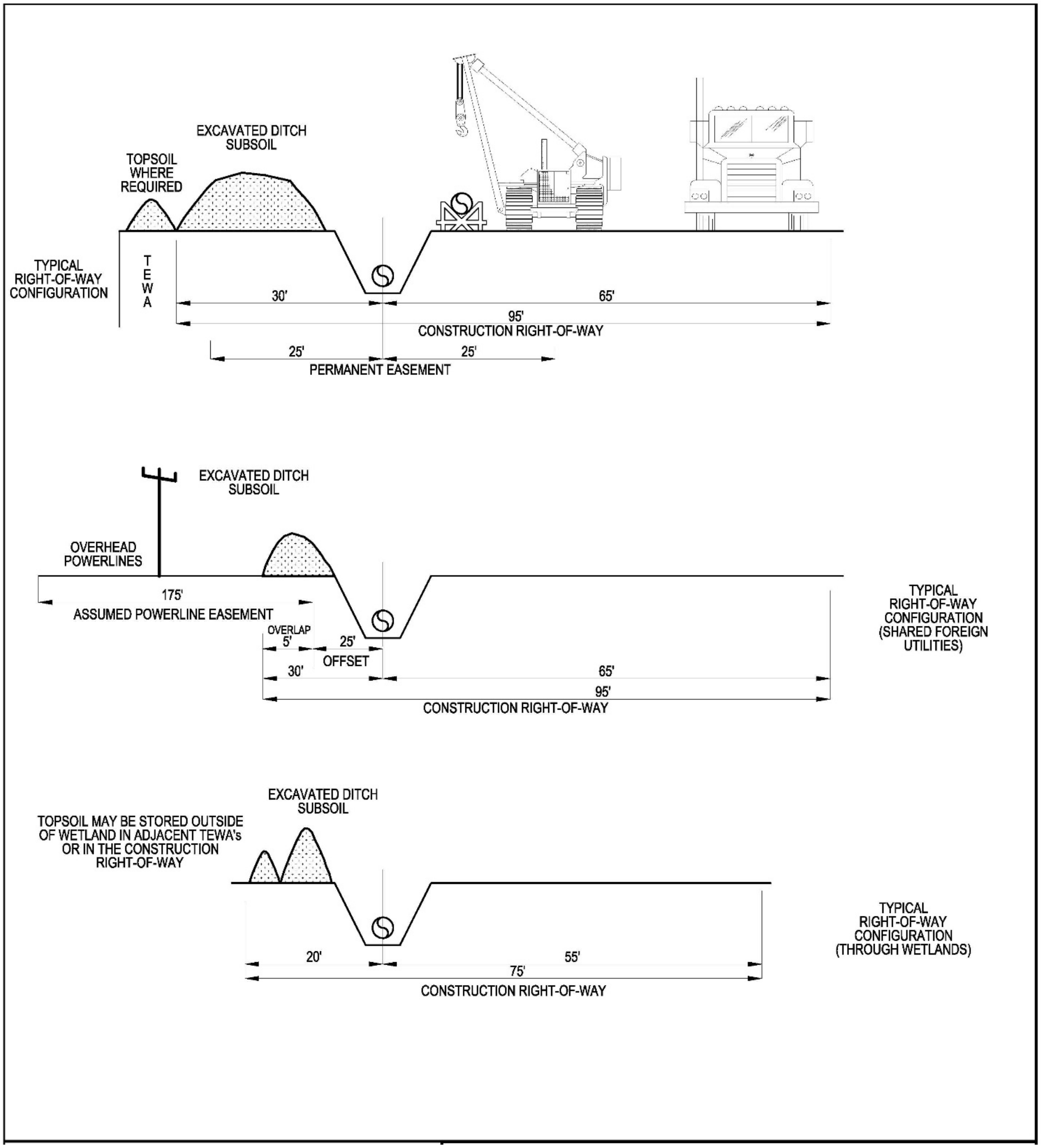


Figure 2.3-1. Typical Pipeline Right-of-Way Cross Sections

Pacific Connector would also use approximately 676 acres of uncleared storage areas (UCSA). UCSAs would not be cleared of trees during construction. UCSAs would be used to store forest slash, stumps, and dead and downed log materials that would be removed from the construction work area before construction and then scattered back across the right-of-way after construction.

In some locations, the UCSAs may be used to store spoil or to temporarily park equipment between the mature trees. However, storage and temporary parking of equipment/vehicles would not occur immediately adjacent to any trees so as to minimize tree damage. In extremely steep and side sloping topography, the UCSAs may be required as a contingency location to contain rock which rolls beyond the construction limits. Along extremely steep and narrow ridgeline areas, logs, slash, and dead and downed material may be used as cribbing to contain materials disturbed or excavated during right-of-way grading and trenching activities. During restoration, some of the materials that are pulled out of the cribbing may roll beyond the construction limits. Where feasible, Pacific Connector would retrieve materials that have rolled downhill using cables and chokers attached to standard on-site restoration equipment (i.e., bulldozers and trackhoes) to winch the material back to the right-of-way. There may be some cases where retrieval of the lost cribbing material may cause more harm to resources than allowing it to remain where it settled. On federal lands, Pacific Connector would protect trees within the UCSAs in accordance with the procedures outlined in its *Leave Tree Protection Plan* (Appendix P of its POD). After construction, the UCSAs would be restored to their pre-construction condition and use.

Operational Pipeline Right-of-Way

Pacific Connector would retain a 50-foot-wide permanent easement for the long-term operation and maintenance of the pipeline on non-federal lands. On federal lands, an operational right-of-way may be issued for a specific period of use, with potential for extension. After construction, workspace outside of the maintenance easement would be restored to its original condition and use (although mature forest would take many years to be re-established). The restoration and revegetation of the temporary construction right-of-way would be done in accordance with Pacific Connector's *Erosion Control and Revegetation Plan* (ECRP). On NFS and BLM lands where Riparian Reserves would be affected, up to a 100-foot riparian strip or to the edge of the existing riparian vegetation would be replanted adjacent to stream crossings.

Access Roads

Pacific Connector would primarily use existing roads to access pipeline workspaces. Existing roads that would be used for construction access are listed in table D-2 in appendix D of this EIS. Pacific Connector has identified 10 locations where it would be necessary to construct new temporary access roads (TARs). Pacific Connector has also identified 27 existing roads that would need to be modified to handle construction traffic. The roads would be stabilized using gravel and appropriate BMPs, as outlined in the ECRP, to minimize potential surface water runoff and to avoid potential sedimentation impacts. Following construction, new TARs would be removed, and the affected areas restored to pre-construction conditions.

Pacific Connector would construct 15 new permanent access roads (PARs) to access the pipeline and aboveground facilities. These roads would provide access during construction as well as during operations and maintenance activities. Most of the new PARs would be within Pacific Connector's operational pipeline easement.

Contractor and Pipe Storage Yards

Pacific Connector has identified 36 potential sites for yards and rail ports that may be used during construction to off-load and store pipe and stage contractor equipment (see table D-9 in appendix D). These sites are near the pipeline but generally not immediately adjacent to the proposed pipeline.

Pacific Connector has identified approximately 920 acres of TEWAs that would be disturbed during construction of the pipeline. All of these areas are considered temporary disturbance and would be restored upon completion of construction. All TEWAs that were forested prior to construction would be replanted with trees.

Rock Source and Permanent Disposal Sites

Pacific Connector has identified 20 potential rock source/disposal sites. These sites are indicated on the Mapping Supplement included as appendix C of this EIS. Of these locations, 15 sites are existing quarries/gravel pits or abandoned quarries/gravel pits. Although some of the existing/abandoned sites appear to have land use types other than quarries/gravel pits, Pacific Connector would not expand these sites beyond the existing or previously disturbed footprints.

Cathodic Protection System

Pacific Connector would protect the pipeline from corrosion over time through a cathodic protection (CP) system. The CP system would consist of below ground rectifier/anode beds that input a low voltage electrical charge into the pipeline. These rectifier/anode beds would be spaced about 30 to 40 miles apart and typically installed within previously disturbed areas near the permanent pipeline right-of-way. Each CP site would use electric power from a local utility. A typical CP site would include installation by a standard backhoe within an area up to 500 feet long by 15 feet wide and 5 feet deep. In limited locations a deep CP site may be required which would be installed by a truck-mounted drill rig. Identification of the CP sites and installation itself would occur about one year after pipeline installation to allow the trench to stabilize and for collection of post-construction data on electro-conductivity soil potentials, which is required before the system can be designed and installed. Pacific Connector would consult with appropriate federal, state, and local regulatory agencies after pipeline construction to determine the level of environmental compliance and agency authorizations necessary for the installation and maintenance of the CP system. On federal lands, any ground-disturbing construction and installation work to install the CP system would require separate authorization and environmental review.

2.3.2.2 Aboveground Facilities

Land required for construction and operation of the proposed aboveground facilities is listed in table 2.3.2-1 above. Operation of the aboveground facilities would require about 27 acres outside of the pipeline operational right-of-way.

2.3.2.3 Pipeline Facilities on Federal Lands

The Pacific Connector pipeline would cross 46.9 miles of federal land managed by the BLM, 30.6 miles managed by the Forest Service, and 0.31 mile managed by Reclamation (see table 2.3.2.3-1). The temporary and permanent acres of impact from the specific components are also provided in table 2.3.2.3-1. Tables 2.3.2.3-2 and 2.3.2.3-3 show the breakout by BLM District and by National Forest of the miles crossed through the various 2016 BLM RMP and Northwest Forest

Plan (NWFP) land allocations. Table 2.3.2.3-4 lists the Reclamation jurisdictional facilities, with their milepost locations, easement widths, acres of impact, and townships, ranges, and sections.

TABLE 2.3.2.3-1

Federal Lands Affected by the Pacific Connector Pipeline Project

Pipeline Facility/Component	Jurisdiction: BLM	Forest Service	Reclamation
Miles Crossed by Pipeline	46.9	30.6	0.31
Temporary Construction Acreage Requirements (acres)			
Construction Right-of-Way	535.02	349.75	3.69
TEWAs	166.26	102.76	0.46
UCSAs	183.75	123.17	0.00
Off-site Source/Disposal	6.99	9.26	0.00
Contractor and Pipe Storage Yards	0.00	0.00	0.00
Existing Roads Needing Improvements in Limited Locations a/	4.71	1.00	0.00
Temporary Access Roads	0.69	0.24	0.00
Total Temporary Impacts (acres)	**897.42**	**586.18**	**4.15**
Right-of-Way (50 feet)	284.00	185.35	1.90
Permanent Access Roads	0.34	0.00	0.00
Aboveground Facilities	0.26 b/	0.00	0.00
30-Foot Maintained	170.38	111.20	1.14

a/ Includes those existing roads requiring widening in specific locations; does not include limbing/brush clearing or blading/grading for potholes.
b/ MLVs #4, #7, and #12 are located on BLM lands.

TABLE 2.3.2.3-2

BLM Federal Land Allocations – Miles Crossed by the Pacific Connector Pipeline

Land Use Allocation	Coos Bay District	Roseburg District	Medford District	Lakeview District	Total
District-Designated Reserve (No Harvest)	0.04	0.47	5.04	0.00	**5.55**
District-Designated Reserve (Non-Forest)	0.69	1.65	2.32	0.04	**4.70**
Eastside Management Area	0.00	0.00	0.00	0.26	**0.26**
Harvest Land Base (Low Intensity Timber Area)	0.73	0.00	0.68	0.00	**1.41**
Harvest Land Base (Moderate Intensity Timber Area)	2.61	1.65	0.00	0.00	**4.26**
Harvest Land Base (Uneven-Aged Timber Area)	0.00	2.73	1.98	0.97	**5.68**
Late-Successional Reserve (Dry Forest)	0.00	5.06	4.21	0.00	**9.27**
Late-Successional Reserve (Moist Forest)	11.40	1.52	0.00	0.00	**12.92**
Riparian Reserve a/ (Dry Forest)	0.00	0.16	0.92	0.02	**1.10**
Riparian Reserve a/ (Moist Forest)	1.60	0.11	0.00	0.00	**1.71**
Totals	**17.07**	**13.35**	**15.15**	**1.29**	**46.86**

a/ Calculated using 2016 RMP DATA\RWO_ROD_SWO.gdb/RWO_ROD_SWO_LUA_poly and 2016 RMP DATA\RWO_ROD_NCO.gdb/RWO_ROD_NCO_LUA_poly.

TABLE 2.3.2.3-3

Forest Service Federal Land Allocations – Miles Crossed by the Pacific Connector Pipeline

Jurisdiction	Late Successional Reserves (miles)	Matrix (miles)	Total	Riparian Reserves a/ (miles)
Forest Service – Umpqua	5.03	5.78	**10.81**	0.78
Forest Service – Rogue River-Siskiyou	13.72	0.00	**13.72**	0.24
Forest Service – Fremont-Winema	0.00	6.05	**6.05**	0.38
Total	**18.75**	**11.83**	**30.58**	**1.40**

a/ Riparian Reserves overlay other land use allocations.

TABLE 2.3.2.3-4

U.S Bureau of Reclamation Administered Lands and Canals

U.S Bureau of Reclamation (Reclamation) Jurisdictional Facilities (Easement Width) a/	Approx. Pipeline Milepost	Length of Pipeline Crossing (feet)	Index No. Easement Width	Waterbody ID b/	Quarter Quadrant	Township	Range	Section
C-4-E Lateral c/	NA	Not Crossed c/	KO-20-080 30 feet	ADX293	SWNE	39S	9E	20
Withdrawn Land	NA	Not Crossed	KO-20	N/A	SWNE	39S	9E	20
No. 1 Drain	200.54	14.59	KO-20-276 60 feet	ADX294	SWNE	39S	9E	20
C-4-E Lateral	201.63	15.49	KO-20-164 40 feet	ADX096	NENW	39S	9E	28
C-4 Lateral	204.12	48.18	KO-09-013 50 feet	ADX100	NWNE	40S	9E	3
C-4-F Lateral	204.33	12.91	KO-09-013 50 feet	ADX101	NWNE	40S	9E	3
No. 3 Drain	204.74	17.80	KO-09-14 60 feet	ADX105	NWNW	40S	9E	2
C-4-C Lateral	205.50	18.28	KO-09-018 60 feet	ADX109	SWNE	40S	9E	2
C Canal	205.96	54.90	KO-09-027 75 feet d/	ADX111	NWSW	40S	9E	1
D-2 Lateral	206.51	23.76	KO-09-050 60 feet	ADX113	NWNE	40S	9E	12
5-A-1 Drain	207.11	4.00	KO-09-053 60 feet	AW-114	NESE	40S	9E	12
5-A Drain	207.26	28.61	KO-09-054 50 feet d/	ADX115	NESE	40S	9E	12
C-4-7 Lateral	207.40	15.20	KO-10-031 60 feet	ADX116	NWSW	40S	10E	7
5-A Drain	207.42	16.84	KO-10-032 50 feet	ADX117	NWSW	40S	10E	7
5-A Drain	207.60	61.56	KO-10-032 50 feet	ADX118	SWSW	40S	10E	7
5-A Drain	207.99	25.26	KO-10-034 50 feet	ADX119	NENW	40S	10E	18
5-A Drain	208.18	19.94	KO-10-034 50 feet	ADX123	SENW	40S	10E	18
5-K Drain	209.02	24.95	KO-10-048 30 feet d/	ADX130	SESE	40S	10E	18
C-9 Lateral	209.15	16.03	KO-10-047 30 feet	ADX134	NWNW	40S	10E	20
No. 5 Drain	210.26	17.90	KO-10-061 50 feet	ADX143	SESE	40S	10E	20
5-H Drain	210.85	10.71	KO-10-074 20 feet	ADX260	SWNW	40S	10E	28
G Canal	213.87	43.90	KO-10-086 165 feet	ADX275	SESE	40S	10E	26
Total		**490.81**						

a/ Reclamation Facility Name, (easement width) Reclamation ID, and Index No included as attributes in Bureau of Reclamation Pacific Connector-Crossing Shapefile provided to Pacific Connector - January 7, 2009. Easement widths determined from scanned easement plats provided by Reclamation.

b/ Waterbody ID from Pacific Connector wetland and waterbody surveys as shown on the Environmental Alignment Sheets in Appendix AA to the POD.

c/ The C-4-E Lateral is not crossed by the centerline but the easement for the lateral is within the construction right-of-way for approximately 270 feet.

d/ Canal easement widths not provided on easement plats provided by Bureau of Reclamation; therefore, crossing widths estimated based on photography and similar canal easements on adjacent canals.

In addition to the permanent and temporary access roads needed for construction listed in the preceding tables, existing federal roads would also be used. It is estimated that approximately 276 miles of BLM roads, 113 miles of Forest Service roads, and 2 miles of Reclamation roads would be utilized for construction activities.[32] All of the requirements for the use of federal roads are included in Appendix Y of the POD (i.e., the *Transportation Management Plan* [TMP]). This POD attachment outlines the requirements for road use permits, maintenance, modification and reconstruction, road decommissioning, culvert/bridge upgrades, new road construction (PARs and TARs), and traffic management. The federal agencies are continuing to coordinate with the applicant in refining the TMP, and road miles may vary as a result.

2.4 CONSTRUCTION PROCEDURES

Under the provisions of the Natural Gas Pipeline Safety Act of 1968, as amended, Jordan Cove would design, construct, operate, and maintain the LNG terminal facilities in accordance with the USDOT's Liquefied Natural Gas Facilities: Federal Safety Standards (49 CFR 193). The loading facilities and any appurtenances located between the LNG carriers and the last valve immediately before the LNG storage tank would be required to comply with applicable sections of the Coast Guard regulations in Waterfront Facilities Handling Liquefied Natural Gas (33 CFR 127).

The proposed pipeline facilities would be designed, constructed, operated, and maintained in accordance with USDOT regulations in Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards (49 CFR 192). Among other design standards, these regulations specify pipeline material selection; minimum design requirements; protection from internal, external, and atmospheric corrosion; and qualification procedures for welders and operations personnel. In addition, Pacific Connector would comply with the siting and maintenance requirements of the FERC's regulations at 18 CFR 380.15, and other applicable federal and state regulations.

Jordan Cove and Pacific Connector would construct the Project in accordance with its project-specific *Erosion and Sediment Control Plan* (ESCP), its *Upland Erosion Control, Revegetation, and Maintenance Plan* (Jordan Cove's *Plan*) and its *Wetland and Waterbody Construction and Mitigation Procedures* (Jordan Cove's *Procedures*).[33] Jordan Cove adopted elements of the FERC's *Plan* and *Procedures* (May 2013 versions) into its *Plan* and *Procedures* as applicable for the Project (see appendix E for modifications). We have reviewed Jordan Cove's *Plan* and *Procedures* and find them to be consistent with the FERC's *Plan* and *Procedures*. In addition, Jordan Cove has prepared Spill Prevention, Containment, and Countermeasures (SPCC) Plans for both construction and operations.[34]

[32] Estimates derived from Table A.8-1 in Resource Report 8 of Pacific Connector's September 2017 application to the FERC.

[33] Jordan Cove's ESCP including its *Plan* and *Procedures* was attached as Appendix H.7 in Resource Report 7 as part of the Environmental Report included with Jordan Cove's September 2017 application to the FERC.

[34] Jordan Cove's construction and operation SPCC Plans were included as Appendices F.2 and G.2 of Resource Report 2, respectively, of its September 2017 application filed with the FERC.

2.4.1 Jordan Cove LNG Terminal

2.4.1.1 Upland Site Preparation

Temporary Concrete Batch Plant

One of the first construction procedures that Jordan Cove would undertake is the installation of a temporary concrete batch plant within the LNG terminal site or within a construction laydown area. The concrete batch plant would support construction of LNG terminal facilities that include concrete. A washout area would be located adjacent to the batch plant to allow for containment and disposal of waste water related to concrete batching operation.

Demolition and Clearing

Site preparation would include demolition, clearing, and removal and relocation of existing infrastructure to enable earthworks to progress. During this initial phase the IWWP and several existing utilities would be relocated. Other demolition and clearing activities would include:

- Removal and disposal of hydrocarbon contaminated soils – The South Dunes portion of the site contains small areas of hydrocarbon-contaminated soils remaining after the decommissioning of the former Weyerhaeuser paper mill. The contamination is located in the vicinity of the proposed site for the permanent buildings. Jordan Cove plans to conduct additional testing to further characterize the area of potentially contaminated soils and would develop a disposal plan for the approval of ODEQ and would remove and dispose of the contaminated soils in accordance with the approved plan.
- Clearing – The dune areas at the LNG terminal site would be cleared and any merchantable timber would be processed for commercial sale. Scrub and stumps would be processed into mulch for use during construction.

2.4.1.2 Material Deliveries

Transportation of materials, supplies, and staff to the LNG terminal site would be accomplished via a combination of road, marine transport, and rail. The larger and heavier pieces of equipment would be delivered to the site by marine transport in two phases. Initial marine deliveries would be via a temporary material barge berth, constructed in the existing shoreline within the footprint of the eventual marine slip. The temporary material barge berth would allow for material deliveries by barge while the permanent MOF is under construction and would be removed when construction of the MOF is completed.

Jordan Cove anticipates that some bulk materials, such as temporary buildings, construction equipment, steel reinforcement, pipe spools, cable drums, and insulation, would be delivered to the site by road. An existing rail line is located adjacent to the LNG terminal site and would be utilized for deliveries as permitted.

2.4.1.3 Earthworks and Soil Improvement

Earthworks would include removal of topsoil and storage for re-use, cut (excavation and dredging), fill (placement of excavated material), and grading of material to the approximate design elevations. The upland earthworks phase would include work by heavy equipment and require some periods of 24-hour operation. Jordan Cove would construct a temporary traffic overpass to allow separation of the traffic traveling to and from the existing Roseburg Forest Products Company from the large, off-road haul trucks and equipment required for the earthworks phase. During this phase boiler ash previously disposed on the site of the LNG terminal would be relocated to the South Dunes portion of the site where it would be buried within the fill.

The soil conditions at the site require improvement before any aboveground facilities can be constructed. These conditions include peat, clay, buried driftwood, and liquefiable soil, which could cause excessive settlement and stability concerns, or issues associated with liquefiable soils should a seismic event occur. Liquefiable soils within the LNG terminal site have been delineated in distinct soil layers from the groundwater table to various depths down to about 30 feet. A peat layer about 2-4 feet thick is present in areas of the site generally from just below the groundwater table to about 7 to 15 feet below grade. A layer of clay up to about 2.5 feet thick has been identified in areas of the South Dunes, and there are several areas in the South Dunes portion of the site where accumulations of buried driftwood are estimated to be present.

Jordan Cove plans to conduct additional site investigations to further characterize the existing subsurface conditions at the site and based on results would develop a plan for soil improvement, however potential soil improvements identified by Jordan Cove are listed below.

- Soil Densification Method 1 – Vibro-compaction could be utilized to condition liquefiable soils. This method consists of driving a vibration device into the sand layers to compact the soils.
- Soil Densification Method 2 – Sand compaction piles could be utilized to compact liquefiable soils, depending on the availability of suitable equipment.
- Organic Material Treatment Method 1 – Excavation and removal would be the preferred method to remove larger peat deposits where dewatering of the excavation pits is possible without affecting adjacent wetlands or waterbodies.
- Organic Material Treatment Method 2 – Excavation and removal of peat without dewatering the excavation pits may be attempted in areas with adjacent off-site wetlands and waterbodies.
- Organic Material Treatment Method 3 – Mixing of the mineral surface soils with peat layers may be attempted where excavation is not feasible.

During the operation of the Weyerhaeuser mill, boiler ash was deposited at Ingram Yard. Jordan Cove would dry excavate this boiler ash, and relocate it to South Dunes, where it would be buried with the fill.

2.4.1.4 Subsurface Civil Work

Piling

Construction of the LNG terminal and associated marine facilities would require the installation of temporary and permanent piles. Approximately 1,400 temporary piles and 17,800 permanent piles would be installed. Piles would be installed using vibratory hammering methods for the sheet piles (approximately 60 percent of the total piles), vibratory and drilled methods for the pier piles (15 percent of the total piles) and vibratory and impact methods for the pipe piles (25 percent of the total piles). Jordan Cove states that pile driving would be done over two 10-hour shifts per day, 6 days per week (not on Sundays or major holidays) over a 31-month period.

On-site Underground Utilities

Installation of underground utilities and services would be completed early in the site preparation phase to allow completion of site grading for stormwater control, completion of plant roadways, and installation of foundations and aboveground work. Underground work would be closely coordinated with the site preparation earthwork to install as much of the underground facilities as possible while the site is still being brought to grade.

Foundations

Major foundation work for equipment and structures would generally follow the installation of pilings and underground utilities. Typically, shallow isolated or raft foundations would be used for equipment and structures unless the design requires the use of deep foundations. All foundation loads, analysis, design, and construction would be in accordance with statutory and regulatory requirements. Where required, foundations would be evaluated and designed to mitigate the hazards associated with settlement, bearing capacity, overturning, sliding, buoyancy, erosion, and scour. Formwork for foundations would comprise a mix of metal form systems and job-built wooden forms. Rebar required for foundations would be fabricated off-site, delivered, and tied into place on-site. The temporary on-site batch plant would provide concrete as required for poured foundations.

2.4.1.5 Marine Facilities

Construction of the marine facilities would be done in three phases. The first phase would include upland excavation of the slip. The second phase would include excavation and dredging of the slip area above the natural earthen berm maintained in place to separate the freshwater construction activities from Coos Bay. Maintaining the berm would allow year-round work without being in contact with the waters of Coos Bay. The third phase would require work within Coos Bay and would include excavating the access channel (including area around MOF), removal of the berm and excavation/dredging of the berm area, and installation of MOF fender piles. This third phase would occur during periods when fisheries considerations allow in-water work, between October 1 and February 15. The estimated volume of material removed from each phase and component of excavation and dredging for the marine facilities are listed in table 2.1.1.8-1. Additional details for construction of the marine facility components are described below.

Construction of Sheetpile Walls

The sheetpile system would serve as a retaining wall for the shoreline on the east and west sides of the slip. It would be designed to support the dead loads of the soils and structures, as well as the live loads of the LNG carrier at berth and LNG transfer equipment; it would also be designed to meet the seismic criteria for the facility and water-imposed loads. The sheetpile wall system would include face sheet piles for retaining the soils as well as tail-walls for anchorage of the retaining wall. Sheet piles and tail-walls would be driven from the land during the first phase of marine facilities construction while the slip construction activities are isolated from Coos Bay.

Dry Excavation

The existing natural ground surface is at an elevation of approximately +20 feet NAVD88. The water table across the slip occurs at an elevation of approximately +10 feet NAVD88. Material above an elevation of approximately +10 feet NAVD88 would be removed by conventional earthmoving equipment such as excavators, scrapers, bulldozers, and front-end loaders. Excavated material would be hauled by trucks to upland disposal within the Ingram Yard, Access/Utility Corridor, South Dunes, and Roseburg site. A berm would be maintained as a barrier to the bay during this construction phase. The north slope of the slip would be finished at 2.5 to 1 horizontal to vertical slope. The same slope would be maintained on the slip side of the temporary berm to preserve the integrity of the berm during excavation and dredging. Contouring of the final slip perimeter above +10 feet NAVD88 would be performed during this step.

Slip Dredging

The material removed from the slip area that is at or below the water table would be removed by means of hydraulic dredging using a barge mounted cutter-suction dredge. The dredge would be delivered by ocean-going barge to the site, partially disassembled, and then pulled over the berm into the slip area. A dredge slurry pipeline would connect the dredge to the South Dunes portion of the site, and a decant water return pipeline would return the water to the slip area or purpose-built decant basin. The hydraulic dredge would be capable of dredging to the final slip depth.

The slurry and decant water pipelines would follow the shoreline and then the route of the future access and utility corridor. The pipes would be made of 18- to 20-inch-diameter seamless polypropylene pipe placed on the ground, braced as necessary, and would span any wetlands or waterbodies along the route. At any point along the pipeline route where the slurry pipeline could rupture, and the contents could potentially enter the waters of Coos Bay, secondary containment would be provided. When the hydraulic transport has been completed, the pipelines would be drained, flushed with clean water, and cut apart only in those areas where any residual material in the pipeline could not potentially be released into the bay, wetlands, or other waterbodies. The pipeline would be removed and taken off-site for reuse, recycling, or disposal in a permitted landfill.

Dredged material that would be disposed of at the Kentuck project site would be transported along the Federal Navigation Channel via marine transport barge and then deposited on the site using a temporary transfer pipeline. The materials would be dredged “in the dry” (i.e., the material would be dry when dredged), and then re-liquefied and piped through the transfer pipeline to Kentuck.

Access Channel and Proposed Modifications to the Marine Waterway

The access channel would be dredged using a barge mounted crane with clamshell bucket or hydraulic dredge system. The operation would start at the MOF and progress out to the navigation channel. Jordan Cove anticipates that access channel dredging would occur around the clock in order to complete within the available window for in-water work from October 1 to February 15. The channel dredging would occur during the second available in water work window (with the MOF being constructed during the first available in-water window). Dredged material would be loaded into material barges and the barges would be towed to shore and the material transferred to trucks for placement at Ingram Yard, the access and utility corridor, Roseburg Forest Products property, or the South Dunes portion of the site. Material dredged from the along the Federal

Navigation Channel (as part of the proposed marine waterway modification) would be transported to APCO Sites 1 and 2 by temporary dredge pipeline laid adjacent to the Coos Bay navigation channel (via a floating or submerged pipe).

Driving of Piling for Marine Structures

Marine piling for the tug dock would be driven "in-the-dry" by land-based mobile cranes, meaning the piles would be installed prior to or concurrent with the freshwater dredging of the slip and while the berm is still in place separating the slip from Coos Bay. All piles required for the LNG loading foundation, and all mooring and berthing structures for the LNG and emergency berths would be located behind the sheetpile walls and would be driven on dry land.

Connection of Slip to the Channel

After completion of the slip excavation and dredging while working behind the berm, the berm would be removed, and the remaining area of the slip would be dredged. This work would be conducted during the allowed in-water work window of October 1 to February 15. Dredging may be conducted from both the Coos Bay side and the slip side to reduce the duration of the activity. Additional dredging to contour the access channel at the connection of the channel and slip would also be conducted at this time. Material would be removed by hydraulic dredge or clam-shell dredge. A portion of the material may be transported to the Kentuck project to be used as fill, and the remainder would be placed at the South Dunes portion of the site. Armoring of the remaining unarmored slip side slopes would then be completed.

Restoration of Marine Facilities

Following the excavation activities, all areas disturbed by marine facilities construction, including exposed slopes, would be protected from erosion and stabilized with an erosion protection system and/or an approved seed mixture specified for the site. The northern slip face would be armored with rip rap to protect the slope from scour. The dredge slurry and decant water return pipelines would be removed, and any areas that are disturbed by the haul truck or pipelines route that do not become part of the access and utility corridor would be restored to pre-construction condition.

2.4.1.6 LNG Loading Platform and Facilities

The LNG carrier loading facilities would be constructed once the eastern sheet pile wall system is complete. All of the loading facilities would be on the shore side of the slip, with no facilities located in the water of the slip. The platform with the loading arms (inclusive of the loading and vapor return arms) would be constructed on a concrete pad at the edge of the slip. The LNG transfer piping would be located over LNG troughs that would contain any spills and divert the LNG to a containment basin. The LNG carrier loading facilities would be constructed using land-based equipment. Installation of berth piping and equipment, and hookup and commissioning of the loading system and utilities would follow.

2.4.1.7 LNG Storage and Support Facilities

LNG Storage Tank Construction

Construction of the LNG storage tanks would be the most time-consuming element in the development of the LNG terminal. General steps would include installation of the foundations and tank bottom slab, construction of the outer concrete container wall, insertion of the bottom carbon steel vapor liner, construction of the steel dome roof and suspended deck, installation of the 9 percent nickel steel inner tank, installation of the internal tank accessories (pump columns, instrumentation, and piping), installation of external tank accessories, installation of insulation, and installation of LNG pumps. Following a successful inner container hydrotest (see below), the tank would be washed down and cleaned. After installation of the LNG pumps, the tank would be closed and purged with nitrogen to a positive gauge pressure. At this point in the construction process, the tank would be ready for cooldown with LNG.

Support Facilities

Construction of buildings and installation of major mechanical equipment would occur once LNG storage tank construction is underway. Installation of mechanical equipment would be followed by electrical and instrumentation installation. As the construction of the process portion of the LNG terminal progresses, work would commence on the pre-commissioning activities, so that these activities would be completed concurrently with the completion of the LNG storage tanks.

2.4.1.8 Testing

Jordan Cove would conduct testing of the LNG storage tanks in accordance with API 620, while piping would be tested in accordance with the American Society of Mechanical Engineers (ASME) B31.3. Some of the tests are described below.

Testing of the LNG Storage Tanks

Jordan Cove proposes to use raw water from the existing CBNBWB raw water pipeline for hydrostatic testing of the LNG storage tanks. The inner container of each LNG storage tank would be hydraulically tested by filling the tank with water, and then pressurizing the tank. To minimize water usage, the two tanks would be hydrotested with the same water by transferring the water at the conclusion of the hydrotesting of one tank to the other tank. For both tanks combined, about 60 million gallons would be used during hydrostatic testing. Following testing, the water would be locally discharged, following ODEQ approval, to the stormwater system for infiltration or discharged into the IWWP according to applicable NPDES permit requirements. If the hydrostatic test water is discharged to the IWWP, it has the capacity to handle the anticipated discharge of 2.9 mgd. Jordan Cove would use a pneumatic test on the outer container for each LNG storage tank. The pneumatic test would be completed in accordance with API 620 Section R.7.

Testing of Pipework

Piping within the LNG terminal facility would be tested using hydrostatic or pneumatic methods. In general, cryogenic piping (piping that would transfer LNG) would be pneumatically tested with dry air or nitrogen. Non-cryogenic piping (piping that would transfer natural gas) would be hydrotested using clean water. Water used for testing of pipeworks would be discharged in the same manner as water used for hydrostatic testing of the LNG storage tanks, as described above.

2.4.2 Pacific Connector Pipeline and Associated Aboveground Facilities

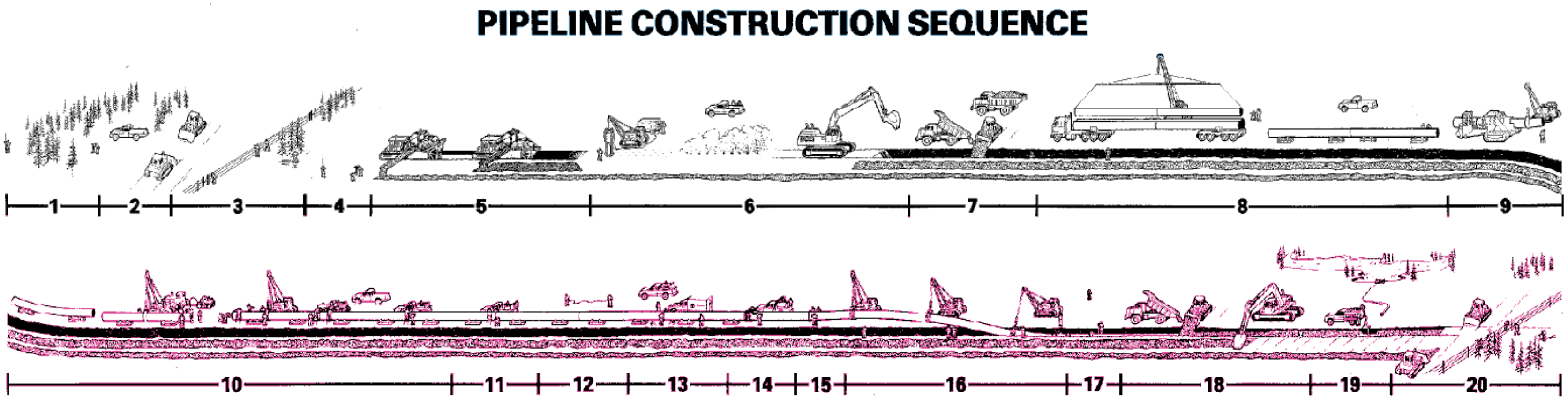
Construction of the proposed pipeline would primarily involve standard cross-country pipeline construction as described in section 2.4.2.1. Special construction techniques would also be used when constructing across wetlands; waterbodies; roads, railroads, and other utilities; agricultural and residential areas; and rugged terrain. These special construction techniques are described in section 2.4.2.2. Construction of the aboveground facilities is discussed in section 2.4.2.3.

Minor alignment shifts or additional temporary workspace may be required prior to and during construction to accommodate currently unforeseeable site-specific constraints related to construction, safety, engineering, landowner, and/or environmental concerns. All such alignment shifts or workspace needs would be subject to review and approval by the FERC and the other permitting agencies prior to construction, as appropriate.

2.4.2.1 General Pipeline Construction Techniques

Figure 2.4-1 shows the typical steps of cross-country pipeline construction, which proceeds in the manner of an outdoor assembly line of specific activities that make a linear construction sequence. Typical steps include survey and staking of the right-of-way, clearing and grading, trenching, pipe stringing and bending, welding and coating pipe, lowering-in pipe and backfilling, hydrostatic testing, right-of-way cleanup, and restoration. Pacific Connector anticipates construction would be divided into eight separate construction spreads, with each spread consisting of all construction activities necessary to construct the pipeline along that spread, as follows:

- Early Works MPs 0.00-7.34R;
- Spread 1 MPs 7.34R-29.54;
- Spread 2 MPs 29.54-51.58;
- Spread 3 MPs 51.58-71.37;
- Spread 4 MPs 71.37-94.75;
- Spread 5 MPs 94.75-132.52;
- Spread 6 MPs 132.52-162.40; and
- Spread 7 MPs 162.40-228.81.



LEGEND

1 - Right-of-Way Acquisition and Survey*
2 - Clearing and Grading
3 - Fencing
4 - Centerline Survey of Ditch*
*Owner's Responsibility

5 - Ditching (Rock-Free)
6 - Ditching (Rock)
7 - Padding Ditch Bottom
8 - Stringing

9 - Bending
10 - Line Up, Stringer Bead and Hot Pass
11 - Fill and Cap Weld
12 - As-Built Footage*

13 - X-Ray* and Weld Repair
14 - Coating Field and Factory Welds
15 - Inspection (Jeeping) and Repair of Coating
16 - Lowering In and Tie-Ins

17 - As-Built Survey*
18 - Pad and Backfill
19 - Test and Final Tie-In
20 - Replace Topsoil and Cleanup

Figure 2.4-1

Typical Pipeline Construction Sequence

Surveying and Staking

Prior to the start of construction, the exterior limits of the approved construction right-of-way and boundaries of TEWAs would be civil surveyed and clearly staked and signed. Professional land surveyors licensed in the state of Oregon would perform all work and would hold a valid and current Certified Federal Surveyor certificate for federal land surveying and setting of monuments. All surveys would be performed in accordance with procedures found in the *Manual of Surveying Instructions* (U.S. Department of the Interior 2009), and all applicable state or county statutes, codes and regulations, and specifications of the County Surveyor. Pacific Connector's environmental inspectors (EIs) would verify the limits of the staked right-of-way and TEWAs, and would monitor the stakes throughout construction. Any pre-existing property line or survey monuments that occur within the construction right-of-way would be protected where possible, and if damage occurs during construction, these monuments would be replaced according to state and federal standards. Approved access roads would be signed. Also signed would be sensitive environmental areas that would be off-limits to construction crews.

Property line monuments or survey corners on BLM-managed and NFS lands would be reestablished according to federal standards if damaged during construction. Civil surveys on federal lands would adhere to guidelines established by the BLM, Forest Service, and Reclamation. Pacific Connector developed a *Right-of-Way Marking Plan* in consultation with the BLM and Forest Service as part of the POD (see Appendix T to the POD). This plan identifies the survey standards and types of survey markings that would be used on federally-managed lands.

Access to the Construction Right-of-Way

Equipment involved in pipeline construction would be moved onto the right-of-way using approved access roads and would then generally proceed down the right-of-way. The standard 95-foot-wide construction right-of-way would include a travel lane for construction equipment and vehicles. Pacific Connector would place mats over wetlands and bridges over waterbodies along the travel lane, in accordance with its *Plan* and *Procedures*, and install temporary erosion control devices in accordance with its ERCP. Pacific Connector has produced a TMP for federal lands as Appendix Y of its POD and also a TMP for non-federal lands.[35]

Clearing and Grading

The construction right-of-way and TEWAs would be cleared of brush and trees. Pacific Connector has produced a *Right-of-Way Clearing Plan for Federal Lands* as Appendix U of its POD. The general clearing procedures outlined in that plan would also apply to non-federal lands. During clearing existing fences crossed by the pipeline route would be cut and braced, and temporary gates installed to control livestock and limit public access to the right-of-way. Temporary erosion control devices would be installed at the end of clearing activities.

Hayfields, pastures, and grassy areas would not be cleared except in areas directly over the trench or where grading would be required to create a level working surface. Tall shrubs, such as sagebrush, would be mowed or scalped off with a motor-grader or a bulldozer. Cleared grasses

[35] Appendix F.8 in Resource Report 8 included as part of Pacific Connector's September 2017 application to the FERC.

and brush would be stockpiled along the edge of the right-of-way or within TEWAs or UCSAs, then mulched and spread back over disturbed areas during final cleanup and restoration.

In forested areas, timber would be cut and cleared from the right-of-way and TEWAs. Clearing would follow seasonal timing restrictions as discussed in section 4.5 of this EIS. Merchantable timber would be removed and/or sold according to landowner stipulations. In general, ground-based skidding and cable (where feasible) logging methods would likely be the standard method; however, in some isolated rugged topographic areas with poor access, helicopter logging may be used. See additional discussion in section 4.4 of this EIS.

Following clearing, the right-of-way would be graded where necessary to create a reasonably level working surface to allow safe passage and operation of construction equipment. During grading, topsoil would be separated from subsoils in certain areas, and each would be stored in segregated piles within the construction right-of-way and TEWAs. Where topsoil would be segregated on non-federal lands,[36] Pacific Connector has requested 10 additional feet of TEWA for topsoil storage in addition to its nominal 95-foot-wide construction right-of-way in uplands. On BLM-managed and Forest Service lands, Pacific Connector would segregate topsoil in all wetlands according to its *Procedures*. Pacific Connector may segregate topsoil in other areas as determined from the results of biological surveys for federal Survey and Manage species and Region 6 sensitive species including moss, lichen and fungi. Where these species are identified within the construction right-of-way, Pacific Connector would consult with the BLM and Forest Service to determine if topsoil segregation in these areas is a feasible and appropriate mitigation or management measure to minimize impacts on these species.

Trenching

A rotary trenching machine, rock trencher, track-mounted backhoe, or similar equipment would be used to excavate a trench for the pipeline. Spoil excavated during trenching would be temporarily stockpiled to one side of the right-of-way adjacent to the trench. The depth of the trench would vary according to site-specific conditions and USDOT requirements in 49 CFR 192.327, which specifies that the minimum depth of cover must be:

- 30 inches in normal soil and 18 inches in consolidated (solid) rock for Class 1 locations; and
- 36 inches in normal soil and 24 inches in consolidated rock for Class 2, 3, and 4 locations, and under drainage ditches, public roads, and railroad crossings.

Pacific Connector states that it would strive to exceed USDOT depth requirements where possible and bury its pipeline up to 36 inches deep in Class 1 areas with normal soils and 24 inches deep in Class 1 areas with consolidated rock. The trench may be deeper at stream crossings with scour concerns based on Pacific Connector's study of channel migration and scour analysis.

In areas where bedrock is found within the pipeline trench depth, Pacific Connector would first attempt to dig the trench with specialized equipment, such as rock saws, or ripping using hydraulic hammers. If these methods are ineffective, blasting may be necessary to achieve the required trench depth. Pacific Connector has identified a high potential for blasting for about 100 miles of

[36] For example, topsoil salvaging would occur in areas occupied by Applegate's milkvetch, Kincaid's lupine, and Gentner's fritillary, per the *Federally-listed Plant Conservation Plan* (see section 4.6).

the proposed pipeline route. All blasting would be done by licensed contractors under the terms of applicable regulatory requirements. Pacific Connector produced a *Blasting Plan* as Appendix C of its POD. Blasting is further discussed in section 4.1 of this EIS.

Stringing, Bending, and Welding

After trenching, pipe sections would be trucked to the right-of-way and strung along the route, using side-boom tractors to unload the pipe from the flatbed trucks. A hydraulic bending machine would bend some pipe sections to fit the contour of the trench bottom, and in some locations pipe sections would be factory bent, or special pre-fabricated pieces would be used. A separate, trained crew of welders would weld the pipe sections together and place them on wooden skids adjacent to the trench. All welds would be visually inspected, nondestructively tested (using radiographic or equivalent methods), and repaired, if necessary. Line pipe, normally mill-coated prior to stringing, would require field applied coating at the welded joints prior to final inspection and the entire pipeline coating would then be inspected and repaired as needed.

Lowering-in and Backfilling

After welding and coating, the pipe would be lowered into the trench by side-boom tractors and excavators, after first inspecting the trench to ensure it is free of rocks or debris that could damage the pipe or the coating, and after adding padding such as sandbags at the bottom of the trench. To prevent water from the trench from entering wetlands or waterbodies, Pacific Connector would install permanent trench plugs, consisting of sandbags, foam, or bentonite, at the base of slopes adjacent to wetlands and waterbodies. Drain tiles crossed by the pipeline would be checked, and if damaged, they would be repaired before backfilling. Segregated topsoil, where applicable, would be replaced after backfilling the trench with subsoil. Following backfilling, a small crown of material would be left over the trench line to account for any future soil settling that might occur.

Hydrostatic Testing

After backfilling, the pipeline would be hydrostatically tested in accordance with USDOT regulations to ensure that is capable of operating at the MAOP. During the test, sections of the pipeline would be filled with water and pressurized. Should a leak or break occur during testing, the line would be repaired and retested until the specifications are achieved. Pacific Connector produced a *Hydrostatic Testing Plan* as Appendix M of its POD, which provides the location of the proposed hydrostatic test water withdrawal locations.

The pipeline would be tested in approximately 35 sections, each with varying lengths and water volume requirements. Pacific Connector would reuse test water from one section to the next as much as practical and minimize release between test sections (called cascading). The required volume of test water would range between approximately 16 to 60 million gallons depending on how much water would be reused by cascading. Water for hydrostatic testing would be obtained from commercial or municipal sources or from surface water right owners. If water for hydrostatic testing is acquired from surface water sources, Pacific Connector would obtain all necessary appropriations and withdrawal permits prior to construction, including permits through the OWRD. As part of this process, ODEQ and ODFW would review OWRD applications reviewed to evaluate potential impact on water quality and fish and wildlife and their habitats. Pacific

Connector would negotiate water appropriations with private owners in the year prior to construction.

Pumps used to withdraw surface water would be screened according to ODFW and NMFS standards to prevent entrainment of aquatic species. In addition, Pacific Connector included BMPs in its *Hydrostatic Testing Plan* to avoid the potential spread of aquatic invasive species and pathogens of concern. BMPs were developed in consultation with the BLM, Forest Service, the Center for Lakes and Reservoirs and Aquatic Bioinvasion Research and Policy Institute, and ODEQ.

Following testing the hydrostatic test water would be released from the pipeline test sections, potentially at each of the 35 test section breaks, or at fewer sites if cascading of water between test sections is used. Hydrostatic test water would be discharged in upland areas into erosion control devises typically constructed of hale bales and silt fence, in accordance with Pacific Connector's ECRP and the POD. Water discharged during testing would not be used to fill existing or proposed fire suppression sources (e.g., heli-ponds). Pacific Connector would apply for permission from the ODEQ prior to discharge of hydrostatic test water. Additional discussion of hydrostatic testing discharges can be found in section 4.3 of this EIS.

Dust Control

Fugitive dust[37] may be created by pipeline construction activities. To control dust, Pacific Connector would use water trucks to spray the right-of-way. Water for dust control would be obtained from commercial or municipal sources, and all appropriate approvals and/or permits would need to be obtained prior to withdrawal. Pacific Connector produced an *Air, Noise, and Fugitive Dust Control Plan* as Appendix B to its POD. See additional discussion of dust control measures in sections 4.3 and 4.12 of this EIS.

Cleanup and Permanent Erosion Control

After the pipeline is installed and the trench is backfilled, Pacific Connector would complete final grading, returning the right-of-way to its approximate original contours or to a stable contour in areas of steep slope. Fences, gates, drainage ditches, culverts, and other structures that may have been temporarily removed or damaged during construction would be permanently repaired, returned to their pre-construction condition, or replaced. All construction debris, including excess rock, would be removed from the right-of-way and placed in authorized disposal locations. On federal lands, site-specific crossing restoration plans would be implemented for perennial stream crossings. The right-of-way would be mulched, seeded, and revegetated in accordance with Pacific Connector's ECRP. Erosion control fabric would be used on streambanks.

Pacific Connector would install permanent erosion control devices consistent with the requirements of Section V.B. of FERC's *Plan* and as described in its ECRP. The permanent erosion control measures include trench breakers, slope breakers, and revegetation to stabilize disturbed areas. Pacific Connector would consult with the BLM, Forest Service, and Reclamation regarding the installation of permanent erosion control structures on federal lands, and with the

[37] Fugitive dust consists of small particles of dust suspended in the air, which are an inadvertent by-product of construction or other project-related activities.

NRCS regarding such structures on non-federal lands. Table 2.4.2.1-1 lists specifics from Pacific Connector's ECRP for the installation of slope breakers.

TABLE 2.4.2.1-1

Permanent Slope Breaker Spacing from Pacific Connector's ECRP a/

Slope	Highly Erosive Granitic Soils b/	Soils with Moderate or Low Potential for Erosion
0 to 5 percent	None required	None required
5 to 15 percent	100 feet	200 to 300 feet
15 to 30 percent	50 to 75 feet	75 to 100 feet
Greater than 30 percent	50 feet	50 feet

a/ Actual spacing would be determined at the time of installation based on site-specific topographic conditions on the right-of-way to ensure proper slope breaker construction and proper drainage to stable off-site areas. On the Umpqua National Forest between about MPs 109 and 110, where the alignment would cross the historic Thomason cinnabar claim group, waterbars would be installed at 50-foot intervals as recommended by the Forest Service.

b/ Granitic formations would be crossed by the pipeline between: MPs 79.1 to 80.5; MPs 81.6 to 82.2; MPs 87 to 88.8; MPs 97.0 to 101.2; MPs 103.0 to 105.4; and MPs 114.8 to 115.0.

Revegetation

All areas disturbed by construction, including the construction right-of-way, TEWAs, UCSAs, and contractor yards as necessary, would be restored and revegetated in accordance with Pacific Connector's ECRP. A seedbed would be established to a depth of up to four inches where necessary. Consistent with the FERC's *Plan*, if final grading occurs more than 20 days after pipe installation and backfilling, Pacific Connector would apply mulch on all disturbed areas prior to seeding. Based on recommendations provided to Pacific Connector by the Oregon State University Extension Service related to the fertilization rates for nitrogen fertilizer on new pasture seedlings, Pacific Connector would use a standard fertilization rate of 200 pounds per acre bulk triple-16 fertilizer on disturbed areas to be seeded. The Natural Resources Conservation Service (NRCS) did not recommend the addition of lime or other soil pH modifiers. Fertilizer would not be used in wetlands unless required by the land-managing agencies and would not be applied within at least 100 feet of flowing streams that have domestic use or support fisheries and would not be applied during heavy rains or high wind conditions.

It is expected that seeding would be timed to begin in August and could extend into the winter months at lower elevations. Disturbed areas would be seeded within six working days of final grading, weather and soil conditions permitting. Seeding may be done by broadcast methods, drilling, or hydroseeding. Broadcast seeding, using a mechanical broadcaster seeder, is the preferred method of seeding on steep slopes. After broadcast, the seedbed would be lightly dragged by chains or other appropriate harrows to cover the seeds thinly with soil. A drill seeder pulled by a plow may be used as an alternative to broadcast seeding in gently sloping areas. Hydroseeding would be done in accessible upland areas. Seed mixtures were determined in consultations with land-managing agencies and the NRCS. The seed mixtures are listed in Pacific Connector's ECRP and are further discussed in section 4.4 of this EIS. During right-of-way easement negotiations, private landowners may select their own seed mixtures other than those proposed for elsewhere along the pipeline route. The seed mixtures on BLM land were developed based on BLM Instruction Memo-2001-014, which specifies the use of native species, if possible. The POD has additional requirements for revegetation on federal lands.

Mulch would be applied on slopes were necessary to stabilize the right-of-way after seeding. Mulch would consist of native wood, certified weed-free straw, or hydromulch. The BLM and Forest Service have established ground cover standards and fuel loading requirements that are further discussed in section 4.4 of this EIS.

In forested lands, Pacific Connector would replant vegetation according to state and federal reforestation requirements. Reforestation efforts would occur in any given area the first winter/spring (between December and April) after the pipeline is installed in that area. On all forest lands crossed by the pipeline, trees would be replanted across the construction right-of-way up to 15 feet from either side of the pipeline centerline. In riparian areas, shrubs and trees would be replanted across the right-of-way for a width of 25 feet from the waterbody bank. Within Riparian Reserves, Pacific Connector would replant shrubs and trees to within 100 feet of the ordinary high-water mark (OHWM). A list of species to be replanted is included in Pacific Connector's ECRP, and revegetation is further discussed in section 4.4 of this EIS.

2.4.2.2 Special Pipeline Construction Techniques

Construction in rugged topography; across wetlands and waterbodies; through agricultural, residential, commercial, and industrial areas; at road and railroad crossings; and across existing buried pipelines and other utilities may require special construction techniques. These techniques are described below.

Rugged Topography

The Pacific Connector pipeline route would cross several mountain ranges, with steep and rugged topography (e.g., along the Coast Range and foothills between MPs 6.53R to 69.00, as well as between MPs 70 and 127.00). Through those mountains, the pipeline route would follow ridgelines, where feasible, to minimize the amount of cut and fill, and to avoid steep slopes, geologic hazards, and waterbody crossings, and to reduce erosion potential. In areas of steep slopes, two-tone construction techniques may be necessary, creating two step-wise level surfaces within the construction right-of-way (see Drawing #3430.34-X-0019 in Attachment C of Pacific Connector's ECRP, included with Resource Report 1 filed with Pacific Connector's application to the FERC). In addition, Pacific Connector's *Geological Hazards and Mineral Resources Report* identified geological hazards along the pipeline route. Site-specific mitigation measures for the crossing of some of these hazards are discussed in more detail in section 4.1.

During construction through rugged topography, Pacific Connector would consider the following factors:

- Identify adequate work areas to safely construct the pipeline.
- Provide a safe working grade.
- Utilize appropriate construction techniques for site-specific situations.
- Construct during the dry season as much as possible.
- Install temporary erosion control devices during construction.
- Install trench breakers, as appropriate, on slopes and near waterbody and road crossings.
- Backfill the trench immediately after pipe installation.
- Install permanent erosion controls soon after completing rough grading.

- Revegetate slopes with quick germinating seed mixtures.
- Mulch or install erosion control fabric on slopes, as necessary.
- Monitor and maintain the right-of-way as necessary to ensure stability.

Additionally, Pacific Connector's ECRP outlines procedures for fill on slopes exceeding a gradient of 3H:1V, including fill materials, slope preparation, and fill placement and compaction. The POD includes additional factors that would be considered on federal lands.

Waterbody Crossings

Construction of the Pacific Connector pipeline would affect approximately 352 waterbodies[38]. Waterbodies would be crossed in accordance with the FERC's *Procedures* and applicable permits or approvals from other agencies. Pacific Connector filed a *Wetland and Waterbody Crossing Plan* as Appendix BB of its POD. Crossings of perennial streams on NFS lands would be subject to site-specific plans that include construction restoration and monitoring requirements to ensure consistency with the Aquatic Conservation Strategy, and on BLM lands would be subject to the requirements of the BLM's 2016 RMPs. A more detailed discussion of impacts on waterbodies is provided in section 4.3 of this EIS.

TEWAs would be located more than 50 feet away from the edge of waterbodies where possible, and Pacific Connector has identified locations where site-specific conditions or other constraints prevent a 50-foot setback (see appendix E). Hazardous materials, chemicals, fuels, and oils would be stored at least 100 feet from the edge of waterbodies and wetlands (150 feet on federal lands).

Construction equipment would cross waterbodies on temporary bridges. The bridges would be designed to span the entire OHWM of the waterbody, wherever possible. Soil would not be used to stabilize bridges. In order to construct the temporary bridges, waterbody crossings may require one machinery pass through the waterbody without isolation measures in place to construct temporary equipment bridges. On BLM and NFS lands, all streams, whether wet or dry, would be crossed with (1) a bridge, (2) a temporary culvert, or (3) a low water ford with a rock mat.

All waterbodies would be crossed during the in-water work window recommended by the ODFW, or within an approved in-water work window developed through consultation with the ODFW, NMFS, COE, and FERC. Pacific Connector would attempt to cross intermittent streams and irrigation canals and ditches when they are dry, using standard upland cross-country construction methods. The standard depth of cover would be five feet below channel bottom of intermittent streams and ditches.

Pacific Connector would use the following methods to cross waterbodies with flowing water at the time of construction: diverted open cut, dry open cut, conventional bore, HDD, or Direct Pipe® (DP) technique. These are briefly described below.

<u>Wet Open-Cut Crossing</u>

No wet open-cut crossings are currently proposed for this Project. However, an open-cut crossing method may be required if all other crossing methods are attempted and fail. If an open cut crossing method is required, then additional permitting and impact analysis may be required before

[38] This value does not include the wetlands that would be affected by the Project.

the applicable agencies could allow the crossing to occur. A wet open-cut crossing method involves excavation of the pipeline trench across the waterbody with a backhoe-type excavator while water is still present in a waterbody. The excavators operate from one or both banks of the waterbody. Spoil excavated from the trench is placed above the OHWM for use as backfill, with the top 12 inches being segregated for use as the top layer of backfill. The pipe segment needs to be weighted, as necessary, to provide negative buoyancy prior to installation. Once the pipe is installed and the trench backfilled, the banks and stream bottom are restored to pre-construction contours and stabilized. However, as indicated above, this crossing method is not currently proposed, and would only be implemented if all other crossing methods (described below) fail, and may require additional analysis and permitting requirements.

Diverted Open Cut Crossing

Pacific Connector would use a diverted open cut for the eastern (second) crossing of the South Umpqua River at about MP 94.7. The river at this location is too wide for a typical dry crossing using either dam and pump or flume methods, and geotechnical studies indicate that subsurface conditions are not suitable for an HDD or conventional boring. At the proposed crossing location, the South Umpqua River channel is sufficiently flat, wide (175 feet bank to bank), and shallow (varying from a few inches to 15 feet deep), with flow slow enough to allow water to be diverted to one side while work is conducted on the opposite bank. Pacific Connector developed a site-specific plan for the eastern crossing of the South Umpqua River at MP 94.7.[39]

Dry Open Cut

Flume

The flume method would be used to cross streams less than 100 feet across. Water would be directed across the work area through one or more flume pipes. Sandbag and plastic sheeting would be used to support and seal the ends of the flume and to direct stream flow into the flume and over the construction area. Temporary dams at both the upstream (inlet) and downstream (outlet) sections of the flume would contain stream channel disturbance. After fish are salvaged from the confined area between the dams, water would be pumped out, through an upland dewatering structure, to create a dry work area for pipeline installation. Spoil from trenching would be stored in TEWAs located at least 10 feet away from the stream banks; with piles surrounded by silt fence. In-stream work (trenching, pipeline installation, and backfilling) would be conducted while the flume is in place, and the flume would be removed immediately after backfilling and bottom recontouring is completed. Details about stream fluming procedures were attached to the application filed with the FERC.[40]

Dam-and-Pump

The dam-and-pump method is an alternative dry construction technique that can be used to cross small or intermediate width waterbodies that are classified as coldwater fisheries. This method is preferred where the stream bottom is bedrock, and blasting may be necessary during trench excavation. Two temporary in-stream dams would be installed, with sandbags with plastic liner or other structures such as steel plates or water bladders. Stream flow would be diverted around the work area by pumping water through hoses. Intakes would be screened to prevent the entrainment of aquatic species. An energy-dissipation device would be used to prevent scouring

[39] See Appendix E.2 in Resource Report 2 as part of Pacific Connector's September 2017 application to the FERC.

[40] See Appendix C.2 in Resource Report 2 as part of Pacific Connector's September 2017 application to the FERC.

of the streambed at the downstream discharge location. The area between the dams would be dewatered, and the trench then excavated. Spoil would be stored in TEWAs located at least 10 feet from the banks; surrounded by silt fence. After pipeline installation and backfilling the dams would be removed and stream banks restored and stabilized. Pacific Connector would cross streams using the dam and pump method during the ODFW recommended in-water work windows. Details about dam and pump procedures were attached to the application filed with the FERC.[41]

Conventional Bore

Pacific Connector proposes to use conventional bore methods to cross under the Medford Aqueduct at MP 133.4, and all Reclamation water conveyance facilities (canals, laterals, and drains) associated with the Klamath Project. During a standard boring operation, pits are excavated on both ends of the bore, and the pipe fabricated and installed horizontally from one pit to the other beneath the feature being crossed. The walls of the bore pits may be supported by trench boxes or metal sheet piling. If groundwater seeps in to the bore or bore pits, a dewatering system would need to be used.

When crossing irrigation canals associated with Reclamation's Klamath Project, Pacific Connector committed to complying with Reclamation's Engineering and O&M Guidelines for Crossings – Bureau of Reclamation Water Conveyance Facilities (Canals, Pipelines, and Similar Facilities) unless otherwise described in the *Klamath Project Facilities Crossing Plan* (Appendix O of its POD). All crossings would require Professional Engineer–stamped design drawings approved by Reclamation prior to installation.

Horizontal Directional Drilling

Pacific Connector proposes to use the HDD method to cross under the Coos Bay Estuary (MPs 0.3–1.0 and 1.5–3.0) and three major waterbodies (Coos River at MP 11.1R; Rogue River at MP 122.7; and Klamath River at MP 199.4). This technique involves drilling a pilot hole under the feature being crossed, then enlarging that hole through successive reaming until large enough to install the pipeline. High pressure drilling fluids, usually consisting of a slurry made of bentonite clay mixed with water, would be jetted under pressure through the inside of the drill pipe to the drill head to advance the hole, and would then flow back to the drill entry point along annular space between the outside of the drill pipe and the drilled hole. Pipe sections long enough to span the entire crossing would be staged and welded along the construction work area on the opposite side of the waterbody, hydrostatically tested, and then pulled through the drilled hole. Upon completion of HDDs, the drilling mud returns would be hauled off-site and disposed of at an approved disposal facility in accordance with all applicable federal and state regulations. The right-of-way between the entry and exit hole of an HDD would generally not need to be cleared or graded, except for the area of the guide wires, and direct impacts on the waterbody and adjacent riparian vegetation would be avoided.

Pacific Connector prepared an HDD Feasibility Analysis.[42] That study showed that the HDD under the Coos Bay Estuary could be completed in two sections with a total length of about 8,970 feet and a maximum depth of about -190 feet; the HDD under the Coos River would be about

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[41] See Appendix D.2 in Resource Report 2 as part of Pacific Connector's September 2017 application to the FERC.

[42] Attached as Appendix G.2 of Resource Report 2 as part of Pacific Connector's 2017 application to the FERC.

1,602 feet long with a maximum depth of -65 feet; the HDD under the Rogue River would be about 3,050 feet long with a maximum depth of -76 feet; and the HDD under the Klamath River would be about 2,309 feet long with a maximum depth of -71 feet. In case of an HDD failure, or the unanticipated release of drilling mud, Pacific Connector prepared a contingency plan.[43]

Direct Pipe Technology

DP technology is a trenchless construction method that can be used to install pipelines underneath rivers or roads without surface impacts. It is a combination of a micro-tunneling process and HDD. DPs are completed using an articulated, steerable micro-tunnel boring machine (MTBM) mounted on the leading end of the pipe or casing. Bentonite slurry is used to increase lubrication and advance the MTBM. The pipeline is pre-fabricated and welded in sections to the back of subsequent sections as the MTBM advances.

Pacific Connector proposes to use DP technology to install its pipeline under the western crossing of the South Umpqua River at about MP 71.3 and the associated crossings under I-5, Dole Road, and the Central Oregon & Pacific Railroad. This DP crossing would be about 1,680 feet long, with a maximum depth of -90 feet. Further details are available in Pacific Connector's I-5/South Umpqua River Direct Pipe Feasibility Evaluation and a separate site-specific crossing plan.[44]

Wetland Crossings

Pacific Connector would construct the pipeline across wetlands in accordance with the FERC's *Procedures*. The construction right-of-way through wetlands would be limited to a 75-foot width or less, where possible, and TEWAs would be located at least 50 feet away from wetlands, except where topographic constraints prevent this. Grading and stump removal in wetlands would only occur over the trench. Silt fence and straw bales would be installed at the edges of the construction right-of-way through wetlands. Trench plugs would be put in where the pipeline enters and exits wetlands. In saturated wetlands, Pacific Connector may use low ground weight equipment operating off pre-fabricated wooden mats. Pipe stringing in saturated wetlands may be done next to the trench or in adjacent TEWAs. If the wetland is flooded, Pacific Connector may use "push-pull" or "float" techniques. Pipeline installation through wetlands is further discussed in section 4.3 of this EIS.

Agricultural and Residential Areas

The FERC's *Plan* requires topsoil segregation in all residential areas, cultivated or rotated agricultural lands, pasture, and hayfields, or where requested by landowners. In these areas, topsoil would be stripped and segregated from either the full construction right-of-way, or over the trench line and subsoil storage area. Pacific Connector identified areas, in addition to most wetlands, where it intends to salvage and segregate topsoil along the pipeline route (see table D-4 in appendix D). Where topsoil segregation is proposed, Pacific Connector has requested 10 feet of TEWA in addition to the 95-foot construction right-of-way to stockpile segregated soils. Agricultural lands are further discussed in section 4.2 of this EIS and residential lands in section 4.7.

[43] Attached as Appendix H.2 to Resource Report 2 as part of Pacific Connector's 2017 application to the FERC.

[44] The former is attached as Appendix J.2 and the latter as Appendix E.2 to Resource Report 2 as part of Pacific Connector's 2017 application to the FERC.

Another requirement of the FERC's *Plan* is that excess rock should be removed from at least the top foot of soil in all actively cultivated or rotated cropland, pasture, hayfields, and agricultural lands. Pacific Connector would use rock pickers where necessary to remove excess rocks from these areas during cleanup. Rocks would be removed consistent with the size, density, and distribution in areas adjacent to the right-of-way. Excess rock would be disposed of in existing rock quarries and permanent disposal sites (see table D-7 in appendix D). Pacific Connector also attached an *Overburden and Excess Material Disposal Plan* as Appendix Q to its POD.

The FERC's *Plan* requires that soils in agricultural and residential areas be tested for compaction after construction, and any compaction should be alleviated. According to Pacific Connector's ECRP, during restoration activities soil compaction would be relieved by regrading and scarifying. This may include ripping and chisel plowing up to 18 inches deep.

Pacific Connector would work with individual landowners in agricultural areas to determine how the right-of-way would be restored where the pipeline would cross cropland, orchards, nurseries, or vineyards. If requested by the landowner, the landowner would restore the agricultural land and Pacific Connector would compensate the landowner. In residential areas, Pacific Connector would restore disturbed lawns, ornamental shrubs, gardens, and other landscape features in accordance with their agreement with the landowner. A contractor familiar with local horticultural or landscape practices would do the restoration work in residential areas, or Pacific Connector may choose to compensate a landowner to restore their property.

Pacific Connector has developed site-specific construction mitigation plans for residences within 25 feet of work areas. Some of the typical measures to be taken in residential areas include notification of landowners, limiting hours of construction, dust control, maintaining access, fencing, reducing the width of the right-of-way to increase the buffer to the pipeline, and replacing landscaping (see section 4.7 of this EIS).

Road, Railroad, and Utility Crossings

The Pacific Connector pipeline would include multiple road and railroad crossings. Conventional bores are typically used to cross under railroads, with DP and HDD technology proposed for one crossing each (see table D-2 in appendix D). Roads would either be bored or open cut. At least five feet of cover would be maintained over pipeline crossings of paved county, city, and state roads, as well as railroad crossings.

Pacific Connector would obtain all necessary permits from applicable county, state, or federal land-managing agencies for public roads to be crossed, and permission to cross private roads from the landowners. Pacific Connector produced a TMP for federal lands (as Appendix Y to the POD) and a TMP for non-federal lands.[45] Transportation management is discussed in more detail in section 4.10 of this EIS.

Pacific Connector would endeavor to notify agencies and private landowners at least seven days in advance of any road work or closures caused by pipeline construction activities. During an open cut crossing, Pacific Connector would try to keep one lane of the road open for traffic, with detours around construction, plating over the open trench, or other methods. However, in some situations

[45] Attached as Appendix F.8 in Resource Report 8 as part of Pacific Connector's September 2017 application to the FERC.

the road may have to be closed for a day when the pipeline would be installed across it. Where road closures occur, Pacific Connector would provide access around the construction site for local residents and emergency vehicles. Advanced signage would be used to provide notice of construction activities. In addition, Pacific Connector would utilize traffic control measures, such as signs, lights, barriers, and flaggers to ensure public safety and provide for efficient movement of traffic through or around the construction area, and to protect workers.

The Pacific Connector Pipeline would cross numerous existing utilities, including other pipelines, powerlines, and cables. Prior to construction, Pacific Connector would contact the local "One Call" or "Call Before You Dig" system to determine the location of utilities to be crossed and these utility crossings would then be marked in the field during pre-construction surveys. Pacific Connector would coordinate with each utility owner/operator to design crossings. In most instances, the new pipeline would have to be installed beneath the existing buried utility to maintain the necessary depth of cover.

2.4.2.3 Aboveground Facility Construction

Aboveground sites would be cleared and graded as applicable to accommodate the planned facilities. Excavation would be performed as necessary to accommodate the new reinforced concrete foundations for meter and compressor station equipment. The meter and compressor station equipment would be shipped to the site by truck. All components in high-pressure natural gas service would be strength tested prior to placing in service. Before being placed in service, all controls and safety equipment and systems would be checked and tested. MLVs would be installed within Pacific Connector's operational easement. The installation of the MLVs would meet the same standards and requirements established for pipeline construction.

2.5 CONSTRUCTION SCHEDULE AND WORKFORCE

The date for the start of construction would depend on completion of all required environmental and safety reviews and receipt of all necessary permits, approvals, and Commission authorization. Jordan Cove states that construction of the LNG terminal and slip we be expected to take five years. All in-water work for the terminal, including placement of material for the MOF, dredging, and work required to remove the berm separating the slip and the access channel would occur during an in-water work window between October 1 and February 15. Jordan Cove estimates that the construction workforce would average about 1,020 workers with a peak of about 2,000 workers occurring in year 3 of construction.

Pacific Connector states that construction and restoration of the pipeline and associated facilities would take place over the course of five years. Early works, including the two HDD crossings of Coos Bay, would begin in year one. Some forest clearing along the pipeline would beginning during year 2. Mainline pipeline and aboveground facility construction would take place during years 3 and 4, with the pipeline being placed into service by about the middle of year 4. Right-of-way restoration would begin during year 4 and continue into year 5. The total workforce during construction of the pipeline and associated facilities is estimated to range between about 88 and 4,242 workers, with an average of about 886 workers, with the peak occurring during summer and fall of year 1 of mainline construction (see section 4.9).

2.6 ENVIRONMENTAL INSPECTION, AND COMPLIANCE MONITORING

2.6.1 Jordan Cove Environmental Inspection Program

During construction, Jordan Cove and Pacific Connector would provide contractors with all Project design documents, including environmental alignment sheets, and copies of all applicable federal, state, and local permits. Jordan Cove would provide environmental training before a contractor or Jordan Cove employee steps out to a work area, and training records would be kept to demonstrate training activities. Numerous individuals, including company Chief Construction Inspectors, would supervise construction activities. Environmental Inspectors (EI) would be hired to ensure compliance with approved construction methods and all applicable permit and consultation requirements and conditions.

EIs would have peer status with all other activity inspectors along with the authority to stop activities that violate the environmental conditions of the FERC authorization, other permits, or landowner/land managing agency requirements, and to order appropriate corrective actions. The EIs would also be responsible for advising the chief construction inspector when conditions (such as wet weather) make it advisable to restrict construction activities. EI duties would include maintaining status reports and training records.

The EI's responsibilities would include:

- ensuring compliance with the requirements of the Jordan Cove and Pacific Connector's *Plan* and *Procedures* (including modifications), the environmental conditions of the section 3 and Certificate authorization, the mitigation measures proposed by the applicant (as approved and/or modified by FERC's authorization), other environmental permits and approvals, and environmental requirements in landowner easement agreements;
- verifying that the limits of authorized construction work areas and locations of access roads are properly marked before clearing;
- verifying the location of signs and highly visible flagging marking the boundaries of sensitive resource areas, waterbodies, wetlands, or areas with special requirements along the construction work area;
- identifying erosion/sediment control and soil stabilization needs in all areas;
- ensuring that the location of dewatering structures and slope breakers would not direct water into known cultural resources sites or locations of sensitive species;
- verifying that trench dewatering activities do not result in the deposition of sand, silt, and/or sediment near the point of discharge into a wetland or waterbody. If such deposition is occurring, the dewatering activity would be stopped and the design of the discharge would be changed to prevent reoccurrence;
- identifying, documenting, and overseeing corrective actions, as necessary to bring an activity back into compliance; and
- keeping records of compliance with the environmental conditions of the FERC Certificate, and the mitigation measures proposed by the Project sponsor in the application submitted to the FERC, and other federal or state environmental permits during active construction and restoration.

2.6.2 FERC Environmental Compliance Monitoring

During construction of the Project, third-party Compliance Monitors representing the FERC would be present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to the FERC and Jordan Cove and Pacific Connector's environmental inspection team. Construction progress and environmental compliance would be tracked and documented by the Compliance Monitors. The Compliance Monitors would report directly to a Compliance Manager who would report directly to the FERC Project Manager. Other objectives of the third-party Compliance Monitoring program would be to facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval, with the delegation of some authority to the third-party Compliance Monitors. FERC would also receive regular construction status reports filed by Jordan Cove and conduct periodic field inspections during construction and restoration of the Project. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Jordan Cove. Other federal, state, and local agencies could also monitor the Project to the extent determined necessary by the agency.

2.6.3 Monitoring by Land Managing Agencies on Federal Lands

Monitoring is an essential element of project implementation (CEQ 2011). If the BLM issues a Temporary Use Permit and a Right-of-Way Grant for the Pacific Connector Pipeline Project, those authorizations would provide the terms and conditions for construction, operation, maintenance, and eventual termination of the facility on federal public lands. As cooperating agencies with jurisdiction by law for activities that occur on lands they administer, the BLM, Forest Service, and Reclamation have a responsibility to monitor implementation of the Pacific Connector Pipeline Project to assure that the terms and conditions of the Right-of-Way Grant are carried out (43 CFR 2885.24). This monitoring would be in addition to the Environmental Compliance Monitoring carried out by third-party Compliance Monitors representing the FERC.

CEQ regulations for NEPA (40 CFR 1505.3) also provide that a monitoring and enforcement program should be adopted as part of the decision to implement the Project. Many of the requirements of the POD that are a part of the BLM Right-of-Way Grant on federal lands are project design measures that reduce the environmental consequences of the Project on-site. The Forest Service has also proposed off-site compensatory mitigation plans (see section 2.1.5). In addition to monitoring implementation of the Temporary Use Permit and the Right-of-Way Grant, the BLM, Forest Service, and Reclamation also have a responsibility to monitor authorized actions, whether they are project design features described in the POD or off-site mitigation measures included in Forest Service mitigation plans. As needed, agency representatives of the BLM, Forest Service, and Reclamation would participate in the monitoring process to assure that agency priorities are accomplished and agency obligations are fulfilled. Reclamation agency representatives would be on-site during all crossings of Reclamation facilities. Reclamation would require a minimum 48-hour notice for each crossing to ensure that Reclamation agency representatives are able to be on-site during the crossing installations.

Pacific Connector worked closely with the BLM and Forest Service to minimize impacts on federal lands during the proposed pipeline route selection and construction footprint design process. In developing the POD interdisciplinary teams of the BLM and Forest Service worked with Pacific Connector to implement project design features that would reduce impacts on LSR, Riparian Reserves, soil resources, water quality, recreation, and other resources as described in the POD attachments below. Additional discussion on the steps taken to avoid or reduce impacts on LSR and Riparian Reserves is included in appendix F. The POD developed by Pacific Connector is part of the Right-of-Way Grant application and includes monitoring requirements to ensure that impacts from construction and operation of the Project are minimized and that objectives of the respective land management plans are accomplished. The POD includes 28 attachments, 27 of which were developed in cooperation with the BLM, Forest Service, and Reclamation (the remaining attachment is the Environmental Alignment Sheets for the Project). These attachments are individual plans detailing Pacific Connector's proposed method for construction and operation of the proposed pipeline on federal lands. A description of the POD is summarized in table 2.6.3-1. Ongoing discussion between the applicant and agencies may result in refinements to the POD. Because the proposed actions specific to federal lands include amendments to LMPs, the regular monitoring and reporting programs of the respective BLM RMPs and Forest Service LRMPs would be used in addition to those identified in the POD.

TABLE 2.6.3-1

Pacific Connector's Plan of Development

Appendix	Appendix Title	Description
A	Aesthetics Management Plan for Federal Lands	The purpose of this Plan is to outline methods that Pacific Connector would implement to ensure compliance with agency land and resource management plans pertaining to visual and aesthetic resources within the Pipeline Project area. This Plan establishes goals for managing visual resources as they relate to construction, reclamation and management of the Pacific Connector Pipeline Project and describes actions to be taken by Pacific Connector to minimize impacts on visual resources.
B	Air, Noise and Fugitive Dust Control Plan	This Plan describes the practices that would be implemented during construction of the Pacific Connector Pipeline Project to minimize or control the potential impacts on air quality or the impacts caused by noise or fugitive dust on federal lands crossed by the pipeline project. The minimization and control measures described in this plan are also important to protecting the safety of construction workers, visiting agency personnel, and the general public that may use the public roads during the construction activities or reside near the construction right-of-way.
C	Blasting Plan	The purpose of this Blasting Plan is to provide guidelines for the safe use and storage of blasting materials proposed for use during construction of the Pacific Connector Pipeline Project. This Blasting Plan is intended to help ensure the safety of construction personnel, the public, nearby facilities and sensitive resources.
D	Communication Facilities Plan	The purpose of this plan is to describe the construction, modification, operation and maintenance of communication facilities necessary for the operation of the Pacific Connector Pipeline Project on federal lands managed by the BLM and the Forest Service. The communication facilities are necessary to enable communications between facilities constructed in conjunction with the pipeline project and the Pacific Connector gas control center.
E	Contaminated Substances Discovery Plan	The purpose of the Contaminated Substances Discovery Plan is to outline practices to protect human health and worker safety and to prevent further contamination in the event of an unanticipated discovery of contaminated soil, water, or groundwater during construction of the Pacific Connector Pipeline Project.

TABLE 2.6.3-1 (continued)

Pacific Connector's Plan of Development

Appendix	Appendix Title	Description
F	Corrosion Control Plan	Pacific Connector would implement methods to protect the pipeline system from external, internal, and atmospheric corrosion in accordance with USDOT 49 CFR 192. Corrosion Control is critical to public safety and the safe/reliable operation of the pipeline. This plan will illustrate methods used to identify the corrosion control needs for the pipeline project, as well as methods to provide the required protection and mitigation.
G	Environmental Briefings Plan	The purpose of this Plan is to outline the environmental reporting procedures, briefings, or notifications that Pacific Connector would provide to the federal land-managing agencies prior to construction, during construction, post construction, and during operations of the Pacific Connector Pipeline. Detailed compliance management documents would be developed based on the conditions in the permits/authorizations issued for the project and would be provided to the federal land-managing agencies prior to construction.
H	Emergency Response Plan	The purpose of this Emergency Response Plan is to identify the standards and criteria that Pacific Connector would follow to minimize the hazards during pipeline operation resulting from a gas pipeline emergency in accordance with the Pipeline and Hazardous Materials Safety Administration's regulations in 49 CFR 192.615 and 192.617.
I	Erosion Control and Revegetation Plan	The Erosion Control and Revegetation Plan outlines the erosion control and revegetation procedures that Pacific Connector would utilize during construction of the pipeline to minimize erosion, sedimentation and enhance revegetation success on all lands crossed by the pipeline.
J	Plant Conservation Plan	The purpose of this plan is to describe the conservation measures that Pacific Connector would implement to minimize the potential effects on federally-listed plants, including one plant identified as a species of concern, that have been documented during Pipeline project survey efforts to-date, or that may be documented during subsequent survey efforts prior to ground-disturbing activities. The plan outlines avoidance, minimization, propagation, restoration and other mitigation measures for federally-listed plant species.
K	Fire Prevention and Suppression Plan	The Fire Prevention and Suppression Plan describes the measures to be used by Pacific Connector and its contractors (Contractor) to ensure that fire prevention and suppression techniques are carried out in accordance with federal, state and local regulations.
L	Fish Salvage Plan	The fish salvage plan has been developed to minimize adverse effects on Endangered Species Act (ESA) listed salmonids (Southern Oregon/Northern California Coast coho salmon and Oregon Coast coho salmon), non-listed salmonids (Chinook, steelhead, cutthroat trout) and ESA-listed catostomids (Lost River sucker and shortnose sucker) during construction of the Pacific Connector Pipeline Project as well as other aquatic organisms.
M	Hydrostatic Test Plan	In accordance with USDOT 49 CFR Part 192, Pacific Connector would strength test (or hydrostatic test) the pipeline system (in sections) after it has been lowered into the pipe trench and backfilled. The purpose of the hydrostatic test is to verify the manufacturing and construction integrity of the pipeline before placing it in service to flow natural gas.
N	Integrated Pest Management Plan	This plan would provide Pacific Connector's management and staff with the necessary BMPs to address the control of noxious weeds, invasive plants, forest pathogens, and soil pests across the route of the Pipeline. The BMPs have been created to minimize the potential spread of invasive species and minimize the potential adverse effects of control treatments.
O	Klamath Project Facilities Crossing Plan	The Plan identifies the locations within Klamath County, Oregon where the Pacific Connector alignment crosses facilities within the Klamath Project that are administered by the Klamath Basin Area Office of Reclamation and the methods proposed to construct the pipeline project across Reclamation facilities.
P	Leave Tree Protection Plan	The purpose of this plan is to describe the measures that would be implemented during construction of the Pacific Connector to identify, conserve and protect selected trees (living and snags) within or along the edges of the pipeline project's certificated work limits.
Q	Overburden and Excess Material Disposal Plan	The purpose of this Plan is to identify the proposed locations on federal lands that may be used for the permanent and temporary storage of excess rock, timber, and spoil generated during timber removal and pipeline construction of the Pacific Connector Pipeline Project.

TABLE 2.6.3-1 (continued)

Pacific Connector's Plan of Development

Appendix	Appendix Title	Description
R	Prescribed Burning Plan	The Prescribed Burning Plan describes the protocols that Pacific Connector would follow to obtain appropriate agency authorization on all lands (federal, state and private) crossed by the pipeline, where it is necessary to dispose of forest slash by burning. This plan also outlines the appropriate BMPs that would be utilized to safely conduct slash burning operations.
S	Recreation Management Plan	The purpose of the Plan is to assist in the management of existing recreation resources on lands within the pipeline project area or impacted by the pipeline. This Plan establishes goals for managing recreation in the vicinity of the pipeline and describes actions to provide continued safe access, prevent resource damage, and to avoid potential user conflict.
T	Right-of-Way Marking Plan	The purpose of this Plan is to identify the survey standards and types of survey markings that would be used by Pacific Connector on federal lands during the pre-construction, construction, and operational phases of the pipeline project.
U	Right-of-Way Clearing Plan	The purpose of this Right-of-Way Clearing Plan (Plan) is to outline the methods that Pacific Connector would implement during timber (and other vegetation) removal within the construction right-of-way and TEWAs. This Plan was developed utilizing applicable BMP compliance protocols outlined in the Erosion Control and Revegetation Plan for the pipeline project.
V	Safety and Security Plan	The purpose of this plan is to describe safety standards and practices that would be implemented to minimize health and safety concerns related to the construction of the pipeline project.
W	Sanitation and Waste Management Plan	The purpose of the Plan is to outline the procedures that would be implemented by Pacific Connector and its contractors to manage sanitation and waste materials during construction and operations of the Pacific Connector Pipeline Project.
X	Spill Prevention, Containment, and Countermeasures Plan	The Plan identifies measures to be taken by Pacific Connector and its contractors to prevent, contain and respond to spills during the construction of the pipeline project.
Y	Transportation Management Plan	The purpose of the plan is to cover all pipeline project transportation-related activities involving Agency-jurisdiction roads or rights-of-way and identifies ongoing cooperative procedures.
Z	Unanticipated Discovery Plan	This plan provides the procedures Jordan Cove, Pacific Connector, its personnel and consultants would follow in the event that unanticipated discoveries of historic properties, archaeological objects, archaeological sites, or human remains are made during the construction and operation of the Project.
AA	Environmental Alignment Sheets	A set of photo-based maps depicting the centerline and construction right-of-way at a scale of 1":200' and the associated environmental features and requirements.
BB	Wetland and Waterbody Crossing Plan	The Plan outlines the construction methods, restoration procedures, and BMPs that Pacific Connector would utilize during construction of its pipeline. The measures set out in this plan would be employed to avoid, minimize, and restore potential impacts associated with wetland and waterbody crossings, as well as to minimize potential effects on aquatic resources.

2.7 OPERATION AND MAINTENANCE PROCEDURES

2.7.1 LNG Terminal Facilities

Jordan Cove would operate and maintain its facilities in compliance with 49 CFR 193, 33 CFR 127, National Fire Protection Association (NFPA) 59A, and other applicable federal and state regulations. Before commencing operation of the LNG terminal, Jordan Cove would prepare and submit for approval operation and maintenance manuals that address specific procedures for the safe operation and maintenance of the LNG storage and processing facilities. Jordan Cove would also prepare an operations manual that addresses specific procedures for the safe operation of the ship unloading facilities in accordance with 33 CFR 127.305. Operating procedures would address normal operations as well as safe startup, shutdown, and emergency conditions.

All operations and maintenance personnel at the terminal would be trained to properly and safely perform their jobs. Jordan Cove states that operators would meet all the training requirements of the Coast Guard, USDOT, ODOE, Oregon State Fire Marshall, Coos Bay, Coos County Fire Department, and other regulatory entities. The SORSC would provide on-site resources and assets, including a Sherriff's office and fire department.

The LNG terminal and related facilities would be staffed with about 180 full-time equivalent employees working three shifts, so there would be coverage 24 hours a day, 365 days a year. The terminal's full-time staff would conduct routine maintenance and minor overhauls. Major overhauls and other major maintenance would be handled by bringing in maintenance personnel specifically trained to perform the maintenance. All scheduled and unscheduled maintenance would be entered into a computerized maintenance management system.

2.7.2 Pipeline and Associated Aboveground Facilities

Pacific Connector would test, operate, and maintain the proposed facilities in accordance with USDOT regulations provided in 49 CFR Part 192; the FERC's guidance at 18 CFR 380.15; rules and regulations promulgated by PHMSA; and maintenance provisions of its ECRP. The pipeline right-of-way would be clearly marked where it crosses public roads, waterbodies, fenced property lines, and other locations as necessary. All pipeline facilities would be marked and identified in accordance with applicable regulations.

The aboveground facilities would be inspected for the life of the pipeline at intervals that meet USDOT requirements. Pipeline personnel would perform routine checks of the facilities, including calibration of equipment and instrumentation, inspection of critical components, and scheduled and routine maintenance of equipment. Safety equipment, such as pressure-relief devices, fire detection and suppression systems, and gas detection systems, would be tested for proper operation. Corrective actions would be taken for any identified problem. Vegetation at aboveground facilities would be periodically maintained using mowing, cutting, trimming and the selective use of herbicides.

To facilitate periodic pipeline corrosion/leak surveys, a corridor centered on the pipeline and up to 10 feet wide would be maintained in an herbaceous state, with no vegetation greater than 6 feet in height. Trees that are located within 15 feet of the pipeline and that are greater than 15 feet in height would be cut and removed from the right-of-way. Vegetation within the permanent easement would be periodically maintained by mowing, cutting, and trimming (either by mechanical or hand methods). Maintenance activities are expected to occur approximately every three to five years depending on the growth rate. During maintenance, trimmed or cut vegetation would be scattered across the operational easement to naturally decompose and to discourage off-highway vehicle (OHV) traffic. Occasionally, where site conditions allow, chipping of this material may also occur. Herbicides would not be used for brush control; however, if noxious weed infestation occurs on the permanent easement, selective use of herbicides would be used to control these species. Herbicides would not be used in or within 100 feet of a waterbody's mean high-water mark.

Pacific Connector would employ a permanent staff of 15 employees, including six operations technicians in the Coos Bay pipeline office in Coos County, five employees in the Medford pipeline office in Jackson County, and four employees at the compressor station near Malin in Klamath County. In addition, the pipeline and aboveground facilities would be monitored all the time using Pacific Connector's gas control communication system and radio towers reporting back to a command center at the Williams' office in Salt Lake City, Utah.

3.0 ALTERNATIVES

As required by NEPA, Commission policy, and in cooperation with the COE, BLM, Forest Service, Reclamation, and the other NEPA cooperating agencies, we identified and evaluated reasonable and practical alternatives to the facilities (and locations) proposed by Jordan Cove and Pacific Connector as described in section 2.1 of this document. Specifically, and consistent with the Purpose and Need of the Project as described in section 1.2, we evaluated the No Action Alternative, System Alternatives, LNG Terminal Site Alternatives, and Pipeline Alternatives (including Federal Lands Alternatives and Compressor Station Alternatives). To satisfy its responsibilities per the CWA Section 404(b)1(1) Guidelines, the COE also evaluated whether alternatives would be practicable.[46]

Our evaluation of alternatives is based on Project-specific information provided by the applicants, affected landowners, and other concerned parties; publicly available information; our consultations with federal and state resource agencies; federally recognized tribes; and our expertise and experience regarding the siting, construction, and operation of LNG export facilities and interstate natural gas transmission facilities and their potential impact on the environment. In evaluating alternatives, we considered and addressed, as appropriate, the comments provided to the Commission regarding possible alternatives.

As described in section 1.4, the Commission received thousands of letters and comments expressing concern about the Project. Many of these letters requested that we evaluate alternatives to the Project. In response to these comments, we required the applicants to provide additional environmental information, requested they assess the feasibility and practicability of alternatives as proposed by the commenters (including other federal agency alternatives requests); conducted site visits and field investigations; met with affected landowners and local representatives and officials; and consulted with federal and state regulatory agencies and tribes. All comments concerning alternatives were considered, and many, but not all, of these alternatives are included in this analysis. Not included in this analysis is an assessment of renewable energy resources as an alternative to the Project. Renewable energy resources include, but are not limited to, wind, solar, and hydroelectric power. These resources are alternatives to electrical power production. Because the Project's purpose is to transport natural gas across southern Oregon and convert it to LNG for export to overseas markets, not generate electricity, the development and use of renewable energy resources would not meet the purpose of the Project, and therefore is not a reasonable or practicable alternative to the proposed action and is not considered further in this analysis.

The purpose of this analysis is to satisfy NEPA requirements that agencies take a "hard-look" at a project's impacts, inform the public of these impacts, and determine whether the adoption and implementation of an alternative(s) would be preferable to the proposed action. As described below, we consider numerous reasonable and practicable alternatives to the proposed action. In consultation with the NEPA cooperating agencies, using our collective professional judgment, and through environmental comparison, each alternative is considered until it is clear that the

[46] When making a decision on whether to issue a permit for the Project, the COE must consider whether the proposed Project represents the least environmentally damaging practicable alternative pursuant to the CWA section 404(b)(1) guidelines. The term "practicable" means available and capable of being done after taking into consideration cost, existing technology, and logistics in light of the overall purpose of the Project. The COE may only permit discharges of dredged or fill material into waters of the U.S. that represent the least damaging practicable alternative, so long as the alternatives do not have other significant adverse environmental consequences.

alternative would not satisfy one or more of the evaluation criteria (see below). Furthermore, it is important to note that the Commission's role under the NGA is to review applications filed with it, not to develop a general plan for energy infrastructure. Thus, comments suggesting that the Commission require applicants to pursue alternatives that are substantially different than their proposals will be considered, but may not result in a reasonable alternative that would be addressed in our alternatives analysis.

Evaluation Process

The purpose of this evaluation is to determine whether an alternative would be preferable to the proposed action. To determine if an alternative would be preferable to a proposed action, we generally evaluate an alternative using three criteria:

1. does the alternative meets the stated purpose of the project;
2. is technically and economically feasible and practical; and
3. offers a significant environmental advantage over a proposed action.

The alternatives were reviewed against the evaluation criteria in the sequence presented above. If the alternative would not meet the Project's purpose, or is not feasible or practical, we did not compare environmental information to determine if the third evaluation criterion was satisfied.

The first consideration for including an alternative in our analysis is whether or not it could satisfy the stated purpose of the Project. As described previously, the purpose and need of the Jordan Cove Project is to export natural gas supplies derived from existing interstate natural gas transmission systems to overseas markets; and the purpose and need of the Pacific Connector Project is to connect the existing interstate natural gas transmission systems of GTN and Ruby with the proposed Jordan Cove LNG terminal. Alternatives that do not achieve these purposes cannot be considered as feasible or reasonable alternatives to the Project. Furthermore, the Commission cannot simply ignore a project's purpose and substitute a purpose it or a commenter deems more suitable.

The only location where the GTN and Ruby pipeline systems interconnect is near Malin, Oregon. Malin is a major natural gas trading hub providing access to multiple supply basins in the United States and Canada. GTN and Ruby have a combined natural gas transportation capacity of 3.8 Bcf/d at Malin providing access to diverse and abundant supplies to support Jordan Cove's export operations. Therefore, in the alternatives analyses below, all pipeline alternatives originate near Malin, Oregon. All of the alternatives considered here, except the No Action Alternative, are able to meet the Project purpose stated in section 1.2 of this EIS.

Not all conceivable alternatives are technically and economically feasible and practical. Technically feasible alternatives, with exceptions, would generally involve the use of common LNG facility and pipeline construction methods. Economically practical alternatives would result in an action that generally maintains the price competitive nature of the proposed action. An alternative that would involve the use of a new, unique, or experimental construction method(s) may be technically feasible, but not economically practical. Generally, we do not consider the cost of an alternative as a critical factor unless the added cost to design, permit, and construct the alternative would render the project economically impractical.

To determine if an alternative is practicable and would provide a significant environmental advantage over the proposed action, we compare the impacts of the alternative and the proposed action (e.g., number of wetlands/waterbodies affected by the alternative and number of wetlands/waterbodies affected by the proposed action). To ensure consistent environmental comparisons and to normalize the comparison of resources, we generally use "desktop" sources of information (e.g., publicly available data, aerial imagery) and assume the same construction and operation right-of-way widths and general workspace requirements. We evaluate data collected in the field if surveys were completed for both the proposed action and the corresponding alternative. Our environmental comparison uses common factors such as (but not limited to) total amount, length/distance, and acres affected of a resource. Furthermore, this analysis considers impacts on both the natural and human environments. The natural environment is generally characterized by vegetation, waterbodies, wildlife, and other biological resources; while the human environment includes land use, existing infrastructure, and community (socioeconomic) characteristics. Where appropriate and available, we also use site-specific information. In comparing the impact between resources, we also consider the magnitude of the impact anticipated on each resource. As applicable, we assess impacts on resources that are not common to the alternative and the proposed action (e.g., an alternative affects old growth forest whereas the proposed action affects agricultural lands). Our determinations attempt to balance the overall impacts (and other relevant considerations) of the alternative(s) and the proposed action. Recognizing the often-competing interests driving alternatives and the differing nature of impacts resulting from an alternative (i.e., impacts on the natural environment versus impacts on the human environment), we also consider other factors that are relevant to a particular alternative or discount or eliminate factors that are not relevant or may have less weight or significance. Ultimately, an alternative that is environmentally comparable or results in minor advantages in terms of environmental impact would not compel us to shift the impacts from the current set of landowners to a new set of landowners.

The factors considered for an aboveground facility alternative are different than those considered for a pipeline route alternative because an aboveground facility is a fixed location rather than a linear facility which is routed between two points. In evaluating aboveground facility locations, we consider the amount of available land, current land use, adjacent land use, location accessibility, engineering requirements, stakeholder comments, and impacts on the natural and human environments.

3.1 NO ACTION ALTERNATIVE

NEPA requires federal agencies to consider and evaluate a No Action Alternative. Additionally, a No Action Alternative serves as a baseline against which the impacts of the proposed action are compared and contrasted. Under the No Action Alternative, the proposed action would not occur, the permits and authorizations listed in section 1.5 would not be required, and as a result, the environment would not be affected.

Under the No Action Alternative, the RMPs of the Coos Bay, Roseburg, Medford, and Klamath Falls Resource Area of the Lakeview District and the LRMPs of the Rogue River, Umpqua, and Winema National Forests would not be amended to make provision for the Project. Furthermore, the Forest Service would not consent to the BLM to grant an easement because construction of the Project would not be consistent with the National Forest LRMPs. The BLM would not issue a Right-of-Way Grant for the Project because the Project would not be a conforming use of federal land. Under the No Action Alternative, there would be no need for Reclamation to concur with BLM with respect to issuance of a Right-of-Way Grant. Also, the FWS and NMFS would not issue Biological Opinions (BO) because there would be No Effect on species listed under the ESA.

Under the No Action Alternative specific to the COE's role in the Project review, construction of the Project would result in a modified project design or location that eliminates work that would require a Department of the Army permit (i.e., avoidance of aquatic resource impacts) or the COE's denial of the permit.

In Order No. 3041-A issued July 20, 2018, the DOE amended its previous authorization to export LNG from the Jordan Cove LNG Project to countries with which the U.S. has a FTA(DOE 2018). By law, under Section 3(c) of the NGA, applications to export natural gas to FTA nations that require national treatment for trade in natural gas are deemed to be consistent with the public interest. The DOE also issued a conditional authorization to the Jordan Cove Project to export to non-Free Trade Agreement countries in Order No. 3413 on March 24, 2014. For the non-Free Trade Agreement conditional authorization, granted under Section 3(a) of the NGA, the DOE determined that exports from the Jordan Cove Project were not inconsistent with the public interest, provided the Project successfully completes the environmental review. In its application, Jordan Cove states the purpose of its Project is to export natural gas supplies derived from existing interstate natural gas transmission systems (linked to the Rocky Mountain region and Western Canada) to overseas markets, particularly Asia. According to Jordan Cove, the Project is a market-driven response to increasing natural gas supplies in the U.S. Rocky Mountain and Western Canada markets, and the growth of international demand, particularly in Asia.

Given that the Project is market-driven, it is reasonable to expect that if the Jordan Cove LNG Project is not constructed (the No Action Alternative), export of LNG from one or more other LNG export facilities could also be authorized by the DOE and eventually be constructed. Thus, although the environmental impacts associated with constructing and operating the Project would not occur under the No Action Alternative, equal or greater impacts could occur at other location(s) in the region as a result of another LNG export project seeking to meet the demand identified by Jordan Cove.

As stated in the introduction to this section, the No Action Alternative would not meet the Project's purpose and need. Therefore, we conclude that the No Action Alternative does not meet the Project purpose (criterion 1) and an alternative project to meet the market demand has not been proposed but would require a similar footprint. Although the resources that would be affected by an alternative project are not defined, we conclude that it would not likely provide a significant environmental advantage over the proposed action (criterion 3). Therefore, we do not consider the No Action Alternative further. However, the other NEPA cooperating agencies, consistent with their review and regulatory responsibilities, may choose to select this alternative.

3.2 SYSTEM ALTERNATIVES

System alternatives would make use of existing or other proposed LNG facilities and pipelines to meet the purpose of the Project. Implementing a system alternative would make it unnecessary to construct all or part of the Project, although some modifications or additions to existing LNG facilities or pipeline transmission systems/facilities, or other proposed LNG or pipeline transmission systems/facilities might be necessary. The pipeline portion of a system alternative would involve the use of all or portions of other natural gas transmission systems to transport natural gas from near Malin, Oregon, to the proposed terminal near Coos Bay, Oregon. Existing natural gas pipelines in southern and central Oregon include the jurisdictional interstate transportation systems operated by Northwest, GTN, and Ruby, and the non-jurisdictional intrastate Coos County Pipeline (figure 3.2-1).

As of the issuance of this EIS, there are no existing LNG export (or import) terminal facilities located on the west coast of the contiguous United States (Washington, Oregon, and California). Additionally, we are not aware of any proposed LNG export (or import) terminals on the west coast of the contiguous United States. Existing and proposed East Coast and Gulf Coast LNG export facilities are located 2,000 – 3,000 miles from Oregon, and would not be reasonable alternatives. According to USDOT PHMSA, there are four LNG storage facilities (peak-shaving plants) in Oregon and Washington connected to natural gas pipeline systems. These facilities are not designed to export LNG, are insufficient to meet the purpose of the Project, and would require significant modifications to meet the Project's purpose. Additionally, an LNG storage facility is being built in Tacoma, Washington (i.e. the Tacoma LNG) that would provide fuel for marine vessels and natural gas service for local residential and commercial customers. However, this facility which is located on a 30-acre site in a highly industrialized area is physically constrained with insufficient land available for the expansion necessary to meet the Project's purpose. Therefore, we conclude that there are no reasonable LNG system alternatives in the contiguous United States.

We received several comments suggesting this analysis consider existing and proposed LNG export facilities located in Alaska, Canada, and Mexico. In Alaska, there is an idle LNG export facility on the Kenai Peninsula. The Commission is also currently reviewing an application (FERC Docket No. CP17-178-000) to construct and operate a new LNG export facility in Nikiski, Alaska. These facilities are not connected to the "lower-48" natural gas transmission pipeline network and although constructing a pipeline from the existing GTN and Ruby pipelines systems near Malin, Oregon to the existing or proposed facility in Alaska (a distance of close to 3,000 miles) is technically feasible, it is not economically practical. Furthermore, constructing a pipeline to Alaska from Malin would result in significantly more environmental impacts than the proposed Project as this pipeline would be an order of magnitude longer than the currently proposed pipeline. Based on the length of the Pacific Connector Pipeline and the total footprint, including all extra workspace, the pipeline would affect about 21.6 acres per mile of length. Therefore, adding 2,700 miles would affect as much as 58,320 acres of land. Consequently, we conclude that an LNG system alternative making use of the existing or proposed Alaska LNG facilities would not provide a significant environmental advantage and do not consider it further in this analysis.

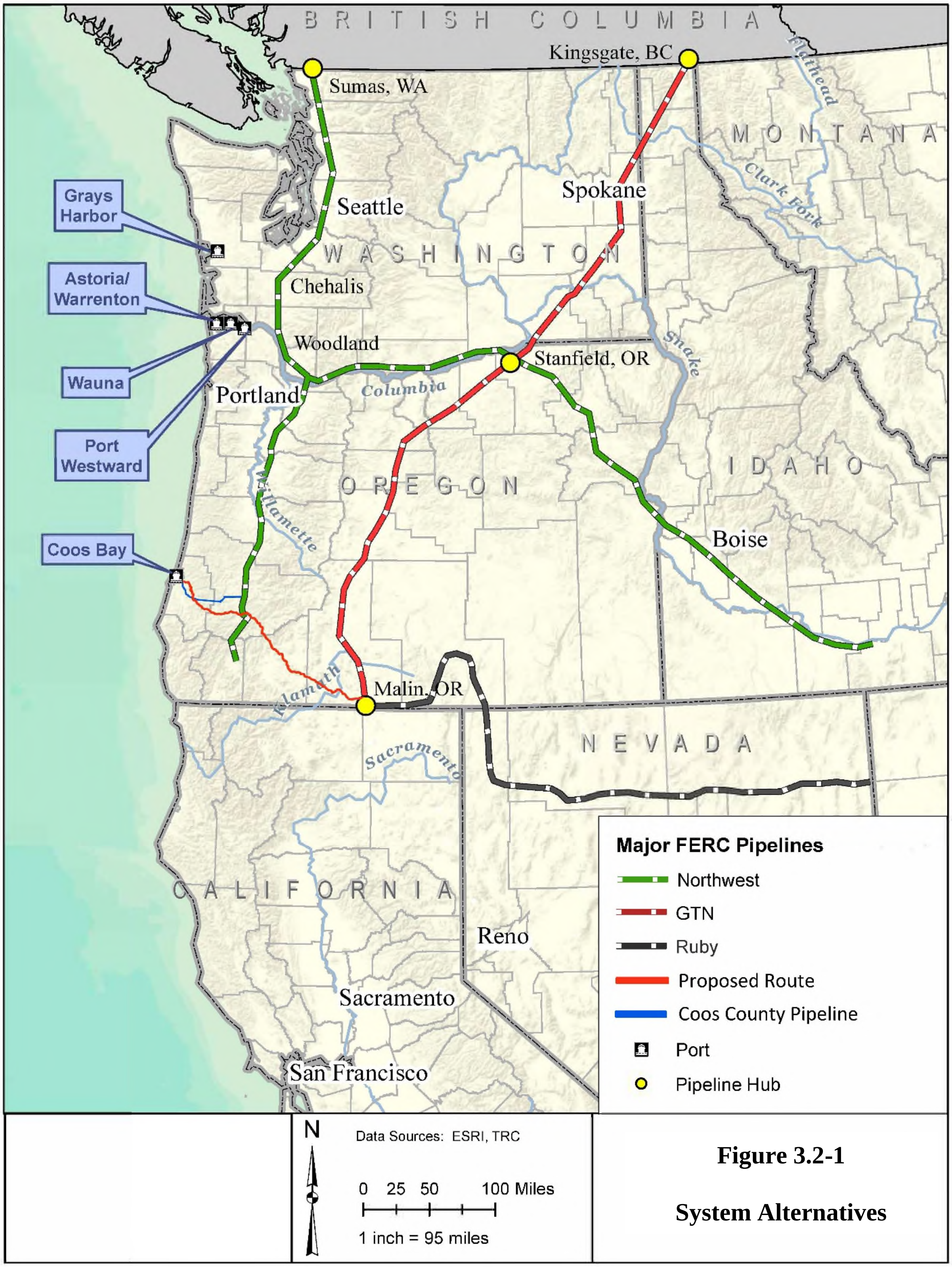


Figure 3.2-1

System Alternatives

According to Natural Resources Canada (2018), 13 LNG export facilities have been proposed in British Columbia, Canada (see table 3.2-1). The final specifications and permitting/ construction statuses of these facilities are unknown. Assuming these facilities have been designed to accommodate a pre-determined need/level of service, it may be possible that with modifications, one or more of these facilities would be able to provide an equivalent level of service to that which would be provided by the Project. However, we are unable to determine what modifications would be necessary and what the impacts of those modifications would be. Furthermore, although constructing a pipeline from the existing GTN and Ruby pipelines systems to western Canada (a distance ranging from 700 to 1,400 miles) is technically feasible, it would increase the Project footprint by between about 10,100 and 25,300 acres. Therefore, we conclude that an LNG system alternative making use of a proposed western Canada LNG facility would not provide a significant environmental advantage and do not consider it further in this analysis.

TABLE 3.2-1

Proposed Canadian LNG Projects

Project	Terminal Location	Output (Max Bcf/d)
Cedar LNG Project	Near Kitimat, B.C.	0.8
LNG Canada Project	Port Edward, Prince Rupert Island, B.C.	3.5
WesPac LNG Marine Terminal	Tilbury Island, B.C.	0.6
Kitimat LNG Project	Kitimat, B.C.	1.3
New Times Energy Ltd.	Prince Rupert area, B.C.	1.6
Orca LNG Project	Prince Rupert area, B.C.	3.2
Steelhead LNG Project	Sarita Bay, Vancouver Island, B.C.	4.3
Woodfibre LNG Project	Near Squamish, B.C.	0.3
Stewart Energy Project	Stewart, B.C.	4.0
Discovery LNG Project	Campbell River, Vancouver Island, B.C.	2.6
Kitsault Energy Project	Kitsault, B.C.	2.7
Triton LNG Project	Floating facility – TBD near Kitimat or Prince Rupert, B.C.	0.3
Watson Island LNG	Watson Island, near Prince Rupert, B.C.	Unknown

There are no existing LNG export facilities on the west coast of Mexico. However, there are two import facilities—the Costa Azul LNG Project in Baja California, and the Manzanillo LNG Project in Colima. The owner of the Costa Azul Project (Sempra Energy) is proposing to convert this project into an LNG export terminal. We are not aware of any other proposed LNG facilities in Mexico; however, we acknowledge that additional proposals may exist. Similar to the proposed Canadian LNG facilities, the final specifications and permitting/construction status of the Costa Azul LNG Project is unknown. Assuming this facility has also been designed to accommodate a pre-determined need/level of service, it may be possible that with modifications, it would be able to provide an equivalent level of service to that which would be provided by the Project. However, we are unable to determine what modifications would be necessary and what the impacts of those modifications would be. Although constructing a pipeline from the existing GTN and Ruby pipelines systems to Baja California (a distance of about 900 miles) is technically feasible, it would increase the Project footprint by about 14,500 acres. Therefore, we conclude that an LNG system alternative making use of the Costa Azul LNG facility would not provide a significant environmental advantage and do not consider it further in this analysis.

The Northwest Pipeline is an approximately 3,900-mile-long bi-directional interstate natural gas transmission system. This system crosses the states of Washington, Oregon, Idaho, Wyoming, Utah, and Colorado. This transmission system provides access to British Columbia, Alberta, Rocky Mountain, and San Juan Basin natural gas supplies. In Oregon, two lateral pipelines connect to the Northwest mainline system. The Camas to Eugene and the Eugene to Grants Pass Lateral are generally parallel to I-5, running north to south through western Oregon. The laterals begin in the north as dual 20-inch-diameter pipelines, and consist of a single a 10-inch-diamter pipeline at the southern end. The only portion of the Northwest Pipeline system that could potentially serve as a system alternative to move gas from near Malin to the LNG terminal in Coos Bay would be a portion of the north-south Eugene to Grants Pass Lateral. Such an alternative would require modifying roughly the eastern one-half of the proposed pipeline to connect to the southern end of the Grants Pass Lateral, then constructing about 70 miles of "looping" pipeline north along the Grants Pass Lateral to near Sutherlin, Oregon, and then constructing about 50 miles of new pipeline west to Coos Bay. Such an alternative would result in roughly the same length of pipeline as proposed; however, may affect more forested area, and could result in similar or greater environmental impacts. Therefore, the implementation of a system alternative involving the use of the Northwest Pipeline Grants Pass Lateral would not provide a significant environmental advantage over the proposed action.

The GTN interstate natural gas transmission system includes about 600 miles of 36- and 42-inch pipeline beginning at Kingsgate, British Columbia, traversing through northern Idaho, southeastern Washington, and central Oregon, and terminating near Malin. Natural gas for the GTN pipeline originates primarily from western Canadian supplies; although it can receive Rocky Mountain gas through interconnections with Northwest near Spokane and Palouse, Washington and Stanfield, Oregon. The Ruby interstate natural gas transmission system includes about 680 miles of 42-inch-diameter pipeline beginning near Opal, Wyoming, and extending west through Montana and Idaho to Malin. Neither GTN nor Ruby would be suitable as system alternatives and neither would be able to meet the purpose of the Project because both systems terminate near Malin and would require a connection to a west coast LNG facility similar to the proposed pipeline route from Malin to Coos Bay. Therefore, systems alternatives involving these systems would not provide a significant environmental advantage over the proposed action.

The Coos County Pipeline is a non-jurisdictional 12-inch-diameter local distribution company (LDC)[47] pipeline that extends about 60 miles from the Northwest Grants Pass lateral, near Roseburg, to Coos Bay. The Coos County Pipeline has a MAOP of 1,000 psig and was designed to bring gas to the communities around Coos Bay. The terminus of the Coos County Pipeline is approximately 7.7 miles south of the proposed Jordan Cove LNG terminal. Northwest Natural built a pipeline lateral from the terminus of the Coos County pipeline across Coos Bay to the North Spit, as part of its LDC system. The diameter and available capacity of the Coos County Pipeline are too small to meet the purpose of the Project. The Coos County Pipeline does not connect to the GTN and Ruby Pipeline systems. Expanding the Coos County Pipeline as needed to provide the required natural gas capacity from the GTN and Ruby Pipeline systems would result in similar impacts as that of the proposed action. For these reasons, the Coos County Pipeline as an existing system cannot meet the Project purpose and expanding it to meet the purpose would not provide a significant environmental advantage.

3.3 LNG TERMINAL SITE ALTERNATIVES

We received numerous comments stating that LNG site alternatives in California, Washington, Canada, and Mexico be considered. Commenters suggested that sites in these states and countries could be more suitable for an LNG terminal. We do not evaluate in this EIS alternative projects

[47] LDCs (local distribution company) are intrastate systems that are regulated by the state, and do not come under the jurisdiction of the FERC.

or LNG terminal sites located in Canada or Mexico. Below we address the potential for an LNG terminal to be sited in California, and then we address potential alternative sites in Oregon and Washington.

As stated previously, the Commission's staff evaluates a proposal and reasonable alternatives. While we may ask the project proponent to evaluate alternative technologies in order to minimize impacts, we do not redesign proposals. However, some alternative technologies or facility designs represent such a large departure from the applicant's proposal that they could significantly affect the feasibility and economic practicality of the proposal. Consequently, we are not evaluating offshore site alternatives that would require specialized LNG carriers. We do however, evaluate the concept of an inland (non-waterfront) alternative (see section 3.3.4).

3.3.1 LNG Terminal Site Alternatives in California

California has 11 public ports. The closest deepwater port to Coos Bay in California is the Port of Humboldt Bay. The Port of Humboldt Bay is located approximately 185 miles south of Coos Bay and 225 miles north of San Francisco (the next closest deepwater port is in San Francisco bay). The Samoa Peninsula lies between the Pacific Ocean and Humboldt Bay and hosts several active and former marine facilities, berths, docks, and terminals. According to the 2018 Humboldt Bay Maritime Industrial Use Market Study, 948 acres of land have been designated for Coastal-Dependent Industry (CDI) on the Samoa Peninsula including the approximately 344-acre Eureka Municipal Airport site which has waterfront access and is the largest single property on the peninsula. It is unknown whether a combination of other CDI properties equaling approximately 200 acres is available. The channel system leading into and within Humboldt Bay varies in length, width, and depth. The Bar and Entrance Channel is approximately 8,500 feet long, 500 to 1,600 feet wide, and is authorized to a depth of 48 feet mean low level water (MLLW). The North Bay Channel which serves the Samoa Peninsula is 18,500 feet long, 400 feet wide, and is authorized to a depth of 38 feet MLLW. The distance by air from Malin, Oregon to Humboldt Bay is about 170 miles (the distance from Malin, Oregon to Coos Bay by air is also about 170 miles). We estimate the pipeline distance between these two points would be at least 200 miles, which is comparable to the proposed pipeline.

An LNG terminal in Humboldt Bay would impact the environment in a manner similar to that of the proposed Project, including; permanent conversion of land use, dredging, turbidity, loss of wetlands, visual impacts, air quality and noise. Concerns at this location such as marine traffic restrictions, socioeconomic impacts, tsunamis, and public safety would also be the same as the proposed Project. A natural gas transmission pipeline from Malin, Oregon to Humboldt Bay, California would traverse Klamath County, Oregon as well as Siskiyou and Humboldt Counties, California. The environment crossed by a pipeline from Malin to Humboldt Bay would be similar to that of the proposed route, including; mountainous terrain, several large rivers, three national forests, and BLM-managed lands. This pipeline route would also cross the ranges of over 20 federally-listed threatened and endangered species including NSO, MAMU, and salmon. Concerns with this pipeline route such as rural property values, socioeconomic impacts, and public safety would also be the same as the proposed Project.

Based on the expected similar impacts of an LNG terminal in Humboldt Bay and the associated natural gas transmission pipeline from Malin, Oregon to Humboldt Bay, we conclude this alternative would not result in a significant environmental benefit when compared to the proposed action.

3.3.2 LNG Terminal Site Alternatives in Oregon and Washington (LNG Terminal Site Characteristics)

As provided in Jordan Cove's application and identified in table 3.3.2-1, we are evaluating four terminal site alternatives. We determined that a reasonable LNG terminal site alternative should include the following site characteristics.

1. **Available Land –** a parcel or combination of parcels available[48] for development and large enough to accommodate the proposed LNG terminal facilities and associated safety exclusion zone, about 200 acres.
2. **Deep Channel Access –** a channel with depth of at least 36 feet MLLW in order to accommodate the draft of anticipated LNG carriers.
3. **Waterfront Access –** a site that can safely accommodate the mooring of an LNG carrier and the facilities required to transfer LNG from the terminal to the carrier.
4. **Comparable Pipeline –** a site that could be reached by a comparable natural gas transmission pipeline from the intersection of the GTN and Ruby pipeline systems.

For the purposes of our alternatives analysis of sites, we do not further evaluate sites that do not or could not satisfy these LNG site requirements. For example, sites that are of insufficient size or are unavailable for purchase or lease are not carried forward into this analysis.

Locations having the four necessary characteristics were identified in Astoria, Wauna, and Port Westward, Oregon, and Grays Harbor, Washington (figure 3.2-1). An environmental comparison and discussion of these LNG terminal site alternatives is provided below.

Each alternative site would require construction of new natural gas pipelines, and in some cases modifications and upgrades to existing transmission pipelines to access western Canadian and U.S. Rocky Mountain natural gas sources from the intersections of the GTN pipeline and Ruby pipeline near Malin, to meet the stated Project purpose. An estimate of the pipeline length required for each alternative is included in table 3.3.2-1. In each of these alternatives, the associated natural gas supply pipeline would need to cross the Cascade Mountains.

[48] Section 3 of the NGA does not grant the authority of eminent domain. In some cases, a site may be of adequate size for an LNG terminal, but the owner is unwilling to sell or lease the property.

TABLE 3.3.2-1

LNG Terminal Port Alternatives Comparison

Feature	Proposed (Coos Bay)	Alternative Port: Astoria, OR	Alternative Port: Wauna, OR	Alternative Port: Port Westward, OR	Alternative Port: Grays Harbor, WA
Available Site Size (acres)	412	519	321	336	272
Supply pipeline length (miles)	229	399	375	332	379
Pipeline construction footprint (acres) a/	4,946	8,618	8,100	7,170	8,186
Freshwater wetland impacts (acres) b/	83	143	49	51	61
Estuarine/open water impacts (acres) b/	35	130	35	60	42
Number of listed species with potential habitat	21 c/	10	15	16	9
Existing residences within 1 mile (number)	116	975	5	828	1,637

a/ Estimated using the average area per mile that would be affected by the proposed pipeline, including all extra temporary work space (21.6 acres/mile).
b/ Assuming all mapped resources within the site would be affected.
c/ This includes the LNG terminal site and LNG carrier transit in the waterway. There are only seven federally listed species that may occur at the LNG terminal site itself.

As shown in table 3.3.2-1, environmental features and potential impacts from use of the alternative sites would vary when compared to the proposed site. Three sites (Astoria, Port Westward, and Grays Harbor) would have a significantly greater number of residences located within 1 mile, while one site (Wauna) would have significantly fewer. Three sites (Wauna, Port Westward, and Grays Harbor) would have less impact on freshwater wetlands than the proposed site, while one site (Astoria) would have more. One site (Astoria) is estimated to require significantly more impact on estuarine and open water habitats than the proposed site. All four alternative sites would require at least 100 more miles of supply pipeline than the proposed site, ranging from an estimated 103 miles (Port Westward) to 170 miles (Astoria) of additional pipeline required, which would require an estimated 2,224 to 3,672 additional acres of disturbance for pipeline construction. When evaluating these potential impacts, we have not identified an alternative site that would result in a significant environmental advantage over the proposed site. Therefore, we conclude that none of the regional alternative sites would result in a significant environmental advantage over to the proposed site in Coos Bay.

3.3.3 Coos Bay Terminal Alternatives

We evaluated one alternative site for the LNG terminal facilities within Coos Bay. The alternative site is located west of the swinging railroad bridge and on the western side of the Coos Bay Navigation Channel. The swinging railroad bridge is an impediment to vessel traffic and the eastern side of the channel does not contain any sufficiently sized parcels due to the presence of the North Bend and Coos Bay communities. Sites along the west side of the North Spit are not suitable because navigational accessibility is limited by exposure to the open ocean.

The Jordan Point alternative site is located about 1 mile east of the proposed LNG terminal site at about river mile 8.5 of the Coos Bay Federal Navigation Channel (figure 3.3-1). The Jordan Point site would be approximately the same size as the proposed site, and Jordan Cove indicates the site would be available for development of an LNG facility. The alternative site overlaps part of the South Dunes portion of the proposed site. A comparison of major environmental factors between the Jordan Point site and the proposed site are listed in table 3.3.3-1.

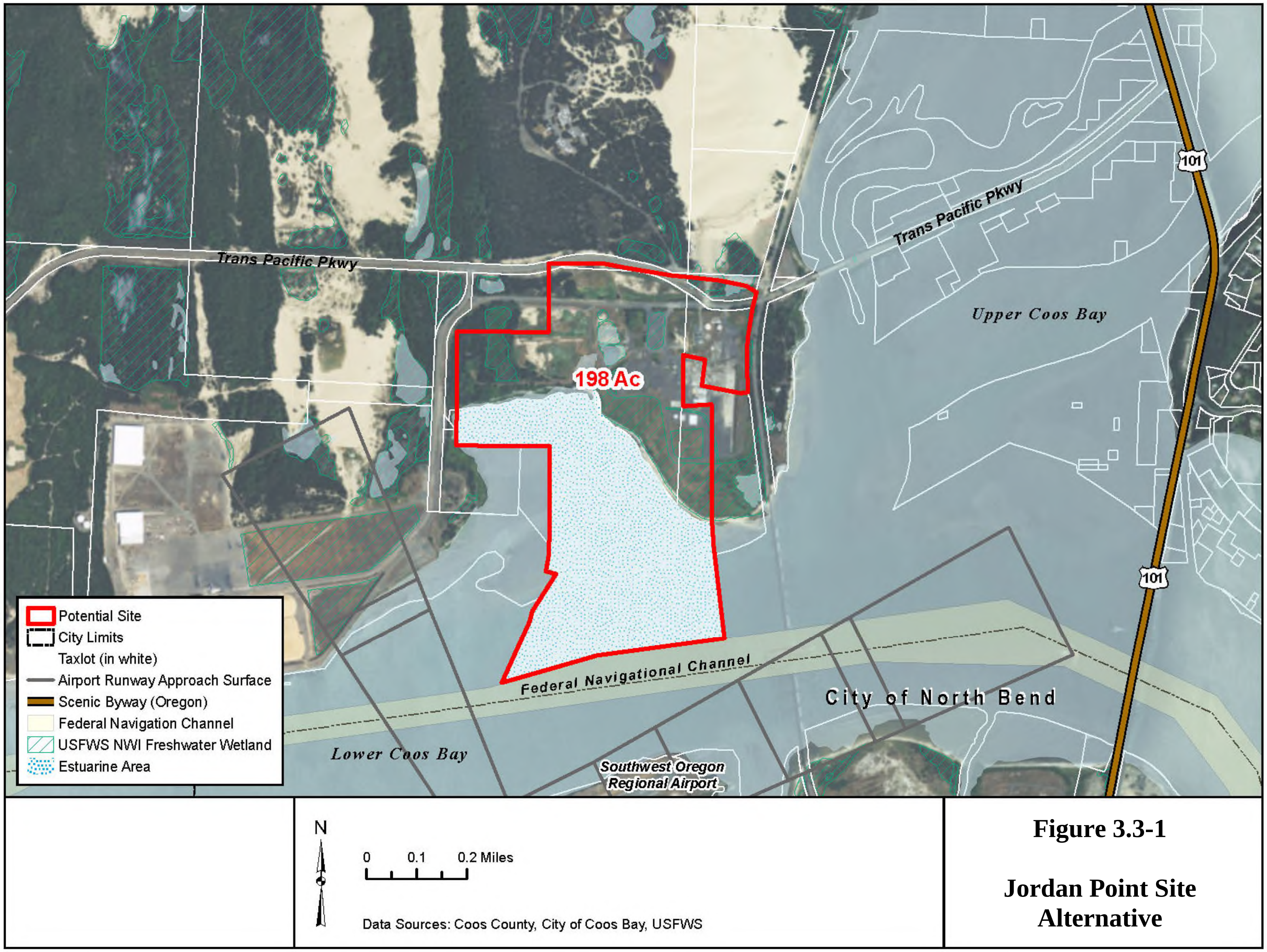


Figure 3.3-1

Jordan Point Site Alternative

TABLE 3.3.3-1

Comparison of Proposed and Jordan Point Alternative LNG Sites

Environmental Factor	Proposed Site	Jordan Point Site
Estuarine Area (acres) a/	32	101
Wetland Area (acres) b/	2	22
Threatened and Endangered Species (number) c/	9	9
Approximate Site Size (acres)	199	198
Land Availability	Y	Y
Federal Land Affected (acres) d/	0	0
Within Airport Runway Approach Zone	No	No
Adequate Area for Safety Exclusion Zone	Y	Y
Existing Residences within 1 Mile (number) d/	116	128

a/ Based on approximate boundary of shoreline to the edge of the Federal Navigation Channel or waterward extent of the potential site boundary.
b/ Based on NWI wetland GIS data within potential site boundary, See Figures 10.3-9 to 10.3-11 in Jordan Cove Resource Report 10.
c/ Based on FWS 2017a and NMFS 2015.
d/ Based on GIS tax lots.

The number of residences within 1 mile would be slightly more for the Jordan Point site (128) than for the proposed site (116), and LNG carriers would have to travel about 1 mile farther along the Federal Navigation Channel to reach the site. Based on NWI mapping, the Jordan Point site would also include more wetlands (approximately 22 acres) compared to the proposed site (approximately 2 acres). The primary disadvantage of the alternative site is its farther distance from the Federal Navigation Channel, which would require a greater area of dredging within the estuarine area between the site and channel (approximately 101 acres) compared to the proposed site (32 acres). For the reasons described above, the Jordan Point site would not provide a significant environmental advantage over the proposed site.

3.3.4 Inland (Non-Waterfront) Alternative

We received comments from the COE requesting that we evaluate an inland LNG terminal site, in order to reduce impacts on wetlands and Coos Bay. An inland alternative site would locate the liquefaction and LNG storage facilities at an upland location outside of Coos Bay and would be connected to the proposed marine loading facilities by an LNG cryogenic pipeline or LNG trucking system. At the proposed site, approximately 86.1 acres of wetlands would be affected by construction and approximately 22.3 acres of wetlands would be permanently lost (see table 4.3.3.1-1). An inland site would not completely eliminate impacts on wetlands as numerous operational and safety facilities would still be required along the shoreline to support the marine loading and LNG carrier berth facilities. Operational and safety facilities would include spill containment systems and utilities such as compressed air, nitrogen, potable water, utility water, fire water, and electrical equipment. An inland site would also require the use of a marine berth and turning basin; therefore, dredging in Coos Bay would still be necessary. As a result, impacts on Coos Bay would not be substantially reduced by an inland terminal site. In either scenario, impacts on Coos Bay would be localized and relatively short term.

Due to the presence of the Oregon Dunes National Recreation Area immediately north of the proposed site, the cities of North Bend and Coos Bay, immediately south, and the Pacific Ocean to the west, any inland site alternative would need to be located at least five miles east of the proposed site. Furthermore, due to the steep topography east of Coos Bay, the distance from the marine loading facilities to a suitable parcel of land for the terminal facilities would likely be greater than five miles and likely require a larger site with more ground disturbance (50 acres or more) to accommodate the significant earthwork (spoil storage, leveling, and slope considerations) that would be required to create an appropriate site. The marine loading facilities would remain at the proposed site because LNG carriers are prevented from travelling farther east by the rail and Highway 101 bridges across Coos Bay.

An LNG cryogenic pipeline, which would be subject to expansion and contraction due to temperature fluctuations, could be located aboveground or underground within a tunnel system. Regardless of the pipeline placement, the USDOT's siting requirements and regulations would apply. In order to ensure pipeline integrity and public safety, the USDOT may require the operating company to obtain legal control of activities up to 400 feet on each side of the pipeline, resulting in an additional 450 acres of land encumbered by the permanent easement. The subsequent amount of affected land when compared to the amount of land typically affected by a natural gas pipeline would be significantly greater. In addition, the USDOT siting requirements for LNG cryogenic pipelines require security features (fencing and exclusion zones) and spill containment systems. At a minimum, an LNG cryogenic pipeline system would need to accommodate the LNG ship loading pipe, an LNG recirculating and cooldown pipe, and the ship vapor return pipe as well as access points for inspection and maintenance work. The cryogenic pipelines would also require insulation along the entire length to maintain (low) operating temperatures. These facilities would require a larger permanent operational easement and would likely require a larger construction right of way, both of which would increase impacts on the environment. Unlike an interstate natural gas pipeline regulated under Section 7 of the NGA that provides for the use of eminent domain, temporary and permanent easements required for an LNG cryogenic pipeline regulated under Section 3 of the NGA must be obtained without the use of eminent domain which could result in a longer pipeline route further increasing impacts on the environment. An LNG cryogenic pipeline would also require pump stations to ensure LNG flows and pressures are maintained. These pump stations would need additional provisions for electrical power, security, firewater, control room, etc. and would require the permanent use of additional lands and impacts on the environment. A cryogenic pipeline transporting LNG from an inland terminal site to the marine loading facilities is technically feasible, but would require numerous design and siting changes, resulting in additional environmental impacts, and could affect the economic competitiveness of the Project.

An inland LNG terminal alternative could impact a larger footprint than the proposed site and would affect other resources. Because the proposed site has been previously disturbed, the impacts of an inland LNG terminal could be greater than the impacts at the proposed site. Furthermore, constructing a LNG cryogenic pipeline would require several additional systems and measures to be designed and implemented to ensure safety and integrity. Ultimately, when considering the footprint of the inland terminal, the marine loading facilities, power infrastructure for the pumps, and the difficulties and costs associated with a redesigned pipeline, we conclude that while perhaps feasible, an inland site would not be practical.

A trucking system transporting LNG from an inland terminal site to the marine facilities at the proposed output volumes would require thousands of truck trips per day. This amount of traffic on area roads would be a significant impact and would greatly increase public safety concerns. In addition, exhaust emissions from the trucks would impact local air quality. Therefore, we conclude that an inland terminal with a trucking system would not provide a significant environmental advantage over the proposed LNG terminal.

3.4 PIPELINE ROUTE ALTERNATIVES AND VARIATIONS

We evaluated numerous pipeline route alternatives and variations to determine whether their implementation would be preferable to the proposed corresponding action. Major route alternatives are generally greater than 50 miles in length and can deviate from the proposed route by a significant distance. Route variations are generally less than 50 miles in length and deviate from the proposed route to a lesser degree than a major route alternative.

Route alternatives and variations were identified based on public comments, information provided by Pacific Connector, agency consultations, and our independent review of the Project. Also, as required by Subsection 28 (p) of the Mineral Leasing Act, the agencies considered opportunities for co-location with existing rights-of-way where the proposed pipeline would cross federally managed lands. In addition to alternatives and variations evaluated in this EIS, during the course of refining the proposed route, Pacific Connector incorporated a number of minor route modifications to address agency concerns and landowner requests, constructability issues or constraints, to avoid cultural resources or geological hazards, or reduce impacts on special status, threatened, or endangered species. These include minor modifications recommended by the BLM between MPs 119.5 and 119.8, at MP 126.0, and at MP 131.5, and between MPs 183.9 and 187, and recommended by the Forest Service between MPs 154.7 and 155.1, MPs 157.1 and 158.7, and MPs 171.2 and 173.0.

3.4.1 Major Route Alternatives

Elements we considered during our analysis of potential alternatives included pipeline length, use of or co-location with existing rights-of-way, forest land, agricultural land, waterbody and wetland crossings, residences, known cultural resources, habitat for federally listed threatened or endangered species, and geological hazards and slope stability.

3.4.1.1 All Highway Alternative

We evaluated the All Highway Alternative as a potential alternative that would follow existing highways as much as possible in order to co-locate rights-of-way and reduce the creation of new corridors through resource areas. This alternative would follow Highway 50 west from Malin to Highway 39, northwest to Klamath Falls, then along Highway 140 west to Medford, then along I-5 north to Winston, then west along Highway 42, and then north along Highway 101 to Coos Bay. This route would be approximately 281 miles long, or about 52 miles longer than the proposed route, resulting in approximately 600 acres of additional construction right-of-way disturbance.

The potential advantage of the All Highway Alternative is that the pipeline would be co-located with the existing highway right-of-way, co-locating new disturbance and associated impacts with existing disturbance. However, as explained below, the pipeline would be placed adjacent to, but not within, highway rights-of-way, and therefore the alternative would still require acquisition of new right-of-way. The Federal Highway Administration (FHWA) historically prohibited the installation of new utility facilities within the rights-of-way of access-controlled freeways except in some extraordinary cases. This prohibition was consistent with the American Association of State Highway Transportation Officials (AASHTO) policies for longitudinal accommodation. However, with a 1988 amendment to the FHWA regulations, the FHWA's policy changed to allow each state to decide whether to permit new utility facilities within these rights-of-way, or continue to adhere to the stricter AASHTO policies (FHWA 2014). Oregon defines its policy for accommodating utilities in highway rights-of-way in OAR 734-055-0080. In general, Oregon does not allow utilities to occupy interstate rights-of-way with the exception of perpendicular crossings (Caswell 2008).

In addition to the further disturbance that would result from the longer length of the alternative, there are disadvantages related to its location parallel to highways. The pipeline route paralleling the highway rights-of-way has constraints such as highway cuts and fills; elevated roadway sections, bridges, overpasses and underpasses; clover leaf and other interchanges; as well as commercial, industrial, and residential developments located immediately adjacent to the rights-of-way and interchanges. For these reasons, we have determined that implementation of the All Highway Alternative would not result in a significant environmental advantage and is not preferable to the proposed route.

3.4.1.2 Federal Lands Route Alternative

We considered a conceptual Federal Lands Alternative that would place the pipeline entirely on federal lands as a potential alternative to avoid or significantly reduce impacts on private property. Given the patchwork nature of federal land holdings in the Project area in southern Oregon, with federal blocks scattered between private tracts, we were unable to identify a route between Malin and Coos Bay that would be entirely on federal lands and not cross private lands. Therefore, a route that would be entirely on federal land and would avoid private property is not feasible and is not considered further in this EIS.

3.4.1.3 Federal Lands Avoidance Route Alternative

We attempted to identify a pipeline route alternative that would avoid crossing federally managed lands. However, given the extensive Forest Service lands and the checkerboard nature of BLM-managed lands in southwest Oregon (see figure 1.1-1), we were unable to identify a route between Malin and Coos Bay that would avoid crossing federally managed lands. We also attempted to identify a pipeline route that would avoid crossing federally managed lands by heading in any direction from Malin and eventually reaching Coos Bay, regardless of length. Again, due to the extensive and connected Forest Service lands to the north, east, south, and southwest of Malin, we were unable to identify a route that could reach Coos Bay without crossing federally managed lands. Therefore, a federal lands avoidance route alternative is not feasible and is not considered further in this EIS.

3.4.2 Pipeline Variations

3.4.2.1 Coos Bay Estuary Variations

We received a number of comments concerning the impact of the pipeline crossing of the Coos Bay estuary, including comments from the Coos Tribe. Pacific Connector proposes to cross the Coos Bay estuary using HDD in two segments between MPs 0.3–1.0 and MPs 1.5–3.0. We evaluated several pipeline variations in this area that would modify the crossing location and method to determine if any alternatives might reduce effects on the estuary, including a North Route Variation, a Modified North Route Variation, and a Haynes Inlet East Avoidance Variation (see figure 3.4-1).

The North Route Variation and the East Avoidance Variation would begin at the pipeline terminus and cross north of Haynes Inlet to the north of Sherwood, and both include HDDs to avoid impacts on the Mangan and Wetle Natural Resource Conservation Service Wetland Reserve Program (WRP) easements on the west and east side of Haynes Inlet (see figure 3.4-1). The Modified North Route Variation would have the same route as the North Route Variation until a point north of Sherwood where it includes an HDD (approximately 5,200 feet in length) that extends from ridgeline to ridgeline on either side of the inlet.

A comparison of major environmental and land use features crossed by each of these variations compared to the corresponding segment of proposed route is included in table 3.4.2.1-1. The potential advantage of the variations is avoidance of pipeline-related disturbance on the North Point area of North Bend, and avoidance of the Federal Navigation Channel that would be crossed twice, by HDD, at MP 0.66 and MP 1.6 of the proposed route. However, activities proposed by Jordan Cove, which would still occur with use of any of these variations, would affect both the North Point area and the Federal Navigation Channel, essentially negating any benefit of avoiding these areas with the pipeline. The North Point would still be used for construction laydown yards and dredge spoil disposal (within APCO sites 1 and 2, see sections 2.1.1.8 and 2.1.1.10) and the Federal Navigation Channel would still be affected by dredging for the access channel and the marine waterway modifications (see section 2.4.1.5).

The primary disadvantages of the Coos Bay Estuary variations are greater pipeline length and greater associated construction disturbance. Other disadvantages include greater number of waterbody crossings, more forest clearing, and greater number of private land parcels affected.

For the reasons described above, we have determined that implementation of these alternatives would not result in a significant environmental advantage and are not preferable to the proposed route.

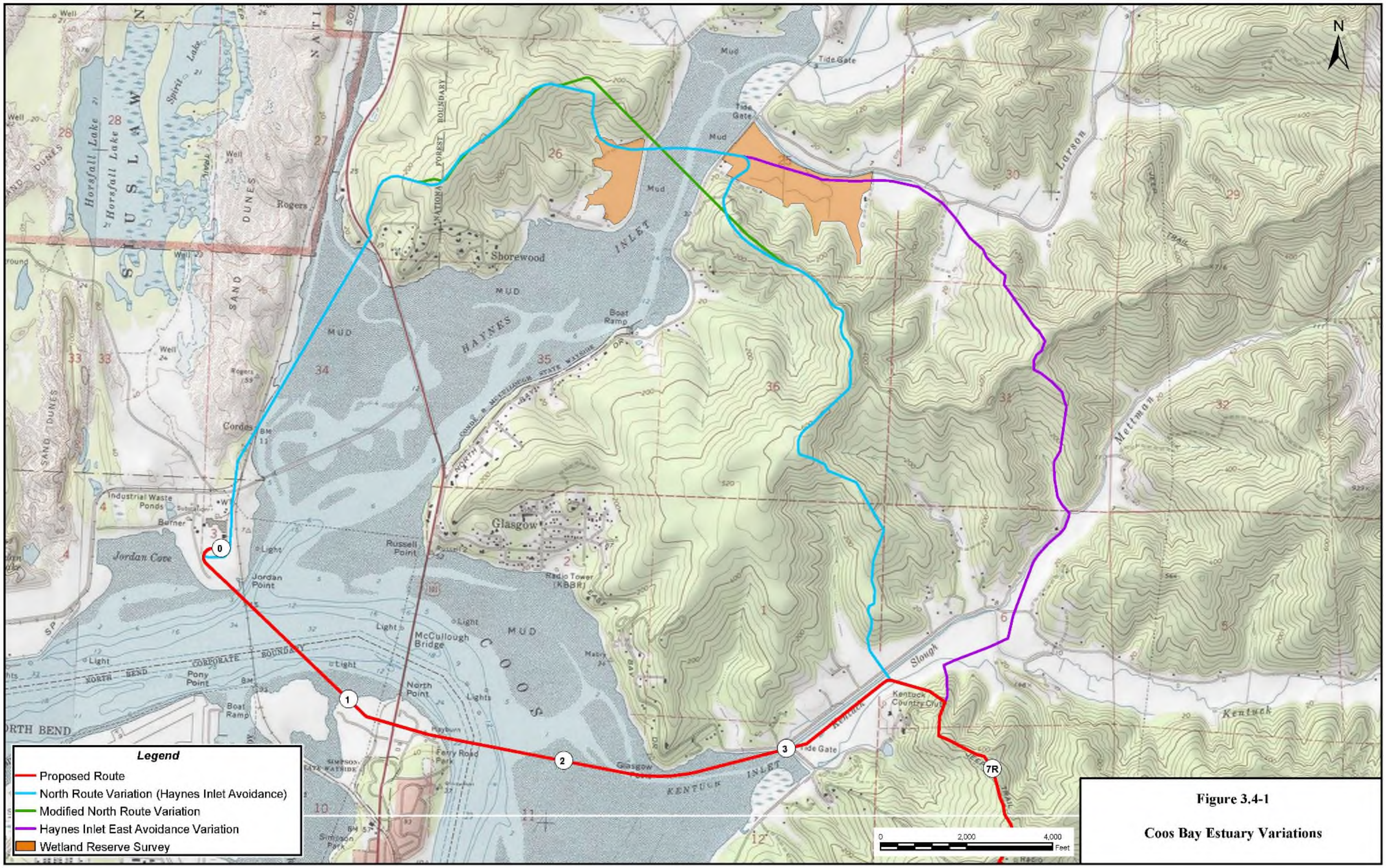

Legend
Proposed Route
North Route Variation (Haynes Inlet Avoidance)
Modified North Route Variation
Haynes Inlet East Avoidance Variation
Wetland Reserve Survey
Figure 3.4-1
Coos Bay Estuary Variations
0
2,000
4,000
Feet
N
Shorewood
Glasgow
Jordan Cove
Haynes Inlet
Coos
Kentuck Slough
Kentuck Country Club
McCullough Bridge
North Bend

TABLE 3.4.2.1-1

Comparison of Coos Bay Estuary Variations with Proposed Route

Impact/Issue		**Proposed Route**	**North Route Alternative**	**Modified North Route Alternative**	**Haynes Inlet East Avoidance Alternative**
Variation length (miles) a/		3.43 (2.20 HDD)	7.15 (1.65 HDD)	6.55 (2.54 HDD)	7.55 (1.65 HDD)
Construction right-of-way (acres) b/		9.3	65.5	52.4	67.9
Temporary extra work areas (TEWA) (acres)		54.9	60.9	49.3	64 c/
Total acres of construction disturbance		64.2	126.4	101.7	131.9
Operational easement (acres) d/		9.8	36.3	30.0	45.8
Land ownership (miles)	0.2	5.5	5.1	5.3	0.2
	3.3	1.7	1.4	2.3	3.3
	0.0	0.0	0.0	0.0	0.0
Number of residences within 50 feet of the construction right-of-way		0	0	0	1 (HDD)
Number of waterbodies crossed e/		3	7	6	16
Length of wetland crossings (feet) e/		3,168	3,711	950	12,936
Agricultural land affected (miles)		0.5	0.5	0.2	2.2
Forest lands affected (miles) f/		0.0	3.5	3.8	2.8
Miles of right-of-way parallel or adjacent to existing rights-of-way (percent of route length)		0.2	1.9	1.9	2.5
COE 408 facilities g/		2	0	0	0
NRCS WRP Easements h/		0.0	0.4	0.0	0.9
Miles of critical habitat for federal T&E species and EFH species		0 (2.2 avoided by HDD)	0 (1.3 avoided by HDD)	0 (1.2 avoided by HDD)	0 (1.3 avoided by HDD)

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).

a/ Variation lengths are measured from the point where they deviate from and then return to the proposed route. Lengths cannot be accurately calculated by comparing mileposts due to shifts in the alignment.

b/ The construction right-of-way for the proposed route and Alternatives is 9 feet wide in upland areas and, where HDDs are proposed, the right-of-way width has been removed.

c/ TEWAs for the Haynes Inlet East Avoidance Variation are estimated.

d/ The assumed permanent easement width is 50 feet.

e/ NWI coverages and photo interpretation were used for the Proposed Route and the Haynes Inlet East Avoidance Variation.

f/ Includes all forestland types: Evergreen forest, Mixed conifer, Regenerating forests and clear-cuts. The routes do not cross late successional nor old-growth forests.

g/ The proposed route would traverse under the Coos Bay Federal Navigation (shipping) Channel twice at MPs 0.66 and 1.6 by HDD. The alignment of the Haynes Inlet East Avoidance Variation was realigned to avoid crossing dikes associated with the Larson Inlet Flood Damage Reduction (FDR) Project located along Larson Slough. According to the National Levee Database (http://geoplatform.usace.army.mil/home), the Larson Inlet FDR Project is a federally authorized and constructed and a non-federally operated and maintained, agricultural flood-protection project.

h/ The Mangan WRP would be crossed by both North and East Avoidance Variation on the west side of Haynes Inlet for approximately 1,150 feet. The Wetle WRP would be crossed on the east side of Haynes Inlet by the North Route Variation for approximately 1,130 feet and by the East Avoidance Variation for approximately 3,450 feet.

3.4.2.2 Blue Ridge Variation

Based on comments received during scoping and concerns expressed by the BLM regarding steep topography, late-successional old-growth (LSOG), and potential impacts on threatened and endangered terrestrial species, we evaluated an alternative between about MPs 11 and 25 referred to as the Blue Ridge Variation. The 15.2-mile-long Blue Ridge Variation, which is depicted in figure 3.4-2, would deviate from the proposed route near MP 11 just south of the Coos River, continuing southwest across Catching Slough, turning south/southeast, generally co-located with an existing utility right-of-way before rejoining the proposed route near MP 25. Table 3.4.2.2-1 compares the variation to the corresponding segment of the proposed route. Additional details regarding the assessment of this variation can be found in appendix F.

When compared to the corresponding segment of the proposed route, the Blue Ridge Variation would require clearing less (about 32 acres less) LSOG forest (late-successional forest stands greater than 80 years old); would substantially reduce the number of occupied and presumed occupied (3 and 14 less, respectively) MAMU stands affected as well as acres of suitable MAMU habitat removed (about 29 acres less); and cross five fewer miles of LSRs and 0.47 mile less of NSO home range. As discussed in more detail in section 4.4.2.1, LSOG forest stands have a well-defined, multi-tiered canopy, which creates microhabitats for many species (Bingham and Sawyer, Jr. 1991; Spies and Franklin 1996), including the federally listed NSO and MAMU. Additionally, the variation would affect 3 fewer acres of designated Riparian Reserves on BLM-managed lands and about 15 acres less of NSO High NRF and NRF habitat. However, the variation is longer and would affect about 14 additional acres of land. It would also more than double the number of private parcels (24 to 53) and miles of private lands crossed (6.46 to 13.76). The variation would also increase the number of perennial waterbodies crossed by 27, and would increase the number of known and assumed anadromous fish-bearing streams crossed from 4 to 18, which would also increase the clearing of upland riparian vegetation associated with each crossing.

As indicated in the comparison table, the above discussion, and the analysis contained in appendix F, the primary trade-offs between the proposed route and the variation are between terrestrial (e.g., LSOG forest and MAMU stands/habitat) and aquatic resources (e.g., waterbody crossings and anadromous fish habitat), as well as public and private lands. With respect to terrestrial and aquatic resources, the measures that would be implemented to avoid or minimize these impacts differs considerably. Constructing and operating the pipeline along the proposed route would result in a permanent loss of LSOG forest and would adversely affect MAMU (see sections 4.4 and 4.6 for discussions regarding these resources); the applicants have very minimal options available for avoidance and minimization measures to address these permanent effects to upland resources (i.e., LSOG and MAMU), and have not proposed mitigation for these permanent effects. In contrast, some of the impacts on aquatic resources, waterbodies, and anadromous fish are expected to be temporary to short-term with implementation of Jordan Cove's and Pacific Connector's proposed impact minimization and waterbody restoration measures (e.g., Jordan Cove's *Plan*, *Procedures*, and ECRP), as well as our recommendations (see sections 4.3 and 4.5 for discussions regarding these resources). The applicants have also proposed some mitigation for the effects to waterbodies and anadromous fish as part of the BLM's right-of-way grant application and proposed plan amendments (see appendix F). However, some permanent unmitigated effects on waterbodies and anadromous fish would occur in the form of the permanent loss of mature riparian areas associated with affected waterbodies.

Our experience from reviewing stream crossings by FERC-regulated pipelines constructed in numerous habitats across the U.S. has confirmed that the short duration of the crossing and the prompt restoration of the stream bed and stabilization of the stream banks results in very few impacts on waterbodies that extend in time beyond the construction and initial restoration of the right-of-way. This is in part due to implementation of best management practices such as dry crossing methods, timing and duration, and restoration methods that are required by the FERC's *Plan* and *Procedures*, which are methods that the applicants have incorporated into their proposal. By comparison, the removal of LSOG habitat is a permanent impact for the operational right-of-way and, even in temporary work areas, recovery of the habitat would take at least 80 years.

We acknowledge that the variation would increase the number of private parcels crossed. Numerous public comments in the Commission's administrative record express concerns about how these lands would be affected. However, we note that although many additional private parcels are affected by the variation, only one residence is located within 50 feet of the construction right-of-way. This EIS addresses numerous measures to be employed during and following construction that would reduce impacts and facilitate restoration of the right-of-way.

We also acknowledge the concerns expressed by the NMFS and the COE regarding the increased impacts on waterbodies, threatened and endangered aquatic species, and adjacent riparian vegetation; and the BLM, FWS, and Tribes regarding the impacts on LSOG forest, threatened and endangered terrestrial species, and other upland managed resources. As stated previously, there are considerable trade-offs between the proposed route and the variation.

In the alternatives methodology described at the beginning of this section, we state that an alternative would be preferable if it meets the stated purpose of the Project; is technically and economically feasible and practical; and if implemented would result in a significant environmental advantage when compared to the proposed action. We also state that when making an alternatives determination we attempt to balance the overall impacts (and other relevant considerations) of the alternative and the proposed action. Therefore, recognizing the trade-offs between the proposed route and the variation; the differences between terrestrial and aquatic resource impacts in regard to temporal effects, as well as the scope of avoidance, minimization, and mitigation for these effects; and the magnitude of the effects, we have determined that the Blue Ridge Variation would result in an overall environmental advantage when compared to the corresponding segment of the proposed route. Our conclusion is based primarily on the variation's ability to reduce long-term to permanent impacts on particularly valuable LSOG habitat affected by the proposed route. Both the sensitivity and value of this habitat and the duration of the impact contribute to this finding. Therefore, **we recommend that:**

- **Prior to construction, Pacific Connector should file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the Blue Ridge Variation into its proposed route between MP 11 and MP 25.**

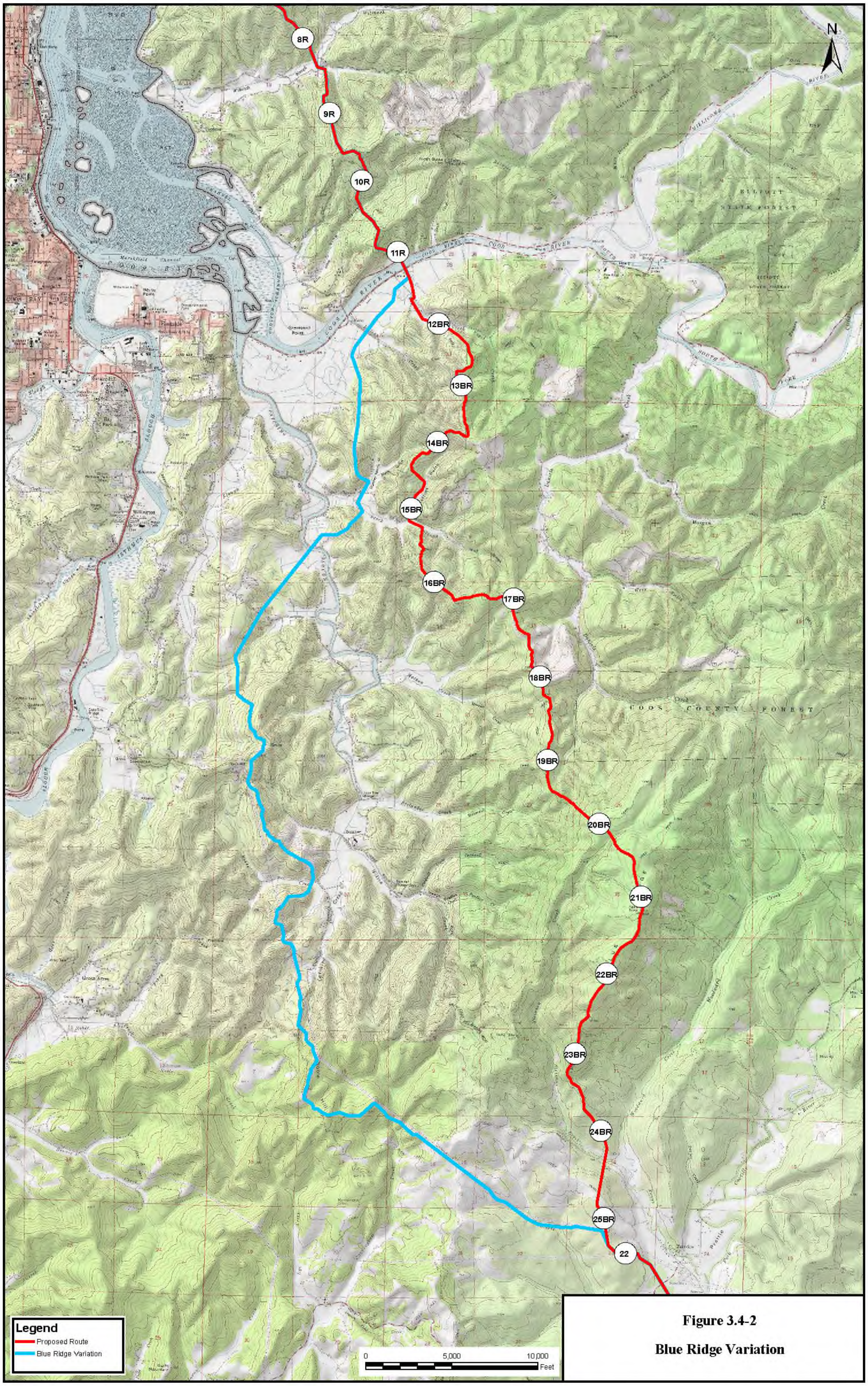


Figure 3.4-2

Blue Ridge Variation

TABLE 3.4.2.2-1

Comparison of Blue Ridge Variation with the Proposed Route

Impact/Issue		**Proposed Route**	**Blue Ridge Variation**
Length (miles) a/		14.0	15.2
Construction right-of-way (acres)		161.4	175.5
Temporary extra work areas (TEWA) (acres)		37.0	57.0
Uncleared storage areas (acres)		45.4	1.5
Temporary access roads (TARs)		0	1 (TAR 13.8)
Permanent access roads (PARs)		0	1 (PAR 15.6)
Operational easement (acres) b/		85.0	92.1
Land ownership (miles)	Private	6.5	13.8
	BLM	7.5	1.4
	State	0.0	0.1
Number of landowner parcels crossed	Private	24	53
	BLM	11	0
	State	1	2
Number of residences within 50 feet of the construction right-of-way		0	1
Water supply wells within 50 feet of the construction right-of-way c/		0	0
Number of waterbodies crossed	Field survey data	3 perennial 5 intermittent d/ e/ (6.5 unsurveyed)	30 perennial 29 intermittent (4.6 unsurveyed)
Length of wetland crossings (miles)		2.0	1.9
Designated Riparian Reserves on BLM-managed lands Impacted (acres)		12.3	9.1
Agricultural pastures affected (acres construction right-of-way)		8.4	11.1
Coniferous forest (acres construction right-of-way) f/	LSOG	40.5	8.8
	Mid-seral	41.8	47.3
	C – R	77.1	113.3
LSRs/ Unmapped LSRs crossed (miles/acres)		5.5 mile / 12.3 acres	0.44 mile / 5.16 acres
Northern Spotted Owl (NSO) home range (1.5-mile radii)		1 / 1.22 miles	1 / 0.75 mile
High NSO NRF and NRF habitat removed (acres) g/		23.8	8.8
Number of marbled murrelet (MAMU) stands crossed by right-of-way		3 occupied stands; 18 presumed occupied stands h/	4 presumed occupied stands
MAMU suitable habitat removed (acres) i/		32.2 (5.8 acres occupied; 26.4 acres presumed)	3.0
Number of anadromous fish-bearing streams crossed j/	Known	4	9
	Assumed	0	9
Fisheries critical habitat (streams crossed)	Coho k/	4	7
	Green Sturgeon l/	0	0
Landslide prone areas m/		2 landslide areas (totaling 3,267 feet)	5 landslide areas (totaling 7,137 feet)
Number of known cultural resources sites		1 n/ o/	0
Number of newly identified cultural resources		1 n/	0 p/
Right-of-way adjacent to existing rights-of-way (miles and percent of route length) q/		8.3 (59 percent)	7.1 (47 percent)

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).
a/ Route Alternative lengths are measured from the point where they deviate from and then return to the proposed route. Lengths cannot be accurately calculated by comparing mileposts due to shifts in the alignment.
b/ Acres of permanent easement calculated based on a 50-foot-wide permanent easement.
c/ OWRD (2017).
d/ Includes waterbodies not crossed by the centerline but within the right-of-way.
e/ Field surveys on BLM lands and desktop analysis on private lands.
f/ Evergreen Forest: LSOG (late successional/old-growth forest) = 80+ years; Mid-seral = 40 to 80 years; C-R (Clear-cut/regenerating forest) = 0 to 40 years.
g/ Acreage is based on 2017 updated NSO habitat coverage for the pipeline project (nesting, roosting, and foraging habitat: NRF, High NRF).
h/ "Presumed occupied stands" have not been surveyed following the species-specific survey protocol (Mack et al. 2003). "Occupied stands" are confirmed occupied based on the species-specific survey protocol.
i/ Acreage is based on 2017 updated MAMU habitat coverage for the pipeline.
j/ ODF (2017). Each crossing would include clearing of some riparian vegetation.
k/ NMFS (2008a).
l/ NMFS (2009).

TABLE 3.4.2.2-1 (continued)

Comparison of Blue Ridge Variation with the Proposed Route

m/ Based on published sources, including the Oregon Department of Geology and Mineral Industries (DOGAMI) open file report 0-11-01 and Statewide Information Database for Oregon (SLIDO).
n/ Surveys are incomplete on approximately 6.0 miles (43 percent) of the route on private lands.).
o/ The historic Barker-Morris Families Cemetery, dating to 1872, is located on private land in Township 27 S, Range 12 W, Section 14. The historic cemetery is situated at MP 24.3 of the proposed route. The cemetery is shown on the McKinley 7.5-minute quadrangle approximately 24 meters east of the construction right-of-way. However, cultural surveys have not been conducted on this privately-owned parcel, and the exact location of the cemetery has not been verified. The cemetery is listed in the Oregon Burial Site Guide but has not been recorded as an archaeological site with the Oregon State Historic Preservation Office.
p/ Surveys are incomplete on route deviations that are outside the cultural survey corridor for the 2015 FEIS Route.
q/ Approximately 5.3 miles (35 percent) of the Blue Ridge Variation is co-located/adjacent to a BPA Powerline corridor, whereas the proposed route is adjacent/co-located with logging roads.

3.4.2.3 Weaver Ridge Variations

At the request of the BLM, we evaluated several route variations between MPs 42.7 and 49.8 to determine if impacts on MAMU and NSO critical habitat could be reduced. As illustrated in figure 3.4-3, we evaluated the Deep Creek Variation, Weaver Ridge Variation 1, Weaver Ridge Variation 2, Weaver Ridge Variation 2a, Weaver Ridge Variation 3, Weaver Ridge Variation 3a, and Weaver Ridge Variation 4.

The Weaver Ridge Variation 1 would deviate from the proposed route around MP 46.0 crossing the logging spur road north of a reservoir and head almost due east on the north side of a tributary of Wildcat Creek over ridges, reconnecting with the proposed route at about MP 49.8. This alternative would be slightly shorter than the proposed route. However, the Weaver Ridge Variation 1 would cross more miles of critical habitat for MAMU and NSO, and would cross two MAMU occupied stands (compared to one along the proposed route) and five NSO home ranges (compared to four along the proposed route).

The Weaver Ridge Variation 2 would start at the same location as Variation 1 but deviate from Variation 1 east of the proposed route at about MP 46, crossing a logging spur road, pass the Signal Tree Quarry, then follow Signal Tree Road for about 3 miles. It would head south over ridges, then join Variation 3 along Wildcat Creek. Weaver Ridge Variation 2a would deviate from Variation 2 just across the Coos County line along Signal Tree Road, cutting diagonally along Wildcat Creek to rejoin Variation 2 Route across the Douglas County line.

The Weaver Ridge Variation 3 would deviate from the proposed route at about MP 42.6. It would follow ridges for about 3.5 miles, crossing Signal Tree Road and Upper Rock Creek. The variation would then turn east and follow ridges for almost 4 miles, crossing Wildcat Creek before rejoining the proposed route at about MP 48.5. Weaver Ridge Variation 3a would deviate from Variation 3 and follow Wildcat Creek for 1.5 miles to join the proposed route at about MP 49.0.

A comparison of the environmental features of the Weaver Ridge Variations and the corresponding segment of proposed route are shown in table 3.4.2.3-1. Weaver Ridge Variations 2, 2a, 3, and 3a are all longer than the corresponding segment of proposed route and would cross more miles of MAMU and NSO critical habitat. Variations 3 and 3a would cross six NSO home ranges, while Variations 2 and 2a would cross five NSO home ranges (compared to four for the corresponding segment of proposed route). Compared to the proposed route, these variations would require clearing more LSOG and affect more acres of LSR on lands managed by the BLM. As a result, none of these variations within this area would ultimately reduce impacts on MAMU and NSO critical habitat. Therefore, we have determined that implementation of Weaver Ridge Variations 2, 2a, 3, and 3a would not result in a significant environmental advantage and are not preferable to the proposed route.

Weaver Ridge Variation 1 would be shorter than the corresponding segment of proposed route and would cross less waterbodies than the proposed route; however, it would have greater impacts on forested habitats, cultural resources, as well as MAMU and NSO critical habitat. Therefore, we have determined that implementation of Weaver Ridge Variation 1 would not result in a significant environmental advantage and is not preferable to the proposed route.

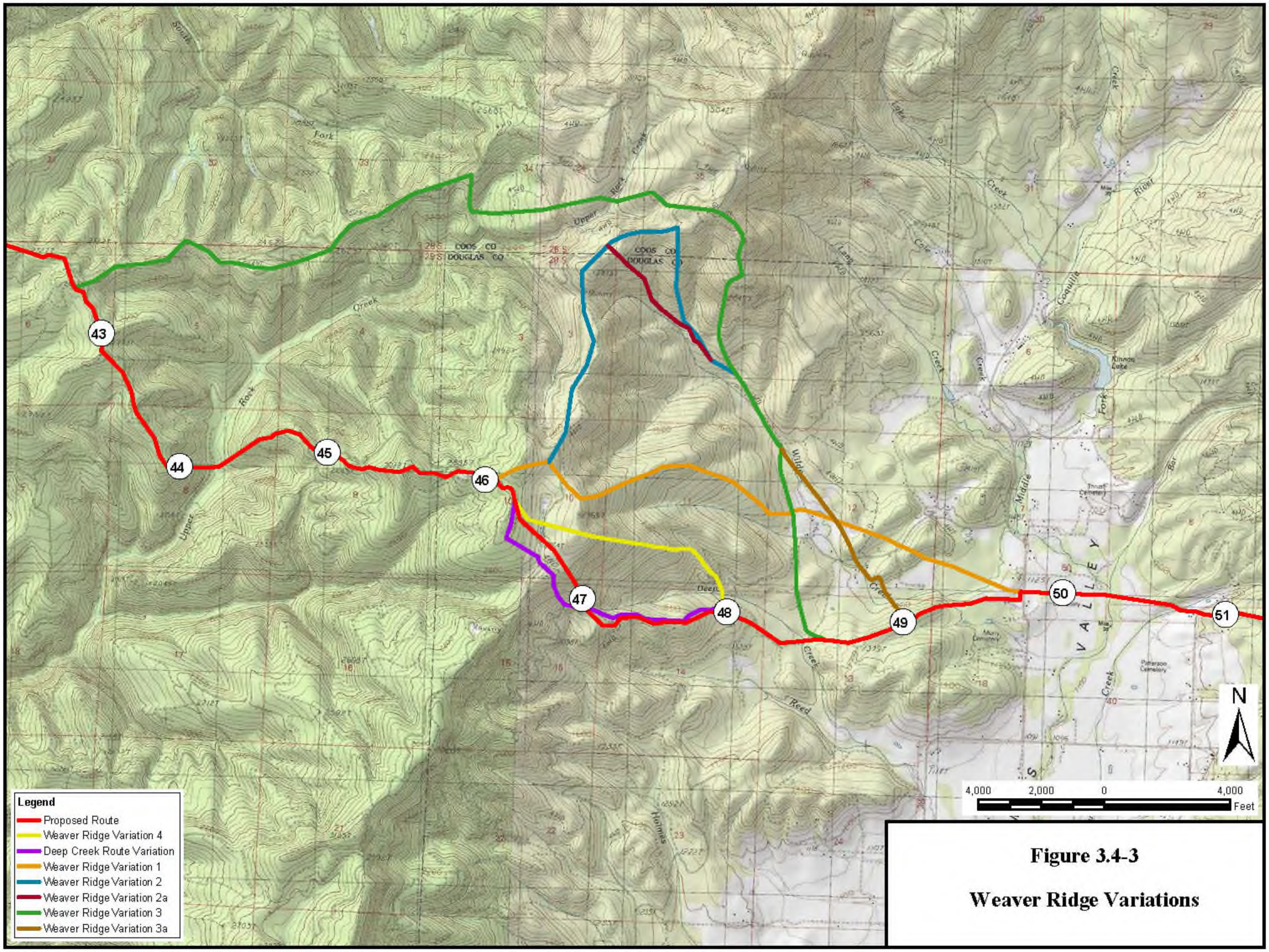


Figure 3.4-3

Weaver Ridge Variations

TABLE 3.4.2.3-1

Comparison of Weaver Ridge Variations with the Proposed Route

Alternatives Analysis		Proposed Route	Deep Creek Variation	Weaver Ridge Variations 4	1	2	2a	3	3a
General									
Total length (miles) a/		7.3	7.4	7.2	7.0	9.3	9.0	8.6	8.2
Construction right-of-way (acres) b/c/		84	85	82	80	107	103	99	94
Operational easement (acres) d/		44	45	43	42	56	54	53	50
Number of Parcels Affected	BLM	4	4	4	3	5	4	4	4
	Private	12	12	11	11	15	14	12	13
	State	0	0	0	0	0	0	0	0
Land ownership (miles)	BLM	2.7	2.8	3.3	2.5	3.4	2.8	3.6	3.2
	Private	4.6	4.6	3.9	4.5	6.0	6.2	5.0	5.0
	State	0	0	0	0	0	0	0	0
Waterbodies and Wetlands									
Number of waterbodies crossed e/		5	5	5	2	7	7	11	11
Total wetland crossing length (feet) f/		0	0	0	0	0	0	0	0
Land Use									
Land Allocations (miles)	Matrix	2.1	2.1	2.1	1.1	1.4	1.4	0.7	0.4
	LSR	0.6	0.7	1.2	1.4	1.9	1.4	2.9	2.9
	Riparian Reserves	0.5	0.7	0.5	<0.1	0.5	0.3	0.6	0.5
Evergreen forest, Mixed conifer (late successional/old-growth) (miles)		0.4	0.7	0.4	1.8	2.2	1.7	1.2	1.7
Regenerating/mid-seral forest (miles)		3.7	5.4	3.9	3.4	4.5	4.5	6.3	5.2
Total forest lands affected (miles)		6.0	7.1	5.9	6.3	8.5	8.1	8.0	7.4
Other land use types (miles)		1.3	0.3	1.3	0.7	0.8	0.8	0.7	0.8
Right-of-way parallel or adjacent to existing rights-of-way (miles)		3.2	3.8	3.6	2.4	3.6	3.2	2.7	2.3
Number of previously identified cultural resources along the route f/		0	0	0	1	0	0	0	0
Newly identified cultural resources along the route (number) f/		0	0	0	0	0	0	0	0
Endangered Species									
MAMU critical habitat crossed (miles)		0.6	0.7	1.2	1.4	2.0	1.4	2.9	2.9
Number of MAMU occupied stands crossed		1	1	2	2	1	1	0	0
MAMU occupied stands crossed (miles)		<0.1	<0.1	0.4	1.0	<0.1	<0.1	0	0
NSO critical habitat crossed (miles)		0.9	1.0	1.0	1.1	1.7	1.3	2.5	2.5
Number of NSO home ranges crossed		4	4	4	5	5	5	6	6
NSO home ranges crossed (miles)		5.9	6.0	5.8	6.0	8.1	7.8	7.3	7.0
Number of NSO 500-acre core areas crossed		1	1	0	1	2	2	2	2
NSO core areas crossed (miles)		0.6	0.6	0	1.1	1.4	1.0	1.9	1.9

TABLE 3.4.2.3-1 (continued)

Comparison of Weaver Ridge Variations with the Proposed Route

Alternatives Analysis	Proposed Route	Deep Creek Variation	Weaver Ridge Variations 4	1	2	2a	3	3a
Number of 30-acre nest patches crossed	0	0	0	1	1	0	0	0
NSO 30-acre nest patches crossed (miles)	0	0	0	0.1	0.4	0	0	0

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).
a/ Variation lengths are measured from the point where they deviate from and then return to the proposed route. Lengths cannot be accurately calculated by comparing mileposts due to shifts in the alignment.
b/ Assumes a 95-foot-wide construction right-of-way for all variations.
c/ TEWAs for all route variations have not been designed and are not included in the total acres of disturbance.
d/ The assumed operational easement is 50 feet; however, Pacific Connector would only maintain vegetation within 15 feet of the pipeline centerline for a total of 30 feet during operation.
e/ Waterbodies from PNW Hydrography Framework Clearinghouse.
f/ NWI CONUS data.

Weaver Ridge Variation 4 would deviate from the proposed route at about MP 46.3 and head southeast over ridges on the north side of Deep Creek, crossing the logging spur road south of the reservoir and reconnecting with the proposed route at about MP 48.0. The Deep Creek Variation would deviate from the proposed route at about MP 46.3 and follow a ridge north of Holmes Creek Spur Road and an unnamed four-wheel-drive road back to the proposed route at about MP 47.0 and cross to the north side of the proposed route and parallel that route for about 1 mile before reconnecting with the proposed route near MP 48.0. The Deep Creek Variation would be about 0.1 mile longer than the corresponding segment of proposed route. Based on a geotechnical review, a high risk of landslides and surface erosion were identified where the Deep Creek Variation would cross the eastern flank of Weaver Ridge above a first order stream. Similarly, where Weaver Ridge Variation 4 would cross Weaver Ridge, it would traverse an extremely steep, narrow rock outcrop that would require blasting. These areas would be avoided by the proposed route where it would ascend Weaver Ridge westward from a forest plantation near MP 46.5 up the slope to the north avoiding the rock outcrop. For these reasons, we have determined that implementation of the Deep Creek Variation and Weaver Ridge Variation 4 would not result in a significant environmental advantage and are not preferable to the proposed route.

3.4.2.4 Camas Valley Northern Variation

Pacific Connector had initially identified a potential variation through the Camas Valley between MPs 50 and 53 to minimize impacts on MAMU habitat (i.e., the Camas Valley Northern Variation), and we evaluated this variation to see if it would be environmentally preferable to the proposed route. This variation is illustrated on figure 3.4-4 and compared in table 3.4.2.4-1.

The Camas Valley Northern Variation would deviate from the proposed route at about MP 50.2 and head northeast across the Camas Valley then turn southeast over forested hills before rejoining the proposed route near MP 53.0. This variation would cross habitat and one occupied stand for MAMU and habitat for NSO on BLM-managed lands. For this reason, the BLM found it unacceptable. We agree and have determined that implementation of the Camas Valley Northern Variation would not result in a significant environmental advantage and is not preferable to the proposed route.

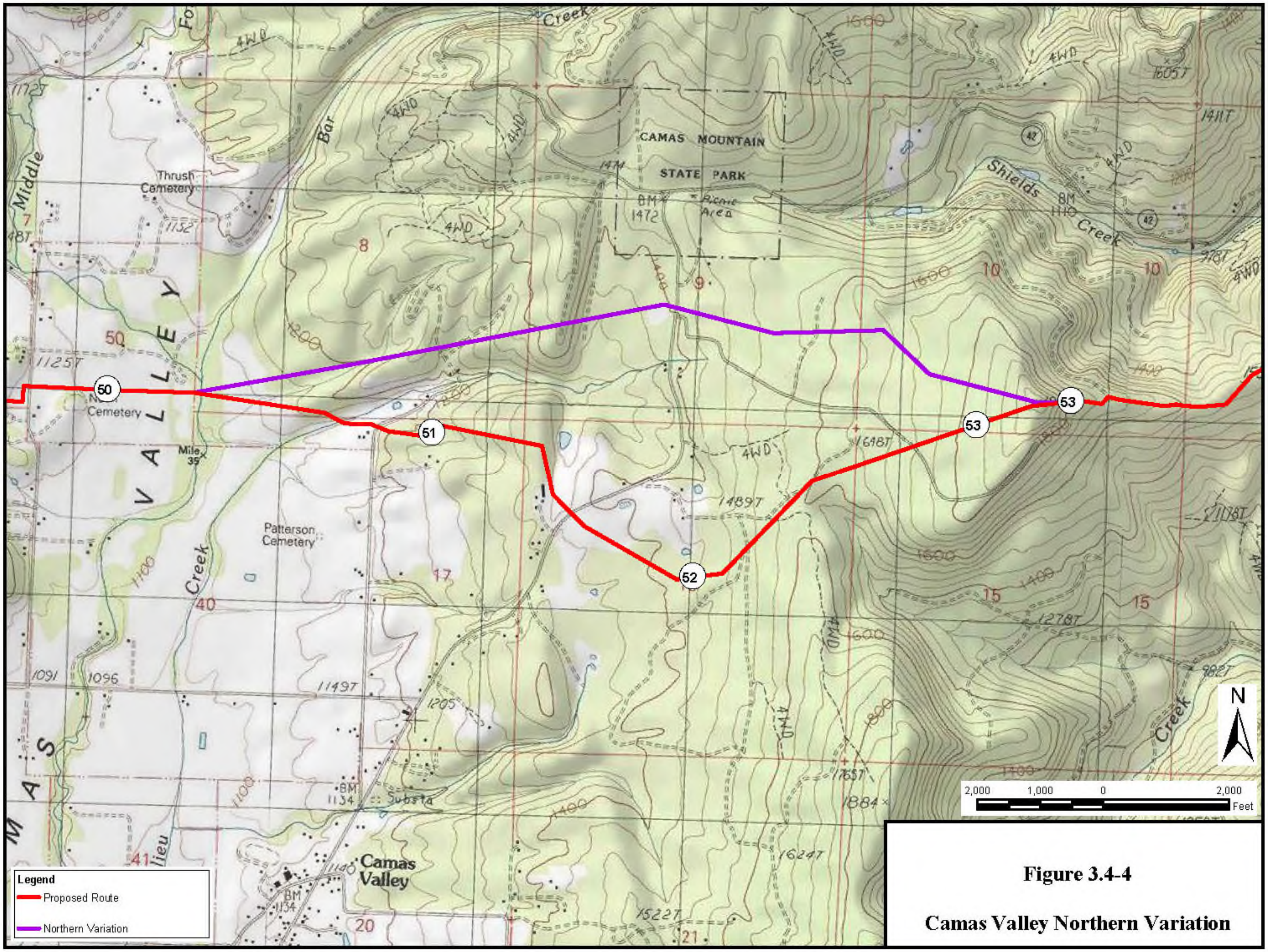


Figure 3.4-4

Camas Valley Northern Variation

TABLE 3.4.2.4-1

Comparison of Camas Valley Northern Variation with the Proposed Route

Alternatives Analysis		Proposed Route		Camas Valley Northern Variation
General				
Length (miles) a/		2.9		2.7
Construction right-of-way (acres)		33		31
Permanent easement (acres) b/		17		16
Land Use				
Land Ownership (miles)	Private	2.3		2.0
	State	0		0
	Federal (BLM/NFS lands)	0.6		0.8
Number of landowner parcels crossed		15		8
Number of residences within 50 feet of construction right-of-way		0 c/		0
Right-of-way parallel or adjacent to existing rights-of-way (miles)		0.1		0.1
LSR - Federal land use designation (acres)		5 d/		0
Riparian Reserves - federal land use designation (acres)		1		3
Waterbodies and Wetlands				
Number of waterbodies crossed e/		4		11
Length of wetland crossings (feet) f/		0		0
Vegetation				
Agricultural lands affected (acres)		8		2
Total forest clearing (acres)		28		39
Clearcut/ Regenerating (0 to 40 years) (acres) g/		14		22
Mid-Seral Forest (40 to 80 years) (acres)		8		10
Late-Successional Forest (80 to 175 years) (acres)		6		2
Old-Growth Forest (175 years +) (number)		0		4
Biological Resources				
MAMU suitable habitat crossed (feet) h/		5		18
MAMU stands		No known stands	Occupied	Alignment crosses 1,043 feet of Occupied Stand R3027
		No known stands	Presumed	Alignment crosses 350 feet of potential MAMU Stand B12 not likely to be occupied based on 2-year survey protocol.
MAMU critical habitat (acres)		5 Pacific Connector made a minor adjusted to the Southern Route Variation to avoid crossing approximately 175 feet of the old-growth forest within this Critical Habitat Unit.)		0
NSO suitable habitat crossed (acres) i/		20		33
NSO nest patch/cores		No known nest patch/cores		None
NSO critical habitat crossed (feet)		0		0
Area affected by habitat category (acres) j/			Category	
		2	1	5
		13	2	5
		17	3	15
		16	4	18
		2	5	2
		3	6	2

TABLE 3.4.2.4-1 (continued)

Comparison of Camas Valley Northern Variation with the Proposed Route

Alternatives Analysis	Proposed Route	Camas Valley Northern Variation
Kincaid's lupine	Approximately 1.1 miles of habitat may be suitable for Kincaid's lupine.	Approximately 2.2 miles of potential habitat crossed; 0.8 mile surveyed of which 0.3 mile was considered suitable.
ESA fish species present/habitat k/	1 stream crossing known, 3 stream crossings unknown. 1 stream crossing - Oregon Coast ESU Coho, assumed.	1 stream crossing known, 3 stream crossings unknown. 1 stream crossing - Oregon Coast ESU Coho, assumed.
StreamNet – anadromous fish distribution l/	None	None
Geotechnical		
Steep or difficult terrain (miles) m/	0.0	0.0
Highly erosive soils (miles) n/	0.2	0.2
Cultural Resources		
Number of previously recorded cultural resources	2 sites	3 - Isolated finds; 2- sites
Number of newly identified cultural resources o/	1- isolated find	N/A

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).
a/ Variation length is measured from the point where it deviates from and then returns to the proposed route. Length cannot be accurately calculated by comparing mileposts due to shifts in the alignment.
b/ Assumes 50-foot-wide operational easement.
c/ There are 2 outbuildings (barns/sheds) in the vicinity of the proposed route that are within 50 feet of the construction right-of-way (MP 51.4 and MP 51.9). Neither of these structures is suspected of being residences; however, during the right-of-way acquisition phase, Pacific Connector would attempt to locate the construction right-of-way at least 50 feet from any residences, where feasible.
d/ Approximately 5 acres of LSR would be affected, with 3 acres occurring within clear- cut/regenerating forests (0 to 40 years) and 2 acres occurring within mid-seral forest (40 to 80 years).
e/ Waterbodies from PNW Hydrography Framework Clearinghouse.
f/ NWI CONUS data.
g/ Forest Age Classes: Includes recent clearcut forests and areas of inroad construction where forest clearing would be reduced.
h/ Huff et al. (2006).
i/ Forest Service (2005a).
j/ Based on surveys completed by Pacific Connector.
k/ FWS, NMFS, and StreamNet (http://www.streamnet.org).
l/ ODFW (2000, 2006a); StreamNet.
m/ Based on Soil Mapping Units that have slopes of 50-75 percent and have a water erosion rating of high or severe (NRCS 2004).
n/ Based on Soil Mapping Units that have a water erosion rating of high or severe (NRCS 2004).
o/ Variation has not been completely surveyed.

3.4.2.5 Umpqua National Forest Variations

In consultation with the Forest Service and to evaluate potential options to reduce impacts on forested lands, we evaluated three route variations within the Umpqua National Forest between MPs 104.8 and 111.5. The proposed route and variations are shown on figure 3.4-5.

Variation 1 would generally follow along Wildcat Ridge close to the proposed route between MPs 105 and 109, where it would then turn east and then southeast, crossing near Long Prairie, then south before rejoining the proposed route near MP 111.2. Environmental features crossed or affected by Variation 1, and a comparison to the corresponding segment of proposed route, are included in table 3.4.2.5-1.

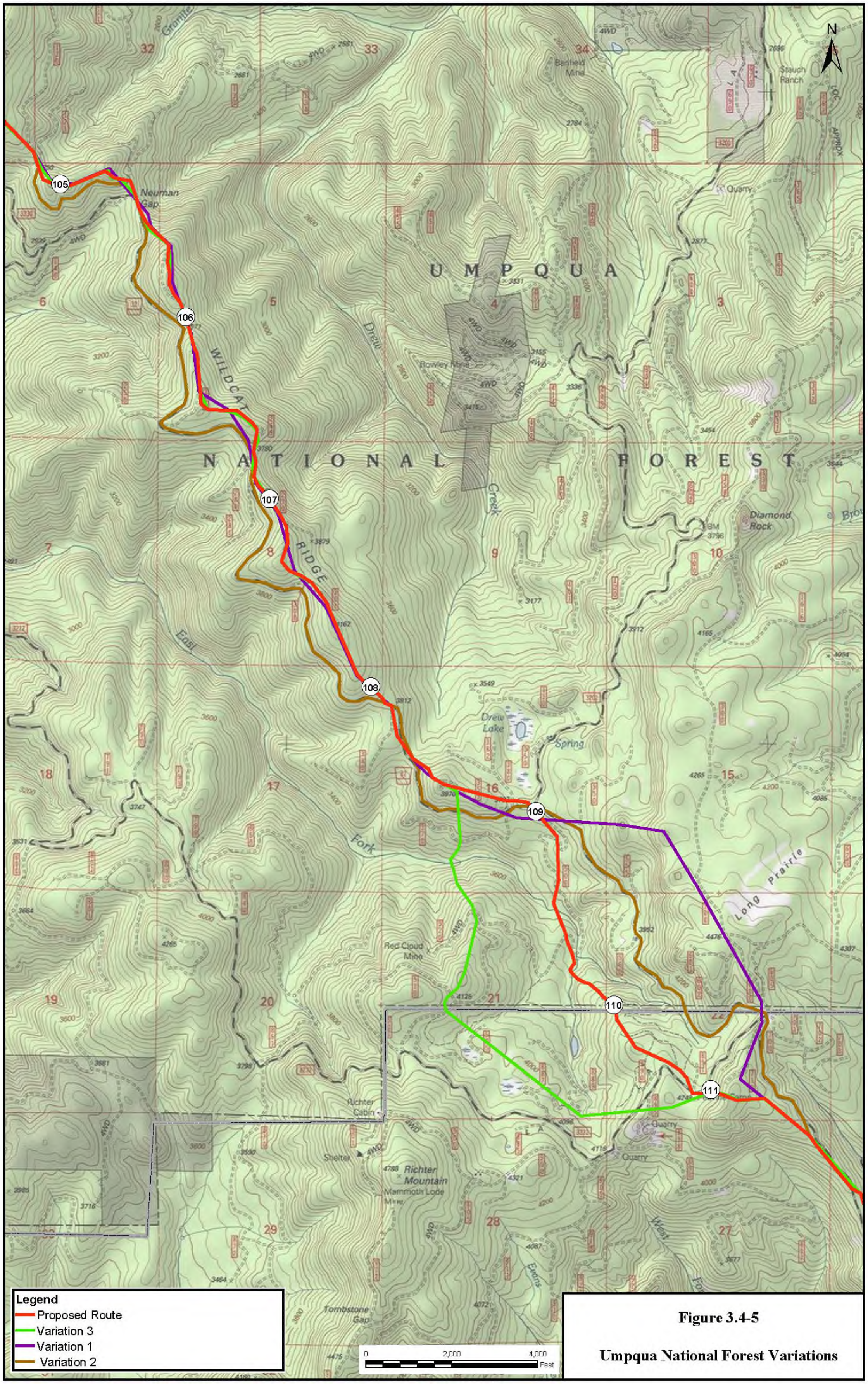


Figure 3.4-5

Umpqua National Forest Variations

TABLE 3.4.2.5-1

Comparison of Umpqua National Forest Variations with the Proposed Route

Impact/Issue	Proposed Route	Variation 3	Variation 1	Variation 2
General				
Total length (miles) a/	6.4	6.7	6.4	7.5
Construction right-of-way (acres) b/	73	77	73	86
Total construction disturbance (acres)	110	117	110 c/	129 c/
Operational easement (acres) d/	45	41	45	45
Land Ownership (miles)				
Forest Service	6.4	6.7	6.4	7.5
Geotechnical				
Steep or difficult terrain crossed (miles) e/	0.2	0.4	0.1	7.5 (side hill along existing road)
Waterbodies and Wetlands				
Number of waterbodies crossed f/	5	6	1	13
Wetlands crossed (feet) f/	150	120	0	30
Waterbody and wetland disturbance during construction (acres)	0.2	0.3	0	0
Land Use				
Land allocations crossed (miles):				
Matrix	2.9	3.3	3.1	3.3
LSR	3.5	3.4	3.3	4.2
Riparian Reserves	0.5	0.2	0.0	0.3
Evergreen Forest, Mixed conifer (miles)	4.2	3.9	3.4	5.6 h/
Regeneration Forest (miles)	1.8	2.3	2.7	1.8 h/
Clearcuts (miles)	0.0	0.0	0.1	0.0 h/
Total forest lands crossed (miles)	6.0	6.2	5.9	7.4 h/
Other land use types	0.4	0.5	0.4	0.1 h/
Parallel or adjacent to existing rights-of-way (miles)	5.6	5.1	5.4	7.3
Cultural Resources				
Number of previously identified cultural resources along route	0	1 – site 2 – isolated finds	3	0
Number of newly identified cultural resources along route	3 – site 1–isolated find	Information not available	1	Information not available
Critical Habitat g/				
Federally listed critical habitat for NSO affected (acres)	52	33	34	40 (95-foot ROW only)
Federally listed critical habitat for NSO crossed (miles)	6.4	6.7	6.3	7.5
Number of NSO core areas crossed (0.5-mile buffer of nest site)	3	4	3	3

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).
a/ Variation lengths are measured from the point where they deviate from and then return to the proposed route. Lengths cannot be accurately calculated by comparing mileposts due to shifts in the alignment.
b/ Assumed construction right-of-way 95 feet wide.
c/ TEWAs for the variation have not been designed but are estimated assuming they would be comparable to the proposed route.
d/ The assumed operational easement is 50 feet.
e/ Based on slopes that are greater than 50 percent (based on 10-meter digital elevation model).
f/ Waterbodies identified using USGS National Hydrography Dataset, and wetlands identified using FWS National Wetland Inventory mapping.
g/ Includes acres of impact associated with the construction right-of-way and TEWAs. This analysis used the final revised critical habitat designation (2008).
h/ Variation 2 follows existing Forest Service Road 3200 which is assumed would require extensive side-cuts, therefore, miles crossed considered habitat adjacent to the road.

Most environmental impacts from Variation 1 would be similar to those from the proposed route. The primary environmental advantage would be fewer waterbodies crossed (1 compared to 7), and less NSO critical habitat affected (34 compared to 52 acres) than the corresponding segment of proposed route. The primary disadvantage of the variation is that it has the potential to impact an important traditional cultural property as identified by the Forest Service and Cow Creek Tribe.

Based on this concern, we have determined that implementation of Variation 1 would not result in a significant environmental advantage and is not preferable to the proposed route.

Variation 2 would follow a route suggested by the Forest Service that would follow existing Forest Service Road 3200 between about MPs 104.8 and 111.5 of the proposed route. The rationale for this variation is to utilize the existing cleared road corridor to minimize forest fragmentation and reduce impacts on LSRs. Variation 2 would be about 1.1 miles longer and result in about 19 additional acres of construction disturbance and would follow 7.3 miles of existing roadway (97 percent) compared to 5.6 miles (88 percent) along the proposed route. Environmental features crossed or affected by Variation 2, and a comparison to the corresponding segment of proposed route, are included in table 3.4.2.5-1.

Most environmental impacts from Variation 2 would be similar to those of the proposed route. The primary environmental advantage would be its location along an existing roadway which would reduce creation of a new linear forest clearing. The primary disadvantages of Variation 2 would be that more perennial waterbodies would be crossed (13 compared to 7) and that the route would be located adjacent to steep sideslopes along the existing narrow Forest Road 3200. A high risk of landslide occurrence from pipeline installation has been identified along Forest Service Road 3200 headwall swales and constructed fill slopes that would be required to create a working surface for pipeline installation. Steep side slopes along Forest Road 3200 would require significant excavations to construct a 95-foot-wide construction corridor. Pacific Connector estimates the cut slope required to create the work space would be between 100 to 135 feet in height and extend at least 50 feet upslope of the existing cut slope along the road. The required extra cut and fill construction impact area would negate any advantage from following the existing roadway. For these reasons, we have determined that implementation of Variation 2 would not result in a significant environmental advantage and is not preferable to the proposed route.

Variation 3 would begin at MP 108.5 where it would turn south from the proposed route, and then turn southeast and then east, rejoining the proposed route at MP 111.1. Environmental features crossed or affected by Variation 3, and a comparison to the corresponding segment of proposed route, are included in table 3.4.2.5-1.

The Forest Service has stated that Variation 3 would cross an area planned for expansion of the Peavine rock quarry and therefore considers the variation an incompatible use, and identified concerns with potential slope instability and aquatic impacts at the crossing location of the East Fork Cow Creek. The Peavine quarry is the largest and most extensively developed quarry within the upper reaches of the watershed and is of strategic importance to the Umpqua National Forest. For these reasons, we have determined that implementation of Variation 3 would not result in a significant environmental advantage and is not preferable to the proposed route.

3.4.2.6 Rogue River National Forest Variations

To evaluate potential alternatives that may reduce impacts on LSR and Riparian Reserves, we consulted with the Forest Service and evaluated two route variations within the Rogue River National Forest in the vicinity of Robinson Butte and Cox Butte between about MPs 155.1 and 168.9. Table 3.4.2.6-1 provides a comparison of Variation 1 and Variation 2, and the corresponding segment of proposed route. These variations and the proposed route are shown on figure 3.4-6.

TABLE 3.4.2.6-1

Comparison of Rogue River National Forest Variations with the Proposed Route

Impact/Issue		Proposed Route	Variation 1	Variation 2
General				
Total Length (miles) a/		13.8	12.9	15.7
Construction right-of-way (acres) b/		159	148	180
Total construction disturbance (acres)		209	194 c/	236 d/
operational easement (acres) e/		84	78	95
Land ownership crossed (miles)	Forest Service	12.5	11.5	14.3
	Private	0.5	0.5	0.6
	State	0.0	0.0	0.0
Waterbodies and Wetlands				
Number of waterbodies crossed f/		6	2	14
Land Use				
Land allocations crossed (miles)	Matrix	0.0	0.0	0.0
	LSR	12.5	11.5	14.3
	Riparian Reserves	0.4	1.5	1.1
Evergreen Forest, Mixed Conifer crossed (miles)		6.1	6.8	6.0
Regeneration Forest crossed (miles)		5.6	5.9	5.4
Clearcuts crossed (miles)		0.3	0.1	0.0
Total Forest lands crossed (miles)		12.0	12.8	11.4
Right-of-way parallel or adjacent to existing rights-of-way (miles)		4.4	1.6	14.0
Visual Resources				
Visual Impacts along existing Forest roads		Moderate where parallel to existing roads (4.4 miles)	Minimal except at existing road crossings	Existing road corridors expected to be significantly altered from 95-foot-wide construction footprint along 13.6 miles of Forest roads.
Cultural Resources				
Number of previously identified cultural resources along route		1	1	0 g/
Habitat for Federally Listed Species				
Federally listed critical habitat for the NSO (acres) h/		159	148	180
Number of NSO activity centers crossed		2 - ½ mile buffer of site	2 - ½ mile buffer of site	2 - ½ mile buffer of site

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).
a/ Route Alternative are measured from the point where they deviate from and then return to the proposed route. Lengths cannot be accurately calculated by comparing mileposts due to shifts in the alignment.
b/ The construction right-of-way for the preferred route and original proposed alignment is 95 feet.
c/ Pacific Connector estimates that the Variation 1 would likely require more TEWAs compared to the compromise route because of side slope construction between approximately MPs 149 and 152.9 and because of the increased number of stream crossings along the Variation 1. However, because they have not been designed, we have estimated the area of TEWAs based on a comparable length of the proposed route.
d/ TEWAs have not been designed for this route; however, we have estimated the area based on a comparable length of the proposed route.
e/ The assumed operational easement for all routes is 50 feet. However, Pacific Connector would only maintain vegetation within 15 feet of the pipeline centerline for a total of 30 feet in the long term.
f/ Waterbodies from PNW Hydrography Framework Clearinghouse.
g/ Surveys are incomplete or in progress on the proposed route.
h/ Includes acres of impact associated with the construction right-of-way.

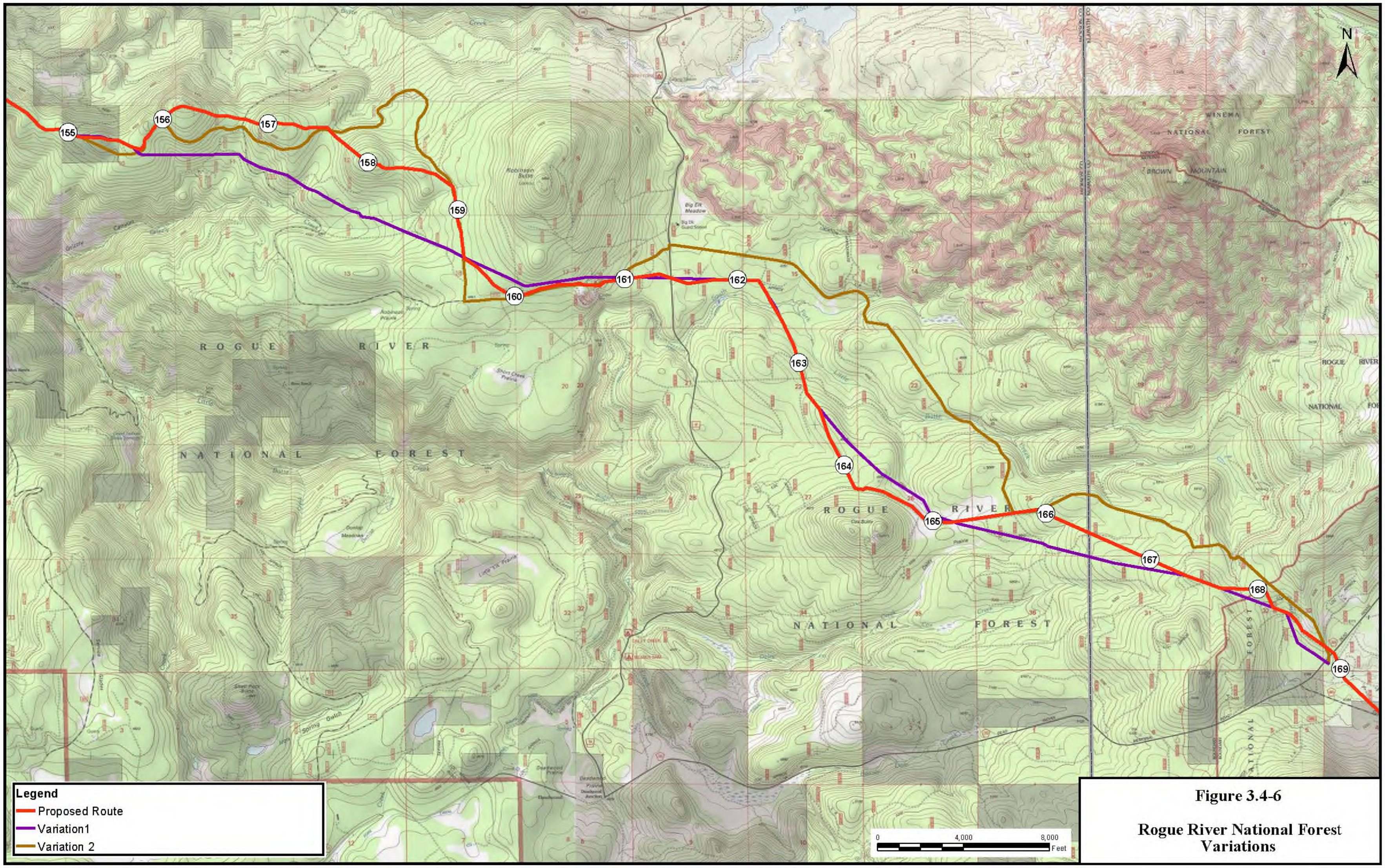


Figure 3.4-6

Rogue River National Forest Variations

Variation 1 would deviate from the proposed route at about MP 155 and remain south of it on the south side of Robinson Butte near MP 159. From that point, Variation 1 would closely follow the proposed route but would be straighter and cross through older forests, which provide NSO habitat. Variation 1 would cross Big Elk Road, cross northeast of Cox Butte, and would cross Daley Prairie, then cross into Klamath County and rejoin the proposed route near MP 169. Variation 1 would be about a mile shorter than the corresponding segment of proposed route. The variation would be adjacent to existing rights-of-way for 1.6 miles (12 percent) compared to 4.4 miles (32 percent) for the corresponding segment of the proposed route.

The primary advantage of Variation 1 is it would require less construction disturbance (194 compared to 209 acres), cross fewer waterbodies (2 compared to 6), cross less LSR (11.5 compared to 12.5 miles), and affect less critical habitat for NSO (148 compared to 159 acres) than the corresponding segment of the proposed route.

The primary disadvantages of Variation 1 are that it would affect more forest (12.8 compared to 12.0 acres) and more riparian reserves (1.5 compared to 0.4 acres) than the corresponding segment of proposed route. As described above, the variation would have some environmental advantages and some environmental disadvantages over the corresponding segment of proposed route. Overall, we do not believe that the advantages overcome the disadvantages, and for this reason we have determined that implementation of the Rogue River National Forest Variation 1 would not result in a significant environmental advantage and is not preferable to the proposed route.

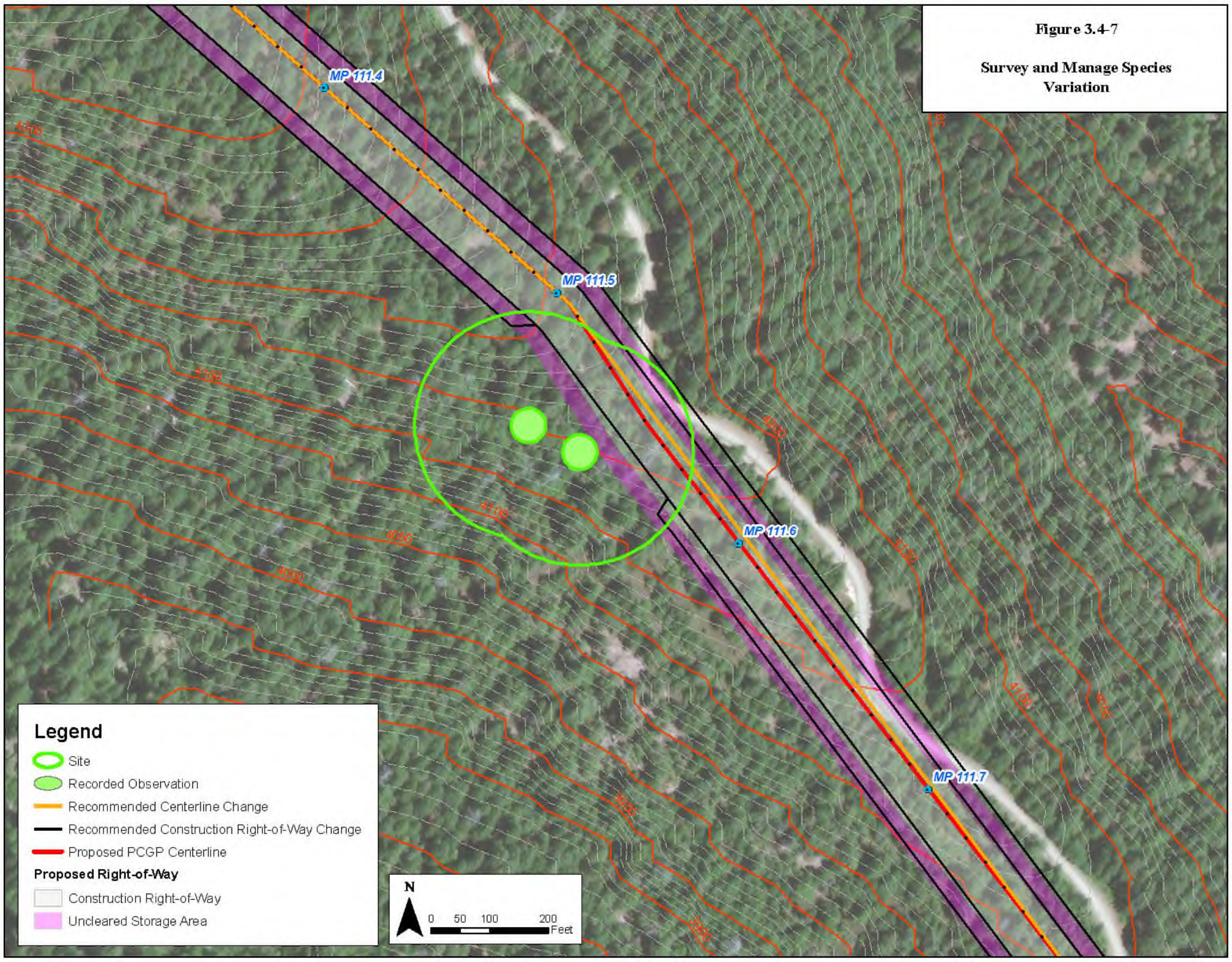
The rationale for evaluating Variation 2 was to evaluate the potential for reducing forest vegetation clearing by utilizing the existing cleared roadways as part of the construction corridor, thereby reducing some of the forest fragmentation and habitat loss in LSR 227. Also, this variation would cross the Pacific Crest Trail (PCT) along an existing road, reducing potential impacts on trail users by eliminating a separate crossing. Variation 2 would deviate from the proposed route at about MP 155, north of Grizzly Canyon, and head east along Forest Service Roads 410 and 300, around the south side of Robinson Butte along Forest Service Road 3730, south of Big Elk Guard Station along Forest Service Road 3705, across the South Fork Little Butte Creek, turn east along Forest Service Road 3720, entering Klamath County, to Forest Service Road 700, cross the PCT several miles south of Brown Mountain, then head southeast cross-county into the Winema National Forest, across Dead Indian Memorial Highway, and would rejoin the proposed route along Clover Creek Road north of Burton Butte just east of MP 169.

Variation 2 would be about 3 miles longer than the proposed route and would require widening the existing roads, which are generally between 20 and 30 feet wide. This would require cutting mature forest in portions of the right-of-way. Based on input from the engineering review conducted by Pacific Connector, the pipeline would not be constructible along portions of some roads due to the steep terrain and side slope and the tight radius turns. For this reason, we have determined that implementation of the Rogue River National Forest Variation 2 is not technically feasible and do not consider it further.

3.4.2.7 Survey and Manage Species Variation

In consultation with the Forest Service, we evaluated a route variation between MPs 111.5 and 111.6 to avoid impacts on *Sarcodon fuscoindicus,* a Survey and Manage fungi species). This variation would provide a no-disturbance buffer for *Sarcodon fuscoindicus*. The buffer is necessary to protect these sites to comply with the 2001 Survey and Manage Record of Decision to maintain the persistence of the affected species within the range of the NSO (see section 4.6.4.3, Survey and Manage).

Under this variation, the construction right-of-way between MPs 111.5 and 111.6 would be shifted at least 25 feet to the northeast, and the UCSA on the southwest side of the construction right-of-way would be eliminated. As a result, at least one of the two known occurrences of this species within the site would be at least 100 feet from any Project-related disturbance (see figure 3.4-7).



The primary advantage of this variation is that a buffer would be provided to protect known sites of *Sarcodon fuscoindicus*. No disadvantages have been identified for this variation. As a result, this variation would result in an environmental advantage and is preferable to the proposed route. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, Pacific Connector should file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the Survey and Manage Species Variation into the proposed route between MPs 111.5 and 111.6, and provide documentation of consultation with the Forest Service.**

3.4.2.8 East Fork Cow Creek Variation

In consultation with the Forest Service, we evaluated a route variation between MPs 109.7 and 109.8 that considered a modified crossing of the East Fork Cow Creek (EFCC) to avoid the parallel pipeline alignment between the upper reaches of the perennial streams in this area. In the EFCC Variation, the pipeline from MP 109.6 would proceed southeasterly crossing a reach of the EFCC and then continue east crossing an upper reach of the EFCC. The variation then follows a gentle ridgeline to the south rejoining the proposed route at MP 109.9 (see figure 3.4-8). This variation would negate the need for amendment UNF-2 on the Umpqua National Forest.

The primary advantage of the variation is that it would reduce the amount of pipeline (about 535 feet) parallel to tributaries to EFCC between MPs 109.7 and 109.8 (see figure 3.4-8). In this area between the tributaries, the proposed route alignment also traverses a narrow ridgeline that supports old-growth forest/high NRF habitat within Riparian Reserves. Avoidance of this area would reduce the potential for long-term restoration and monitoring of hydrologic features affected during construction. The route variation incorporates crossings that are perpendicular to the hydrologic features, reducing the risk of site destabilization and increasing the likelihood of successful stream channel restoration.

The EFCC Variation is the same length as the proposed route and would result in less disturbance (0.12 acre) than the proposed route because of neck-downs along the construction right-of-way at the crossings of EFCC (see table 3.4.2.8-1). The EFCC Variation would also affect slightly less old growth and northern spotted owl suitable habitat than the proposed route. No environmental disadvantages have been identified for this variation.

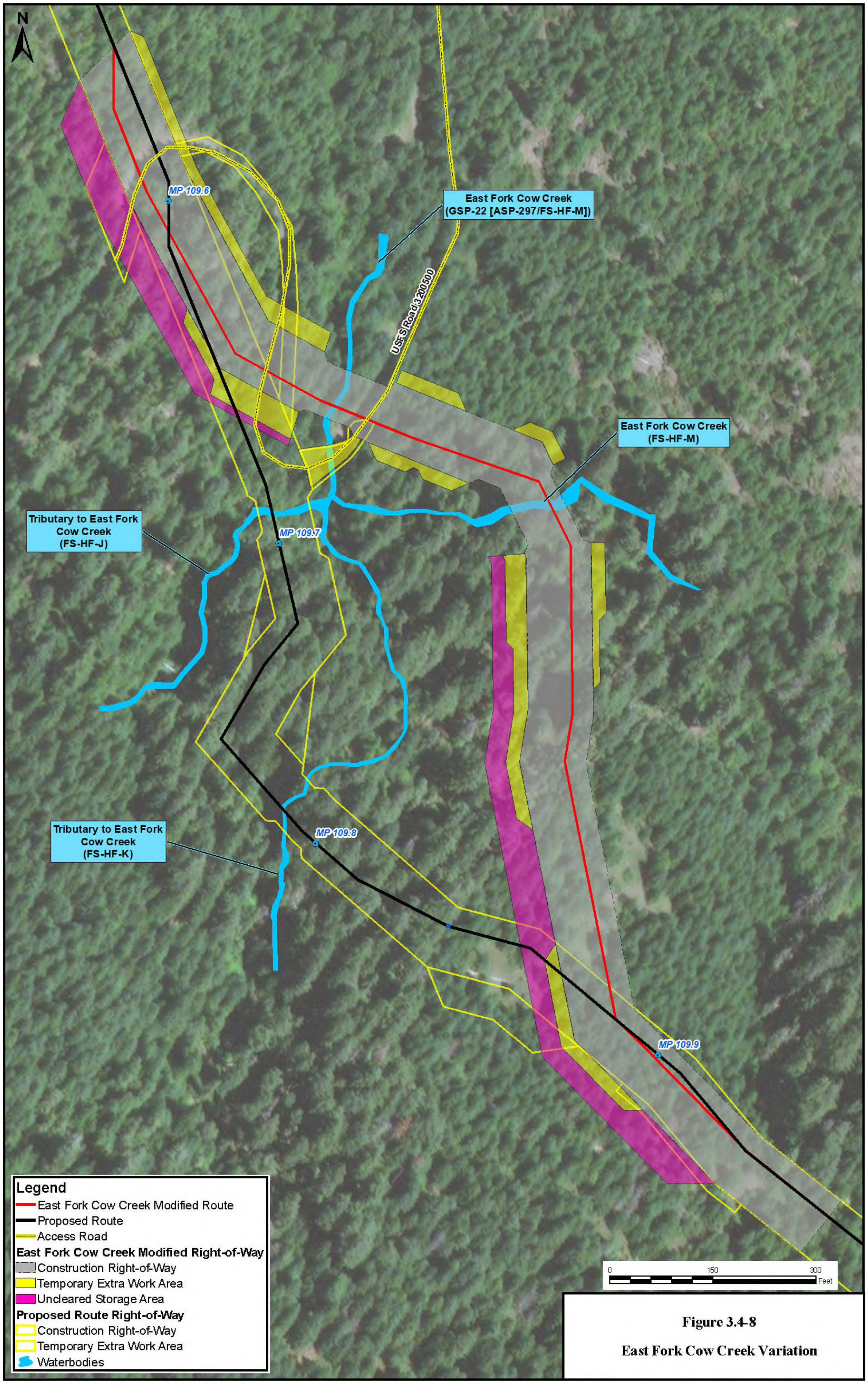


Figure 3.4-8

East Fork Cow Creek Variation

TABLE 3.4.2.8-1

East Fork Cow Creek Variation

Alternatives Analysis	Proposed Route	EFCC Variation
General		
Length (miles)	0.42	0.42
Construction right-of-way (acres)	4.75	4.63
Number of temporary extra work areas (TEWAs)	7	9
Acres of TEWAs	0.91	1.0
Number of Uncleared Storage Areas (acres) a/	0 (0.00)	2 (1.34)
Permanent Easement (acres) b/	2.55	2.55
Land Use		
Miles of right-of-way parallel or adjacent to existing rights-of-way (percent of alternative length) c/	0.02 (6.7%)	0.00 (0.00)
Riparian Reserves - Federal Land Use Designation (acres)	4.26	4.41
Waterbodies and Wetlands		
Number of waterbodies crossed d/	2	2
Length of waterbody crossings (feet) e/	17	12
Alignment parallel to waterbody (feet) d/	535	0
Vegetation		
Total forest clearing (acres)		
Acres clear-cut/regenerating (0-40 years)	2.22	2.19
Acres mid-seral forest (40-80 years)	0.26	0.51
Acres Late Successional Forest (80-175 years)	0.00	0.00
Old Growth Forest (175 +)	2.70	2.65
Biological Resources		
Northern Spotted Owl Suitable Habitat Crossed (High NRF & NRF) (acres) f/	2.70	2.65
Northern Spotted Owl nest patch/cores (NSO)	0	0
Northern Spotted Critical Habitat Crossed (acres)	5.66	5.64

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).
a/ Acres of Uncleared Storage Areas are not included in the impact comparison (acres) of the various resources because grading and tree clearing will not occur in these areas.
b/ Acres of permanent easement calculated based on a 50-foot width.
c/ Based on inventoried roads included in Umpqua NF Road data and BLM GTRN data (https://www.blm.gov/or/gis/data.php).
d/ Based on field surveys (see Table A.2-3 to Appendix A.2 to Pacific Connector's Resource Report 2 and supplemental wetland delineation report filed in May 2018).
e/ Based on the proposed alignment between the tributaries to EFCC (FS-HF-J and FS-HF-K) (MPs 109.7 to 109.8). In this area the alignment follows a narrow ridge.
f/ See Section 3.3.4.2 in Applicant-Prepared Draft Biological Assessment.

The EFCC variation would result in a significant environmental advantage and is preferable to the proposed route. Therefore, **we recommend that**:

- **Prior to construction, Pacific Connector should file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the East Fork Cow Creek Variation into its proposed route between MPs 109.6 and 109.9, and provide documentation of consultation with the Forest Service.**

3.4.2.9 Pacific Crest Trail Variation

In consultation with the Forest Service, we evaluated a variation that would include an alternative crossing location of the PCT. The variation would co-locate the pipeline with an existing Forest Service Road (3720-700) north of MP 167.8 (see figure 3.4-9). This variation would minimize potential impacts on trail users by realigning the pipeline to an area of the trail that is adjacent to existing disturbance/intrusion from Forest Service Road 3720-700.

The primary advantages of the PCT Variation are that it would minimize potential visual impacts on PCT trail users by locating the crossing at an existing road, and it would be co-located with existing road rights-of-way for 1.37 miles (77.4 percent of its length). The variation would avoid crossing the PCT in an old-growth forest stand and corresponding recreation corridor that lies between Peterson Snow Park and the Brown Mountain Shelter, thereby reducing visual impact from pipeline clearing on trail users. This would also alleviate the need for a multiple-year revegetating/screening plan at the proposed crossing location, which is expected to require ongoing monitoring to ensure new vegetation is successfully established post construction. The PCT Variation would also be located about 1,000 feet farther from the Brown Mountain Shelter, which would minimize potential noise disturbance to shelter users during construction and potentially during restoration efforts. The water well at the shelter is proposed as an irrigation source for replanted trees for restoration of the trail crossing along the proposed route. Further, the PCT Variation would minimize potential construction-related traffic effects because traffic would follow the construction right-of-way at the trail crossing, which is co-located with the existing Forest Service Road 3720-700. The PCT Variation would also cross approximately 0.5 mile less of northern spotted owl nest patch and core areas and would impact less old growth habitat (175 + years old) than the proposed route (see table 3.4.2.9-1). The PCT Variation would also avoid the potential impacts from geotechnical borehole investigation that would be required for the HDD crossing along the proposed route.

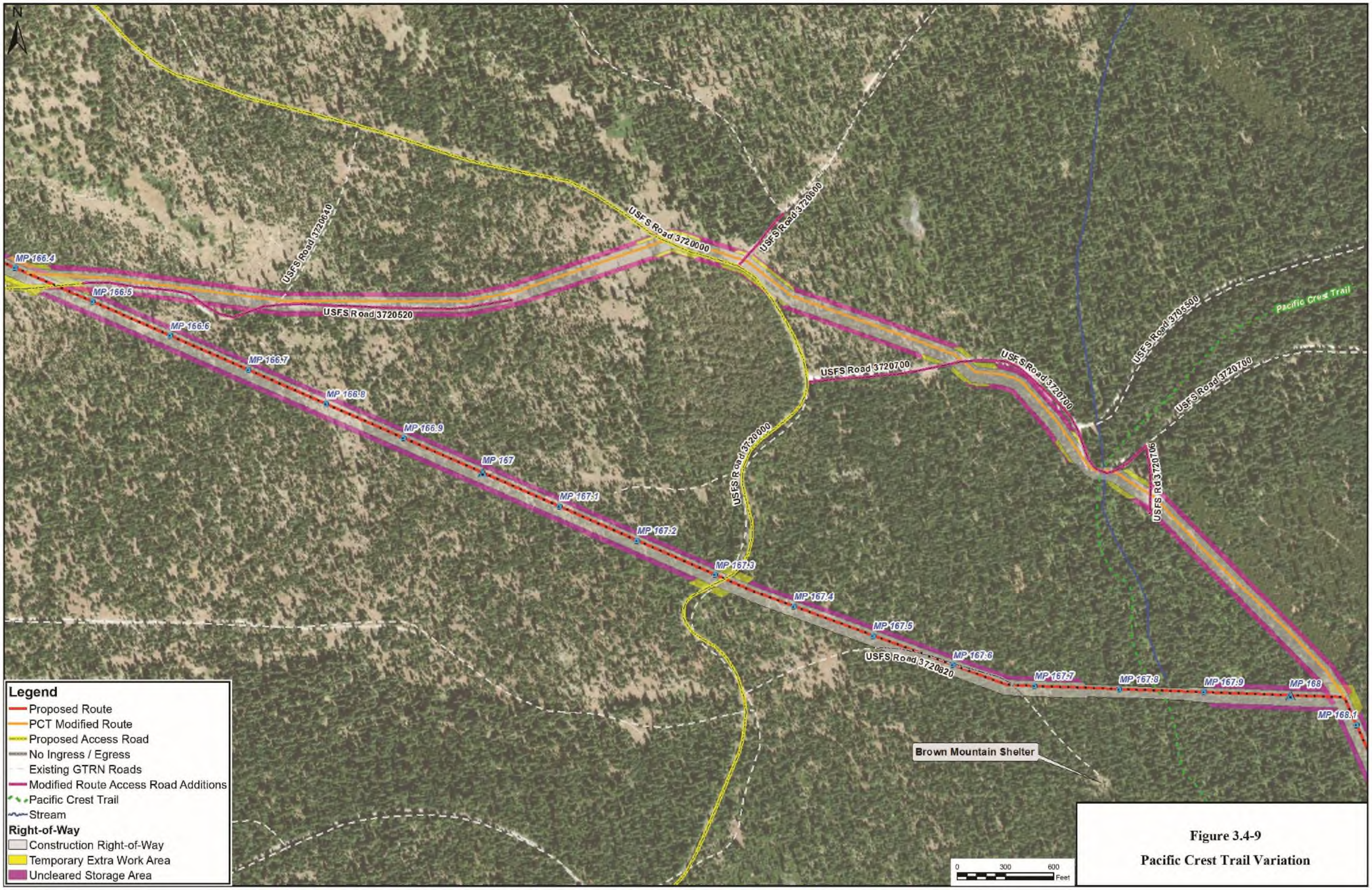


Figure 3.4-9. Pacific Crest Trail Variation

TABLE 3.4.2.9-1

Comparison of the PCT Variation with the Proposed Route

Alternatives Analysis		**Proposed Route**	**PCT Variation**
General			
Length (miles)		1.65	1.77
Construction right-of-way (acres)		18.64	20.14
Number of temporary extra work areas (TEWAs)		7	18
Acres of TEWAs		1.36	1.81
Number of Uncleared Storage Areas (acres) a/		5 (8.52)	10 (10.73)
Permanent Easement (acres) b/		10.00	10.73
Land Use			
Land Ownership (miles)	Private	0	0
	State	0	0
	Federal (Rogue River-Siskiyou NF)	1.59	1.73
	Federal (Fremont-Winema NF)	0.06	0.04
Number of landowner parcels crossed		1	1
Number of road crossings (centerline) c/		3	6
Miles of right-of-way parallel or adjacent to existing rights-of-way (percent of alternative length) d/		0.19 (11.52)	1.37 (77.40)
Late Successional Reserve - Federal Land Use Designation (acres)		18.96	21.52
Riparian Reserves - Federal Land Use Designation (acres)		0	0.94
Visual Quality Objective (miles) e/		0.52-FGPR	0.55-FGPR 0.13-FGR
Waterbodies and Wetlands			
Number of waterbodies crossed f/		0	1
Length of waterbody crossings (feet) f/		0	4
Vegetation			
Total forest clearing (acres)			
Acres clear-cut/regenerating (0-40 years)		16.95	8.70
Acres mid-seral forest (40-80 years)		0.00	5.64
Acres Late Successional Forest (80-175 years)		0.00	2.77
Old Growth Forest (175 + years)		2.75	0.68
Biological Resources			
Northern Spotted Owl Suitable Habitat Crossed (High NRF & NRF) (acres) g/		2.75	4.94
Northern Spotted Owl nest patch/core area (NSO) (acres)		3.39	2.87
Northern Spotted Critical Habitat Crossed (acres)		20.01	21.95

General: All values are rounded (acres to nearest whole acre, miles to nearest tenth of a mile, feet to nearest whole foot).
a/ Acres of Uncleared Storage Areas are not included in the impact comparison (acres) of the various resources because grading and tree clearing will not occur in these areas.
b/ Acres of permanent easement calculated based on a 50-foot width.
c/ Based on inventoried roads included in Rogue River-Siskiyou NF travel route data and BLM GTRN data (https://www.blm.gov/or/gis/data.php).
d/ Based on inventoried roads included in Rogue River-Siskiyou NF travel route data and BLM GTRN data (https://www.blm.gov/or/gis/data.php), as well as non-inventoried roads identified during civil surveys (June 2018).
e/ FGPR = Foreground Partial Retention; FGR = Foreground Retention
f/ Based on field surveys (see Table A.2-3 to Appendix A.2 to Pacific Connector's Resource Report 2 and supplemental wetland delineation report filed in May 2018) and subsequent site visit (May 31, 2018). The pipeline centerline stream crossing on the PCT Modified Route would occur within the FS 3720700 Road, where the stream is culverted.
g/ Rogue River-Siskiyou National Forest (Forest Service 2017a)

The primary disadvantages of the PCT Variation are that it would be slightly longer than the proposed route (0.12 mile) resulting in slightly larger construction right-of-way impacts (1.5 acres), and would cross one headwater stream and lands designated as Riparian Reserve. It would also affect more acres of NSO suitable habitat (High NRF & NRF) (4.94 acres) compared to the corresponding segment of proposed route (2.75 acres).

As described above, the PCT Variation would include some environmental advantages and some disadvantages compared to the proposed route. Overall, because the variation reduces impacts on old growth forests greater than 175 years old and would move the pipeline crossing of the PCT to be co-located with Forest Service Road 3720-700, the PCT Variation would result in a significant environmental advantage and is preferable to the proposed route. Therefore, **we recommend that**:

- **<u>Prior to construction</u>, Pacific Connector should file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the Pacific Crest Trail Variation into the proposed route between MPs 166.4 and 168.1, and provide documentation of consultation with the Forest Service.**

3.5 CONCLUSION

We reviewed alternatives to the proposed action based on our independent analysis and comments received. Although many of the alternatives appear to be technically feasible, we identified only four alternatives that would provide a significant environmental advantage over the Project. We have included recommendations that these modifications be adopted. Based on these findings, we conclude that the proposed Project, as modified by our recommendations, is the preferred alternative that can meet the Project purpose.

4.0 ENVIRONMENTAL ANALYSIS

In this section, we describe the existing natural and human environment, and assess the impacts on it resulting from construction and operation of the Project. Our independent analysis and discussion prepared in consultation with the NEPA cooperating agencies considers the affected environment, the applicants' proposed construction methods, their impact minimization and mitigation measures, and, as appropriate, makes recommendations (boldface and bulleted text) to avoid or further reduce/minimize impacts on the environment. This analysis also considers cumulative impacts that may result when the Project's impacts are added to those of past, present, and reasonably foreseeable future projects. The analysis is organized by resource, includes as appropriate information pertaining to federal lands, and by resource concludes with a determination of significance.

For the purposes of this analysis, we discuss four impact durations: temporary, short-term, long-term, and permanent. A temporary impact generally occurs during construction with the resource returning to preconstruction condition almost immediately afterward. A short-term impact could continue for up to three years following construction. An impact is considered long-term if the resource would require more than three years to recover. A permanent impact would occur if an activity modifies a resource to the extent that it would not return to preconstruction conditions during the life of the Project. Permanent impacts may also extend beyond the life of the Project. For example, we consider the clearing of mature forests a permanent impact because it would take several decades for these habitats to attain their pre-construction condition. The construction and operation of aboveground facilities would also cause permanent impacts. When determining the significance of an impact(s), we consider the duration of the impact; the geographic, biological, and/or social context in which the impact would occur; and the magnitude and intensity of the impact. The duration, context, and magnitude of impacts vary by resource and therefore significance varies accordingly. Lastly, our analysis considers and addresses direct and indirect; and primary and secondary impacts on resources collectively.

The structure of this EIS follows the standard format used by the Commission with respect to the order and content of the resources affected by the Project. Each resource section in chapter 4 includes a focused discussion of effects on federally managed lands (i.e., lands managed by the BLM, Forest Service, and Reclamation). As described in chapter 2, the BLM and Forest Service have identified the need to amend their respective land and resource management and resource management plans in order to ensure any action authorized by FERC would be compliant with these plans. While specific effects on federally managed lands are addressed in each resource section, section 4.7.3 of this chapter provides a detailed discussion of consistency with these management plans and evaluations of the proposed plan amendments.

The Project would cross ecologically diverse areas from Coos Bay to the Klamath Basin (see figure 4-1). The Project lies within four ecoregions: (1) the Coast Range; (2) the Klamath Mountains; (3) the Cascades; and (4) the Eastern Cascades Slopes and Foothills (Bryce et al. 2003). This diversity in ecoregions crossed results in a wide variety of conditions, habitats, and environments that could be affected by the Project.

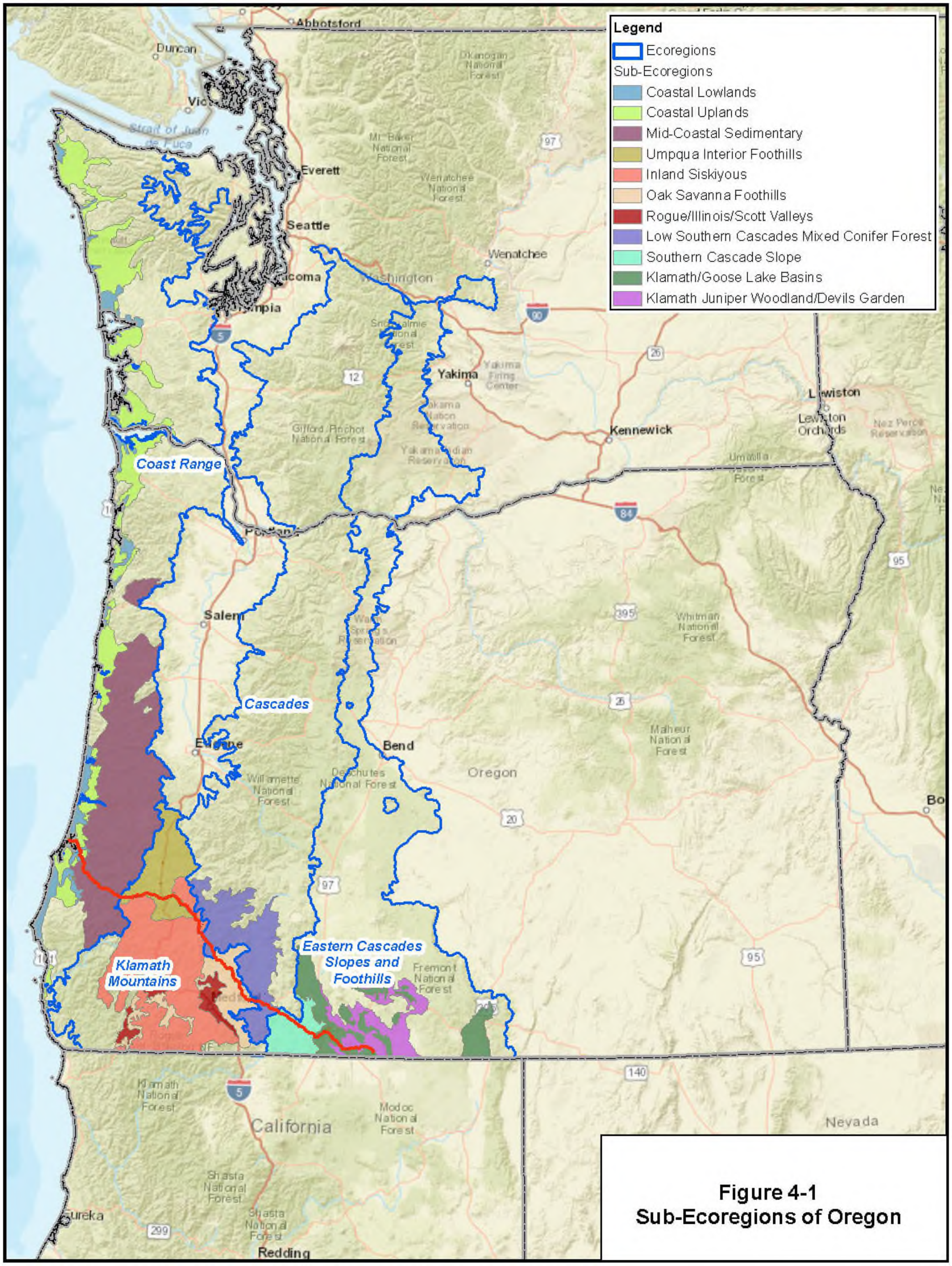


Figure 4-1
Sub-Ecoregions of Oregon

4.1 GEOLOGICAL RESOURCES

The following section describes geological resources and potential impacts related to the various aspects of the Project, including the Jordan Cove LNG terminal and the Pacific Connector pipeline and associated facilities.

4.1.1 Jordan Cove LNG Project

4.1.1.1 Geologic Setting

The Jordan Cove LNG Project site is located within the Pacific Border physiographic province at the western edge of the coastal headlands of the Central Coast Mountain Range, on the North Spit of Coos Bay. The North Spit of Coos Bay marks the southern edge of the Holocene-age Coos Bay Dune Sheet (Peterson et al. 2005).

The LNG terminal site is underlain by loose to dense fill and a relatively clean, fine-grained sand, which is in turn underlain by a weathered sandstone. Fill depths are typically 10 to 15 feet at the Ingram Yard and up to 25 feet at the mill site. The clean, fine-grained sand is a dune sand of Holocene and Pleistocene age (Peterson et al. 2005) with thicknesses of over 100 feet. Sand fill is also present to a depth of about 15 feet at the location of the Trans-Pacific Parkway/U.S. 101 intersection. The lower-lying portions of the Kentuck project site are mantled and underlain by soft alluvial deposits to depths of more than 100 feet in some areas.

Bedrock underlies these sands and includes Eocene marine interbedded siltstones and sandstones of the Coaledo Formation (Baldwin et al. 1973). The upper member of the Coaledo Formation is composed of gray, coarse to fine-grained weathered, very dense, weakly cemented sandstone with silt and minor amounts of coal. Weathered sandstone is generally encountered beneath the dune sands to a depth of about 125 feet (GRI Geotechnical and Environmental Consultants [GRI] 2007a).

Jordan Cove completed 11 deep borings GRI (2007a) at the location of the LNG storage tanks to obtain geotechnical information for the design of the LNG terminal. These subsurface explorations identified sand extending to depths of 124 to 133 feet. Organic mill waste was encountered in the fill at the ground surface at the Ingram Yard and also in several landfills in the vicinity of the mill site. A geotechnical report by GRI (2017a) provides additional geotechnical subsurface investigations performed in 2012 and 2013, and more recently continuing into 2017, at the Jordan Cove site. As noted in the geotechnical report, Jordan Cove plans to conduct additional subsurface investigations to support detailed design.

Jordan Cove also conducted two overwater geophysical seismic reflection surveys between the LNG terminal site and the Southwest Oregon Regional Airport located on the east side of the Coos Bay navigation channel. The subsurface profile indicates shallow bedrock, which becomes progressively deeper toward Pony Slough (southeast of the airport), to a depth of approximately 150 feet below the bay floor (GRI 2007a), and to a depth of approximately 120 feet near the south edge of the proposed slip (DEA 2017a).

Effects on surface geology would be limited primarily to the construction phase of the LNG terminal, when the topographic features at specific locations on the site would be altered by clearing, mechanical excavation, dredging, and fill placement. Construction of the slip and access channel would change the surface geology of the site as a result of excavation and dredging. No blasting would be required during any phase of construction of the LNG terminal because the entire site consists of unconsolidated material. Any shoreline areas disturbed by construction would be armored to protect against erosion or shifting beyond the Jordan Cove project design limits.

4.1.1.2 Mineral Resources

The principal mineral production of Oregon in order of value was crushed stone, construction sand and gravel, Portland cement, diatomite, and crude perlite (USGS 2013a). Mineral resources available in Coos County, Oregon, include chromium, gold, clay, manganese, sand and gravel, silica, stone, and titanium. Coal was mined historically in Coos Bay, starting in 1855 until the early decades of the twentieth century. Coal deposits are known to occur in the upper and lower members of the Coaledo Formation (Newton 1980). The Steva coal seam and the Hardy coal seam have been identified within the vicinity of the Kentuck project site (Diller 1914). The closest major productive coal mine was known as the Libby, which operated until about 1920, located south of city of Coos Bay at the head of Coalbank Slough.

Based on the State of Oregon Mineral Information Layer for Oregon-Release 2, there are no permitted coal mines or oil and gas wells within 0.25 mile of the LNG terminal site (DOGAMI 2017). There are three permitted sand and gravel mines within 0.25 mile of the LNG terminal site; however, all three of these mines are closed and are not producing material (DOGAMI 2017). Based on available database information, construction and operation of the LNG terminal is not anticipated to have effects on identified mineral resources, active mines, or oil and gas production facilities.

4.1.1.3 Seismic and Related Hazards

Seismic-related hazards including earthquakes, ground-shaking, volcanic hazards, surface rupture, soil liquefaction, lateral spreading, tsunamis, subsidence, and scour hazards are addressed in section 4.13 of this DEIS (i.e., the Reliability and Safety section).

4.1.1.4 Paleontological Resources

There are no state or federal laws or regulations that protect paleontological resources on private lands (Niewendorp, DOGAMI, personal communication, 2008). The Antiquities Act of 1906 protects "objects of antiquity" on federal lands. The Paleontological Resources Preservation Act of 2009 applies to federal lands including BLM and NFS lands, as well as "Indian" lands, but does not apply to private land. See section 4.1.3.

4.1.2 Pacific Connector Pipeline Project

The pipeline would be constructed by conventional cross-country techniques as described in chapter 2. Typical pipeline trench depth would range from 6 to 10 feet, although it would be deeper at stream crossings with scour concerns or areas with geological hazards. In Class 1[49] areas, the pipeline would have 36 inches of cover and 24 inches of cover in Class 1 areas with consolidated rock. Excavation

[49] Pipeline Class designations are described in 49 CFR § 192.5 as locations within 220 yards of the pipeline centerline. A Class 1 location has 10 or fewer buildings intended for human occupancy; and a Class 2 location has more than 10 but fewer than 46 buildings intended for human occupancy.

of the trench would encounter a range of soil and rock materials. Special construction methods for crossing rugged terrain were also previously discussed in chapter 2.

The proposed route would cross a wide variety of terrain and geological conditions. The proposed route was evaluated for seismic, landslide, erosion and scour, mine, and volcanic hazards that may potentially occur across or near the alignment and that could adversely affect the pipeline. In addition, an evaluation was made of the potential impact that pipeline construction and operation could have on the natural geological environment and geological processes in the pipeline vicinity. During route planning, Pacific Connector identified and attempted to avoid geological resource areas and hazards.

Pacific Connector selected the proposed route with input from agencies, stakeholders, and land managers/owners to avoid areas with high risk of geological hazards. The initial proposed route was changed in numerous locations to avoid high hazard areas as more detailed data were collected. During construction, Pacific Connector would implement site-specific construction techniques and BMPs to mitigate local geological hazards that could not be completely avoided. The following sections discuss these hazards and how they would be mitigated.

4.1.2.1 Geologic Setting

The proposed route crosses four regional physiographic provinces in Oregon: the Coast Range, Klamath Mountains, Cascade Range, and Basin and Range. The proposed route begins within the Klamath Basin, which is part of the larger Basin and Range physiographic province of the Great Basin; an area characterized by ridges and valleys that are separated by faulting (Burns 1998). The route would then head westward over the High Cascades sub-province, a chain of geologically active volcanoes with high andesitic peaks, and the Western Cascades sub-province, an ancestral range of deeply eroded (extinct) volcanoes. The proposed route then passes through the Klamath Mountains physiographic province, which consists of several complex geological terrains composed of metamorphosed and fractured volcanic and marine sedimentary rocks. The proposed route would proceed over the Coast Range physiographic province, an area underlain by estuarine and alluvial deposits in lowland areas and sedimentary rocks in the uplands and terminate at the Oregon Coast. Between the mountain ranges are several valleys, predominantly filled with recent alluvial materials. Some of the major river valleys and their tributaries crossed by the proposed route heading west to east include the Coquille River Valley, Umpqua River Valley, Rogue River Valley, and Klamath River Valley (see section 4.3 of this EIS for more information about waterbodies).

The pipeline alignment is located within varying soil and lithologic units ranging from soft sediments to hard granite and basaltic rock. Unconsolidated silt, sand, and cobbles occur locally in streambeds, alluvial fans, and valley floodplains in all four physiographic provinces. Detailed descriptions of geology along the proposed route are included in Table B-1 in Appendix B of the *Geologic Hazards and Mineral Resources Report* (GeoEngineers 2017a) filed with Resource Report 6 of Pacific Connector's application to the FERC. Below is a west to east description of the physiographic provinces crossed by the pipeline.

Coast Range

The proposed route passes through the southernmost part of the Coast Range province for approximately 71 miles (approximately MP 0 to MP 71). The Coast Range is 30 to 60 miles wide and averages 1,500 feet in elevation, although the highest point (Mary's Peak) reaches an altitude of 4,097 feet (Orr and Orr 2012).

The Coast Range is composed of relatively soft marine sedimentary rock units that overlie basalt at depth. The wet conditions of the western slopes of the Coast Range, along with steep terrain composed of relatively weak rock, contribute to an active erosional environment with frequent landslides.

Uplift of the Coast Range deposits has deformed the bedrock units with folds and faults. Coastal uplift of the present Coast Range over the past 10 to 15 million years has been simultaneous with stream incision and coastal erosion and depositional processes. Ocean-cut terraces exist near the shoreline, some of which have been elevated to altitudes of up to 1,600 feet (Orr and Orr 2012). Low-lying areas near the coast are underlain by modern beach deposits, sand dunes, estuarine mud and alluvial sediments.

Klamath Mountains

The proposed route passes through the northeast corner of the Klamath Mountain physiographic province for approximately 49 miles (approximately MP 71 to MP 120). The province has a rugged landscape of high peaks and deep canyons, with a total local relief of 2,000 to 5,000 feet (Baldwin 1964). The highest peak of the Klamath Mountains in the state of Oregon is Mt. Ashland, at 7,530 feet (Burns 1998). Most of the Klamath Mountain physiographic province is composed of highly deformed volcanic and marine sedimentary rocks, as well as metamorphic terranes. The physiographic province also contains deformed pieces of the oceanic crust (accreted terrain from the Cascadia subduction zone [CSZ]) and granitic intrusive bodies (Walker and MacLeod 1991). Bedrock is often intensely metamorphosed and fractured.

The proposed route passes through three tectonic geological terranes in the Klamath Mountain segment of the alignment. West to east and youngest to oldest, these terranes are: (1) the Franciscan and Dothan belt; (2) the Western Jurassic terrane; and (3) the Western Paleozoic and Triassic terrane. The alignment crosses through the northernmost part of the Franciscan and Dothan belt, an area composed of turbidite sandstone, mudstone, and chert formed on the continental slope and subsequently scraped off the ocean floor during accretion. East of the Franciscan and Dothan belt, the alignment passes through the northern section of the Western Jurassic terrane, an area composed of volcanic flows and ash altered to greenstone, ophiolite, and metamorphosed ocean sediments, including conglomerate, siltstone, and sandstone. Between the Western Jurassic terrane and the Western Paleozoic and Triassic terrane, the alignment crosses the White Rock pluton (a large body of intrusive igneous rock that solidified within the crust). The Western Paleozoic and Triassic terrane is composed of metamorphosed pieces of ocean crust (ophiolites) and metamorphosed ocean-island basalt (Orr and Orr 2012).

Cascade Range

Approximately 40 miles (approximately MP 120 to MP 160) of the route crosses Oregon's southern Cascade Range. The Cascades consist of two north-south trending mountain chains: (1) the older, more weathered Western Cascades; and (2) the younger, higher-elevation High Cascades. The Western Cascades drain westward and reach altitudes of 5,800 feet. The southern High Cascades drain toward the east and the west and reach altitudes of up to 9,493 feet at the summit of Mt. McLoughlin (USGS 2006).

Precipitation of 60 to 100 inches annually on the western side of the Cascades results in extreme weathering of bedrock and soil deposits and the existence of larger rivers in the physiographic province (Orr and Orr 2012). Both the Western Cascades and the High Cascades consist primarily of volcanoes formed as a result of the subduction of the Juan de Fuca oceanic plate beneath the North American continental plate. The Western Cascades terrain consists of deeply dissected volcanoes that formed between about 42 and 8 to 10 million years ago (USGS 2006). The volcanoes of the High Cascades began erupting about 5 million years ago. As the High Cascades volcanoes erupted, their magma chambers emptied and collapsed, creating calderas (large craters). Crater Lake, north of the pipeline alignment in Klamath County, is one of these caldera lakes. During the Quaternary, andesitic cones formed the range's notable high peaks.

After the formation of the high-altitude andesitic peaks, volcanic activity in the High Cascades has continued intermittently to the present. Minor volcanic vents manifest near the pipeline alignment. These include Brown Mountain, which is a Quaternary-aged volcano situated about 3 miles north of the proposed route near MP 167.

Repeated glaciation of the High Cascades during the Pleistocene Epoch produced glacial U-shaped valleys, cirques, and jagged mountain ridges. No active glaciers exist along or near the pipeline alignment.

Basin and Range

Approximately the easternmost 45 miles (approximately MP 160 to MP 224) of the pipeline alignment pass through the southwestern corner of the Basin and Range province in Oregon, a geographic area named the Klamath Basin. The Basin and Range province contains the Upper Klamath Lake and Lower Klamath Lake National Wildlife Refuge, which, unlike the rest of the province, drain to the Pacific Ocean via the Klamath River.

The Basin and Range is a complex series of alternating uplifted mountain blocks (horsts) and down-dropped basins (grabens). These mountain ranges and valleys are separated by generally north-south trending normal (extensional) faults. The altitude of the Basin and Range province is generally over 4,000 feet, and the summit of Steens Mountain in southeast Oregon reaches 9,670 feet.

Crustal extension is responsible for development of the Basin and Range physiographic province. The extension occurred in two phases, the first of which happened between 20 and 10 million years ago and produced widespread volcanic activity resulting in thousands of feet of basaltic flows and tuffs. The second phase of extension occurred in the last 10 million years and produced the distinct horst and graben block faulted topography.

The low precipitation and runoff rates east of the Cascades restrict the amount of erosional debris that can be transported from watersheds. As a result, sediment has accumulated in the basins, in thicknesses greater than 1,000 feet in some places. Eroded material is deposited in alluvial fans and channels around the margins of the basins and as marsh and lake deposits in the lower elevations. During the wetter and cooler periods of the ice ages, the basins were occupied by much larger lakes; at maximum extent, Pluvial Lake Modoc extended over the pipeline alignment from Klamath Marsh, north of Upper Klamath Lake, to the Tule Lake basin in northern California (Orr and Orr 2012:304).

4.1.2.2 Mineral Resources

Mineral resources that occur in the pipeline area include the following metals: chromite, copper, gold, manganese, mercury, and silver. Other rock and mineral resources include basalt, cinders, coal, conglomerate, limestone, natural gas (including coal bed methane), sand and gravel, sandstone, shale, silica, talc, and tuff/breccia (DOGAMI n.d.). Most of the non-metal minerals are mined to produce aggregate. Mineral resources, surface and subsurface mines, mining claims and leases, mineral material disposals, and oil and gas fields located within one-half mile of the Pacific Connector pipeline construction right-of-way were identified from USGS topographic maps, BLM and Forest Service mineral resource databases (including oil and gas leases, geothermal leases, and mining claims), ODOT aggregate resources Geographic Information System (GIS) data, DOGAMI GIS data, published reports, published and unpublished maps, county mineral overlay maps, and the updated Oregon MILO-2 mineral information layer (DOGAMI n.d.).

Portions of the pipeline alignment cross six areas with county zoning that recognizes the potential for future mineral resource development. This zoning implies that mines and oil and gas wells could be sited at any location within these areas in the future as long as the zoning remains compatible with the resource extraction operations.

Table B-5 of Appendix B from GeoEngineers (2017a) identified the active, inactive, and planned mineral resources or mining sites (organized by MP) within 0.25 mile of the pipeline. Twenty-nine mineral or mine locations were identified as within 500 feet of the pipeline. Sixteen of these mines identified within 500 feet of the alignment are aggregate or quarry-related mines. The aggregate or quarry-related mines generally consist of open excavations and the primary potential hazards at these mines would be related to failure of steep slopes and/or high walls. Pacific Connector's civil survey crews did not observe such conditions along or adjacent to the alignment. Pacific Connector would provide a more comprehensive evaluation of such conditions during the final detailed design.

The remaining seven non-aggregate-related mines were investigated by Pacific Connector through field reconnaissance on January 23 and 24, 2007, and June 13 and 15, 2007. The reconnaissance of the seven mines did not identify any apparent mine workings located within 500 feet of the pipeline alignment. However, adits associated with the Nivinson Prospect/Mars Fraction Lode and Thomason mines were identified within 500 feet of the proposed pipeline. Therefore, Pacific Connector conducted a site-specific mine hazards assessment for those prospects as well as the nearby Red Cloud Mine, and the findings of that study were provided in a stand-alone report dated August 23, 2007, and its 2009 addendum (GeoEngineers 2007a, 2009a). The reports document the existence of naturally occurring mercury in the vicinity of the mines. Six samples were collected along a previous pipeline route and indicated that very low concentrations of naturally occurring mercury mineralization exists. Mercury was not detected in any of the samples at levels that exceed applicable ODEQ and EPA screening levels for protection of worker health. However, a 2,000-foot section of the pipeline route was moved 2,500 feet to avoid the area of the mines.

No mine hazards related to subsidence or slope stability have been identified by the research and investigations completed by Pacific Connector to date. Pacific Connector's ECRP includes erosion and sediment control measures that would be employed to avoid potential impacts from the naturally occurring mercury concentrations identified in the vicinity of the Nivinson Prospect/Mars Fraction (MP 108.7).

Pacific Connector also identified areas where the pipeline would cross: (1) areas where county land-use zoning allows mineral resource extraction, or (2) federal land that has been or is available for mineral resource or geothermal leases (GeoEngineers 2017a). The BLM & Mineral Legacy Rehost 2000 System, LR 2000, was accessed on April 26, 2013 and again in September 2017 by Pacific Connector to include the more recent information. The BLM would review and verify the validity of this database query by Pacific Connector during their right-of-way permit review. Coos County recognizes three coal-basin resource areas between MPs 0 and 7.6; and one between MP 13.2BR and 13.4BR. Eighteen oil and gas areas are located between MP 10.4R and 45.7 in Coos County. Two mining claims are located between MPs 0 and 1.4 in Coos County. Seven oil and gas areas, two placer mining claims, one mine, four lode mining claims, a chromite resource, and a quarry are located in the vicinity of the pipeline alignment between MPs 46.9 and 110 in Douglas County. Ten oil and gas areas and two lode mining claims are located in the vicinity of the pipeline alignment between MPs 115.4 and 166.4 in Jackson County. One lode mining claim, one oil and gas area, and two geothermal resources areas are located in the vicinity of the pipeline alignment between MPs 170.1 and 216.8 in Klamath County.

Constructing and operating the pipeline could affect future mineral extraction operations. Surface mining activities (including materials storage) across the permanent pipeline easement would be prohibited and heavy equipment crossings of the pipeline would be restricted to specific crossing locations. Sub-surface mining could occur, but would require coordination between the pipeline and the mining company, and the implementation of measures to ensure pipeline integrity.

Mine Hazards

Mine hazards potentially exist in areas underlain by or adjacent to underground mine workings and surface mines that have not been properly stabilized, closed, and made safe in accordance with applicable local, state, and federal laws. Pacific Connector identified surface and subsurface mines within 0.5 mile of the proposed construction right-of-way from USGS topographic maps, BLM and Forest Service databases, and LR 2000 (2017). DOGAMI GIS data, published reports, published and unpublished maps, and county mineral overlay maps. No mine hazards, were identified at the aboveground facilities locations.

The primary hazards involve the potential for:

- subsidence in areas underlain by or adjacent to air shafts, tunnels, underground workings, and mine tailings;
- rockfalls and slides caused by the failure of unstable benches, slopes, and tailing piles in nearby surface mines, including those benches and slopes occurring within water-filled pits; and
- the presence of tailings or waste piles containing naturally occurring metals.

According to Pacific Connector's application (Table B-5 of Appendix B from GeoEngineers 2017a), the pipeline alignment was identified as being located within 500 feet of potential mine hazards based on the information provided in the databases at 29 locations. Sixteen of the 29 mines identified within 500 feet of the alignment are aggregate or quarry-related mines. Aggregate or quarry-related mines generally consist of open excavations. The primary potential hazards at these mines would be related to failure of steep slopes and/or high walls. These are expected to be localized conditions. Civil survey crews involved with surveying the right-of-way did not observe these conditions along or adjacent to the alignment. Consequently, these potential hazards are not expected to pose a threat to the pipeline.

The remaining non-aggregate-related mines were investigated by field reconnaissance on January 23 and 24, 2007, and June 13 and 15, 2007. The database indicated that these mines are located at MPs 9.8, 10.0, 16.2, 58.8, 75.3, 105.6, 108.7, 109.3, 109.4, 110.7 142.6, and 150.5. The reconnaissance of these mines did not identify any apparent mine workings located within 500 feet of the pipeline alignment. Adits [50] associated with the Nivinson Prospect/Mars Fraction Lode and Thomason mines were identified within 500 feet of the pipeline location. Therefore, a site-specific mine hazards assessment was completed for those prospects as well as the nearby Red Cloud Mine, and the findings of that study were provided in a stand-alone report dated August 23, 2007, and its 2009 addendum (GeoEngineers 2007b, 2009a). The following summarizes the report findings with regard to the proposed route.

<u>Nivinson Prospect/Mars Fraction Mercury Mine</u>

The pipeline alignment at MPs 108.6-108.7 does not cross the Nivinson Prospect mercury mine but is approximately 200 feet upslope from mine adits. Based on documented excavated depths, trends, and distances from the pipeline, it was concluded from the field investigation that the adits of the Nivinson Prospect mercury mine likely do not extend into the right-of-way and do not pose a risk to the pipeline. However, the pipeline route was moved 2,500 feet from these areas to avoid potential risks.

<u>Red Cloud Mercury Mine</u>

The pipeline alignment is approximately 400 feet west of the Red Cloud mercury mine at MP 109.3. No evidence of the mine was observed during site reconnaissance of the alignment.

<u>Thomason Mine (Inactive)</u>

The pipeline alignment at MP 109.4 crosses the mapped location of the Thomason Mine. No evidence of the Thomason Mine was observed during site reconnaissance of the alignment. Approximately 260 feet downslope of the mapped Thomason Mine location at MP 109.4, the proposed route crosses East Fork Cow Creek. The proposed route crosses the East Fork Cow Creek outside of the Thomason Mining Group boundaries and all other mining groups mapped by Brooks (1963).

<u>Heppsie Quarry</u>

The proposed alignment at MP 150.5 is located within approximately 80 feet northeast of the Heppsie quarry, and parallels the length of the quarry. The Heppsie quarry is a regional hard rock quarry and to utilize this rock quarry it is necessary to blast the rock. The BLM and Pacific Connector determined that due to the proximity of the pipeline to the quarry and the incompatibility of production blasting the rock quarry near the pipeline; that 70,000 cubic yards of rock would be blasted at the expense of Pacific Connector and left on site. The BLM is requiring this blasting because the BLM will not assume unknown risk associated with complications, limitations, or liability associated with utilizing this quarry in the future. Based on aerial

[50] A horizontal passage leading into a mine for the purposes of access or drainage.

photographs and the BLM data Pacific Connector has shown that the pipeline parallels the quarry. Pacific Connector has told the BLM that it would use this quarry to purchase approximately 70,000 cubic yards of rock to crush, per 43 CFR 3600. The BLM has provided Pacific Connector with core drill logs, maps, and a development plan for use of the quarry.

4.1.2.3 Seismic and Related Hazards

The proposed route crosses a complex geological area that has developed through extensive crustal deformation and volcanic activity. Two primary mechanisms for generating earthquakes of design significance exist along the pipeline alignment: (1) a major, regional earthquake associated with the CSZ; and (2) local earthquakes associated with a seismic hot spot near Klamath Falls. Based on the catalogs of recorded earthquakes from the Pacific Northwest Seismograph Network, 1872 to September 2017, and the Earthquake Database for Oregon, 1833 to 1994 (Wong and Bott 1995; Johnson et al. 1994), 336 earthquakes have been recorded within 100 miles of the Pacific Connector pipeline alignment. Table 4.1.2.3-1 lists the recorded historical earthquakes by magnitude range and by epicentral distance to the nearest segment of the Pacific Connector pipeline. Major historical earthquakes near the proposed route include two events in 1873: (1) an estimated magnitude 7.0 earthquake at the southwestern tip of Oregon; and (2) a magnitude 6.3 earthquake near Coos Bay. In addition, a magnitude 6.0 event occurred in 1938 approximately 75 miles south of Coos Bay. Closer to the planned alignment, two earthquakes occurred within about 2 hours of each other on September 21, 1993 that had epicenters located about 15 miles northwest of Klamath Falls: both were magnitude 6.0 earthquakes (Yelin et al. 1994; Braunmiller et al. 1995). However, most of the pipeline construction area has experienced very few earthquakes during the period of historical record.

Geological maps of the pipeline area show many faults that cross the pipeline alignment or are located near the pipeline corridor (Walker and MacLeod 1991). However, with the exception of the Klamath Falls area, these mapped surface faults are not considered active based on evidence of recent Quaternary tectonic activity and are not believed to be capable of renewed movement or earthquake generation (USGS 2009a, 2010). Many earthquakes of magnitude 2.0 and larger have occurred during historical times in the Klamath Falls area. Most earthquake epicenters are clustered northwest of Klamath Falls, near the southwest shoreline of Upper Klamath Lake. Epicenters of these earthquakes are typically at depths of about 3 to 5 miles. These events seem to be associated geographically with the boundary between the Basin and Range province and the Cascade Range province. The earthquake clusters also may be associated with volcanic activity (Cole and Bugni 1993).

TABLE 4.1.2.3-1

Historical Earthquakes within 100 Miles of the Proposed Pacific Connector Pipeline a/

Magnitude Range b/	Number of Earthquakes	Epicenter Distance From Alignment (miles)
3.0 to 3.99	174	5 to 100
4.0 to 4.99	143	3 to 99
5.0 to 5.99	15	8 to 100
6.0 to 6.99	3	9 to 74
7.0 to 7.99	1	82

a/ Earthquake catalog data from the USGS Earthquake (i.e. the Comcat database) Search (January 1, 2006, to August 28, 2013), Pacific Northwest Seismograph Network (2006) and the Earthquake Database for Oregon, 1833 to 1993 (Johnson et al. 1994).

b/ Earthquakes with less than magnitude 3.0 are termed micro-earthquakes and are not usually felt (Reiter 1990). Earthquakes of magnitude 5.0 and greater are generally considered to have engineering significance.

The primary seismic hazards to pipelines include potential strong ground shaking, surface fault rupture, soil liquefaction (and related lateral spreading), earthquake-induced landslides, and regional ground subsidence. The degree of risk from these hazards varies and depends on several factors, including the magnitude (or size) of the earthquake, the distance of the earthquake origin from the pipeline facilities (lateral and vertical), soil/rock conditions, and slope angle of the ground.

Empirical reviews of historical earthquakes demonstrate that welded steel pipelines are not prone to failure due to earthquakes. Modern buried pipes with welded joints have low vulnerability to elastic ground displacement related to earthquake shaking. Ground displacements from wave propagation occur over widespread areas and lack the local strain concentrations necessary to damage a modern welded pipeline. A 1996 study of earthquake performance data for steel transmission lines and distribution supply lines operated by Southern California Gas over a 61-year period found that post-1945 arc-welded transmission pipelines in good repair have never experienced a break or leak during a southern California earthquake and are the most resistant type of piping, vulnerable only to very large and abrupt ground displacement (e.g., severe landslides), and are generally highly resistant to traveling ground wave effects and moderate amounts of permanent deformation (O'Rourke and Palmer 1994). The study included evaluation of pipeline performance during the 1933 Long Beach earthquake (magnitude 6.4), the 1952 (magnitude 7.3) and 1954 Kern County earthquakes (magnitude unknown) the 1971 San Fernando earthquake (magnitude 6.5-6.7) and the 1994 Northridge earthquake (magnitude 6.7). A study of water transmission pipeline response to the 2011 Tohoku earthquake (magnitude 9) indicated that steel pipe over 137 kilometers required 12 repairs – a rate of approximately 0.1 repair per kilometer (Wakamatsu et al. 2016). Similar studies for large (magnitude 8 and greater) earthquakes were not available for natural gas transmission pipelines.

In addition to ground shaking, subsidence and ground rupture from seismic activity, tsunamis can be generated by strong ground motions associated with offshore earthquakes or submarine landslides. Coastal areas of Oregon, including Coos Bay, could experience the effects of tsunamis. The portion of the pipeline near the LNG terminal occurs in the relatively sheltered areas of Coos Bay, where the effects of a tsunami on the pipeline would be expected to be relatively minor (GeoEngineers 2017a).

Seismic hazards for the pipeline were evaluated by reviewing available historical data, by researching geological evidence of prehistoric earthquakes for the Pacific Northwest, and by qualitatively evaluating the potential risk to the pipeline along the overland sections of the alignment. Quantitative evaluation of the potential for liquefaction, lateral spreading, and tsunami inundation was accomplished for the Coos Bay crossing, where liquefaction and lateral spreading hazard were identified during the initial assessment (GeoEngineers 2017a).

Cascadia-type earthquakes are discussed in section 4.13 (i.e., the Reliability and Safety section) for the Jordan Cove LNG Project. If a Cascadia-type earthquake of magnitude 8 or greater occurred during the operating life of the pipeline, the ground shaking and possible ground subsidence would be strongest in the Coast Range province and in low-lying areas near Coos Bay. Although ground shaking would likely be felt throughout the length of the pipeline from a Cascadia event, hazards would diminish in the eastward direction, with increasing distance from the offshore epicenter. Documented subsidence zones associated with the 1960 subduction zone earthquake in Chile (Plafker and Savage 1970) indicate subsidence on the order of 3 to 6 feet vertically distributed over a wide trough of approximately 60 miles. Pacific Connector studies (GeoEngineers 2017a) have indicated that the resultant strain accrual on a welded steel pipeline distributed over that length of pipe would not pose a substantial risk to the integrity of the pipeline.

Ground Shaking and Peak Horizontal Ground Acceleration

Earthquake magnitude and ground motion are two different parameters discussed in relation to CSZ events. Earthquake magnitude describes the earthquake source, and peak horizontal ground acceleration (PGA) describes the effect of the earthquake at a certain distance from the source and based on the geological conditions. The PGA used to design for a certain earthquake is therefore based on the earthquake magnitude as well as other factors. As described below, the pipeline would be designed using PGA values that correspond with an 8-9 magnitude CSZ earthquake and the specific return period.

Using the historical seismicity record including the records for CSZ earthquakes and the available data on Quaternary faults in the United States, the USGS (2009a) has produced probabilistic seismic hazard mapping for the United States in general, and for the region that would be crossed by the pipeline in particular. This mapping has generally been used to address two risk levels: (1) a 10 percent probability of exceedance in 50 years (475-year return period); and (2) a 2 percent probability of exceedance in 50 years (2,475-year return period). The output from the seismic hazard mapping includes estimates of the PGA and spectral accelerations for 0.2 and 1.0 second structural periods. The PGA values are given in percentages, or decimal fractions, of the acceleration of gravity (g). The acceleration resulting from gravitational forces (g) is defined as 32 fps2. PGAs for the Project were calculated for the specific 475-year and 2,475-year return periods and the site-specific PGA of 0.5g for each corresponding milepost interval of the pipeline alignment (GeoEngineers 2017a).

The 10 percent probability of exceedance in 50 years (475-year return period) is defined by the American Society of Civil Engineers (ASCE) Technical Council on Lifeline Earthquake Engineering as the contingency design earthquake for pipeline design (ASCE 1984). The highest 475-year return period PGAs expected along the pipeline alignment are about 17 percent (MP 0 to 2.0 and MP 9R to 16BR) of gravity. The University of Washington (2001) noted that these intensities are moderate and relate Instrumental Intensity VIII and a “Moderate to Heavy” potential damage to aboveground structures as described by the Modified Mercalli Intensity scale as follows:

> *Steering of cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.* (USGS 1931)

The USGS (1931) indicates that instrumental intensities of IX up to XII are seismic conditions where damage to pipelines may occur. It is noted that the intensity scale was created in 1931 and that modern pipeline materials and design protocols have improved considerably, as discussed in the following section. The potential damage to buried pipelines from the ground-shaking intensity at the site (intensity of VIII or greater) is, therefore, considered to be low. The pipeline would be designed to shut down automatically if a mechanical failure poses risk to the equipment or otherwise constitutes a hazard. Additional discussion of public safety concerns related to potential earthquake damage to the pipeline is provided in section 4.13 (i.e., the Reliability and Safety section).

Surface Rupture Potential from Faulting

Differential, or shear, movements of fault surfaces can be entirely subsurface, or they can extend to the ground surface as surface fault rupture. The nature of the shear movements at the surface depend on the character of fault movement. In general, surface fault rupture across a pipeline alignment can result in rapid differential ground displacements across the pipe, with displacement magnitudes ranging from a few inches to several feet. The typical mechanics of fault movement in the Basin and Range province (crossed by the pipeline between MP 160 to MP 224) is normal faulting at near-vertical inclinations (dip angle) caused by crustal extension. This extension forms grabens, or down-dropped blocks of the earth's crust bounded on both sides by normal faults. Although deep earthquakes occur beneath the continent within the subducting Juan de Fuca Plate in association with the CSZ, there is no risk of fault offsets at the ground surface associated with these deep earthquakes.

Based on the USGS Faults and Folds Database (USGS 2014b) and the DOGAMI geologic mapping (Black and Madin 1995; Personius 2002a; Mertzman et al. 2007; Mertzman 2008; Hladky and Mertzman 2002), and review and interpretation of light detection and ranging (LiDAR) data available from DOGAMI (http://www.oregongeology.org/lidar/), the pipeline alignment crosses the following regional Quaternary and Holocene age fault zones:

- Sky Lakes fault zone (includes Lake of the Woods Fault), near MPs 172 to 182;
- West Klamath Lake fault zone, near MP 187;
- Lower Klamath Lake section of the Klamath Graben Fault system near MPs 204 to 206 (4-5 crossings); and
- The South Klamath Lake section of the Klamath Graben Fault system near MPs 212 to 213 (Stukel Mountain fault).

The mapped Holocene age fault (defined by the USGS as active within the last 10,000 years) that would be crossed by the pipeline alignment occurs within the South Klamath Lake section of the Klamath Graben fault system, in the vicinity of Klamath Falls near MP 213. This fault is specifically named the Stukel Mountain Fault. Review of USGS data sources (Personius 2002a, 2002b) does not provide potential earthquake magnitude along this fault, but provides other information about slip rate and fault length. LiDAR imagery of recent alluvial sediments in this area does not show linear features typical of fault movements at the ground surface. Recently acquired color stereo aerial photographs do not show linear features or changes in soil color indicative of fault movement at the ground surface.

The location of the Stukel Mountain Fault was evaluated further by completing a seismic reflection survey (NORCAL Geophysical Consultants 2015) in the vicinity of the mapped fault location. The survey confirmed that a near-vertical normal fault extends southeastward from Stukel Mountain into the valley fill area and that the structural offset in bedrock is large—about 1,800 feet to 850 feet—and indicates that the graben is increasing in depth to the north. The disturbed zones from the two seismic lines align well with the USGS and DOGAMI interpretations of fault extensions into the valley fill. The fault offset extends from the bedrock surface (at about 325 feet deep) to shallower than 60 feet, the shallowest depth that could be explored by the seismic reflection survey. Thin alluvial cover over the disturbed sediments indicates that little time has passed since the fault displaced, supporting a conclusion that the Stukel Mountain fault is active.

The data generated by NORCAL indicates that the faulting in bedrock and valley fill commenced long ago and has continued intermittently into the Holocene; this affirms the published classification that the fault is active and has the potential for surface rupture. Based on the NORCAL survey locational information, a fault crossing assessment and design is needed between about MP 212.8 and MP 212.9, a 600-foot-wide zone of potentially active faulting.

Pacific Connector conducted a detailed hazard assessment and mitigative design for the fault crossing (SSD, Inc. 2017). The design fault displacement was computed using a simple and conservative MCE approach, which neglects probabilistic seismic hazard methods and assumes that the entire fault is capable of rupturing all at once. The fault is relatively short and is capable of, at most, about 3.3 feet of differential movement. The force on the pipe would be limited to the weight of backfill on top of the down-dropped side based on the nature of the fault. Therefore, detailed numerical simulation of the pipe-soil interaction of a potential maximum 3.3-foot offset was performed using a proprietary software called PIPLIN. The preliminary results of the Stukel Mountain numerical simulation analyses indicate that mitigative construction is not necessary.

Pacific Connector would further evaluate and select specific designs for fault mitigation during the final detailed design. In general, Pacific Connector would follow published guidance to estimate the potential amount and direction of fault offsets as well as the magnitude of strain accumulation at the pipe crossing location (Takada et al. 2001; Honegger and Nyman 2004). Based on trench observations during pipeline construction by EIs, if mitigation becomes necessary at any of the suspected Quaternary fault crossings, it is anticipated that the mitigation design would consist of trenches with shallow-angled sidewall slopes that are backfilled with loose, cohesionless sand and/or gravel. Site-specific numerical simulation would be used to develop optimum trench geometry for the pipeline alignment where the mitigation is implemented. If backfill material is obtained from federal land and not sourced from within the right-of-way itself, 43 CFR 3600 regulations must be followed. This applies to any material required for constructing access roads and pads. This mitigation option would use trenches with shallow-angled sidewall slopes that are backfilled with loose, cohesionless sand and/or gravel material. Pipeline load reduction with low-strength backfill is likely the most cost-effective mitigation approach for fault rupture hazards. This mitigation option also involves the use of isolation valves on opposite sides of a fault crossing. In the event of a fault-induced rupture or leak of the pipeline, the isolation valves would detect the pressure loss and close automatically, thus preventing flow of gas to the location of the rupture. Such mitigation options are typically only utilized if warranted by site conditions.

The performance of a buried pipeline subjected to fault rupture can be improved further by using different backfill material surrounding the pipe, such that the pipeline is less restrained to movement, thereby reducing shear and bending stresses (ALA 2001, 2002). Also, a coating material can be applied to the pipe to reduce the soil-pipe interface friction, such that the tensile and compressive stress of the pipe can be reduced. This technique has been used by All American Pipe Line Company for its pipeline that crosses the San Andreas Fault in California, by the Sakhalin II Pipeline (Sakhalin Energy Investment Corp. 2008) that crosses multiple active faults in Russia, and by the BTC Pipeline in the Republic of Georgia. In addition, use of stronger material (additional wall thickness) would increase the load capacity of the pipeline, hence increasing the amount of ground movement tolerable by the pipeline. Pacific Connector would consider, evaluate, and implement the best mitigation options for specific conditions during the final detailed design in coordination with the FERC.

Liquefaction and Lateral Spreading Potential

The potential for soil liquefaction from an earthquake is a function of the intensity or strength of the earthquake shaking (high PGA), the duration of strong earthquake shaking, the nature of the soil (it must generally be loose to medium dense and granular such as silt or sand), and groundwater conditions (the soil must be saturated with a shallow groundwater table). In general, liquefaction that results in permanent ground deformation or buoyant displacement of buried pipelines has the potential to result in pipeline damage (O'Rourke and Liu 1999). Pipeline damage associated with liquefaction typically occurs where a sharp transition exists between liquefiable and non-liquefiable materials. Shear or bending movements at such sharp transitions can damage pipelines. In addition, liquefaction can change the buoyancy forces such that the pipeline may float if not mitigated during design. The evaluation of liquefaction potential is complex and depends on numerous site parameters, including soil grain size, soil density, age of soil deposit, depth of the water table, site geometry, static stresses, and design accelerations.

In addition to settlement or pipeline buoyancy, the possibility exists that liquefaction could result in lateral spreading. Lateral spreading involves lateral displacement of surficial blocks of non-liquefied soil as the underlying soil layer liquefies. Lateral spreading generally develops in areas where sloping ground is present, such as along the banks of rivers, sloughs, canals, or lakes. Because lateral spreading is associated with liquefaction of soils, the potential for lateral spreading along the pipeline alignment was evaluated based on the same criteria as liquefaction potential.

The potential for liquefaction along the Pacific Connector pipeline was evaluated based on topography and soil conditions obtained from geological maps, NRCS soil surveys, and, at some sites, limited geotechnical boring data. Areas along the proposed pipeline that are subject to being under water-saturated soils within the pipeline depth are generally limited to valley floors. The groundwater table is not expected to be encountered within the trench depth along mountainous terrain. Excavation depths within the gently sloping valley floors crossed by the pipeline would be limited to the pipeline trench. The pipeline trench backfill is not considered to be of sufficient volume to liquefy during an earthquake. Additionally, trench breakers would be installed in the pipeline trench at regular intervals to prevent the trench from capturing and conveying near surface groundwater.

Liquefaction potential was identified for portions of the proposed route that would be expected to encounter loose to medium dense sandy soils (generally occurring in alluvial valleys or near rivers, streams, sloughs, lakes or other waterbodies). The characteristics were incorporated by Pacific Connector into a numerical liquefaction analysis used to characterize the potential risk of liquefaction. Based on an initial numerical analyses, sites that were underlain by strata with a safety factor against liquefaction of less than 1 are shown as having a "High" risk for potential liquefaction. These areas are listed in table 4.1.2.3-2 as having potential for liquefaction and/or lateral spreading. Those listed as low potential include sites with subsurface conditions of fine-grained soils that are not susceptible to liquefaction or soils that are not expected to be saturated. Those listed as high potential include sites that are underlain by potentially saturated loose to medium dense granular soils. The unknown potential site is an area of private property where no site-specific subsurface information is available due to lack of access.

TABLE 4.1.2.3-2

Summary of Potential Liquefaction and Lateral Spreading Hazards

From MP	To MP	Feature	Liquefaction Potential/ Lateral Spreading Potential	Ownership
1.4R	3.0R	Coos Bay	High/Low	Private, State
3.00R	6.50R	Kentuck Inlet	High/High	Private, State
8.26R	8.47R	Willanch Slough	High/High	Private, State
11.0R	11.3R	Coos River	High a/	Private, State
10.10	10.40	Stock Slough	Low/Low	Private
10.80	11.40	Catching Slough	Low/Low	Private, State
15.72	15.77	Boone Creek	Low/Low	Private
22.60	23.10	North Fork Coquille River	Low/Low	Private
27.00	27.15	Park Creek (aka Middle Creek)	Low/Low	BLM, Private
29.41	30.20	East Fork Coquille River	Low/Low	Private
48.02	48.40	Deep Creek	Low/Low	County, Private, BLM
49.70	50.45	Middle Fork Coquille River	Low/Low	Private
55.80	56.60	Alluvial Valley	Low/Low	Private
56.90	59.00	Olalla Creek	Low/Low	Private
66.85	67.05	Willis Creek	High/High	Private
68.95	69.80	South Umpqua River #1	High a/	ODOT
88.20	88.65	Days Creek	Low/Low	Private
94.55	94.80	South Umpqua River #2	High a/	Private
122.55	122.75	Rogue River	High a/	Private, State
128.50	128.70	Indian Creek	Unknown b/	Private
131.80	132.00	Neil Creek	Low/Low	Private
191.60	199.00	Klamath Valley	High/Low	Private
199.00	201.00	Klamath River	High a/	Private, State, Reclamation
201.00	214.00	Lost River Valley	Low/Low	Private, State, Reclamation
217.10	218.33	Alluvial valley	Low/Low	Private
221.80	224.40	Alluvial valley	Moderate/Low	Private

a/ A potential for occurrence may exist, but hazard would be mitigated.
b/ Landowner permission to evaluate site was not granted.

Mitigation for liquefaction conditions can include avoidance by routing around or under the potentially liquefiable materials, by reinforcing the pipe with thicker walls, and/or by weighting the pipe with a concrete coating. Potential ground improvement measures would also be considered including vibroflotation [51], stone columns, compaction grouting, and deep dynamic compaction. Primary geotechnical factors involved in selecting the type of mitigation include: the depth of liquefiable soils, fines content, groundwater depth, the potential for obstructions (i.e., buried logs), and the density of overburden soils over the liquefiable soils.

Pacific Connector proposes to cross four river crossings (Coos River, Rogue River, Klamath River, and South Umpqua River) using trenchless crossing methods including HDD and DP technologies in order to minimize the environmental impacts of construction and to install the pipeline below

[51] Vibroflotation is a technique for improving the strength and bearing capacity of unsaturated, granular soils.

zones of potentially liquefiable soil. Regardless of the performance standard that is established Kentuck Slough and Coos River sites would be constructed with special backfill placed around the pipeline in areas where the pipeline transitions from rock to soil to alleviate potential stress resulting from differential movement in accordance with the pipeline operator's design basis specifications. For the pipeline segments that transition from the alluvial soils to rock, the special backfill would extend approximately 40 feet into the rock from the soil/rock interface. The special backfill material would consist of clean, imported, processed sand of alluvial origin (crushed materials would not be used). The special backfill material would completely surround the pipe, with a minimum of 1 foot of sand backfill covering the crown of the pipe. This backfill would help to alleviate stresses induced by differential settlement between the rock and the alluvial soils. The pad of special sand backfill beneath the pipe and the sand backfill adjacent to and above the pipe would be placed in lifts not greater than 12 inches in loose thickness and lightly tamped with hand-operated vibratory equipment; and the native backfill above the imported sand would be lightly compacted with mechanical equipment.

4.1.2.4 Landslide Hazards and Slope Stability

Many types of landslides occur that can affect property and public safety. However, most landslides can be placed in two general categories: (1) shallow-rapid landslides (debris slides/flows) and (2) deep-seated landslides. Shallow-rapid, or rapidly moving, landslides generally originate on very steep slopes, often where no prior indications of movement are present. In the Coast Range, especially in the Tyee formation, recurring debris flows produce debris chutes. These are evident by narrow concave gullies containing activity indicators such as bare rock, soil generation, and vegetation stratification. Fans and coalescing fans (from multiple chute discharges) form plains. Mass-movement of rapid-shallow landslides is typically triggered by large, infrequent storm events.

Deep-seated landslide movement can occur where no previous movement is evident, but commonly occurs where topographic and vegetative indications of past or chronic slope movements are present. Deep-seated landslides range in depth from tens to hundreds of feet and can occur anywhere on a hill slope. The larger deep-seated landslide complexes may occupy several square miles of terrain. These features can usually be identified on topographic maps or aerial photos based on distinctive contour or vegetative patterns. Slope movement can vary from rapid to nearly imperceptible and may entail small to large displacements. The greatest risk of deep-seated landslide movement arises from existing (dormant) features that can reactivate in response to land management practices, seismic activity, stream erosion and/or prolonged periods of precipitation. Movement can be complex, ranging from slow to rapid, and may include small to large slope displacements. The greatest risk of deep-seated landslide movement is from existing (dormant) deep-seated landslides reactivating in response to human activity, seismic activity, stream erosion, or heavy precipitation. Assuming unchanged conditions, it is much less common for a deep-seated landslide to occur on a previously undisturbed and intact slope than reactivation of an existing landslide feature.

Risk is greatest where the direction of slide movement is across (perpendicular to) the pipeline alignment. This typically occurs where the pipeline crosses a slope instead of descending straight down the fall line. Although the greatest risk is where a pipeline crosses a landslide, headward (upslope) expansion of the slide could eventually involve a pipeline located upslope of an active landslide. Strain within a pipeline can develop slowly from a deep-seated landslide as a result of long-term slow movement, or it can develop quickly as a result of a single movement event. Shallow-rapid landslides are unlikely to induce long-term strain to a pipeline, but rather more likely to expose the pipe and result in a loss of support where it crosses a debris slide source area. Once mobilized into a debris flow, shallow-rapid landslides often have tremendous erosional potential. Debris flows that originate upslope of the pipeline also have the potential to scour, expose, and damage the pipeline by debris impact; however, as discussed in the following sections, moderate and high-risk landslide areas have been avoided during routing of the pipeline.

Construction along side slopes can also result in instability during construction, restoration, and operation, and could be a source of debris flows. Construction factors that may increase the potential for slope failure and debris flow could include trenching along slopes and the burden of construction equipment on unstable surfaces. Cut slopes and fill slopes along the pipeline right-of-way could be a source of debris flow in the Project area triggered by intense and/or prolonged rainfall events. A typical debris flow pathway consists of an upper initiation site or source area, a main path down a slope and then into and down a stream channel, and then a lower depositional area or run out zone on an alluvial fan at the base of the mountain. Fill slopes, especially inadequately constructed and maintained fill slopes, are a potential source of debris flows. Fill slope failures could become debris flows that damage not only the pipeline corridor but also the slopes, stream channels, or other resources hundreds or thousands of feet downslope from the corridor. Cut slope or fill slope failures pose a risk to pipeline construction workers, the public, and natural resources. As a result, the cut-and-fill slopes would be designed for slope stability by taking into account slope percent and other engineering geology and geotechnical engineering factors such as the orientation of the bedrock surface as well as geologic structure. The ODF has developed guidelines for the identification of high risk areas for rapidly moving landslides (including debris flows) that have a substantial risk to public safety (ODF 2000). Additional discussion of public safety concerns related to potential landslide hazards is provided in section 4.13 (i.e., the Reliability and Safety section).

An initial landslide hazards evaluation was conducted in three phases: initial office review, aerial reconnaissance, and surface reconnaissance. The purpose of the first phase study was to identify existing landslides as well as areas susceptible to landslides within one-quarter mile of the initial alignment by reviewing published maps and digital data (Burns et al. 2011a, 2011b), aerial photographs and LiDAR-generated hillshade models. The purpose of following two phases was to further evaluate only those landslide hazard sites that represent potentially moderate or high risk to the pipeline, based on the results of the previous phase of evaluation. These initial evaluation phases are described in greater detail below. No landslide hazards were identified at the aboveground facility locations.

Rapidly Moving Landslide Risk Assessment

An assessment of rapidly moving landslides (RMLs) was conducted based on available detailing mapping, risk assessment methods, and on follow-up site reconnaissance in areas of concern. DOGAMI, in cooperation with other agencies, produced a map of Potential Rapidly Moving Landslide Hazards in Western Oregon (Hofmeister et al. 2002). This map was limited to western Oregon because the vast majority of historical RML occurrence has been within that portion of the state. Pacific Connector has provided geologic hazards maps in Appendix F of the *Geologic Hazards and Minerals Resources Report* (GeoEngineers 2017a) that show the slopes in and around the pipeline alignment in western Oregon that have been mapped as potential RML hazards.

Creation of the map involved the use of GIS modeling, checking and calibration with limited field evaluations, and making comparisons with historical landslide inventories. The intent was to identify areas that have some potential to be affected by RMLs so that they would be considered and evaluated appropriately.

The Blue Ridge Reroute was identified and evaluated after the RML mapping by DOGAMI had been discontinued and is no longer being used to evaluate RML hazard risk. Other methods were used to evaluate RML hazards (such as LiDAR hillshade and aerial photograph interpretation). No RML hazards were identified along the Blue Ridge Reroute that pose a threat to the proposed pipeline alignment.

The portion of the pipeline alignment that crosses the Coast Range physiographic province has the greatest risk of being affected by rapidly moving landslides because of rugged terrain composed of relatively weak sedimentary bedrock and relatively high precipitation rates. In particular, studies indicate that the Tyee Core Area within this province has a higher susceptibility to rapidly moving landslides than other areas of the pipeline (Robinson et al. 1999).

The potential for rapidly moving landslides to occur east of MP 166 (east of the Cascade Range) generally is considered to be relatively low based on geological conditions, relatively little rainfall, and statistically fewer past historical rapidly moving landslide occurrences (Hofmeister et al. 2002). Climate change models predict a drier climate east of the Cascade Range, including less snowpack (and snowmelt), more rain instead of snow in low elevation basins, lower summer and early fall streamflows, and decreased soil moisture (University of Oregon 2008). These conditions are not likely to increase the potential for rapidly moving landslides in this region. Slopes east of MP 166 were reviewed to identify high-risk sites based on general guidelines of the ODF (ODF 2000). Based on available topographic mapping, no slopes along the pipeline alignment east of MP 166 exceed 65 percent or appear to be at high risk of rapidly moving landslide occurrence.

Pacific Connector conducted an initial risk assessment to evaluate the potential risk (high, moderate, and low) where the pipeline alignment crosses the mapped hazard areas using some of the input parameters used for the DOGAMI model (Hofmeister et al. 2002). Using LiDAR where available, 10-meter digital elevation model, and aerial photography, Pacific Connector identified moderate and high risk RML sites along the proposed route. Pacific Connector then conducted a surface reconnaissance of these sites to further evaluate potential risk. In general, the risk of landslide occurrence and mobilization increases with slope gradient and with the degree of convergence (concavity).

A total of 304 pipeline segments were initially identified within rapidly moving landslide hazard areas. Based on the risk assessment, approximately 128 of these sites were considered to be a potentially moderate or high risk and were selected for further study. Site-specific reconnaissance was conducted in certain areas with the potential for shallow-rapid landslide hazards, as documented on Tables B-3a and B-3b of Appendix B in GeoEngineers (2017a).

Deep-seated Landslide Risk Assessment

Larger, deep-seated landslides can usually be identified from topographic maps (including LiDAR) and aerial photographs. Areas susceptible to deep-seated landslide movement were identified from existing geological maps and from topographic or photographic indications of historical or ancient landslide movement.

Table B-2 from GeoEngineers (2017a) lists the identified deep-seated landslides, the data source, and the initial risk to the pipeline. High hazard landslides were identified where the alignment crosses landslide mass or is located on the slope such that the slide could move or expand to involve the pipeline. Surficial, geomorphic, and vegetative features suggest that the landslide is active or dormant historic (past movement less than 100 years ago) (Keaton and DeGraff 1996). Moderate hazard landslides were identified where the alignment crosses landslide mass or is located on the slope such that the slide could move or expand to involve the pipeline, and where surficial, geomorphic and vegetative features suggest that the landslide is dormant-young (last movement 100 to 5,000 years ago) (Keaton and DeGraff 1996). Fifteen of the landslides were judged to pose a moderate to high potential risk to the pipeline. In these instances, Pacific Connector either rerouted the pipeline route to avoid the hazard or assessed the feature further through aerial reconnaissance and risk assessment. The subsequent aerial reconnaissance of the deep-seated landslides identified as moderate to high risk included assessments of geomorphic and vegetative conditions. These data were incorporated into a model of potential risk related to each deep-seated landslide. Pacific Connector then identified potential alternative routes around moderate- to high-risk landslides that appeared to be active or to have the potential to reactivate. Six landslides were identified as posing a moderate to high potential risk and were evaluated further in the field. Five of these six landslides are located in Coos County within the Coast Range physiographic province (at MPs 14.7-14.8, 23.8-24.2, 24.4-24.6, 65.2-65.5, 65.3-65.5, and 72.7-72.9).

Seismically Induced Landslides and Rockfalls

Strong ground shaking associated with an earthquake may induce landslide failures at great distances from the earthquake source (Keefer 1984). The potential exists, at least locally along portions of the proposed route, for ground shaking to induce rockfalls, landslides, or soil slumps (USGS 2010, 2002). Potential areas of seismically induced landslides include the mapped existing landslides summarized in Table B-2 of GeoEngineers (2017a) Geologic Hazards and Mineral Resources Report from Pacific Connector's application to the FERC.

Areas of potential ground shaking of sufficient intensity to initiate landslides or rockfalls include the areas of greatest seismic activity: the Klamath Falls region (with relatively recent events of magnitudes 5.9 and 6.0) and the Coos Bay region (with the potential for very large, long recurrence interval, Cascadia megathrust events).

Landslide Hazards Avoidance and Minimization of Adverse Effects

For the purposes of landslide hazard evaluation in this report, a distinction is made between the hazard associated with a landslide and the risk associated with that hazard. In the following discussions, statements of risk apply to the potential for damage or failure of the pipeline from earth movements. It is recognized that the consequences of a pipeline failure may be catastrophic and involve fire and/or explosion. However, those consequences are location-specific and are not considered in the following evaluations of risk to the pipeline. Pacific Connector has worked to avoid landslides along the proposed route. Ridgetops are generally considered to be stable and, therefore, an attempt has been made to route the vast majority of the pipeline along ridgetops.

Risks associated with landslides include both the risk that installation of the pipeline may adversely affect slope stability, and that post-construction land movements could damage the pipeline. Pacific Connector selected its proposed route to avoid existing landslides and areas susceptible to landslides (i.e., unstable slopes where construction-induced landslides could occur). In addition, the potential for construction-induced landslides would be avoided through appropriate construction techniques and BMPs included in the ECRP. Appendix B, Table B-2 from GeoEngineers (2017a) identifies where Pacific Connector's initial proposed route was changed to avoid identified landslides and landslide hazard areas.

Table B-2 from the GeoEngineers (2017a) indicates where reroutes were completed to avoid identified landslides. Tables B-3a and B-3b from the same report indicate where reroutes were incorporated into the proposed route to avoid moderate- and high-hazard RML hazard areas. All of the moderate- and high-hazard deep-seated landslides identified along the alignment were avoided where feasible during final route selection.

All known hazardous landslides thought to pose a risk to the pipeline have been avoided through routing. At this time, no sites have been identified (through the use of LiDAR interpretation, helicopter-based reconnaissance, and ground-based reconnaissance) as requiring additional monitoring beyond the standard monitoring protocols for the entire pipeline. Pacific Connector would develop monitoring protocols and/or mitigation measures prior to construction if warranted based on findings from the ground-based reconnaissance. There are two primary ways in which pipeline construction has the potential to adversely impact slope stability: (1) deep excavation into and across the slope where the pipeline is oriented in the "side-slope" direction; and (2) capturing, concentrating and conveying surface or near surface water along the pipeline right-of-way surface or within the pipeline trench and routing it to potentially unstable slopes. The current proposed pipeline alignment generally avoids traversing steep slopes perpendicular to slope direction (side-hill) to the extent practicable.

GeoEngineers identified segments along the proposed pipeline centerline that are oriented at an angle of 45 degrees or less from contour and where slope gradients are greater than 30 percent. The slope gradients were analyzed using GIS software and a combination of LiDAR-based digital elevation model (DEM) and publicly available 10-meter DEM. Following Pacific Connector's proposed BMPs described in the ECRP would limit potential adverse impacts on slope stability for those side slopes segments that are less than 30 percent gradient. In general, these BMPs include using well-drained structural fill placed in lifts and compacted for the side slope sites with gradients of 30 percent or greater oriented perpendicular to the pipeline. At sites where import of large volumes of structural fill is not practical, alternative methods would be implemented to construct the fill slopes with native soils. For example, perforated drain pipes can be installed within the inside edge of the construction right-of-way prior to placement of the fill to improve drainage of the native soils. Perforated drains would be surrounded by 12 inches of drain rock, all of which would be wrapped in a geotextile filter fabric. After drains are installed, the fills would be placed in horizontal lifts and compacted.

Pacific Connector would further identify steep side slope pipeline construction segments during the final design phase. Fill slope construction details and specifications would be designed for all identified pipeline segments that traverse steep side slopes (30 percent or greater).

Pipeline Construction BMPs for Landslides and Slope Stability

Pacific Connector has prepared and would implement the ECRP included in its POD to avoid and minimize impacts from pipeline construction, including reducing the potential for construction to adversely affect slope stability. Because the pipeline would cross extensive areas of rugged terrain, there is potential for previously unidentified landslides or new landslides to affect the pipeline after it is installed. Monitoring higher-risk areas along the pipeline can aid in detecting landslide occurrence and movement so that action can be taken to prevent damage to the pipeline. Monitoring can range from visual surface observations from the air or ground to the use of strain gauges and subsurface instrumentation, such as inclinometers, to detect and measure slope movements (typically, these instrumentation methods are used only on pipeline segments affected by active slope movement). Monitoring is further described in the section below.

Pacific Connector's ECRP includes several BMPs that are intended to reduce the potential for pipeline construction to change or alter natural stormwater runoff and/or near surface groundwater. The following summarizes these BMPs:

1. Trench breakers would be installed in the pipeline trench on slopes prior to backfilling to prevent water from flowing along the pipeline and eroding trench backfill materials (see ECRP, Section 4.2.1). Spacing of trench breakers would be based on slope gradient. Slopes greater than 30 percent in mountainous terrain would receive trench breakers spaced at least every 100 feet. Pacific Connector would utilize sandbags (foam trench breakers may be used if approved by the State of Oregon) for trench breaker construction (see Section 4.2.1 of the ECRP for additional trench breaker details).
2. Pacific Connector would install temporary slope breakers to reduce runoff velocity, concentrated flow and to divert water off the construction right-of-way to avoid excessive erosion. Temporary slope breakers may be constructed of materials such as soil, silt fence, staked straw bales, straw wattles, or sand bags. The outfall of each temporary slope breaker would be to a stable, well-vegetated area or to an energy dissipating device at the end of the slope breaker and off the construction right-of-way. Pacific Connector would install temporary slope breakers on all slopes greater than 5 percent according to the spacing in Table 4.1-1 of the ECRP, unless the EI determines that a closer spacing is required.
3. Permanent slope breakers (waterbars) would be installed across the right-of-way on slopes. The purpose of these structures is to minimize erosion by reducing runoff velocities, by shortening slope lengths, preventing concentrated water flow, and by diverting water off the construction right-of-way. Slope breakers would be constructed with a 2 to 8 percent outslope so that water does not pool or erode behind the breaker. Outflow would be diverted to a stable area off the right-of-way consistent with FERC's Plan. Slope breakers would be installed along the right-of-way based on slope gradient and soil characteristics (see Table 4.2-2 of the ECRP.) All slopes greater than 30 percent gradient would receive slope breakers spaced at least every 50 feet.
4. Project-wide, slash from timber clearing would be stockpiled at the edge of the right-of-way and scattered/redistributed across the right-of-way during final cleanup and reclamation according to the BLM and Forest Service fuel loading specifications to minimize fire hazard risks. However, much of the slash generated during timber-clearing operations would remain on the ground and in place to provide cover to minimize erosion over the winter following construction. Pacific Connector has designated UCSAs that would not be cleared of trees along the route. Generally, slash would not be stored in UCSA in riparian reserves on federal lands. Minimizing overall disturbance would reduce the potential for erosion, especially on steep slopes.

Pipeline Monitoring

Pacific Connector intends to implement a like level of landslide and pipeline easement monitoring currently performed on existing Williams-owned pipeline facilities in southwestern Oregon. Monitoring would consist of weekly air patrol, annual helicopter survey, and quarterly class location. Class location consists of land patrol (including leak detection), semi-annual class 1 and class 2 location land patrol, and annual cathodic protection survey. All the identified ancient landslides crossed by the proposed pipeline fall within class 1 or 2 areas. Observed areas of active third-party activities such as logging or development and areas affected by unusual events such as landslides, severe storms, flooding, earthquake or tsunami may require additional inspection and monitoring determined on an individual basis.

The purpose of the monitoring would be to detect potential movement or pipe strain before it compromised the structural integrity of the pipeline. If movement were detected, immediate action would be taken to reduce the risk to the pipeline. Every landslide is unique, and there are no standard methods for reducing or eliminating landslide-related risks to buried pipelines. However, in concept, initial response actions generally include measures to reduce the stresses in the pipeline caused by slide movements. Secondary response actions are directed at improving the stability of the slide so that movements in the vicinity of pipeline are halted or the impacts on the pipeline are minimized. Tertiary response actions involve rerouting the pipeline to avoid landslide hazards by relocating the pipeline to a safer location.

Although the pipeline route does not cross active or recently active landslides, if any landslides do occur or become reactivated after the pipeline is installed, Pacific Connector would monitor the slide movement so that mitigation can be identified and implemented prior to damage occurring to the pipeline. The frequency of landslide monitoring would be based on the activity level (rate of movement) of each landslide and also includes consideration of precipitation. High-risk landslides (active or dormant-young) that pose a hazard to a pipeline would be instrumented so that movement can be measured. Instrumentation typically includes installation of slope inclinometer casing to measure landslide movement, and installation of strain gages on the pipeline to measure strain induced by slope movement.

Response Actions

Exposure of the pipe by excavation is the initial response action typically taken to reduce stresses in the pipe. By exposing the pipe on both sides, the pipe is allowed to rebound to a position where it carries little residual stress.

Improvements in surface drainage also are important initial response measures. Typical drainage improvement measures include: (1) placement of impermeable liners over the ground surface to limit infiltration of precipitation and erosion; (2) ditching to divert surface water around landslide areas; and 3) routing surface flows across slide areas within tightline drain pipes. If surface drainage improvements would impact jurisdictional resources under Section 404 of the CWA these impacts would need to be permitted as appropriate. See section 4.3 of this EIS.

Once the landslide area is initially stabilized, a decision of permanent action must be made. Permanent mitigation can include repairs and stabilization of the landslide area. Permanent repairs can include drainage improvements, loading and/or stabilization of the toe of the slope, decreasing the load at the head of the slope, or retaining structures at the base or within the slope. If the landslide is large and complex and stabilization is not a reasonable option, rerouting the pipeline around the slide may be the preferred mitigation.

Specialized trench backfill is utilized where pipelines cross landslides or fault zones where differential movement or shearing across the pipeline is expected. For steep slopes, trench breakers and water bars are utilized to minimize the potential for erosion or mass wasting of trench backfill. Section 11.0 of the ECRP provides special backfill and compaction criteria for restoring site grades on slopes greater than 3H:1V. Specifications include use of structural fill, benching slopes to receive fill, and compaction of fill in lifts.

Because the geological and other natural hazards are important considerations for the design, construction, and operation of the facility, information on the final mitigation measures and monitoring protocols of the pipeline in areas which were not accessible during previous studies are required to evaluate slope stability conditions. Six moderate risk, deep-seated landslides were identified for additional surface inspection; the landslides are identified in Pacific Connector's Resource Report 6[52] (as #AM, #126, #127, #AV, #AW, and #AU) and are located at MPs 14.3-14.4, 23.8-24.2, 24.4-24.6, 65.2-65.5, 65.3-65.5, and 72.7-72.9. These areas represent approximately 1.2 miles of the pipeline route. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, Pacific Connector should file with the Secretary, for review and written approval by the Director of OEP, the final monitoring protocols and/or mitigation measures for all landslide areas that were not accessible during previous studies.**

4.1.2.5 Rock Sources and Permanent Disposal Sites

Pacific Connector has identified 20 potential rock source and permanent disposal sites that total approximately 86 acres along the proposed route. Of these 20 rock source/disposal sites, all of the sites (5 of which are temporary extra work areas [TEWAs]) are existing quarries/gravel pits. These sites are listed in table 4.1.2.5-1. The table lists the rock source and disposal sites, their sizes, approximate mileposts in relation to the pipeline, jurisdiction, and existing land use. Only the disposal sites (and not the TEWAs) listed in table 4.1.2.5-1 are being proposed for use as permanent disposal sites.

Rock source sites may contain useable mineral deposits that may be extracted and/or purchased for use during construction. Disposal sites were identified for final placement of unusable, non-merchantable materials. These sites are typically exhausted areas within active quarries or abandoned quarries and may include commercial sites. Other permanent storage sites, including some TEWAs, were identified for permanent storage of excavated material. The material disposed of in these areas would be properly graded, drained (if necessary), and revegetated. The sites identified are not proposed for expansion beyond their proposed permitted or authorized boundaries. Use of any site would be permitted as required by the appropriate jurisdiction or landowner, and Pacific Connector would comply with applicable permits/stipulations. The disposal of mineral material to Pacific Connector from rock sources proposed to be utilized on BLM lands would follow regulations in 43 CFR 3600.

[52] See Appendix B, Table B-2 in Resource Report 6 submitted as part of Pacific Connector's application to the FERC.

TABLE 4.1.2.5-1

Rock Source and/or Permanent Disposal Sites

Site	Size (acres)	Milepost	Land Use	Jurisdiction
Coos County				
TEWA 38.90-W/ Sandy Creek Quarry	4.50	38.90	Strip mines, quarries, and gravel pits, clearcut forest land, regenerating evergreen forest land, transportation, communication, utilities corridors	Private
Douglas County				
Signal Tree Road Quarry – Sec. 3	1.22	45.86	Quarries	BLM Roseburg District
Signal Tree Road Quarry – Sec. 35	1.09	47	Quarries	BLM-Coos Bay District
Weaver Road Quarry Site 1	1.62	47	Quarries	BLM-Coos Bay District
Weaver Road Quarry Site 2	1.30	47	Quarries	BLM-Coos Bay District
Private Quarry Benedict Road	1.49	56.75	Quarries	Private
Roth – Existing Quarry #1	0.77	72.61	Quarries	Private
Roth – Existing Quarry #2	0.34	72.76	Quarries	Private
TEWA 79.85-N (BLM Quarry Site)	3.61	79.85	Quarries, transportation, communication, utilities corridors, regenerating evergreen forest land	BLM-Roseburg District
Hatchet Quarry MP 102.30	2.00	102.30	Strip mines, quarries, gravel pit, transportation, communication, utilities corridors	FS-Umpqua
Rock Disposal MP 104.12	3.36	104.12	Mines, quarries, and gravel pits, transportation, communication, utilities corridors, regenerating forest land	FS-Umpqua
Jackson County				
TEWA 110.73 (Peavine Quarry)	15.87	110.54	Mines, quarries, gravel pit and evergreen forest	FS-Umpqua
TEWA 150.31-W (Heppsie Mountain Quarry)	5.56	150.31	Mines, quarries, and gravel pits, mixed rangeland, evergreen forest land, mixed forest land, transportation, communication, utilities corridors, regenerating evergreen forest land, clearcut forest land,	Private and BLM-Medford District
Rum Rye MP 160.41	4.91	160.41	Strip mines, quarries, and gravel pits	FS-Rogue River-Siskiyou
TEWA 160.54-W (Big Elk Cinder Pit) (Ichabod Rock Quarry)	15.26	160.54	Mines, quarries and gravel pits, transportation, communication, utilities corridors, evergreen forest land	FS-Rogue River-Siskiyou
Klamath County				
Rock Source and Disposal MP 180.56	7.76	180.56	Mines, quarries, gravel pit, transportation communication and utilities corridors, and regenerating forest land	Private
Rock Source and Disposal MP 180.71	2.95	180.71	Mines, quarries, gravel pits, Clearcut forest land	Private
Rock Source and Disposal MP 182.40	5.66	182.40	Quarries, gravel pits	Private
Rock Source and Disposal MP 201.61	4.96	201.61	Transitional areas, cropland and pasture, transportation communication and utilities corridors	Private
TEWA (5) Total			**44.80**	
TEWAs associated with existing quarries (5)			**44.80**	
Existing quarries and rock source and disposal sites—Total			**41.18**	
TOTAL			**85.98**	

Source: Pacific Connector's Resource Report 1, Table 1.2-3, filed with the FERC September 2017.

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If Pacific Connector acquired rock from these sources or permanently disposed of excavated material, all available topsoil would be salvaged. The salvaged topsoil would be used to restore the site as required by landowner stipulations. Rock resource areas managed and developed by Pacific Connector would need quarry Operation and Reclamation Plans, to the extent required by DOGAMI's regulatory authority (OAR 632-030-0005 through 0070 and ORS 517.750 through 990). Appropriate BMPs would be implemented, such as those in Norman et al. (1998). No impacts are anticipated from the rock sources and permanent disposal sites.

4.1.2.6 Blasting During Trench Excavation

Blasting could be required for pipeline trench excavation in areas where hard, non-rippable bedrock occurs. The bedrock units where blasting could be necessary would consist primarily of volcanic and metavolcanic rocks in the Klamath Mountains and volcanic rocks in the Cascade Range as well as along the ridges in the Basin and Range physiographic province. In addition, local areas of well-lithified sedimentary rock may need to be blasted in the Coast Range.

Pacific Connector identified areas where blasting may be necessary by reviewing the NRCS soils maps and descriptions to identify soil units that typically contain bedrock within 5 feet of the ground surface. Soils data, geological maps, and topographic relief were used to rank the qualitative likelihood for blasting along the pipeline as follows:

- No Potential – Areas containing deep soils and alluvial, fluvial, lacustrine, and estuarine sediments that could be readily excavated. General occurrence: the coastal and Klamath basin lowlands and the major valleys and floodplains in all of the physiographic provinces.
- Low Potential – Areas containing soft sedimentary rock and tuff that can typically be excavated without ripping. General occurrence: Coast Range, and local areas of the Klamath Mountains, Cascade Range, and the Basin and Range physiographic provinces.
- Moderate Potential – Areas containing fractured, faulted, or weathered metamorphic or volcanic rocks that generally can be excavated with ripping, but that could require local blasting. General occurrence: local areas in the Klamath Mountains, Cascade Range, and the Basin and Range physiographic provinces.
- High Potential – Areas containing hard or fresh plutonic (for example, granitic) and volcanic rocks that could not be excavated without blasting. General occurrence: local areas of the Klamath Mountains physiographic province, portions of the Cascade Range physiographic province, and local areas in the Basin and Range physiographic province.

Table 4.1.2.6-1 provides a summary of the blasting potential along the pipeline. Blasting is less likely to be required to construct the first 78 miles of the pipeline because the materials are expected to consist of soil, sediments, and rippable sedimentary rocks. Although the blasting potential is classified as high for about 100 miles of the proposed route, this distance estimate includes local areas as much as 0.9 mile in length that contain valley fill, thick soils, and soft volcanic rocks (such as tuffs) that would not need to be blasted. In addition, some of the proposed route classified as having a high or moderate potential for blasting may contain weathered rock that could instead be ripped by conventional excavation equipment.

TABLE 4.1.2.6-1

Summary of Blasting Potential Along the Proposed Pacific Connector Pipeline

From MP	To MP	Blasting Potential	Material	Ownership (Federal Lands)
0.00	19.7BR	None to Low	Soil, sediments, sedimentary rocks and valley fill	BLM – Coos Bay
19.7BR	19.9BR	Moderate	Volcanic	BLM – Coos Bay
19.9BR	21.5BR	None	Sediments	BLM – Coos Bay
21.5BR	21.6BR	Moderate	Volcanic rocks	BLM – Coos Bay
21.6BR	21.9BR	None	Sediments	BLM – Coos Bay
21.9BR	22BR	None to Moderate	Sediments, volcanic rocks	BLM – Coos Bay
22BR	22.1BR	Moderate	Volcanic rocks	BLM – Coos Bay
22.1BR	22.3BR	None	Sediments	BLM – Coos Bay
22.3BR	23.6BR	Moderate	Volcanic rocks	BLM – Coos Bay
23.6BR	45.9	None to Low	Marine sedimentary rocks, sediments	BLM – Coos Bay
45.9	48.2	Moderate	Marine sedimentary rocks (hard)	BLM-Roseburg
48.2	59.2	None to Low	Marine sedimentary rocks, sediments, mélange rocks with valley floor sediments	BLM-Roseburg
59.2	59.3	Moderate	Mélange rocks	BLM-Roseburg
59.3	59.4	None	Sediments	BLM-Roseburg
59.4	59.5	Moderate	Mélange rocks	BLM-Roseburg
59.5	59.9	None	Sediments	BLM-Roseburg
59.9	63.9	Moderate	Mélange rocks	BLM-Roseburg
63.9	64	None	Sediments	BLM-Roseburg
64	65.6	Moderate	Mélange rocks	BLM-Roseburg
65.6	67	None	Sediments, mélange rocks	BLM-Roseburg
67	69.3	Moderate	Mélange rocks	BLM-Roseburg
69.3	70.4	None	Mélange rocks with valley floor sediments	BLM-Roseburg
70.4	71.1	moderate	Metamorphic rocks, sediments	BLM-Roseburg
71.1	71.3	High	Metamorphic rocks, sediments	BLM-Roseburg
71.3	75.1	moderate	Metamorphic rocks	BLM-Roseburg
75.1	78.5	None to Low	Marine sedimentary rocks, sediments	BLM-Roseburg
78.5	79	High	Volcanic rocks, intrusive rocks	BLM-Roseburg
79	79.2	none	Sediments	BLM-Roseburg
79.2	81.1	High	Intrusive rocks, volcanic rocks	BLM-Roseburg
81.1	81.6	None	Sediments	BLM-Roseburg
81.6	87.7	High	Volcanic rocks, intrusive rocks	BLM-Roseburg
87.7	88.3	Low	Marine sedimentary rocks	BLM-Roseburg
88.3	88.8	High	Volcanic rocks, intrusive rocks	BLM-Roseburg
88.8	89	Low	Marine sedimentary rocks	BLM-Roseburg
89	89.5	High	Volcanic rocks	BLM-Roseburg
89.5	89.9	Moderate	Marine sedimentary rocks	BLM-Roseburg
89.9	91.3	Low	Marine sedimentary rocks	BLM-Roseburg
91.3	94.5	Moderate	Marine sedimentary rocks, volcaniclastic rocks	BLM-Roseburg
94.5	95.3	None	Sediments	BLM-Roseburg
95.3	95.5	High	Intrusive rocks	BLM-Roseburg
95.5	97	Low	Marine sedimentary rocks	BLM-Roseburg
97	108.9	High	Intrusive rocks, metamorphic rocks, mélange rocks	BLM-Roseburg / Umpqua NF
108.9	109.4	None	Sediments	Umpqua NF
109.4	111	High	Volcaniclastic rocks, volcanic rocks	Umpqua NF
111	113.3	Low	Volcaniclastic rocks	Umpqua NF
113.3	113.6	High	Volcaniclastic rocks, volcanic rocks	-
113.6	113.7	Low	Volcaniclastic rocks	-
113.7	116.9	High	Volcaniclastic rocks, volcanic rocks, intrusive rocks	BLM-Medford

TABLE 4.1.2.6-1 (continued)

Summary of Blasting Potential Along the Proposed Pacific Connector Pipeline

From MP	To MP	Blasting Potential	Material	Ownership (Federal Lands)
116.9	118.2	Low	Volcaniclastic rocks	BLM-Medford
118.2	119.5	High	Volcanic rocks	BLM-Medford
119.5	119.6	Low	Volcaniclastic rocks	BLM-Medford
119.6	119.8	High	Volcanic rocks	BLM-Medford
119.8	120.2	Low	Volcaniclastic rocks	BLM-Medford
120.2	120.4	High	Volcanic rocks	BLM-Medford
120.4	121.7	Low	Volcaniclastic rocks	BLM-Medford
121.7	122.1	High	Volcanic rocks	BLM-Medford
122.1	122.4	Low	Volcaniclastic rocks	BLM-Medford
122.4	122.6	High	Volcanic rocks	BLM-Medford
122.6	123.1	none	Sediments	BLM-Medford
123.1	126	High	Volcanic rocks	BLM-Medford
126	126.7	Low	Volcaniclastic rocks	BLM-Medford
126.7	133.6	High	Volcanic rocks	BLM-Medford
133.6	134.1	Low	Volcaniclastic rocks	BLM-Medford
134.1	134.7	High	Volcanic rocks	BLM-Medford
134.7	140.2	None to Low	Volcaniclastic rocks, sediments	BLM-Medford
140.2	141.7	High	Volcanic rocks	BLM-Medford
141.7	141.9	Low	Volcaniclastic rocks	BLM-Medford
141.9	143.5	High	Volcanic rocks	-
143.5	143.9	None to Low	Volcaniclastic rocks, sediments	-
143.9	144.8	High	Volcanic rocks	-
144.8	145.2	Low	Volcaniclastic rocks	-
145.2	145.7	High	Volcanic rocks	-
145.7	145.7	None	Sediments	-
145.7	146.8	High	Volcanic rocks	-
146.8	147	Low	Volcaniclastic rocks	-
147	148.2	High	Volcanic rocks	-
148.2	148.3	Low	Volcaniclastic rocks	BLM-Medford
148.3	148.3	High	Volcanic rocks	BLM-Medford
148.3	148.4	Low	Volcaniclastic rocks	BLM-Medford
148.4	172	High	Volcanic rocks, vent and pyroclastic rocks	BLM-Medford / Rogue River-Siskiyou NF / Fremont-Winema NF
172	175.4	None	Volcanic rocks with overlying thick soil	Fremont-Winema NF
175.4	186.6	High	Volcanic rocks	BLM-Lakeview
186.6	186.7	None	Sediments	BLM-Lakeview
186.7	190.8	High	Volcanic rocks	BLM-Lakeview
190.8	212.6	None	Terrestrial sedimentary rocks, sediments	BLM-Lakeview
212.6	214.8	Moderate	Terrestrial sedimentary rocks	BLM-Lakeview
214.8	215	High	Volcanic rocks	BLM-Lakeview
215	215.2	None	Sediments	BLM-Lakeview
215.2	215.6	High	Volcanic rocks	BLM-Lakeview
215.6	216.4	None	Sediments	BLM-Lakeview
216.4	216.5	Moderate	Terrestrial sedimentary rocks	BLM-Lakeview
216.5	217.1	High	Volcanic rocks	BLM-Lakeview
217.1	217.5	Moderate	Terrestrial sedimentary rocks	-
217.5	217.9	None	Sediments	-
217.9	218.5	Moderate	Terrestrial sedimentary rocks	-
218.5	218.9	None	Sediments	-
218.9	218.9	Moderate	Terrestrial sedimentary rocks	-

TABLE 4.1.2.6-1 (continued)

Summary of Blasting Potential Along the Proposed Pacific Connector Pipeline

From MP	To MP	Blasting Potential	Material	Ownership (Federal Lands)
218.9	222.1	High	Volcaniclastic rocks, volcanic rocks	-
222.1	222.5	Moderate	Terrestrial sedimentary rocks	-
222.5	223.9	High	Volcaniclastic rocks, volcanic rocks	-
223.9	224.9	Moderate	Terrestrial sedimentary rocks	-
224.9	225.8	None	Sediments	-
225.8	227	Moderate	Terrestrial sedimentary rocks	-
227	227.7	None	Sediments	-
227.7	228.8	High	Volcanic rocks	-

Source: Table 2.1.2-9 of the Applicant Prepared Draft Biological Assessment, filed December 2017.

Pacific Connector would conduct all blasting in accordance with all federal, state, and local regulations and Pacific Connector Construction Specifications. Pacific Connector would include specifications in any blasting contract to control adverse impacts, including measures to minimize vibrations and flyrock, measures for safe blasting practices near active pipelines, and seasonal restrictions to protect wildlife, as needed. Pacific Connector would have blasting inspectors present to ensure that all specifications were met and to perform pre- and post-blast inspections of nearby structures and wells.

Drilling and blasting would be done with the Pacific Connector inspector present and with the inspector's approval to proceed prior to each blast. Blasting operations would be conducted by or under the direct and constant supervision of experienced personnel legally licensed and certified to perform such activity in the jurisdiction where blasting occurs. Pacific Connector would require their contractor to provide site-specific Blasting Plans at least 5 working days prior to any proposed blasting-related activity, and the contractor would be required to obtain Pacific Connector approval in writing prior to starting work. The Blasting Plan would include the following information:

- explosive type, product name and size, weight per unit, density, and equivalent energy release ratio (N) (the blasting agent Ammonium Nitrate and Fuel Oil [ANFO] would not be allowed);
- delay type, sequence, and delay (milliseconds);
- initiation method (detonating cord, blasting cap, or safety fuse);
- stemming material and tamping method;
- hole depth, diameter, and pattern;
- explosive depth, distribution, and maximum weight per delay;
- number of holes per delay;
- distance and orientation to nearest aboveground structure;
- distance and orientation to nearest underground structure, including pipeline;
- procedures for storing, handling, transporting, loading, and firing explosives, fire prevention, inspections after each blast, misfires, fly rock and noise prevention, stray current accidental-detonation prevention, signs and flagmen, warning signals prior to each blast, notification prior to blasting, and disposal of waste blasting material;
- seismograph company, personnel, equipment, and sensor location, if required;
- copies of all required federal, state, and local permits;
- blaster's name, company, copy of license, and statement of qualifications;

- magazine type and locations for explosives and detonating caps; and
- typical rock type and geology structure (solid, layered, or fractured).

Pre-blast inspections would be completed for structures and wells that are within the influence zone of the blasting. The pre-blast inspections would include but not be limited to an inventory of existing structural integrity and signs of structural distress such as cracks. Post-blasting inspections would include an inspection and comparison of the same elements observed for the pre-blast inspection. If blast related damage is identified by Pacific Connector inspectors and confirmed to be a result of the blasting activities, then damaged structures or wells would be returned to pre-construction conditions or better.

Blasting for grade or trench excavation would be utilized only after all other reasonable means of excavation have been used and are unsuccessful in achieving the required results. Pacific Connector may specify locations (foreign line crossings, near-by structures, etc.) where consolidated rock would be removed by approved mechanical equipment such as rock-trenching machines, rock saws, hydraulic rams, or jack hammers in lieu of blasting.

Every precaution would be taken to prevent damage to aboveground and underground structures during blasting operations; and every precaution would be taken to prevent injuries and damage to persons or inconvenience to the general public. Blasting mats or padding would be used on all shots where necessary to prevent scattering of loose rock onto adjacent property and to prevent damage to nearby structures and overhead utilities. Blasting would not begin until occupants of nearby buildings, residences, places of business, places of public gathering, and farmers have been notified sufficiently in advance to allow for protection of personnel, property, and livestock. Maximum ground motion velocities of 2 inches/second specified at the locations of structures would be required for any structures identified within 200 feet of the pipeline construction area.

Blasting for trench excavation could result in impacts on wells, wetlands, slopes, structures, and other adjacent buried utilities, as described below. The use of Pacific Connector's proposed monitoring and mitigation measures would avoid or reduce the likelihood of local failures of unstable rock and soil, and damage to structures or utilities from blasting vibrations.

Water Wells and Springs

Blasting could affect groundwater quality by temporarily increasing groundwater turbidity near the construction right-of-way. In addition, turbidity and blasting agent by-products could possibly temporarily degrade groundwater quality and potentially have temporary effects on wells in the immediate proximity of the blasting. In general, vibration effects on wells would be expected to be limited to the immediate proximity of the blasting. A common measurement unit for vibration is the peak particle velocity (PPV) of blasting-induced ground motion in inches per second. Siskind (1999) summarizes information on four blasting studies conducted to evaluate vibration effects on wells. One study showed, "There were no physical vibration effects on the wells even as close as 300 feet." The maximum velocities for this testing ranged from 0.84 to 5.44 inches per second, with four of the five sites exceeding 2 inches per second. In another study, a well was tested for casing cement bond damage. The study indicated initial bond losses occurred at 4.7 inches per second. A third study indicated that wells outside the blast pattern were exposed to as much as 8.7 inches per second at a distance of 31 feet and no damage occurred; however, the construction details for these wells are not described in the Siskind (1999) report.

A discussion of water supply wells within 150 feet of the construction right-of-way and measures proposed by Pacific Connector to avoid or minimize impacts on wells, including from blasting, is included in section 4.3. Pacific Connector would employ measures in the Blasting Plan including development of site-specific blasting operation and monitoring plans to address site variables (soil and rock types, etc.), which would incorporate known locations of existing groundwater wells or springs and seeps. Maximum ground motion velocities (or PPV) of 2 inches/second would be set for blast locations within 150 feet of water wells and springs.

Pacific Connector would request authorization from landowners to test and document the baseline condition, yield, and water quality of any private wells located within 200 feet of the pipeline construction right-of-way. This testing would occur before the pipeline construction starts in the nearby area, and the testing results would be shared with the property owner, if requested. Similar information would be gathered for any public water wells located within 400 feet of the pipeline construction right-of-way. Based on testing results, if it is determined after construction that there has been an impact on groundwater supply (either yield or quality), Pacific Connector would work with the landowner to ensure a temporary supply of water, and, if determined necessary by the landowner, Pacific Connector would provide a permanent water supply. Mitigation measures would be coordinated with the individual landowner in order to meet the landowner's specific needs. Mitigation measures for groundwater wells, springs, and seeps would be specific to each property and would be determined during landowner negotiations.

Wetlands

Blasting could potentially redirect surface water and groundwater flows to and from wetlands. In addition, turbidity and blasting agent by-products could possibly temporarily degrade surface water and groundwater quality.

Any turbidity resulting from blasting is expected to be temporary and to dissipate shortly after blasting. Water quality impacts on wetlands from blasting agents, if any, would be expected to be temporary and localized because only small amounts of blasting agents generally would be needed for trenching. Specific blasting agents would be listed in the *Blasting Plan*[53] prior to the initiation of any blasting. The use of ANFO would not be allowed.

Slopes

Unstable rock and soil slopes could locally fail as a result of blasting vibrations. Pacific Connector would complete a reconnaissance of slopes in the vicinity of the blasting, including measuring slope inclinations and observing areas adjacent to planned blasting locations for potential indicators of unstable slopes. Identified slope areas that could be impacted by blasting would be monitored and evaluated for hazards to people and property during the blasting operations.

Structures

Blasting vibrations and flying debris could potentially damage aboveground structures. If structures were present in areas where blasting was necessary, Pacific Connector would request authorization from landowners to inspect structures located within 200 feet of the pipeline construction right-of-way before and after blasting. Blasting mats or padding also would be used when blasting near structures to limit potential damage from flying rocks. To limit potential

[53] The *Blasting Plan* was included in Pacific Connector's January 2018 application to the FERC as Appendix C of the POD.

damage to structures, maximum ground motion velocities (or PPV) of 2 inches/second would be specified at the locations of structures, which is consistent with the language of the *Blasting Plan*.

As an additional precaution, Pacific Connector would require the contractor conducting blasting to limit the size of charges in accordance with the scaled distance factor (SD) guidelines developed by the Office of Surface Mining Reclamation and Enforcement (OSMRE). The SD is equal to the distance from the blast to an aboveground structure divided by the square root of the charge (pound per delay). For distances less than 300 feet, OSMRE states that the SD shall exceed 50 feet, which specifies a maximum blasting charge of 1.0 pound/delay.

Adjacent Pipelines and Buried Utilities

Blasting vibrations could potentially damage adjacent underground pipelines and utilities. In general, blasting would not be allowed within 10 feet of an existing pipeline or buried utility. In cases where blasting near an existing utility was necessary, the pipeline or utility owner would be notified in advance of the blasting, and measures would be taken to minimize the potential for utility damage (as outlined in the *Blasting Plan*).

4.1.2.7 Paleontological Resources

There are no known paleontological resources along the pipeline route.

4.1.3 Environmental Consequences on Federal Lands

4.1.3.1 Geologic Hazards on Federal Lands

The seismic hazard evaluation included surface rupture from faulting, liquefaction potential, and lateral spreading as discussed in section 4.1.2.3 above. In general, seismic hazard risks are low for the proposed pipeline. In addition, liquefaction potential and scour would be avoided by employing HDD construction of the pipeline across streams. The potential exists locally along portions of the proposed route on federal lands for seismically induced ground shaking to induce rockfalls, landslides, or soil slumps. Pacific Connector selected its proposed route to avoid existing landslides and areas susceptible to landslides to the extent practicable.

The pipeline would cross the BLM-Coos Bay District from MP 13.0BR to MP 27.5; and from MP 28.4 to MP 45.7. The western portion of this area is within the outer limit of the Cascadia event impact area. Evaluation of hazards for the design earthquake indicate that the pipeline (designed to standards) would not be susceptible to risks from seismic events. One landslide site located near MP 36.92 on land managed by the BLM Coos District could not be avoided. Additional investigation of this site resulted in a final risk determination of low (GeoEngineers 2017a). The landslide risk at this site is not considered hazardous enough to require additional mitigation or rerouting.

The pipeline would cross the BLM-Roseburg District from MP 46.9 to MP 102.3. Recent faults are not present in this area; and steep slopes and landslides have been avoided in this section of the pipeline route. The pipeline would cross the Umpqua National Forest from MP 99.3 to MP 113.2. Recent faults are not present in this section of the pipeline route; and steep slopes and landslides have been avoided in this section of the pipeline route. The pipeline would cross the BLM Medford District from MP 115.1 to MP 141.9; and from MP 148.3 to MP 153.8. Recent faults are not present in this section of the pipeline route. Steep slopes and landslides have been avoided in this section of the pipeline route. The pipeline would cross the Rogue River-Siskiyou

NF from MP 153.8 to MP 168. Recent faults are not present in this section of the pipeline route. Steep slopes and landslides have been avoided in this section of the pipeline route.

The pipeline would cross the Fremont-Winema National Forest from MP 168 to MP 175.4. The Quaternary-age Sky Lakes fault zone is located from MP 172 to MP 182. Some areas of this route section have a high potential for blasting during construction. Steep slopes and landslides have been avoided in this section of the pipeline route. The pipeline would cross the BLM Lakeview District from MP 176.2 to MP 216.8. The Quaternary-age Sky Lakes fault zone is located from MP 172 to MP 182; the Klamath Lake fault is located near MP 187; the Lower Klamath Lake fault system is located near MP 204 to MP 206; and the Stukel Mountain fault is located near MP 212 to MP 213. Some areas of this route section have a high potential for blasting during construction. Steep slopes and landslides have been avoided in this section of the pipeline route.

Mitigation for pipeline sections that cross recent faults has been discussed in section 4.1.2.3. During construction, Pacific Connector would have the pipeline trench carefully examined by a qualified professional for evidence of stratigraphic offsets potentially related to ground rupture. If such features are observed, Pacific Connector would implement additional mitigation measures, with the specific mitigation developed at that time. Such measures could include burying the pipe in a wide trench that was backfilled with loose gravel or sand, which would allow for relatively unrestrained movement of the buried pipe within the zone of fault movement.

Because the pipeline would cross a predominance of rugged terrain within BLM and NFS lands, there is potential for previously unidentified landslides or new landslides to affect the pipeline after it is installed. To minimize landslide risk, Pacific Connector would implement its ECRP during pipeline construction, which would reduce the potential for construction to adversely affect slope stability. As described in the ECRP, temporary construction BMPs would include sediment barriers, slope breakers, and application of mulch prior to seeding; permanent measures would include installation of permanent slope breakers and revegetation. In addition, as part of its pipeline operation, Pacific Connector would conduct regular monitoring of the pipeline right-of-way, which would aid in detecting landslide occurrence or slope movement. On federal lands, Forest Service and BLM representatives would conduct monitoring with Pacific Connector personnel. Mitigation could include the use of shutoff valves. If movement is detected, immediate action would be taken to reduce the risk to the pipeline. Actions would include initial response to reduce the stresses on the pipeline, and follow-up actions to stabilize the slide. If the slide is large and complex enough such that stabilization would not be feasible, the pipeline could be relocated around the slide area.

Pacific Connector intends to implement a level of landslide and pipeline easement monitoring like that currently performed on existing Williams-owned pipeline facilities in southwestern Oregon. Similar to the Williams-owned pipeline, monitoring would consist of weekly air patrol, annual helicopter survey, and quarterly class location. Class location consists of land patrol (including leak detection), semi-annual class 1 and class 2 location land patrol, and annual cathodic protection survey. Observed areas of active third-party activities such as logging or development and areas affected by unusual events such as landslides, severe storms, flooding, earthquake or tsunami may require additional inspection and monitoring determined on an individual basis.

4.1.3.2 Mineral Resources on Federal Lands

Sixteen oil and gas areas are located between MP 10.4R and 45.7, and two mining claims between MPs 0 and 1.4 in Coos County on BLM land. Seven oil and gas areas, two placer mining claims, one mine, two lode mining claims, and a chromite resource are located in the vicinity of the pipeline alignment between MPs 46.9 and 97 in Douglas County on BLM land. Two load mining claims and a quarry are located in the vicinity of the pipeline alignment between MPs 101.8 and 110 in Douglas County on NFS land. Nine oil and gas areas and two lode mining claims are located in the vicinity of the pipeline alignment between MPs 115.4 and 154.9 in Jackson County on BLM land. One oil and gas area is located in the vicinity of the pipeline alignment between MPs 155.4 and 166.4 and one between MPs 205.2 and 205.7 in Jackson County on NFS land. One lode mining claim in the vicinity of the pipeline alignment is located between MPs 170.1 and 171.1 in Klamath County on NFS land. Two geothermal resources areas are located in the vicinity of the pipeline alignment between MPs 192.7 and 216.8 in Klamath County on BLM land. It is noted that the status of these mining claims are all listed as "closed" or "unknown", so they are not considered as active at this time.

The Green Butte Quarry was identified at MP 101.8 within the Umpqua National Forest. However, GeoEngineers (2017a) indicated that this quarry was never opened and there are no plans for its future development. The proposed route between MPs 108.6 and 110.9 avoids the Peavine Quarry within the Umpqua National Forest. The pipeline alignment at MP 150.5 is within approximately 100 feet northeast of the Heppsie Mountain quarry on BLM land and parallels the length of the quarry. The Heppsie quarry is a regional hard rock quarry and to utilize this rock quarry it is necessary to blast the rock. It was determined by the BLM and Pacific Connector that due to the proximity of the pipeline to the quarry and the incompatibility of production blasting the rock quarry near the pipeline, that 70,000 cubic yards of rock will be blasted at the expense of Pacific Connector and left on site. The BLM is requiring this blasting because the BLM will not assume unknown risk associated with complications, limitations, or liability associated with utilizing this quarry in the future.

Based on aerial photograph review of the quarry depths, trends, and distances from the pipeline, it was concluded that the quarry likely would extend into a stable rock outcrop that currently parallels the proposed route and does not pose a risk to the quarry or the pipeline project (GeoEngineers 2017a). POD attachments include the Blasting Plan, ROW Clearing Plan, and ROW Marking Plan, all of which would serve to ensure the avoidance of quarries.

Near MP 109, the pipeline would be about 0.3 mile and 0.5 mile east of the Nivinson and Red Cloud mercury mines, respectively. These mines are located within NFS lands. Construction and operation of the pipeline would not affect these mines. The proposed route would cross areas mapped as volcanic and volcanogenic rocks at the current crossings of the East Fork Cow Creek. These bedrock units have not been identified as a substantial source of naturally occurring mercury. Naturally occurring mercury in this area typically is associated with metamorphic bedrock units such as amphibolite.

The Forest Service reports that naturally occurring mercury exists in the vicinity of the Mars Prospect located near MP 108.7 (Broeker 2010). Broeker concluded that naturally occurring mercury is present in the disrupted soil regolith and underlying bedrock strata throughout the upper reaches of the East Fork Cow Creek watershed. Although localized, mercury values are sufficiently high enough to have warranted exploration, development and minor production between the 1930s and 1960s. Geochemical analysis of six soil samples collected along a 2,000-foot section of Pacific Connector's previously proposed route in this area that crossed partly through the historic Thomason mining claims near the East Fork Cow Creek determined the area to have very low concentrations of naturally occurring mercury mineralization. Pacific Connector subsequently rerouted its proposed route in this area approximately 2,500 feet from where the samples were taken.

Based on the analytical results, mapped bedrock at the proposed route, and the distribution/location of mercury mines, it is unlikely that the soils underlying the currently proposed crossing of the East Fork Cow Creek would have concentrations of naturally occurring mercury exceeding those measured in samples obtained from the previous crossing location and most likely would have lower levels. Additional details on the literature research, field observations and soil sampling and analysis completed for the prospects and mines located near MPs 108 to 110 are provided in GeoEngineers (2017a). Soil sampling and analysis results also support that mercury specific health and safety protocols would not be needed for the construction activities. It is expected that the planned erosion and sediment control measures described in the Pacific Connector's ECRP would protect the ecological health of upland and in-stream areas from the naturally occurring mercury concentrations.

The pipeline could potentially interfere with future mining and reclamation activities on lands adjacent to and within the right-of-way. Future expansions of surface mines near the right-of-way potentially could be limited or precluded in some cases because mineral resources could not be extracted from immediately up or downslope up of the pipeline right-of-way or from beneath the pipeline. Similarly, the presence of the pipeline could limit or preclude the stockpiling of mineral resources or development of a processing area immediately up or downslope of the pipeline. These considerations also could limit or preclude reclamation activities at mine sites near the pipeline because of the potential to disturb the slopes above and below the pipeline and right-of-way. Any impact would be site-specific and would depend on topography, drainage, and subsurface conditions in that area. If existing mining claims are identified within the Project's proposed right-of-way during the BLM's review, the BLM may require that the Project be microsited outside of these claims.

4.1.3.3 Rock Sources and Permanent Disposal Sites on Federal Lands

Rock source sites may contain useable mineral deposits that may be extracted and/or purchased for use during construction. Disposal sites were identified for final placement of unusable, non-merchantable materials. These sites are typically exhausted areas within active quarries or abandoned quarries and may include commercial sites. Other permanent storage sites, including some TEWAs, were identified for permanent storage of excavated material. The material disposed of in these areas would be properly graded, drained (if necessary), and revegetated. The sites identified are not proposed for expansion beyond their proposed permitted or authorized boundaries. Use of any site would be permitted as required by the appropriate jurisdiction or landowner, and Pacific Connector would comply with applicable permits/stipulations. The disposal of mineral material to Pacific Connector from rock sources proposed to be utilized on BLM lands would follow regulations in 43 CFR 3600.

Pacific Connector has identified 20 potential rock source and permanent disposal sites that total approximately 86 acres along the pipeline route. Of these 20 rock source/disposal sites, 12 are located within federal lands as shown in table 4.1.2.5-1. All of these sites have been previously used and disturbed by quarry operations and/or strip mining. Most of these sites continue to have ongoing quarry operations. Only the disposal sites (and not the TEWAs) listed in table 4.1.2.5-1 are being proposed for use as permanent disposal sites.

Pacific Connector does not intend to expand these sites beyond the existing or previously disturbed footprints. If Pacific Connector acquired rock from these sources or permanently disposed of excavated material, all available topsoil would be salvaged. The salvaged topsoil would be used to restore the site as required by landowner stipulations. Rock resource areas managed and developed by Pacific Connector would need quarry Operation and Reclamation Plans, to the extent required by DOGAMI's regulatory authority (OAR 632-030-0005 through 0070 and ORS 517.750 through 990). Appropriate BMPs would be implemented, such as those in Norman et al. (1998). No impacts are anticipated from the rock sources and permanent disposal sites.

4.1.3.4 Blasting During Trench Excavation on Federal Lands

Pacific Connector identified areas where blasting may be necessary by reviewing the NRCS soils maps and descriptions to identify soil units that typically contain bedrock within 5 feet of the ground surface. Soils data, geological maps, and topographic relief were used to rank the qualitative likelihood for blasting along the pipeline.

Table 4.1.2.6-1 provides a summary of the blasting potential along the pipeline including BLM and NFS areas that would be crossed. Although the blasting potential is classified as high for about 100 miles of the proposed route, this distance estimate includes local areas as much as 0.9 mile in length that contain valley fill, thick soils, and soft volcanic rocks (such as tuffs) that would not need to be blasted. In addition, some of the proposed route classified as having a high or moderate potential for blasting may contain weathered rock that could instead be ripped by conventional excavation equipment. The BLM-Coos Bay District portion of the pipeline alignment has a low potential for blasting during construction.

The pipeline route within the BLM-Roseburg District has low to moderate potential for blasting during construction. Portions of the pipeline route within the Umpqua National Forest, the BLM Medford District, the Rogue River-Siskiyou National Forest, the Fremont-Winema National Forest, and the BLM Lakeview District have a high potential for blasting during construction.

Blasting for grade or trench excavation would be utilized only after all other reasonable means of excavation have been used and are unsuccessful in achieving the required results. Pacific Connector may specify locations (foreign line crossings, near-by structures, etc.) where consolidated rock would be removed by approved mechanical equipment such as rock-trenching machines, rock saws, hydraulic rams, or jack hammers in lieu of blasting.

Pacific Connector would conduct all blasting in accordance with all federal, state, and local regulations and Pacific Connector Construction Specifications. Pacific Connector would include specifications in any blasting contract to control adverse impacts, including measures to minimize vibrations and flyrock, measures for safe blasting practices near active pipelines, and seasonal restrictions to protect wildlife, as needed. Pacific Connector would have blasting inspectors present to ensure that all specifications were met and to perform pre- and post-blast inspections of nearby structures and wells.

Drilling and blasting would be done with the Pacific Connector inspector present and with inspector's approval to proceed prior to each blast. Blasting operations would be conducted by or under the direct and constant supervision of experienced personnel legally licensed and certified to perform such activity in the jurisdiction where blasting occurs. Pacific Connector would require their contractor to provide a Blasting Plan at least five working days prior to any blasting-related activity, or two weeks prior to blasting on federal lands, and the contractor would be required to obtain Pacific Connector approval in writing prior to starting work.

4.1.3.5 Paleontological Resources on Federal Lands

Paleontological resources on federal lands are regulated, as outlined in 36 CFR Ch. 11 261.9 (i). Pacific Connector consulted with federal land management agencies for information on potential paleontological resources crossed by or within the pipeline right-of-way. Based on the consultation, the BLM required an assessment of the potential for paleontological resources on the portion of the right-of-way located on the lands it manages. The assessment indicates that there is a limited potential for encountering paleontological resources on BLM lands and only localized monitoring would need to occur during pipeline construction. The following sections summarize the findings from the paleontological resource assessment. The full assessment report is contained in *Final Paleontology Assessment, Pacific Connector Gas Pipeline Project, Coos Bay to Malin, Oregon* (GeoEngineers 2017c).[54]

Potential Paleontological Resources on NFS Lands

Pacific Connector states that consultation with staff of the Real Estate and Mineral Resources Section of the Umpqua National Forest reported that there were no known paleontological resources on the portions of the pipeline right-of-way located within the boundaries of the Umpqua, Rogue River, and Winema National Forests. According to Paleontology Associates, only the Umpqua and Rogue River National Forests bear potentially favorable lithologic units for fossil content along the pipeline corridor. These units occur in:

- Umpqua National Forest MPs 106 to 109—Fisher formation-volcanic ash and lacustrine siltstone;
- Umpqua National Forest MPs 109.5 to 115.5—Little Butte and Colestin formations-tuffaceous sediments;
- Rogue River National Forest MPs 120 to 121—Colestin formation-tuffaceous sediments; and
- Rogue River National Forest MPs 155 to 158—No formal formation designation-tuffaceous sediments, lahars, waterlaid tuffs.

Based on the information provided regarding the lack of identified paleontological resources within the pipeline right-of-way on NFS lands, no measures appear necessary for the avoidance and minimization of adverse effects on paleontological resources on NFS lands. Pacific Connector does not plan to monitor for lithologic units on NFS lands.

Potential Paleontological Resources on BLM Lands

The BLM required an assessment of the potential for paleontological resources on the portion of the right-of-way located on the lands it manages. Pacific Connector completed an assessment that indicates there is a limited potential for encountering paleontological resources on BLM lands and only localized monitoring would need to occur during pipeline construction. The following

[54] Appendix M to Appendix A-6 of Resource Report 2 in Pacific Connector's September 2017 filing with the FERC.

sections summarize the findings from the paleontological resource assessment. The full assessment report is contained in the *Final Paleontology Assessment, Pacific Connector Gas Pipeline Project, Coos Bay to Malin, Oregon* (GeoEngineers 2017c).

A formal analysis of existing paleontological data was completed for the portions of the pipeline right-of-way on BLM lands. The analysis, completed by Dr. William Orr, who is recognized by the BLM as a qualified paleontologist, was conducted in general accordance with BLM Manual H-8270-1 (BLM 1998).

Fossil-bearing rock formations along the portions of the right-of-way located on BLM lands range in age from the Jurassic period (almost 200 million years old) to the Pleistocene Epoch (about 12,000 years before present). Between MPs 17 and 54, the right-of-way on BLM lands almost entirely traverses Eocene units of the southern Coast Range. The units span the entire epoch, with a wide variety of clastics ranging from coarse conglomerates to very fine-grained deep water silts and shales. Paleocene Epoch intervals in the lower Roseburg Formation could potentially contain plants, invertebrates, reptiles (turtles) and odontocete cetacea (primitive toothed whales). In addition, Pleistocene intervals in localized swamp boggy areas of the Roseburg Formation could potentially yield bones of large Ice Age mammals.

The portion of the BLM lands in the Klamath Mountain interval between MPs 54 and 97 has some of the oldest and most complex rocks in Oregon. Because most of the Klamath rocks are mapped as tectonic accretionary terranes, even the most fragmentary fossils discovered would be an important find.

BLM lands would be crossed between MPs 110 and 123, MPs 128 and 137, and MPs 167 and 172 in the Cascade Range. Two formations in this region, the Colestin and Little Butte, have a potential for producing plant fossils. Both of these formations were deposited in nonmarine, continental settings with volcanogenic ash, tuff and silts mixed with extrusive volcanics of basalt, basaltic andesite and related igneous rocks. Despite the wide range of ages and environments, the floral lists at any given site for either formation are limited. As a result, any new taxa recorded or salvaged in the course of the construction activities would add to the knowledge of the Cascade geologic history.

Between MPs 216 and 217, the pipeline right-of-way crosses BLM lands in the Basin and Range province. Lake sediments of Cascade ash dating between 5 million to 11,000 years ago in this area bear a limited, but stratigraphically important fauna.

<u>Paleontology Field Monitoring Protocols for BLM Lands</u>

Pacific Connector conducted a field survey of the above-referenced portions of the pipeline right-of-way that occur on BLM lands. The locations observed during the survey were selected using the results of the formal analysis of the existing data and a mile-by-mile evaluation of the geologic formations along the right-of-way.

The field survey results were used to classify the potential for encountering paleontological resources on BLM lands during construction. The classifications used for the project were consistent with classes 1 through 5 in the BLM Potential Fossil Yield Classification procedure (revised H-8270-1).

All but 1 mile of the right-of-way on BLM lands has been classified as meeting Class 3a or 3b, based on the formal analysis and the field survey. An approximately 0.25-mile segment from MP

216.5 to 216.75 is classified as Class 4a. For approximately 25 miles of the Class 3a or 3b lands, the BLM would require limited spot monitoring during pipeline construction because the potential presence of fossils cannot be completely eliminated. The 1-mile-long area not classified as Class 3 is divided into two approximately 0.5-mile-long areas classified as Class 1 and Class 2. To satisfy BLM requirements, Pacific Connector would continuously monitor both of these segments for the potential presence of paleontological resources during pipeline construction. The spot or continuous monitoring during construction would be conducted by a field paleontologist working under the supervision of the lead paleontologist.

Procedures for Recovering Significant Discoveries of Vertebrate or Invertebrate Fossil Remains on BLM Lands

Although the likelihood of discovering paleontologically significant fossils on BLM lands is considered remote, such a discovery could potentially occur during the proposed surveys, brush clearing, or construction activities. The field inspector or field paleontologist identifying a fossil of potential interest would be responsible for notifying the lead paleontologist immediately of the discovery. The lead paleontologist would, in turn, evaluate the significance of the finding relative to the salvage parameters. If the fossil was considered salvageable material, it would be recovered under the direction of the lead paleontologist and Pacific Connector. Pacific Connector proposes to designate the University of Oregon Museum of Natural and Cultural History as the repository for any salvageable material recovered from the portion of the pipeline right-of-way located on BLM lands.

4.1.4 Conclusion

Much of the Project is located in the CSZ tectonic area (an area of potential earthquake and tsunami activity). Based on the documentation that mineral resources are not present along the Project; Jordan Cove and Pacific Connector's proposed construction and operations procedures, methods, and plans to appropriately design for geologic hazards; and their implementation of minimization and mitigation measures, we conclude that constructing and operating the Project would not significantly affect geology and would not be significantly affected by geologic hazards.

4.2 SOILS AND SEDIMENTS

4.2.1 Jordan Cove LNG Project

Soils at the proposed LNG terminal and the South Dunes site have been previously disturbed by the operations of the Menasha and Weyerhaeuser companies and from the placement of fill material derived from COE dredging of the Coos Bay Federal Navigation Channel in the 1970s. This fill material (composed predominantly of sand with a small percentage of silt) overlies much of the LNG terminal tract and is more than 10 feet deep in some areas. Recent testing and grading to support a 2014 geotechnical exploration program in a 2-acre area of the LNG terminal revealed the presence of ash-amended soils from 12 to 60 inches (SHN 2015).

Jordan Cove performed geotechnical investigations in the area of the proposed LNG storage tanks and process area in April through May 2013 (GRI 2013). The subsurface data revealed that surficial material in this area is generally fine-grained sand with traces of silt that is underlain by weathered sandstone. The sand layer extends from the surface to a depth of at least 124 feet. Another geotechnical investigation was performed in April 2012 (GRI 2012) in the South Dunes portion of the site. The upper 10 to 20 feet of the South Dunes site was found to be reworked dune sand fill that is underlain by weathered siltstone. Based on geotechnical borings, the sands in the access and utility corridor are composed of areas of fill and native material. Organics and peat were encountered only in the western end of the access and utility corridor at depths of approximately 11 feet below grade. At depths below 30 feet, the conditions for the access and utility corridor are similar to those described for the LNG terminal site. Geotechnical explorations at the proposed Kentuck project site found that surface fill is 1 to 2 feet deep, underlain by native sand and silt to a depth of about 35 feet, and silt to depths of about 70 to 100 feet.

4.2.1.1 General Impacts

Soil types and characteristics in the Jordan Cove LNG Project area were assessed using the NRCS Soil Survey geographic database (NRCS 2017). Construction of the Jordan Cove LNG Project would disturb several soil types, as shown in table 4.2.1.1-1.

The following discussion addresses the soil type characteristics that would be affected in order from highest total impact to lowest, as listed in table 4.2.1.1-1. Soil characteristics for soils that cover 1 percent or less of the total area are not discussed or described in detail.

Dune Land is mapped within approximately 18 percent (180 acres) of the Jordan Cove LNG Project area. It consists of fine and medium textured sands on hills and ridges, formed from aeolian deposits. Permeability is very rapid, and runoff is slow. This soil is severely susceptible to wind erosion and slightly susceptible to water erosion.

Waldport Fine Sand comprises approximately 15 percent (149 acres) of the Jordan Cove LNG Project area. The Waldport Fine Sand is a deep, excessively drained soil occurring on stabilized sand dunes. It is formed from aeolian deposits. Permeability of the Waldport soil is very rapid, but runoff is slow. This soil is severely susceptible to wind and water erosion.

TABLE 4.2.1.1-1

Acres of Impacts at the Jordan Cove LNG Project, by Soil Type a/

Soil Type / Map Unit	Acres b/	Percent (subtotal)
Permanent Operation Areas		
Beaches / 3	1.0	<1
Dune land / 16	23.3	14%
Heceta Fine Sand / 28	39.7	23%
Udorthents level / 57	0.4	<1%
Waldport Fine Sand / 59D	1.1	1%
Waldport Fine Sand / 59E	82.7	48%
Waldport-Dune land complex	0.1	<1%
Waldport-Heceta Fine Sand / 61D	23.5	14%
Subtotal	***171.8***	***100%***
Temporary Construction Areas		
Braillier mucky peat / 7	5.8	2%
Chetco silty clay loam	0.3	<1%
Dune Land / 16	116.8	36%
Heceta Fine Sand / 28	23.3	7%
Heceta Waldport Fine Sand / 29B	1.9	1%
Udorthents, level / 57	46.8	14%
Waldport Fine Sand / 59D	11.4	4%
Waldport Fine Sand / 59E	42.2	13%
Waldport Dune Land complex / 60D	0.1	<1%
Waldport-Heceta Fine Sand	76.9	24%
Subtotal	***325.5***	***100%***

a/ Values exclude aquatic areas that are encompassed by the Project but which do not contain "soils" as well as mitigation areas that are not considered jurisdiction areas.
b/ The totals shown in this table may not equal the sum of addends due to rounding. Acreages are rounded to nearest tenth acre, percentages are rounded to nearest whole value (values below 1 are shown as "<1%").

Bullards sandy loam comprises 12 percent (110 acres) of the Jordan Cove LNG Project area. This is a well-drained soil occurring on dissected marine terraces. It formed in mixed aeolian and marine deposits. Permeability of this soil is moderate, and runoff is medium. This soil is severely susceptible to wind erosion and moderately susceptible to water erosion.

Waldport-Heceta Fine Sands comprise approximately 10 percent (100 acres) of the Jordan Cove LNG Project area. This soil is composed of 50 percent Waldport Fine Sand and 50 percent Heceta Fine Sand (both described herein). This soil is severely susceptible to wind erosion and moderately susceptible to water erosion.

Heceta Fine Sand comprises 10 percent (93 acres) of the Jordan Cove LNG Project area. This is a deep, poorly drained soil found in deflation basins and depression areas between dunes. It is formed on aeolian materials. Permeability of this soil is rapid, and runoff is ponded. This soil is slightly susceptible to water erosion.

Coquille silt loam comprises 8 percent (77 acres) of the Jordan Cove LNG Project area. The Coquille silt loam is a deep, very poorly drained soil that is formed in alluvium on floodplains. Permeability of this Coquille soil is slow. This slow is slightly susceptible to wind and water erosion.

Udorthents soils comprise 5 percent (52 acres) of the Jordan Cove LNG Project area. They occur on floodplains, marshes, and tidal flats and in areas that have been filled and leveled for commercial and industrial uses. Areas on floodplains are made up of sandy, silty, or clayey material; and areas on marsh and tidal flats are made up of dredging spoil, dune sand, and wood chips.

Bandon sandy loam comprises 4 percent (40 acres) of the Jordan Cove LNG Project area. This is a deep, well-drained soil that occurs on dissected marine terraces and formed in sandy marine deposits. Permeability of this soil is generally moderate, and runoff is slow. This soil is slightly susceptible to water erosion and severely susceptible to wind erosion.

Nestucca silt loam comprises 3 percent (30 acres) of the Jordan Cove LNG Project area. This is a deep, somewhat poorly drained soil formed in alluvium on floodplains. Permeability is moderately slow, and runoff is very slow. This soil is slightly susceptible to wind and water erosion.

4.2.1.2 Project-Specific Soil Limitations

Prime Farmland

The NRCS defines prime farmland as land that has the best combination of physical and chemical characteristics for growing food, feed, forage, fiber, and oilseed crops. Prime farmland can include land that possesses these characteristics but is being used currently to produce livestock and timber. Urbanized land and open water are excluded from prime farmland. Prime farmland typically contains few or no rocks, is permeable to water and air, and is not excessively erodible or saturated with water for long periods. Unique farmland is land that is used for production of specific high-value food and fiber crops. In addition, soils may be considered of statewide or local importance if those soils are capable of producing a high yield of crops when managed according to accepted farming methods.

There are no soils at the Jordan Cove LNG Project site that are classified as prime or unique farmland soils. However, Coquille silt loam, Heceta Fine Sands, Bandon sandy loam, Bullards sandy loam, Chetco silty clay loam, Heceta-Waldport Fine Sand, Nestucca silt loam, and Wintley silt loam are classified as farmland of statewide importance. These areas comprise a total of approximately 338 acres (25 percent) of the Jordan Cove LNG Project area. This classification includes areas of soils that nearly meet the requirements for prime farmland and that economically produce high yields of crops when treated and managed according to acceptable farming methods. The criteria for defining and delineating farmland of statewide importance are determined by the appropriate state agencies. Farmland of statewide importance may include tracts of land that have been designated for agriculture by state law (NRCS 2006). No areas within the Jordan Cove LNG Project area are currently being used for cropland, and much of the Project area has been previously modified by industrial activities and the placement of dredged material. Therefore, no farmland of statewide importance would be taken out of production by construction and operation of the Jordan Cove LNG Project.

Erosion Potential

Erosion is a continuing natural process that can be accelerated by human disturbances. Factors that influence soil erosion include soil texture, structure, length and percent of slope, vegetative cover, and rainfall or wind intensity. Soils most susceptible to erosion by wind or water are typified by bare or sparse vegetative cover, non-cohesive soil particles with low infiltration rates, and moderate to steep slopes. The soils at the LNG terminal site occur within an area of high wind intensity and are in wind erodibility groups 1 (extreme) and 2 (high), which are the most susceptible to wind erosion.

Soils with severe wind erosion potential include Bandon sandy loam, Bullards sandy loam, Chetco silty loam, Dune Land, and Waldport Fine Sand. Approximately 487 acres (36 percent) of the total area is characterized by the potential for severe wind erosion. Approximately 107 acres (52 percent) of the permanent operations area of the site includes soils with the potential for severe wind erosion. Soils with moderate to high potential for water erosion include Bandon sandy loam, Beaches, Bullards sandy loam, Chetco silty clay loam, Waldport fine sand, and Waldport-Dune complex. Approximately 291 acres (22 percent) of the total area is characterized with the potential for moderate to high water erosion. Approximately 85 acres (41 percent) of the permanent operations area of the site includes soils with the potential for moderate to high water erosion.

To minimize potential for soil loss due to erosion, temporary erosion controls would be installed and maintained in accordance with Jordan Cove's Plan. Permanent erosion control measures would be installed, as necessary, and in compliance with county and state BMPs. Permanent erosion control measures may include vegetation, vegetated swales, infiltration or settling basins, stormwater runoff diversion and control through ditches, check dams, or other velocity dissipaters. For portions of the storm surge/tsunami barrier and terminal areas above +25 feet in elevation, which are not expected to normally be subjected to severe wind or water conditions (but may be affected by storm surge or tsunami events), alternative erosion control would be used. Alternative erosion control for protection from potential tsunami runups in slope areas would include using concrete cellular mattresses, grout injected geotextile fabric mattresses, or other suitable means as determined during detailed design. The design of the slope protection against waves would be developed through consultation with DOGAMI. Erosion of the engineered slopes within the marine slip is not anticipated under normal wave, tide, and marine vessel traffic conditions. The proposed pile dike rock apron along the access channel side slope would be implemented in coordination with the COE to arrest slope migration and prevent effects on Pile Dike 7.3. The erosion control measures would be designed in accordance with the ODOT Erosion Control Manual. By implementing these erosion control measures, construction and operation of the Project would not result in significant soil erosion by water or wind.

Compaction Potential

Soil compaction is the process by which air spaces in the soil are reduced in size because of physical pressure exerted on the soil surface. Compaction results in soil conditions that reduce infiltration, permeability, and gaseous and nutrient exchange rates. Fine-textured soils with poor internal drainage are the most susceptible to compaction. Compaction can result from construction equipment traveling over wet soils, and could further disrupt soil structure, reduce pore space, increase runoff potential, and cause rutting.

Previous activities at the Roseburg tract and the LNG terminal site have already compacted soils. Jordan Cove would test subsoil for compaction at regular intervals in areas disturbed by construction activities; and would implement BMPs—especially in areas that have not been historically disturbed by industrial land use—as described in Jordan Cove's ECRP. Such BMPs would include limiting construction in wet weather conditions and application of soil amendments to facilitate plant establishment.

Potentially Contaminated Soils and Groundwater

The site of the LNG terminal was a livestock ranch until 1958. After it was acquired as part of the mill complex, the tract was occasionally used for log-sorting activities. In 1972/1973, the COE spread materials dredged during maintenance of the Coos Bay navigation channel on the site. From the late 1970s through the early 1980s, sand, boiler ash, and wood debris from milling operations were placed on the majority of what is defined as the LNG terminal site. Weyerhaeuser, which acquired the mill in 1981, spread decant solids from its wastewater treatment facility at the LNG terminal site between 1985 and 1994. The South Dunes site was originally developed as a sulfite pulp and paper mill by the Menasha Wood Ware Corporation in 1961. It was acquired by Weyerhaeuser in 1981 and converted to a recycle paper mill in 1995. The mill was closed in 2003. Between 1981 and 1992, Weyerhaeuser leased the southern portion of the property adjacent to the geographic Jordan Cove portion of Coos Bay to a fish hatchery operation. The buildings for both the mill and the fish hatchery have been removed.

Jordan Cove conducted multiple Phase I and Phase II Environmental Site Assessments at the terminal tract to assess for environmental contamination. Phase I protocols consist of record searches, inventories, site visits, and other non-intrusive information gathering. Phase II protocols consist of intrusive environmental media sampling. Phase II Environmental Site Assessments were conducted to address the findings of the Phase I Environmental Site Assessments (CH2M Hill 1996; Thiel Engineering 2004; GRI 2005; PES Environmental 2006; GRI 2007b; GSI Water Solutions 2012; GRI 2017b; SHN 2017; SHN 2018). The details of these investigations are all included in FERC filings for the Project and are only generally summarized in the following section.

A Phase I Environmental Site Assessment of the APCO site conducted by SHN in 2013 (SHN 2013a) identified dredge spoils that may have been affected by historical industrial activities upstream of the site as a recognized environmental condition.[55] The existing Boxcar Hill site is being used as a recreational facility with all-terrain vehicle (ATV) rentals, riding trails, and camping. A Phase I Environmental Site Assessment of the Boxcar Hill site did not identify any recognized environmental conditions in connection with the site (SHN 2017). A limited (specifically for the Port Laydown area and not entire property parcels) Phase I Environmental Site Assessment was conducted for the Port Laydown site in February 2018 (SHN 2018) which identified numerous concerns including a potential off-site source of contamination (D.B. Western facility cited for violations including illegal disposal of solid and hazardous waste), potentially contaminated dredge material, burn piles within the site, and the potential for lead in soil from target shooting activities. Contaminants identified as both soil and groundwater concerns include: tributyl tin, heavy metals (arsenic, barium, lead, cadmium, chromium, mercury, selenium and silver), copper, polychlorinated biphenyls (PCB), polycyclic aromatic hydrocarbons (PAH), semivolatile organic compounds (SVOC), volatile organic compounds (VOC), total petroleum hydrocarbons (TPH), dioxins and furans, and formaldehyde. A Phase II Environmental Site Assessment to assess for soil and groundwater contamination is planned for this site.

The following Phase II Environmental Site Assessment investigations were conducted at the proposed LNG terminal site to determine if contaminated soils and/or groundwater are present:

- In 1996, Weyerhaeuser conducted Phase II Environmental Site Assessment investigations which found that VOCs, SVOCs, metals, petroleum hydrocarbons, and PCBs (analytes tested) in the fill were below levels that would necessitate cleanup work (CH2M Hill 1996).

[55] The presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment.

With the exception of arsenic and PCB, material present at the site is below the current (1996) Oregon residential soil cleanup standards. PCB in one ash discrete sample exceeded the residential standard, but was well below the industrial soil standard. Arsenic detected at the site is within typical background concentration levels for the western United States and, therefore, does not represent any substantial environmental issue.

- Phase II Environmental Site Assessment investigations were conducted by PES Environmental, Inc. (PES) in April 2006 (PES 2006). These investigations focused on the South Dunes site (inclusive of the portions of this site to be used for the LNG terminal) as well as the Ingram Yard site.
- Another Phase II Environmental Site Assessment investigation was completed at the LNG terminal site by GRI in October 2006 (GRI 2007b). The assessment was conducted at test pits in the area of the former Ingram Yard and along a wastewater pipeline
- GRI performed a Phase II Environmental Site Assessment investigation in 2005 of the Roseburg property (GRI 2005), which has been used for wood-processing activities since 1968.
- GRI conducted a Phase II Environmental Site Assessment in July 2017 (GRI 2017b) of the APCO site.

Grading for the north access road and the ground improvement geotechnical test site required excavation of between 12 inches and 60 inches of soil from a 2-acre area from April 7 through April 15, 2014. During the grading activities, ash-amended soils were encountered, with a total of 5,600 cy of ash/soil mixture excavated and stockpiled in the area of the north access road in berms as indicated in the 1200C permit. On May 8, 2014, the ODEQ determined that these actions, while not prohibited, required a solid waste letter of authorization before commencement of grading activities. The ODEQ required Jordan Cove to obtain a solid waste authorization letter; on July 16, 2014, a solid waste authorization letter was submitted to the ODEQ. Jordan Cove would be required by the ODEQ to provide prior notice to the ODEQ should any grading or ground disturbance activities be planned to occur on the LNG terminal site. Provisions for long-term disposal of disturbed LNG terminal site soils and any other specific mitigation measures would be specified in detail in the final engineering design.

The results of Phase II environmental sampling activities at the LNG terminal site identified contaminants in soil at levels below or slightly exceeding the applicable ODEQ risk-based concentrations (RBC) and EPA screening levels at several locations. Analytical results from samples collected from the LNG terminal site found low concentrations of PAHs, TPH, metals, VOCs, SVOCs, PCBs, dioxins, furans, and butyltin compounds in soil samples. It is noted that regulatory updates to toxicity values for some compounds have changed the screening levels used in preliminary risk assessments since the preparation of these environmental site assessment reports. Table 4.2.1.2-1 presents a subset of chemicals detected at the site and represents contaminants that either exceed or approach current ODEQ and EPA regulatory screening levels or were present in multiple sample locations at both the South Dunes site and LNG terminal site. Table 4.2.1.2-1 includes applicable ODEQ RBCs for the soil ingestion, dermal contact, and inhalation exposure pathway under the occupational and construction worker scenarios (ODEQ 2015) and the EPA regional screening levels for industrial soils (EPA 2018a). Table 4.2.1.2-1 also includes ODEQ-established natural background concentrations for naturally occurring metals in soil. The maximum detected concentrations for selected compounds generally encountered in on-site soils, as summarized by previous environmental investigations, are also included in table 4.2.1.2-1 (CH2M Hill 1996; GRI 2005; PES 2006; GRI 2007b). As a part of the investigations, a screening-level human and ecological risk assessment of residual contamination was conducted and concluded that residual contaminants did not exceed ODEQ's screening levels for the occupational and construction worker exposure scenarios (PES 2006). Based on the findings of previous environmental investigations, the ODEQ has recommended a "No Further Action" determination for the former Weyerhaeuser mill and the LNG terminal site. A copy of this determination letter is provided in Jordan Cove's September 2017 application to the FERC.[56] A "Condition" of the No Further Action determination states that "While surface soils at the LNG terminal site meet human health and ecological screening criteria, they contain low levels of potentially bio-accumulating chemicals and must not be placed in waters of the state." Implementation of erosion controls for runoff during and construction and operation, as well as revegetation plans would prevent the low-level contamination from entering surface waters. Jordan Cove's ECRP lists the specific measures to be used for erosion and sediment control practices, wind erosion and dust control, and clearing and grading. Peripheral erosion and sediment control would be provided along the site perimeter, and at all operational drain inlets and outlets at all times during construction. Sediment basins would be employed if necessary.

TABLE 4.2.1.2-1

Summary of Applicable ODEQ and EPA Screening Levels Concentrations (in parts per million [ppm])

			ODEQ			EPA
Compound	**Max. Detected Concentration**	**Data Source a/**	**Occupational**	**Construction Worker**	**Natural Background**	**Screening Value**
Petroleum Hydrocarbons						
Diesel	11,000	2	14000	4600	Not Applicable	Not Established
Gasoline	4,150	2	20000	9700	Not Applicable	Not Established
Metals						
Arsenic	28.5	3	1.9	15	19	3
Cadmium	0.799	3	9,000	220,000	0.54	98
Chromium (VI)	56	3	6.3	49	200	6.3
Lead	62	1	800	800	34	800
Mercury	0.34	3	350	110	0.24	4.6
PAHs						
Fluoranthene	62.3	3	30,000	10,000	Not Applicable	3,000
Fluorene	1.29	2	47,000	14,000	Not Applicable	3,000
Pyrene	52	3	23,000	7,500	Not Applicable	2,300
Naphthalene	70	3	23	580	Not Applicable	17
PCBs (Total PCBs)	0.64	1	0.74	8.4	Not Applicable	0.97
2,3,7,8-TCDD (dioxin) equivalents	0.000019	3	0.000016	0.00017	Not Applicable	0.000022

a/ Data Sources:
1. CH2M Hill 1996
2. PES 2006
3. GRI 2007b

[56] Included in Resource Report 7, Appendix G.7, as part of Jordan Cove's September 2017 application to the FERC.

Jordan Cove continues to work with the ODEQ toward the determination of appropriate regulatory requirements for the handling of contaminated soil and sediment. The ODEQ approved Jordan Cove's *Revised Work Plan for Joint Regulatory Closure Settling Basins, Petroleum-Contaminated Soil, Asbestos Waste, and Mill Waste Former Weyerhaeuser Mill Site and Ingram Yard Properties (LNG terminal site)* on July 22, 2013. The plan describes redevelopment of the South Dunes site that would involve increasing existing site grades a minimum of 3 feet with clean structural fill consisting of sand from the new slip to be excavated on the LNG terminal site (Ingram Yard property). Development over the existing mill wastewater system settling basins would require over-excavation of geotechnically unsuitable (highly organic) sludge in the basins and replacement with clean, compacted structural fill. A qualified contractor familiar with handling potentially contaminated materials would be mobilized, and a dredge would be used to remove the basin sludge to a dewatering system. Potentially contaminated material would be transported off-site to an approved ODEQ-regulated facility that would be identified prior to construction. In addition, landfill materials would be removed and handled according to the overall *Mill Site Closure Plan* that was approved by the ODEQ on July 22, 2013.

A disposal plan for contaminated soil would be developed by Jordan Cove once the Project engineering design is finalized. The disposal plan will be submitted to the ODEQ for pre-approval prior to the work. Additional details on the management and regulatory requirements of existing contaminants are provided in Jordan Cove's *Framework Contaminated Media Management Plan.*[57]

Jordan Cove completed a data gap investigation in 2018 to delineate existing petroleum and other contaminants at the former mill site in compliance with the terms and conditions of the No Further Action determination granted by ODEQ in 2006. Based on the analytical results from the data gap investigation, concentrations of PAHs, metals, and/or petroleum hydrocarbons exceeded RBCs for soil. Specific contaminants include naphthalene (46.8 and 92 mg/kg); oil (6,130, 6,190, 14,000, and 61,500 mg/kg); benzo(a)pyrene (2.27 mg/kg); diesel (27,660 mg/kg); and chromium (743 mg/kg). Jordan Cove is in the process of consulting with the ODEQ regarding potential required subsequent remedial mitigation efforts to reduce the concentration of contaminants in soil or eliminate exposure pathways in relation to the Project. Such remedial action(s) would comply with the requirements and recommendations of the No Further Action determination and ODEQ review and approval.

Soils and/or sediments containing residual contamination must be managed and/or disposed in accordance with ODEQ rules. Per guidance from the ODEQ, Jordan Cove would provide prior notice to the ODEQ when grading or ground disturbance activities are planned to occur on the LNG terminal site. In addition, a permanent disposal plan for the boiler ash material would be prepared by Jordan Cove and submitted to the ODEQ for approval prior to site development activities.

Jordan Cove has prepared a *Framework Contaminated Media Management Plan* that includes general measures to be implemented in the event that unanticipated soil contamination is discovered during construction of the Jordan Cove LNG Project but does not include specific monitoring and sampling protocols for handling potential or suspected contamination that might

[57] Included in Resource Report 7, Appendix O.7, as part of Jordan Cove's September 2017 application to the FERC.

be encountered. If Jordan Cove's Environmental, Health and Safety Division determines that additional action is necessary, Jordan Cove would implement the following measures:

- contact a qualified consultant and/or testing laboratory to assist with the determination of the extent and nature of the contamination;
- devise a plan for additional site-specific investigations as necessary;
- conduct site-specific testing and/or laboratory analysis to determine the extent and nature of contamination;
- notify all applicable environmental authorities as required by law, including the ODEQ;
- devise a site-specific plan depending on the nature and extent of the contamination encountered for continuation of construction, which may involve evaluation avoidance options as necessary to support the construction of the proposed facilities;
- devise a strategy or plan for handling wastes in an appropriate manner including waste characterization, hauling, manifesting, and disposal necessary to support continuing construction;
- devise a plan for site stabilization and backfilling; and
- complete all required and necessary agency follow-ups and reporting.

Spills or leaks of fuels, lubricants, or coolant from construction equipment could contaminate soils. The soil and sand on the Project site have high infiltration capacity, and comprise a shallow groundwater (10 feet or less) system with high aquifer transmissivity. A spill, if it occurred, would spread quickly; however, the effects of contamination would typically be minor because of the low frequency of spills and leaks. During construction, Jordan Cove would implement its water quality management plan that includes a SPCC Plan. This plan describes spill prevention practices, spill handling and emergency notification procedures, and training requirements that would be implemented during construction of the Project. The SPCC Plan addresses the unique soil and subsurface conditions of the Project site, including the high permeability, shallow groundwater, and rapid transmissivity. With the implementation of the SPCC Plan and ODEQ requirements, construction of the Project is not anticipated to spread existing contamination or cause additional soil contamination.

4.2.1.3 LNG-Specific Topics

Potentially Contaminated Bay Sediments

The Port developed a sampling and analysis program (SAP; SHN 2006a) that details the sediment collection and testing program conducted on the material that would be dredged during construction of the access channel. The sediment sampling and analysis program followed the Dredged Material Evaluation Framework (DMEF) Tier IIB approach for physical and chemical evaluation of the proposed dredged material and only included physical analysis of materials. As described below, chemical analyses were not required based on grain size.

The results of the grain size distribution based on COE-approved methods (COE et al. 1998) indicated the average percent of sand in sediment samples was over 99 percent. The results of the total volatile solids (TVS) analysis indicated that the average percent TVS in the sediments was approximately 0.7 percent. DMEF Tier IIA states, "If the results of grain size analysis are at least

80 percent sand and TVS is less than 5 percent, the proposed dredging material qualifies for unconfined, aquatic disposal based on exclusionary status." Therefore, the Port's report concluded that further characterization was not considered necessary.

In addition to the access channel, proposed dredging would take place at four locations along/adjacent to the Coos Bay Navigation Channel (i.e., dredge areas 1, 2, 3, and 4). For dredge areas 1 through 4, historical boring logs from the Federal Navigation Channel were evaluated to provide a dredged sediment characterization. Subsurface exploration within the Federal Navigation Channel was performed by GRI in 2005 and 2007 (GRI 2005 and 2007b). More recently, geotechnical site investigations were carried out by GRI in 2011 and 2017. Additional analyses for submittal to the Portland Sediment Evaluation Team (PSET) are underway. A detailed discussion of dredging and material disposal methods is provided in the *Dredged Material Management Plan.*[58]

Jordan Cove has conducted extensive investigations regarding soil contaminants in close coordination with the Portland Sediment Evaluation Team (PSET) at the west portion of the Kentuck mitigation site beginning in 2010. Jordan Cove has submitted four SAPs and three sediment characterization reports for the western portion of the site to the COE from September 2010 to November 2014. These studies document that chemical analysis of samples for VOCs, SVOCs, PAHs, PCBs, metals, dioxins, furans, and butyltin compounds did not detect any contaminants above applicable screening levels and that the material is suitable for its intended use in the Kentuck project site without restriction, with the exception of the golf course irrigation pond. According to the sampling results documented in the November 13, 2014 sediment characterization report, mercury is present at levels above clean fill screening criteria in sediments contained in the golf course irrigation pond. Although oil-range hydrocarbons are also present at this location, these were not detected above applicable screening levels. Affected soil in the Kentuck project site would be excavated and removed to a permitted disposal facility in accordance with an ODEQ work plan that would be approved prior to the removal action.

Jordan Cove prepared a sediment characterization report (GRI 2018) for the east portion of the Kentuck site to characterize material at the former Kentuck Golf Course that would be partially excavated and/or partially overlain by imported material to create a wetlands mitigation site. Sampling and analyses were performed for this portion of the Kentuck site in November 2017. Soil/sediment samples were collected from 10 locations within the intertidal channel and floodplain and analyzed for metals, VOCs, PAHs, SVOCs, PCBs (e.g., Aroclors), and pesticides. With the exception of the detection of the pesticide aldrin above the marine screening level in one area (sample S-27), the sampling and analyses completed show the proposed plan for Kentuck to be consistent with regulatory guidance and applicable screening levels. To address the S-27 area, Jordan Cove proposes to excavate 6 inches below the proposed final grade and replace to design grade with clean imported sand. This excavation would be completed laterally beyond S-27 to a point halfway to the nearest adjacent sample points. The excavated material from the S-27 area would be incorporated into an on-site constructed bermed area with a clean imported sand cap or transported offsite to an approved permitted disposal facility.

[58] Included in Resource Report 7, Appendix N.7, as part of Jordan Cove's September 2017 application to the FERC.

Shoreline along the Waterway for LNG Carrier Marine Traffic

Jordan Cove conducted two studies to evaluate shoreline impacts during the transit of LNG vessels in the waterway to and from the LNG terminal (Moffatt & Nichol 2017a, 2017b). The *Vessel Wakes Impacts Memo* (Moffat & Nichol 2017a) evaluates shoreline erosion within Coos Bay resulting from vessel transit. The study concluded that the proposed LNG terminal combined with the associated changes in the size and speed of vessels expected to utilize the proposed channels would not result in increased shoreline impacts (such as increased erosion) due to ship-generated waves. A rock apron has been proposed to arrest slope migration, or equilibration, before it can progress to a condition that could potentially negatively impact Pile Dike 7.3. Construction of the Pile Dike rock apron is expected to produce a localized, temporary increase in turbidity; however, the long-term effect of the rock apron would improve shoreline stability including accounting for the effects of marine traffic. The *Propeller Wash Analysis Memo* (Moffat & Nichol 2017b) evaluates potential impacts of propeller wash on scour in the slip, access channel, MOF, and at the pile dike areas. An area of potential scour due to propeller wash is located along the eastern side of the slip and access channel, where the maximum bottom propeller wash scour depth is estimated to be nearly 0.5 foot. Jordan Cove would provide slope protection (i.e., armor rip rap as described in section 2.4.1.5) for the west and north sides of the slip, and scour protection would be provided at the base/toe of the bulkhead walls. These measures would provide adequate slope and bulkhead protection to prevent associated scour.

4.2.2 Pacific Connector Pipeline Project

4.2.2.1 General Impacts

Soils along the proposed pipeline route were identified using NRCS surveys for Coos, Douglas, Jackson, and Klamath Counties (NRCS 2004; SCS 1985, 1989, 1993); and NRCS State Soil Geographic Database (STATSGO) and Soil Survey Geographic Database (SSURGO) soil classifications (NRCS 2017). The Forest Service soil resource inventories of the Umpqua, Rogue River, and Winema National Forests were used to assess soil resources in the National Forests (Forest Service 1976, 1977, and 1979). Information in the Forest Service surveys was supplemented by STATSGO and SSURGO data where available.

According to the NRCS Land Resource Regions and Major Land Resource Areas (MLRAs) (NRCS 2006), the pipeline route would cross four MLRAs:

- the Sitka Spruce Belt including the Pacific Coast and Coos Bay area in Coos County;
- the North Pacific Coast Range, Foothills, and Valleys including Coos County and portions of Douglas County;
- the Siskiyou-Trinity Area including portions of Douglas and Jackson Counties, the Umpqua National Forest, and portions of the Rogue River-Siskiyou National Forest; and
- the Klamath and Shasta Valleys and Basins in the southern part of Klamath County.

Soil associations crossed by the pipeline are shown in table G-1 in appendix G by MP, including the mileage percentage of the entire pipeline length. The Medco-McNull-McMullun and Vermisa-Vannoy-Josephine-Beekman soil associations are crossed by 15.7 and 12.9 percent of the pipeline length, respectively. The remaining soil associations are crossed by less than 10 percent of the pipeline length.

Detailed descriptions of all soil associations crossed by the Project and their characteristics are provided in appendix G of this EIS. The remainder of this discussion focuses on the sensitive soils characteristics present along the pipeline route as shown in table 4.2.2.1-1. It is noted that the soil characteristics studies for the Pacific Connector pipeline and the Jordan Cove LNG Project are different in approach. Pacific Connector primarily relies on soils data available from the NRCS databases; and Jordan Cove uses preliminary geotechnical study data as well as NRCS data.

To provide the highest level of detail in quantifying the soil properties and impacts, analysis was based on the characteristics of the individual soil mapping units crossed within each soil association. Major soil characteristics and limitations for the pipeline and aboveground facilities are discussed below. Table 4.2.2.1-1 provides a summary of soil limitations that could be encountered by the pipeline route.

TABLE 4.2.2.1-1

Acreages and Soil Characteristics Crossed by the Pacific Connector Pipeline

Milepost		Total Crossing Length		Sensitive Soil Groups and Estimated Crossing in Miles (acres) a/							
				Erosion From							
From	To	(miles)	County	Water b/	Wind c/	Steep Slopes d/	Large Stones e/	Restrictive Layer f/	Soil Compaction g/	Reclamation Sensitivity h/	Prime Farmland i/
0.00 1.00 10.88R 11.18R 0.09 1.47	0.09 1.47 10.08R 11.72BR 1.00 3.03	1.3	Coos	0.07 (1.22)	0.09 (9.61)	0.07 (1.22)	0.0	0.07 (1.22)	0.84 (22.02)	0.09 (9.61)	0.67 (11.19)
11.08R 3.03	11.18R 10.88R	2.79	Coos	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11.72R 13.65BR 1r.10BR	13.54BR 13.91BR 15.70BR	7.82	Coos	3.35 (45.57)	0.17 (3.19)	3.35 (45.57)	0.0	6.25 (95.44)	7.65 (132.61)	2.76 (38.67)	3.13 (68.51)
20.09BR 24.59BR 28.93 30.31	22.40BR 27.79 29.47 32.50	12.01	Coos	7.55 (117.91)	0.0	5.27 (87.65)	0.65 (11.04)	1.42 (22.78)	10.56 (176)	7.55 (117.91)	0.13 (2.78)
22.40BR 29.47	24.59BR 30.31	2.67	Coos	0.27 (4.12)	0.0	0.27 (4.12)	0.02 (0.13)	0.02 (0.13)	2.67 (41.4)	0.27 (4.12)	1.75 (28.68)
13.54BR 13.91BR 15.70BR 27.79 32.50	13.63BR 15.10BR 20.09BR 28.93 47.26	22.06	Coos Douglas	13.78 (210.15)	0.48 (7.05)	11.15 (170.7)	6.17 (103.95)	15.88 (248.78)	21.45 (329.78)	15.18 (239.45)	0.98 (13.81)
47.26 52.50 57.57	48.06 55.18 58.07	4.28	Douglas	2.02 (28.87)	0.0	1.35 (20.03)	0.342(6.28)	3.53 (46.94)	4.28 (59.94)	3.83 (52.51)	2.74 (37.01)
48.06	52.50	4.47	Douglas	0.67 (8.7)	0.0	0.67 (8.69)	0.0	2.93 (44.93)	4.47 (65.99)	4.23 (62.82)	3.44 (50.64)
55.18 60.59	57.57 61.48	3.35	Douglas	1.45 (22.9)	0.0	1.45 (22.9)	0.07 (2.31)	1.72 (27.5)	3.35 (51.08)	2.59 (40.01)	1.8 (26.71)
58.07 61.48 71.72 91.90	60.59 70.91 89.39 95.23	29.55	Douglas	18.15 (259.16)	0.02 (<1)	18.15 (259.16)	2.3 (52.92)	20.69 (298.78)	29.23 (457.96)	26.22 (406.71)	10.3 (188.82)
70.89 146.38	71.72 146.86	0.9	Douglas	0.49 (10.37)	0.0	0.49 (10.37)	0.29 (7.02)	0.75 (21.83)	0.86 (23.53)	0.49 (10.37)	0.37 (13.16)
74.13	76.36	2.53	Douglas	2.37 (36.24)	0.0	2.37 (36.24)	2.38 (36.28)	2.53 (38.98)	1.3 (22.09)	2.53 (39.53)	<0.1 (1.5)
96.52	104.87	8.36	Douglas	8.24 (122.36)	4.4 (62.36)	8.24 (122.36)	2.88 (41.51)	8.01 (119.45)	4.31 (65.97)	8.36 (124.17)	0.13 (1.81)

TABLE 4.2.2.1-2 (continued)

Acreages and Soil Characteristics Crossed by the Pacific Connector Pipeline

Milepost		**Total Crossing Length (miles)**	**County**	**Sensitive Soil Groups and Estimated Crossing in Miles (acres) a/**							
				Erosion From		**Steep Slopes d/**	**Large Stones e/**	**Restrictive Layer f/**	**Soil Compaction g/**	**Reclamation Sensitivity h/**	**Prime Farmland i/**
73.19 89.39 95.23 104.87	74.13 91.9 96.52 110.10	6.25	Douglas Jackson	3.8 (56.95)	0.85 (11.26)	4.53 (66.7)	2.86 (39.6)	4.11 (61.69)	5.32 (86.28)	5.81 (93.17)	1.72 (32)
105.70 110.10	109.38 111.77	5.0	Douglas Jackson	3.2 (44.26)	3.2 (44.26)	5.0 (84.82)	4.8 (81.57)	4.8 (81.57)	0.37 (5.86)	4.8 (81.57)	0.0
111.77	117.75	5.98	Jackson	1.85 (26.22)	0.0	5.98 (87.09)	4.11 (59.05)	4.25 (62.45)	4.17 (60.15)	4.85 (70.93)	0.59 (8.49)
117.75 146.86 153.07	146.38 152.42 155.02	35.98	Jackson	16.0 (256.54)	0.0	28.87 (449.12)	26.69 (415.9)	32.8 (512.46)	33.68 (526.68)	35.61 (554.35)	5.16 (82.34)
146.38	146.86	0.47	Jackson	<0.1 (1.39)	0.0	<0.1 (1.39)	<0.1 (1.39)	0.47 (6.34)	0.47 (6.34)	0.47 (6.34)	0.39 (4.95)
152.42 155.02	153.07 168.00	13.69	Jackson/ Klamath	0.61 (7.49)	0.0 (0.03)	3.87 (82.93)	5.37 (98.55)	5.29 (82.43)	1.62 (26.5)	3.74 (97.92)	0.75 (12.38)
168.00	174.69	6.81	Klamath	0.0	0.0	0.18 (2.85)	3.13 (38.78)	0.0	2.86 (40.65)	0.18 (2.85)	0.0
174.69	180.20	5.5	Klamath	1.85 (27.19)	0.0	1.85 (27.19)	0.47 (6.41)	2.51 (31.8)	0.0	4.37 (58.99)	0.67 (8.24)
180.2	189.96	9.77	Klamath	1.03 (13.87)	0.0	3.07 (37.89)	1.32 (17.87)	3.36 (25.22)	1.03 (13.23)	3.97 (49.58)	3.45 (45.79)
189.96 197.86 221.06 221.68 224.85 226.22 227.63	190.83 198.59 221.22 224.09 225.52 227.31 228.81	7.2	Klamath	2.24 (27.74)	1.3 (20.91)	4.05 (50.79)	3.96 (49.61)	4.49 (59.32)	6.86 (97.75)	3.83 (48.94)	5.01 (74.57)
190.83 198.59	193.86 199.27	6.66	Klamath	0.33 (6.41)	0.0	0.0 (<1)	0.0 (<1)	4.4 (78.44)	6.66 (118.48)	0.95 (18.93)	6.66 (118.45)
199.27	202.09	2.8	Klamath	0.0	0.23 (4.93)	0.0	0.0	1.34 (23.56)	2.62 (47.16)	0.23 (6.96)	2.62 (47.16)
202.09 215.89 221.22 224.09 225.52 227.31	214.70 218.8 221.68 224.85 226.22 227.63	16.66	Klamath	1.49 (19.72)	3.62 (80.82)	1.81 (24.1)	1.81 (24.1)	8.91 (142.65)	16.65 (278.61)	1.85 (24.89)	15.21 (259.69)

TABLE 4.2.2.1-2 (continued)

Acreages and Soil Characteristics Crossed by the Pacific Connector Pipeline

Milepost		Total Crossing Length (miles)	County	Sensitive Soil Groups and Estimated Crossing in Miles (acres) a/							
				Erosion From		**Steep Slopes d/**	**Large Stones e/**	**Restrictive Layer f/**	**Soil Compaction g/**	**Reclamation Sensitivity h/**	**Prime Farmland i/**
214.7	215.89	4.42	Klamath	3.43	0.09	3.75	3.46	4.04	4.42	3.96	1.2
218.80	221.06			(50.04)	(1.14)	(54.12)	(50.26)	(58.35)	(64.87)	(57.23)	(17.94)
	Project Total	**229.28** [j/]	**All**	**94.3 (1,405.36)**	**14.45 (245.85)**	**115.87 (1,758.04)**	**73.24 (1,144.57)**	**144.57 (2,194.26)**	**178.7 (2,328.14)**	**148.71 (2,328.14)**	**68.90 (1,156.73)**
			Percent	**41.0%**	**6.3%**	**50.5%**	**31.9%**	**63.1%**	**78.1%**	**64.8%**	**30.0%**

Rows and columns may not add correctly due to rounding. Acres rounded to nearest whole acre, miles to nearest tenth of a mile (values below 1 or 0.1, respectively, are shown as "<1"/ "<0.1").

a/ Numerical values shown are miles crossed by construction, including construction right-of-way and TEWAs. Acres affected shown in parenthesis. Soil data from NRCS 2004; SCS (1985, 1989, 1993); Forest Service 1976, 1977, and 1979. NRCS State Soil Geographic Database (STATSGO and SSURGO) soil classifications (NRCS 2017).

b/ Soils with NRCS rating of high or severe.

c/ Soils with NRCS wind erodibility groups 1 and 2.

d/ Soils with slopes greater than 30 percent.

e/ Soils with greater than 25 percent cobbles and/or stones within pipeline trench depth.

f/ Soils with a restrictive soil layer (bedrock or cemented layer) within 60 inches of the soil surface.

g/ Soils with an NRCS rating of high or severe for the Haul Roads, Log Landings, and Soil Rutting category.

h/ Combined rating for soils with high or severe erosion potential, steep slopes, large stones, shallow soils, saline/sodic conditions, clayey soils (greater than 40 percent), and soil map units with dominant amounts of rock outcrop. The Reclamation/Sensitivity type does not include data related to the revegetation sensitivity studies on federally-managed lands (NSR 2015).

i/ Soils with dominant map unit included on either the state or county list of farmland of importance (includes prime farmland, unique farmland, and farmland of statewide or local importance).

j/ In an effort to maintain milepost continuity while adjusting the pipeline route, milepost equations have been incorporated into the alignment. This allows the mileposts, for the most part, to remain unchanged. However, the ending milepost no longer reflects the actual length of the proposed pipeline.

4.2.2.2 Project-Specific Soil Limitations

Prime Farmland

The pipeline alignment crosses approximately 69 miles (30 percent of the pipeline) of soils where the dominant map unit in the MLRA is classified on either the NRCS state or county list of prime farmland or "farmland of statewide importance."[59] These designations were previously described in section 4.2. Permanent impacts on prime farmland soils from the proposed pipeline would be associated with the aboveground facilities, as discussed in section 4.2.2.3 below. Pacific Connector would implement mitigation measures in areas where existing agricultural land uses would be affected (approximated 43 miles of the pipeline route) to minimize impacts on prime farmland and crop yields, such as topsoil salvaging, scarification, and subsequent testing to ensure that potential compaction is remediated. Topsoil salvage is achieved by mechanically segregating topsoil from subsoil to an approved depth and width along the pipeline right-of-way. Topsoil segregation would be performed over the trench line and spoil storage areas in croplands, hayfields, pastures, and areas specified by landowners. Areas where topsoil salvaging and segregation would occur are shown by MP in table 4.2.2.2-1 to minimize potential impact to soil and agricultural productivity.

TABLE 4.2.2.2-1

Areas Where Topsoil Would be Salvaged Along the Pacific Connector Pipeline

Area/Land Use	From (MP)	To (MP)	Mileage
Coos County			
Wetlands/Pasture	3.06	6.45R	3.39
Pasture	8.28R	8.45R	0.17
Pasture	10.96R	11.06R	0.1
Wetland/Pasture	10.96R	11.06R	0.1
Wetland/Pasture	11.19R	12.11BR	0.92
Pasture/Hayfield	22.59	23.04	0.45
Pasture/Hayfield	29.49	29.83	0.34
Pasture/Hayfield	29.87	30.14	0.27
Douglas County			
Croplands/Pasture	49.50	50.25	0.75
Croplands/Pasture	50.30	50.55	0.25
Pasture/Residential	50.72	50.82	0.1
Pasture	51.31	51.55	0.24
Pasture	51.58	51.78	0.2
Pasture/Wetlands/Residential	55.83	56.56	0.73
Pasture/Wetlands/Residential	56.77	57.10	0.33
Pasture/Wetlands/Residential	57.12	57.59	0.47
Wetlands/Pasture/Hayfield	57.61	57.20	-0.41
Wetlands/Pasture/Hayfield	58.21	58.53	0.32
Wetlands/Pasture/Hayfield	58.65	58.73	0.08
Wetlands/Pasture/Hayfield	58.79	59.60	0.81
Wetlands/Pasture/Hayfield	59.66	60.08	0.42
Pasture Pasture/Hayfield	60.15	60.24	0.09
Pasture Pasture/Hayfield	60.45	60.57	0.12
Pasture/Hayfield	60.58	60.66	0.08
Pasture/Hayfield	65.58	65.73	0.15
Pasture	66.88	66.94	0.06
Pasture	66.97	67.08	0.11
Pasture	69.22	69.49	0.27
Pasture	71.36	71.54	0.18
Pasture	76.41	76.47	0.06
Pasture	77.82	78.05	0.23

[59] It is noted that some area mapped as prime farmland or farmland of statewide importance have previously been affected by development activities that have precluded their use for agricultural activities.

TABLE 4.2.2.2-1 (continued)

Areas Where Topsoil Would be Salvaged Along the Pacific Connector Pipeline

Area/Land Use	From (MP)	To (MP)	Mileage
Pasture	79.00	79.03	0.03
Hayfield/Pasture	81.20	81.65	0.45
Pasture	88.29	88.50	0.21
Pasture	88.53	88.57	0.04
Pasture	88.61	88.70	0.09
Pasture/Wetlands	94.35	94.56	0.21
Pasture/Wetlands	94.87	95.07	0.2
Jackson County			
Pasture	118.84	118.91	0.07
Pasture	120.70	120.82	0.12
Pasture/Residential	120.84	120.90	0.06
Pasture/Hayfield	121.90	122.20	0.3
Pasture/Wetlands	128.47	128.69	0.22
Pasture	132.03	132.12	0.09
Pasture/Wetlands	132.03	132.18	0.15
Pasture/Wetlands	132.22	132.51	0.29
Pasture/Wetlands	132.53	132.57	0.04
Pasture/Wetlands	142.26	142.56	0.3
Pasture/Wetlands	142.58	142.66	0.08
Pasture	144.31	144.49	0.18
Pasture	144.58	144.69	0.11
Pasture/Wetlands	145.05	145.95	0.9
Pasture	146.12	146.87	0.75
Klamath County			
Pasture/Hayfield/Wetlands	190.63	197.61	6.98
Pasture/Hayfield/Wetlands	197.74	198.21	0.47
Pasture/Croplands/Wetlands	199.60	214.67	15.07
Pasture	217.30	217.54	0.24
Pasture/Croplands	217.55	217.92	0.37
Pasture/Croplands	221.31	221.85	0.54
Pasture/Croplands	221.95	222.25	0.3
Pasture/Croplands	223.25	223.36	0.11
Pasture/Croplands	224.23	225.65	1.42
Pasture/Croplands	226.03	226.86	0.83
Pasture/Croplands	227.78	227.94	0.16
Pasture	228.35	228.81	0.46
TOTAL			**43.22**

Note: For a description of topsoil segregation and effects on wetlands, see section 4.3. (Up to the top 12 inches of topsoil would be segregated from the area disturbed by trenching in wetlands, except in areas where standing water or saturated soils are present.) Topsoil would not be segregated on federal lands as discussed in section 4.2.3.

Erosion Potential

The pipeline route would cross about 94.3 miles (41 percent of pipeline length) of soils with a high or severe water erosion potential and 14.4 miles (6.3 percent of the pipeline length) of soils with a high wind erosion potential (NRCS wind erodibility groups 1 and 2).

Impacts on soils from erosion would be minimized by following the Pacific Connector's Plan and Procedures and their Project-specific ECRP. Pacific Connector would implement specific water erosion prevention measures such as covering temporary storage piles; covering, seeding and mulching of soil and vegetation piles; and installation of sediment barriers, interceptor ditches or berms, or other measures where necessary, to filter water and divert flow away from sensitive areas. With these measures, significant water erosion would not occur. Pacific Connector would implement reseeding efforts, apply mulch, and water for dust control to minimize potential erosion by wind on the disturbed soils during construction. In addition, as described in section 4.1 of this

EIS, an extensive geotechnical review was conducted to ensure that the route avoided known or potential areas of mass soil movement. This effort required minor reroutes in numerous areas along the alignment to ensure the safety and integrity of the pipeline.

Temporary erosion control measures would be installed immediately after clearing and prior to grading (i.e., the initial soil disturbance). Near waterbodies and wetlands, the EIs would determine in the field the extent of temporary erosion control measures (i.e., sediment barriers) that would need to be installed prior to clearing activities to minimize the potential for runoff to enter a wetland or waterbody. All erosion control devices would be routinely inspected and any damaged or temporarily removed structures would be replaced at the end of each working day. Temporary erosion control measures would be maintained until successful revegetation has been achieved.

Sediment barriers would be used to confine sediment to the construction right-of-way and would be constructed of either silt fence or straw bales. Sediment barriers would generally be placed as follows:

- at the base of slopes adjacent to road, wetland and waterbody crossings where sediment could flow from the construction right-of-way onto the road surface or into the wetland or waterbody;
- adjacent to wetland and waterbody crossings, as necessary, to prevent sediment flow in the wetland or waterbody consistent with the requirements of the FERC's *Procedures* (which Pacific Connector's *Procedures* were based upon); and
- on the downslope side of the right-of-way where it traverses steep side slopes (greater than or equal to 30 percent).

Pacific Connector would install temporary slope breakers to reduce runoff velocity, concentrate flow, and to divert water off the construction right-of-way to avoid excessive erosion. Temporary slope breakers may be constructed of materials such as soil, silt fence, staked straw bales, straw wattles, or sand bags. If it becomes necessary to delay final cleanup, including final grading and installation of permanent erosion control measures, beyond 20 days (10 days in residential areas) after the trench is backfilled in a specific area, Pacific Connector would apply mulch on all disturbed slopes before seeding.

Trench breakers would be installed in the trench and keyed into trench walls on slopes prior to backfilling to slow the flow of subsurface water along the trench to prevent erosion of trench backfill materials. A permanent slope breaker and a trench breaker would be installed at the base of slopes near the boundary between the wetland and adjacent upland areas.

Waterbody crossings would be stabilized and temporary sediment barriers installed within 24 hours of completion of backfilling in accordance with Pacific Connector's *Procedures*. Pacific Connector would install erosion control fabric (such as jute or excelsior) on streambanks and steep slopes at the time of recontouring. The erosion control fabric would be designed for the proposed use and would be approved by the EI, and authorized agency representative on federal lands.

Permanent slope breakers (waterbars) would be installed across the right-of-way on steep slopes (greater or equal to 30 percent). The purpose of these structures is to minimize erosion by reducing runoff velocities, by shortening slope lengths, preventing concentrated flow, and by diverting water off the construction right-of-way. Slope breakers are also intended to prevent sediment deposition into sensitive resources.

Compaction Potential

The proposed pipeline alignment would cross a total of 178.7 miles (78.1 percent of the total pipeline length) of soils that are highly susceptible to compaction. Soils in this sensitive group were determined based on the NRCS rating of high or severe for the Haul Roads, Log Landings, and Soil Rutting categories. Soils in this group are rated based on Unified soil texture classification, rock fragments on or below the surface depth to a restrictive layer, depth to a water table and slope. However, most soils are susceptible to compaction depending on the number of passes of heavy equipment and the moisture content of the soils at the time of construction. Unmitigated soil compaction can result in long-term reductions of soil productivity and increased erosion from increased surface runoff.

Pacific Connector would minimize soil compaction, rutting, and structural damage to wet soils and soils with poor drainage by employing BMPs such as the use of low-ground-weight construction equipment, or operating normal equipment on timber riprap, prefabricated equipment mats, or terra mats. In addition, Pacific Connector would not conduct construction activities during extremely wet weather conditions. During forest clearing activities, the potential for soil compaction would be minimized where cable and helicopter logging methods are used. Where log skidding occurs, several practices would be employed as described in Section 2.3 of Pacific Connector's ***Right-of-Way*** *Clearing Plan for Federal Lands*,[60] where feasible, to minimize the potential for soil compaction.

As described in Pacific Connector's ECRP, regrading, recontouring, scarifying, and final cleanup activities after pipeline construction would mitigate potential soil compaction in all areas of pipeline construction. However, these measures alone would not be sufficient to entirely address soil compaction, and additional measures including subsoil ripping and decompaction with hydraulic excavators would also be necessary to fully address soil compaction. Mitigating compaction promotes infiltration, reduces surface water runoff, minimizes erosion, and enhances revegetation efforts. Pacific Connector would test for soil compaction in agricultural areas (e.g., active croplands, hayfields, and pastures), residential areas, and on NFS and BLM lands. Soil compaction mitigation on federal lands is more specifically discussed in section 4.3.2.

Potentially Contaminated Soils and Groundwater

A review of the ODEQ's ECSI database (ODEQ 2017a, 2017b, 2017c, and 2017d) and EPA's (2017) EnviroMapper - Facility Detail Report revealed that there are 116 sites with either cleaned-up, potential, or confirmed soil and/or groundwater contamination within 0.25 mile of the pipeline route as listed in table G-2 in appendix G. Based on a review of these sites, the sites listed in appendix G have the potential to encounter contaminated soil or groundwater during construction. During the review of these sites, the following issues were considered: sites that are closed might have residual contamination and contaminated soils might be carried by the wind to adjacent areas.

The sites listed below are close to the proposed pipeline infrastructure and construction areas, and database listings were insufficient to reach a conclusion regarding the potential for encountering

[60] This plan was included in Pacific Connector's application to the FERC as Appendix U to the POD.

associated contaminated soil or groundwater during Project construction. As a result, **we recommend that**:

- **<u>Prior to the end of the draft EIS comment period</u>, Pacific Connector shall consult with the ODEQ regarding existing soil and groundwater contamination at the sites listed in appendix G, and file the results of this consultation, along with any proposed site-specific soil or groundwater handling, management, and disposal procedures.**

During construction, contamination from accidental spills or leaks of fuels, lubricants, and coolant from construction equipment could adversely impact soils. To minimize impacts, Pacific Connector would implement measures contained in its SPCC Plan, which specifies cleanup procedures in the event of inadvertent spills during Project construction. Pacific Connector has developed a *Contaminated Substances Discovery Plan*[61] that specifies the measures that would be implemented if unanticipated contaminated soil or groundwater are encountered during construction. Some of the measures outlined in that plan specify that all construction work in the immediate vicinity of areas where hazardous or unknown wastes are encountered would be halted; that all construction, oversight, and observing personnel would be evacuated to a road or other accessible up-wind location until the types and levels of potential contamination can be verified, and that if an immediate or imminent threat to human health or the environment exists, one of Pacific Connector's emergency response contractors identified in the SPCC Plan or the National Response Team would be notified and mobilized. Pacific Connector would update the *Contaminated Substances Discovery Plan* to be consistent with the latest information regarding contaminated sites in proximity to the pipeline alignment prior to construction.

4.2.2.3 Pipeline-Specific Topics

Soil Limitations

<u>Reclamation Sensitivity</u>

The pipeline alignment would cross a total of 148.7 miles (64.8 percent of the pipeline length) of soils that are rated as having reclamation sensitivity or poor revegetation potential (NSR 2014). These soils may have a combination of characteristics that could require additional measures or BMPs to reduce erosion and sedimentation potential. Restoration of these soils may require adaptive seed mixtures and implementation of revegetation practices (i.e., fertilization, mulching, monitoring) to enhance revegetation success. Section 10.0 of Pacific Connector's ECRP includes a detailed description of soil restoration procedures and requirements. Pacific Connector would implement revegetation procedures, such as topsoil segregation, recontouring, scarification, soil replacement, seedbed preparation, fertilization, seed mixtures, seeding timing, seeding methods, and supplemental plantings to ensure revegetation success. Information contained in the BLM/Forest Service *Technical Memorandum Soil Risk and Sensitivity Assessment on BLM and National Forest System Lands* (NSR 2015a) would be used to identify and treat areas on BLM and Forest Service lands where specific and focused soils remediation measures may be required to minimize potential erosion and accomplish vegetation objectives (see section 4.2.3).

Pacific Connector would work with individual landowners to address restoration of active agricultural and residential landscaping, if affected by pipeline construction. In active agricultural

[61] The *Contaminated Substances Discovery Plan* was included in Pacific Connector's application to the FERC as Appendix E to the POD.

areas, Pacific Connector would restore the lands in compliance with the *Plan* and *Procedures*, and would also compensate the landowner for any additional restoration measures (e.g., replanting crops) that the landowner preforms. In residential areas, Pacific Connector would use contractors familiar with local horticultural and lawn establishment procedures for reclamation work or would compensate the landowner if the landowner conducts that restoration work; Pacific Connector would still be responsible for ensuring the restoration efforts are successful.

Seedbed preparation would be conducted, where necessary, immediately prior to seeding to prepare a firm seedbed conducive to proper seed placement and moisture retention. Seedbed preparation would also be performed to break up surface crusts and to eliminate weeds which may have developed between initial reclamation and seeding. A seedbed would be prepared in disturbed areas, where necessary, to a depth of up to four inches using appropriate equipment to provide a seedbed that is firm, yet rough. A rough seedbed is conducive to capturing or lodging seed when broadcasted or hydroseeded, and it reduces runoff and erosion potential. The rough seedbed would retain soil moisture for seedling germination and establishment.

In most areas, final right-of-way cleanup procedures are sufficient because they leave a surface smooth enough to accommodate a drill seeder pulled by a farm tractor and rough enough to catch broadcasted seed and trap moisture and runoff. Where residential and cropland areas are disturbed, more intensive ground and seedbed preparations may be required including rock collection, grading, and soil preparation/amending. The EI would be responsible for determining where seedbed preparation measures are required prior to seeding.

Pacific Connector has consulted with the NRCS and land management agencies regarding recommended seed mixtures for the Project area. The seed mixtures developed for the Pacific Connector Pipeline Project are based on these agency recommendations and are provided in the ECRP. During right-of-way negotiations, private landowners may also request other seed mixtures than those proposed in the ECRP. These specific landowner requested/specified seed mixtures would be documented in landowner right-of-way agreements.

Disturbed areas would be seeded within six working days of final grading, weather and soil conditions permitting. If final grading occurs more than 20 days after pipe installation and backfilling, Pacific Connector would apply mulch on all disturbed areas prior to seeding. Seeding would proceed in accordance with the ECRP.

Restrictive Layer

Soils that are rated as having a restrictive layer are shallow soils that have a lithic, paralithic, or other restrictive soil layer within 60 inches of the soil surface. The pipeline alignment would cross a total of about 144.6 miles (63.1 percent of the pipeline length) of soils with a restrictive layer. These soils have thin profiles, restrictive root zones and hold less available water for plant growth. Shallow and hard bedrock can also restrict trenching, requiring special equipment (rock hammers/saws) or blasting in some areas to efficiently excavate the trench to required design depths. Excavation of bedrock or cemented layers may require additional measures to provide suitable pipe bedding materials. Soils in this group are also included in the soils that have reclamation sensitivity. Section 4.1 of this EIS discusses shallow soils, rock lithology, potential blasting locations, rock removal, and disposal.

Large Stones

Soils with more than 25 percent cobbles and stones in the soil profile can present problems with surface reclamation because they hold less available water for plant growth and generally require broadcast seeding methods. Further, the introduction of stones or rocks from subsoils to surface soil layers during trenching or blasting can adversely affect agricultural productivity and agricultural equipment operation.

The pipeline route would cross a total of 73.2 miles (31.9 percent of the pipeline length) of soils containing cobbles and stones. Pacific Connector has developed measures that would reduce impacts on restoration and revegetation caused by rocks, cobbles, and stones near the soil surface. In agricultural and residential areas, topsoil would be segregated except on federal lands as discussed in section 4.2.3. A rock picker would be used to remove large fragments.

Rocks excavated from the trench would be kept separate from topsoil during construction and during surface preparation as part of restoration. Pacific Connector has identified rock disposal sites. These sites are listed in table 4.1.2.4-1. Large rocks and boulders would also be used as OHV barriers along the right-of-way and at road crossings to control unauthorized OHV access to the right-of-way both during construction and operation. Additionally, large rocks and boulders would be piled in upland areas along the right-of-way to create habitat diversity features where approved by the EI or Pacific Connector's authorized representative and the landowner or land management agency.

Aboveground Facilities

Pacific Connector's aboveground facilities would be located within or immediately adjacent to the pipeline construction right-of-way. Each facility would be fenced and graveled immediately after construction. Permanent impacts on soils would occur at aboveground facilities that would be graded and graveled or where facilities would be constructed. Soil limiting characteristics at aboveground facilities are listed on table 4.2.2.3-1. Soils at specific aboveground facilities are described below. Section 10.0 of Pacific Connector's ECRP includes a detailed description of erosion control and soil reclamation procedures and requirements.

TABLE 4.2.2.3-1

Summary of Soils Limitations – Pacific Connector Pipeline Aboveground Facilities

Proposed Facility	Area (ac) a/	Soil Mapping Unit (STATSGO)	High Erosion Potential b/	Steep Slopes c/	Large Stones d/	Restrictive Layer e/	High Compaction Potential f/	Poor Revegetation Potential g/	Prime Farmland h/
Jordan Cove Receipt MS, BVA #1, Receiver Site	1.72	S6398 (61D)	N/A i/	N/A i/	N/A i/	N/A i/	N/A i/	N/A i/	N/A i/
MLV #2 (Boone Creek Road) /	<1	S6399 (54F)	No	No	No	Yes	No	No	Yes
MLV #3 (Myrtle Point Sitkum Rd)	<1	S6402 (47B)	No	No	No	No	Yes	No	No
MLV #4 (Deep Creek Rd)	<1	S6408 (262E)	No	No	No	Yes	Yes	Yes	No
MLV #5 (S. of Ollala Creek)	<1	S6360 (14C)	No	No	No	No	Yes	No	Yes
MLV #6 Launcher/ Receiver & CT	<1	S6385 (189F)	Water	Yes	Yes	Yes	No	Yes	No
MLV #7 (Pack Saddle Rd)	<1	S6360 (270F)	Water	Yes	No	No	Yes	Yes	No
MLV #8 (Hwy 227)	<1	S6360 (183B)	No	No	No	No	Yes	Yes	Yes
MLV #9 (BLM Rd 33-2-12) /	<1	S6381 (69E)	No	Yes	Yes	Yes	No	Yes	No
MLV #10 (Shady Cove)	<1	S6380 (122E)	Water	Yes	Yes	Yes	Yes	Yes	No
MLV #11 (Butte Falls & Launcher/Receiver Site) /	<1	S6380 (125C)	No	No	Yes	Yes	Yes	Yes	No
MLV #12 (Heppsie Mtn Quarry)	<1	S6380 (111G)	Wind	Yes	Yes	Yes	Yes	Yes	No
MLV #13 (Clover Creek Rd)	<1	S6387 (R6)	No	No	No	No	Yes	No	No
MLV #14 & Launcher/ Receiver Site	<1	S656 (129B)	No	No	Yes	Yes	No	Yes	No
MLV #15 Klamath River /	<1	S1150 (40)	No	No	No	No	Yes	No	Yes
MLV #16 (Hill Road)	<1	S6356 (58A)	No	No	No	Yes	Yes	No	Yes
Klamath Compressor Station, Klamath-Beaver and Klamath-Eagle Meter Stations, MLV #17, Launcher/Receiver & CT	21.40	S542 (19C)	Wind	No	No	No	Yes	No	Yes

TABLE 4.2.2.3-1 (continued)

Summary of Soils Limitations – Pacific Connector Pipeline Aboveground Facilities

Proposed Facility	Area (ac) a/	Soil Mapping Unit (STATSGO)	High Erosion Potential b/	Steep Slopes c/	Large Stones d/	Restrictive Layer e/	High Compaction Potential g/	Poor Revegetation Potential h/	Prime Farmland k/
Blue Ridge Communication Site	<1	S6396 (4D)	Water	No	No	No	Yes	Yes	No
Signal Tree Communication Site	<1	S6395 (50D)	No	No	Yes	Yes	Yes	Yes	No
Sheep Hill Communication Site	<1	S6395 (50D)	No	No	Yes	Yes	Yes	Yes	No
Harness Mountain Communication Site (Existing)	0.0	S6396 (122E)	No	No	Yes	No	No	No	No
Starveout Communication Site	<1	S6361 (89E)	Water	No	Yes	Yes	No	Yes	No
Flounce Rock Communication Site	<1	S6380 (113G)	Water	Yes	No	Yes	Yes	Yes	No
Robinson Butte	<1	S6388 (0038)	No	Yes	Yes	No	No	No	No
Stukel Mountain Communication Site	<1	S6388 (16E)	No	Yes	Yes	No	No	Yes	No

MS = meter station, MLV = mainline block valve, CT = communication tower. Soil data from NRCS (2004); SCS (1985, 1989, 1993); Forest Service (1976, 1977, and 1979). NRCS State Soil Geographic Database (STATSGO and SSURGO) soil classifications (NRCS 2017).

a/ Area of pipeline construction and operation right-of-way disturbance. Acreages rounded to nearest whole acre; values less than 1 are reported as <1.

b/ Soils with NRCS water erosion rating of high or severe; and/or soils with NRCS wind erodibility groups 1 and 2.

c/ Soils with slopes greater than 30 percent.

d/ Soils with greater than 25 percent cobbles and/or stones within pipeline trench depth.

e/ Soils with a restrictive soil layer (bedrock or cemented layer) within 60 inches of the soil surface.

f/ Soils with an NRCS rating of high or severe for the Haul Roads, Log Landings, and Soil Rutting category.

g/ Combined rating for soils with high or severe erosion potential, steep slopes, large stones, shallow soils, saline/sodic conditions, clayey soils (greater than 40 percent), and soil map units with dominant amounts of rock outcrop. The Reclamation/Sensitivity type does not include data related to the revegetation sensitivity studies on federally managed lands (NSR 2015).

h/ Soils with dominant map unit included on either the state or county list of farmland of importance (includes prime farmland, unique farmland, and farmland of statewide or local importance).

i/ These aboveground facilities would be located entirely within the proposed Jordan Cove LNG terminal. This soil association has been previously disturbed and would be graded and built up during construction of the Jordan Cove LNG terminal prior to construction of the Pacific Connector pipeline.

Jordan Cove Meter Station

The Jordan Cove Meter Station (at MP 0.0) would be within the South Dunes site, on the North Spit, in Coos County. This area was formerly the location of the Menasha-Weyerhaeuser mill (operated between 1961 and 2003), which is now dismantled. Petroleum hydrocarbons (e.g., fuel, fuel oil, lubricants, solvents, and hydraulic oil constituents) are present in subsurface soils and groundwater from past mill operations/practices in the area of the South Dunes site. In addition, transite/asbestos siding and other debris from the Weyerhaeuser Company mill demolition are present in surficial soils. The meter station would occupy approximately 1 acre on the Bullards-Nehalem-Dune Land soil association. There are no known soil limitations that would affect the construction and use of this parcel for a meter station. The meter station site would be graded and its elevation built up by Jordan Cove from soils excavated and dredged from the LNG terminal access channel and marine slip. The Jordan Cove Meter Station would also contain MLV#1, a receiver, and a communication tower.

The Jordan Cove Meter Station location and pipeline alignment are in the general area of potential debris/fill; however, the TEWA usage has been reduced in size, and the debris/fill material would not be disturbed as the TEWA would be used only for staging equipment or materials. To protect human health and ensure worker safety, Pacific Connector or qualified contractor personnel would collect representative samples of the debris/fill in the excavation zone prior to construction for the meter station and pipeline alignment and surrounding materials for laboratory analysis for contaminants of concern listed above. Based on the results of laboratory analysis, any contaminated material would be removed and properly disposed of in accordance with appropriate federal and state regulations. Where the removed fill must be stockpiled pending characterization and ODEQ approval, Pacific Connector would take precautions to avoid mitigation of existing contamination (e.g., appropriate liner for storage area, berms). Clean backfill would be utilized to backfill excavations. This approach is consistent with ODEQ recommendations for this general area (ODEQ - No Further Action Determination Letter, Former Weyerhaeuser Containerboard Mill North Bend, Coos County, Oregon Tax Lots #25S-13W-4-100, 25S-13W-3-200, and the LNG terminal [Ingram Yard portion of 25S-13W-0-200 ECSI Site ID No. 1083]).[62] Lastly, Pacific Connector would mandate pipeline contractor training that would include this site's status and history, and instruct that site excavation and disturbance is to be limited. Documentation of all analytical results and disposal records would be filed with the FERC following construction of the meter station.

Klamath Compressor Station

The Klamath Compressor Station would be located at MP 228.8 in Klamath County. The site would also include the Klamath-Beaver and Klamath-Eagle meter stations, MLV #17, a launcher/receiver, and a communication tower. The compressor station would occupy a 21.4-acre site within the Fordney-Calimus Poman soil association. The two dominant mapped soil units (i.e., Fordney loamy fine sand and Calimus loam) are considered prime farmland if irrigated; however, the site is not irrigated or otherwise in agricultural use. Fordney loamy fine sand has a high wind erosion hazard; therefore, periodic watering may be necessary to minimize fugitive dust during construction clearing and grading activities until the site has been stabilized with gravel.

[62] Included in Jordan Cove's Resource Report 7, Appendix G.7, in their September 2017 application to the FERC.

Gas Control Communication Towers

Pacific Connector would install a series of communication towers for gas control and system monitoring at 8 locations. As discussed above, one new communication tower would be erected within the Klamath Compressor Station and the Jordan Cove Meter Station. No soils would be disturbed where an existing tower would be utilized. Pacific Connector expects to erect new communication towers adjacent to existing facilities at three locations: Flounce Rock, Robinson Butte, and Stukel Mountain. Construction of the new towers would disturb about 0.2 acre at each location. Information on the soil characteristics for the new tower locations is provided in table 4.2.2.3-1. Pacific Connector would minimize erosion by following its ECRP. Because the communication towers are industrial facilities, the presence of stones, restrictive layers, and poor revegetation potential would not be environmentally adverse factors in the construction and operation of the towers.

Launchers/Receivers and Mainline Block Valves

Seventeen MLVs would be installed along the pipeline according to USDOT spacing requirements (49 CFR Part 192 Section 192.179). Potential impacts from the MLVs are accounted for within the proposed pipeline because these facilities would be located entirely within the construction right-of-way. However, because these small (less than a tenth of an acre) sites would contain aboveground facilities, they would permanently affect soils. Six of the MLV locations would be on soils designated as prime farmland, with five of these locations (MLVs 5, 8, 15, 16, and 17) within existing cropland/pastures rangeland. Construction and operation of the launchers/receivers and MLVs would take a total of about one-third of an acre out of agricultural production, excluding acres that were already discussed under the meter stations. Loss of agricultural production would be a factor considered in compensation to landowners negotiated by Pacific Connector while obtaining easement agreements.

Temporary Storage Yards

Pacific Connector has identified 36 potential, privately-owned contractor and pipe storage yards in the general area of the proposed route. These yards would be used for pipe offloading, office trailers, fabrication, equipment storage, material staging and employee parking. Although it is unlikely that all 36 yards would be utilized, numerous sites are identified and evaluated given that some sites could become unavailable at the time of construction. Most (28) of the yards are located in existing industrial areas or sites that have been previously disturbed by filling, grading, and gravelling activities, and therefore the soils resources at these locations have been substantially altered from natural conditions. Of the remaining storage yards, two have been partially disturbed (i.e., Coquille Park and Rogue Aggregates). Only six storage yards have not been disturbed previously. These include four storage yards that are currently used for agriculture (i.e., Roth, Riddle Pasture, Klamath Falls North of Cross Road East, and Klamath Falls North of Cross Road West). The remaining undisturbed storage yards (i.e., Klamath Amuchastegui Building, and Klamath Falls Industrial Oil) are undeveloped land in industrial parks.

Soil associations, mapping units, and sensitive soil characteristics are listed for each of the storage yards in table 4.2.2.3-2.

TABLE 4.2.2.3-2

Contractor and Pipe Storage Yards with Sensitive Soil Characteristics (Pastures, Fields and Vacant Lots)

Name	County	Section, Township, Range	Acres a/	Description	Soil Association – Soil Mapping Units and Sensitive Soil Characteristics b/
Coquille Park	Coos	Section 35, T. 27 S., R. 13 W.	3.3	Sturdivant Park, adjacent to rail siding	Soil Association: Waldport (OR0797) Soil Mapping Units: (Coos County): 40 & 41 Sensitive Soil Characteristics: 8, 10, 11, 12
Roth	Douglas	Section 29, T. 28 S., R 5 W.	3.8	Pasture, adjacent to rail siding, connect to Pipeline right-of-way	Soil Association: Ruch-Medford-Takilma (OR059) Soil Mapping Units: (Douglas County): 81A & 189F Sensitive Soil Characteristics: Philomath-Dixonville complex soil: 1, 4, 5, 8, 9 Foehlin soil: 8, 12
Riddle Pasture	Douglas	Section 45, T. 30 S., R. 6 W.	7.3	Vacant field adjacent to industrial sites and rail siding	Soil Association: Ruch-Medford-Takilma (OR058) Soil Mapping Units (Douglas County): 14A &14C Sensitive Soil Characteristics: 1, 3
Rogue Aggregates	Jackson	Section 20, T. 36 S., R. 2 W.	38.9	Pasture/undeveloped land within active aggregate quarry and processing facility and undeveloped land includes rail siding	Soil Association: Ruch-Medford-Takilma (OR059) Soil Mapping Units (Jackson County): 10B, 31A, 55A, 133A Sensitive Soil Characteristics: 1
Klamath Amuchastegui Building	Klamath	Section 10, T. 39 S., R. 9 E.	25.5	Existing commercial site and undeveloped industrial lots adjacent to rail siding	Soil Association: Fordney-Calimus-Poman (OR059) Soil Mapping Units (Klamath): 19A, 90 Sensitive Soil Characteristics:1, 5
Klamath Falls Industrial Oil	Klamath	Sections 8, 9 & 10, T.39 S., R. 9 E.	39.5	Undeveloped Industrial Lots adjacent to highway, rail and rail sidings	Soil Association: Malin-Laki-Henley (OR008) Soil Mapping Units (Klamath): 7C, 18A, 74D Sensitive Soil Characteristics: 1, 4
Klamath Falls North of Cross Road East	Klamath	Section 1, T. 40 S., R.9 E.	7.0	Farmland, adjacent to rail siding	Soil Association: Fordney-Calimus-Poman (OR059) Soil Mapping Units (Klamath): 58A Sensitive Soil Characteristics: 1, 4
Klamath Falls North of Cross Road West	Klamath	Section 1, T. 40 S., R.9 E.	37.0	Agricultural Field	Soil Association: Fordney-Calimus-Poman (OR059) Soil Mapping Units (Klamath): 58A Sensitive Soil Characteristics: 1, 4

a Acreages are rounded to nearest tenth acre.
b/ Sensitive Soil Characteristics:
1 – All soils within this mapping unit (based on SSURGO geographic databases) are considered prime farmland soil or farmland of statewide importance.
2 – These soils are positioned on floodplains and stream terraces and have soil components within the mapping unit that may be poorly drained and have either seasonal high water tables at or near the surface and have surface soils that are susceptible to compaction impacts and some that are susceptible to occasional or rare flooding.
3 – These soils have low strength and are susceptible to compaction especially if wet.
4 – Shallow to bedrock or duripan
5 – Seasonal high water table

Pacific Connector would use appropriate erosion control measures to minimize potential impacts at the yards. After the pipeline is constructed, the temporary yards would be restored to their previous condition and use.

The Coquille Yard is identified as a TEWA intended for use as a contractor yard for staging pipe, equipment, or other construction supplies and materials. Based on historical information, contaminated soil at the site was removed and treated in a soil treatment area and the site was encapsulated with fill dirt from ODOT in 1995. In 1998, the ODEQ recommended no further action for the site. Pacific Connector has identified this yard for staging of pipe, equipment or other construction supplies and materials and the use would be surface use only. Minor surface grading would be limited to pushing berms as needed to support pipe joints. This limited use of the site is not expected to result in effects on the encapsulated area or in potential effects on human health, worker safety, or the environment. However, Pacific Connector would consult with the ODEQ prior to use of the site to confirm that the intended use is consistent with the protections required for this property. In addition, Pacific Connector would include pipeline contractor training regarding this site's status and history and would require that site excavation and disturbance be limited.

Access Roads

Most access roads for the pipeline would be existing federal (BLM and Forest Service), state, county, and private roads that intersect the proposed pipeline alignment. Where needed, Pacific Connector proposes to modify existing roads and construct new roads to ensure construction and operation access. Approximately 3.8 acres of soils would be disturbed to construct 10 TARs, and approximately 2.16 acres of soils would be permanently affected to construct or reconstruct 15 PARs. The TARs would be constructed using appropriate BMPs to minimize potential impacts and would be designed and constructed for their intended use. All TARs would be reclaimed (i.e., regraded, scarified, and replanted) upon completion of construction according to the landowner or agency requirements. Soils along PARs would be permanently compacted and unvegetated.

4.2.3 Environmental Consequences on Federal Lands

The causes and extent of environmental effects on soil resources from the proposed Project are described above. The Forest Service has determined that these effects will, in some areas and for some activities will exceed allowable thresholds for detrimental soil conditions established by the applicable forest plans. Therefore, the Forest Service has proposed plan amendments and compensatory mitigation actions to make provision for the proposed project.

The BLM has not established detrimental soil condition thresholds within the applicable Resource Management Plans and therefore has not proposed similar plan amendments.

4.2.3.1 Environmental Consequences on National Forest Lands

The Project may cause soil mixing, displacement, and compaction on the backfilled trench and the spoils side of the corridor, steep slopes in some locations, and rocky soils where subsoil ripping would not effectively be restored to a condition with less than 15 percent increase in bulk density. As a result, an estimated 30 to 70 percent of the project area would likely have detrimental soil conditions from mixing, displacement, or compaction. Complete rehabilitation would also require recovery of the soil biology, which requires restoration of the soil organic matter and time. Some surface erosion is likely to occur; however, 85 to 95 percent of surface erosion can be prevented or trapped on-site by application of measures in the ECRP. Any surface erosion that does occur is expected to be minor, and within the range of natural variability for watersheds in southwest Oregon (see appendix F.4).

The Project may cause sediment transport from construction clearing and use of roads by the project. As part of the Project mitigation, road sediment reduction projects are aimed at reducing the chronic contributions of fine-grained sediment from road surfaces and fill failures to stream systems. As described in chapter 2, table 2.1.5-1, mitigation activities include decommissioning of 93.9 miles of Forest Service roads. Proposed road decommissioning would increase infiltration of precipitation, reduce surface runoff, and reduce sediment production from road-related surface erosion in the watershed where the impacts from the Project occur. Sediment reduction would also include closure of about 1.2 miles of Forest Service roads, reducing fine-grained sediments by eliminating traffic impacts.

LRMPs for the Umpqua, Rogue River, and Winema National Forests have standards and guidelines that establish thresholds for detrimental soils conditions as shown in table 4.2.3.1-1.

TABLE 4.2.3.1-1

Thresholds for Detrimental Soil Conditions on NFS Lands

Watershed	Total Project Acres a/	Cleared Acres b/	Threshold Acres Allowed c/	Minimum Projected Acres in Detrimental Condition d/	Maximum Projected Acres in Detrimental Condition	Minimum Acres Over Threshold	Maximum Acres Over Threshold
Umpqua National Forest							
Days Creek- South Umpqua	53	21	11	6	15	-5	4
Elk Creek-South Umpqua	30	29	6	9	20		14
Upper Cow Creek	74	74	16	22	52	6	36
Trail Creek	50	41	12	12	29	0	17
Total Umpqua NF	***207***	***165***	***45***	***49***	***116***	***8***	***71***
Rogue River National Forest							
Little Butte Creek	277	207	28	62	145	34	117
Winema National Forest							
Spencer Creek, All Land Allocations other than Management Area 8	85	73	17	22	51	5	34
Spencer Creek Riparian Areas (Management Area 8)	7	7	1	2	5	<1	4
Total Winema NF	***92***	***80***	***18***	***24***	***56***	***5***	***38***
Total Cumulative Direct Effect, All NFS Lands	**576**	**452**	**91**	**135**	**317**	**47**	**226**

Rows and columns may not add correctly due to rounding. Acres rounded to nearest whole acre (values below 1 are shown as "<1").
a/ Total Project Acres is all acres within the right-of-way. This includes cleared and uncleared areas.
b/ Cleared Acres are the construction corridor and TEWAs.
c/ Threshold Acres Allowed is the threshold from the standards and guidelines times the Total Project Acres.
d/ Projected Acres in Detrimental Conditions is estimated at 30 percent (minimum) to 70 percent (maximum) of the Cleared Acres.

Detrimental soil conditions are measured upon completion of a project after restoration and rehabilitation work is completed. Detrimental soil conditions are defined in each national forest LRMP, but generally include:

- compaction, which is defined as an increase in bulk density of 15 percent when compared to adjacent undisturbed soils for all soils except volcanic ash or pumice. For volcanic ash soils, compaction is defined as a 20 percent increase in bulk density when compared to adjacent undisturbed soils;
- displacement or mixing, which is the horizontal removal by mechanical means of 50 percent or more of the topsoil or "A" horizons, or mixing of these layers with less fertile subsurface mineral layers such that the continuity of the horizons is lost; and
- detrimental puddling, which is the physical change to soil structure that results when traffic ruts and molds a soil to a depth of 6 inches or more.

Precise estimates of detrimental soil conditions likely to exist at completion of a project are impossible to make. For the purposes of this assessment, 30-70 percent of the pipeline project area may be in a detrimental soil condition upon completion of all soil restoration and rehabilitation efforts. Table 4.3.2.2-1 provides an estimate of predicted detrimental soil conditions. Where projected acres exceed the threshold, an amendment of the affected LRMP is necessary to make provision for the Pacific Connector Pipeline Project.

The impacts of detrimental soil conditions include:

- a possible reduction in soil productivity from mixing or displacement of nutrient-bearing soil layers; and
- a potential increase in runoff and erosion from decreased infiltration of compacted soils.

See section 4.3.4 for measures that would be applied on federal lands to address these issues.

Amendments of Forest Plans Related to Thresholds for Detrimental Soil Conditions

Where detrimental soil conditions exceed the threshold established in an LRMP, an amendment of the LRMP is necessary for the Project to proceed. The following amendments of National Forest LRMPs are proposed to waive limitations on detrimental soil condition thresholds to make provision for the Project. Additional discussion of forest-specific management direction related to soil conditions is provided in section 4.7.3.

UNF-3. Project-Specific Amendment to Waive Limitations on Detrimental Soil Conditions Within the Pacific Connector Right-of-Way in All Management Areas[63]

For planning purposes, soil impacts are considered long term. Soil compaction and displacement would be confined to the project area, but predicting how much would be affected is an estimate based on professional judgment and the nature of corridor construction. See section 4.3.2.3 for a discussion of environmental consequences.

The Project would likely result in a detrimental soil condition on 30 to 70 percent of the project area on the Umpqua National Forest (165 acres) due to displacement and compaction. Approximately 11 of those acres would likely be in Riparian Reserves. Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the Project. Existing LRMP standards and guidelines allow up to 20 percent of the project corridor (about 33 acres of the corridor on the Umpqua National Forest) to be in a degraded soil condition upon completion of a project. The Pacific Connector Pipeline Project would exceed these thresholds by about 8 to 71 acres on the Umpqua National Forest. These impacts would be spread over four separate fifth-field watersheds. See section 4.7.3 and appendix F.4, Aquatic Conservation Strategy Assessment, for a watershed-specific evaluation. Amendment of the Umpqua National Forest LRMP to waive limitations on detrimental soil conditions is not expected to prevent attainment of Aquatic Conservation Strategy objectives (section 4.7.3 and appendix F.4). See section 4.7.3 for a discussion of this amendment in the context of the Umpqua National Forest LRMP.

[63] Forest-Wide Soils Standard and Guideline #1 (Umpqua LRMP IV-67)

RRNF–6. Project-Specific Amendment to Waive Limitations on Detrimental Soil Conditions Within the Pacific Connector Right-of-Way in All Management Areas[64]

The Pacific Connector Pipeline Project would likely result in a degraded soil condition on an estimated 30 to 70 percent of the pipeline right-of-way on NFS lands in the Rogue River National Forest (all in the Little Butte Creek Watershed) due to displacement and compaction (Orton 2009). Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing LRMP standards and guidelines allow up to 10 percent or 28 acres of the pipeline corridor to be in a degraded soil condition on completion of a project. Thus, the pipeline project would likely exceed this threshold by about 34 to 117 additional acres or 0.07 to 0.2 percent of the 57,234 acres (NFS lands only) within the Little Butte Creek Watershed upon completion. About 2 to 6 acres of degraded soil conditions above LRMP thresholds may be in Riparian Reserves. See section 4.7.3 and appendix F.4, Aquatic Conservation Strategy, for a watershed-specific evaluation of consequences. Amendment of the Rogue River National Forest LRMP to waive limitations on detrimental soil conditions is not expected to prevent attainment of Aquatic Conservation Strategy objectives (section 4.7.3 and appendix F.4). See section 4.7.3 for a discussion of this amendment in the context of the Rogue River National Forest LRMP.

WNF-4 and WNF-5: Project-Specific Amendment to Waive Limitations on Detrimental Soil Conditions within the Pacific Connector Right-of-Way in All Management Areas[65]

These standards and guidelines of the Winema National Forest LRMP restrict the amount of an area that may be in a degraded soil condition as a result of a management activity. They are considered together here because the assessment is the same for both standards.

The Pacific Connector Pipeline Project would likely result in a degraded soil condition on an estimated 30 to 70 percent project right-of-way on NFS lands in the Winema National Forest (all in the Spencer Creek Watershed) due to displacement and compaction (Orton 2009). Compaction can largely be addressed by subsoil ripping, but displacement would be unavoidable because of the nature of the project. Existing LRMP standards and guidelines allow up to 10 percent (1.5 acres) of the project corridor in Management Area 8 Riparian Areas or 20 percent (17 acres) in the pipeline corridor outside of Management Area 8 to be in a degraded soil condition on completion of a project. Thus, the pipeline project would likely exceed this threshold by an estimated 5 to 38 additional acres or 0.03 to 0.16 percent within the Spencer Creek watershed upon completion. See section 4.7.3 and appendix F.4, for a watershed-specific evaluation of consequences. Amendment of the Winema National Forest LRMP to waive limitations on detrimental soil conditions is not expected to prevent attainment of Aquatic Conservation Strategy objectives (section 4.7.3 and appendix F.4). See section 4.7.3 for a discussion of this amendment in the context of the Winema National Forest LRMP.

Cumulative Impacts, All Units

Cumulatively, on the Umpqua, Rogue River, and Winema National Forests, detrimental soil conditions within the pipeline project area are expected to range between about 135 and 317 acres

[64] Standards and guidelines in the Rogue River National Forest LRMP (pp. 4-41, 4-83, 4-97, 4-123, 4-177, 4-307)
[65] Winema National Forest LRMP Management Direction for Riparian Areas page 4-73 (WNF-4) and 4-137 (WNF-5).

(table 4.3.3.3-1), or about 47 to 226 acres over the combined LRMP threshold for the pipeline project of 91 acres. Assuming an even distribution over the 30.6-mile NFS part of the pipeline project area, this equals about 2 to 8 acres of detrimental soil conditions above the LRMP thresholds for each mile of pipeline, spread over six separate fifth-

Mitigation also includes storm-proofing of 11.4 miles of Forest Service roads would reduce sediment from roads by increasing the resistance of a road to failure during high-intensity rainfall events. Storm-proofing strategies include improving drainage, reducing diversion potential at culverts, outsloping road surfaces and replacing culverts with hardened low water fords. Road sediment reduction activities would result in approximately 207 total acres (assuming a typical 16-foot wide roadway) of long-term sediment mitigation on federal lands.

Road stabilization and culvert replacement of 11 sites on NFS lands would reduce road-related sediment by stabilizing or removing failing cut and fill slopes. Culvert replacement reduces sediment by replacing undersized or failing culverts with culverts that are appropriate to pass debris at higher flows. This reduces the probability of fill failure associated with plugged culverts.

The locations of the road sediment reduction activities are listed in table 4.2.3.1-2.

TABLE 4.2.3.1-2

Mitigation Projects to Address LMP Amendments on NFS Lands

Unit	Watershed	Mitigation Group	Project Type	Project Name	Quantity	Unit
Umpqua National Forest	Elk Creek - South Umpqua	Road sediment reduction	Road Storm-proofing	Elk Creek Road Storm-proofing	9.2	miles
	Elk Creek - South Umpqua	Aquatic and Riparian Habitat	Fish Passage	Elk Creek Fish Passage Culverts	5	sites
	Elk Creek - South Umpqua	Road sediment reduction	Road Decommissioning	Elk Creek Road Decommissioning	5.9	miles
	Trail Creek	Road sediment reduction	Road Decommissioning	Trail Creek Road Decommissioning	0.3	miles
	Trail Creek	Road sediment reduction	Road Storm-proofing	Trail Creek Storm-proofing	2.2	miles
	Upper Cow Creek	Road sediment reduction	Road Closure	Upper Cow Creek Road Closure	1.2	miles
	Upper Cow Creek	Road sediment reduction	Road Decommissioning	Upper Cow Creek Road Decommissioning	1.0	miles
	Upper Cow Creek	Aquatic and Riparian Habitat	Fish Passage	Upper Cow Creek Fish Passage Culverts	6	sites
Rogue River National Forest	Little Butte Creek	Road sediment reduction	Road Decommissioning	Little Butte Creek Road Decommissioning	57.5	miles
Winema National Forest	Spencer Creek	Road sediment reduction	Road Decommissioning	Spencer Creek Road Decommissioning	29.2	miles

a/ Mileages are rounded to nearest tenth of a mile.

4.2.3.2 Soil Risk and Sensitivity Assessment

At the request of the BLM and Forest Service, Pacific Connector identified areas on BLM and NFS lands along the proposed Project where there is a low vegetation recovery potential. These soils included combined characteristics including high or severe erosion potential, steep slopes, large stones, shallow soils, saline/sodic conditions, clayey soils (greater than 40 percent), and soil map units with dominant amounts of rock outcrop. Certain types of disturbed soils where residual soil compaction exists in subsurface soil layers, topsoil has eroded, soil horizons have been mixed, and/or topsoil has been removed, can lead to conditions where revegetation can be very difficult, no matter what mitigation methods are employed.

In order to specifically identify areas of revegetation concern where more rigorous mitigation might be required, a Soil Risk and Sensitivity Assessment was performed for the BLM and Forest Service in 2015. The intent of the assessment was to identify the areas where additional soil decompaction, erosion control, or other types of site-specific and focused remediation measures may be required on BLM and NFS lands to minimize erosion potential and/or accomplish agency revegetation objectives. Soil risk and sensitivity factors were identified by a BLM/Forest Service team including four criteria in the assessment of the risk element; plant mortality, soil erosion, slope rating and aspect; and three levels of sensitivity, primarily based on qualitative values related to management objectives.

As depicted in table 4.2.3.2-1, approximately 83 percent of the Project area, or about 1,143 acres, is rated as Level 1 – very low or Level 2 – low for combined risk and sensitivity. These are locations where revegetation measures are expected to be successful with decompaction and other standard methods described in the ECRP. Approximately 18 percent of the Project area, or about 237 acres, is rated as Level 3 – moderate or Level 4 – high for combined risk and sensitivity where more aggressive erosion controls and/or soil remediation are likely to be needed.

TABLE 4.2.3.2-1

Risk/Sensitivity Ratings by Administrative Unit by Watershed (Acres)

Unit	Watershed	Risk Sensitivity Rank				
		1 (very low)	**2 (low)**	**3 (moderate)**	**4 (high)**	**5 (very high)**
Coos Bay BLM	East Fork Coquille River	13	26	4	32	0
	Coquille River	0	<1	<1	<1	0
	North Fork Coquille River	5	22	8	8	0
	Middle Fork Coquille River	9	58	6	9	<1
	Coos Bay-Frontal Pacific Ocean	<1	2	<1	<1	0
	Subtotal	**27**	**108**	**20**	**19**	**<1**
Roseburg BLM	Clark Branch South Umpqua	2	7	1	0	0
	Olalla-Looking Glass	10	10	5	0	0
	Days Creek -South Umpqua	13	146	16	3	0
	Middle Fork Coquille River	6	17	3	<1	0
	Myrtle Creek	2	65	24	<1	0
	Elk Creek	<1	2	<1	<1	0
	Subtotal	**33**	**247**	**50**	**4**	**0**
Medford BLM	Big Butte Creek	3	<1	1	7	0
	Little Butte Creek	35	63	12	3	0
	Shady Cove RR	10	49	13	3	0
	Trail Creek	28	41	5	0	0
	Subtotal	**76**	**153**	**32**	**13**	**0**
Lakeview BLM	Spencer Creek	**2**	**<1**	**12**	**<1**	**0**
Umpqua National Forest	Days Creek - South Umpqua	0	40	15	0	0
	Elk Creek - South Umpqua	<1	31	<1	0	0
	Trail Creek	15	24	0	0	0
	Upper Cow Creek	7	39	15	9	<1
	Subtotal	**22**	**134**	**30**	**9**	**<1**
Rogue River National Forest	Little Butte Creek	**158**	**119**	**14**	**3**	**0**
Winema National Forest	Spencer Creek	**12**	**52**	**25**	**3**	**0**
	Total	**328**	**814**	**183**	**54**	**<1**

Note: Rows and columns may not sum correctly due to rounding. Acres rounded to nearest whole acre (values below 1 are shown as "<1").

Areas rated as Level 3 – moderate (about 183 acres or 13 percent of the Project) had either high risk or high sensitivity but not both, or were ranked as moderate for both criteria. Areas that ranked as Level 4 – high (about 54 acres or 4 percent of the Project) had both high sensitivity and high risk and would be considered high priority areas for aggressive soil remediation. Less than one acre was ranked Level 5 – very high and considered to have a very high priority for aggressive restoration measures.

Areas ranked a Level 3 – moderate to 5 – very high (237 acres total) would be recommended for more site-specific validation of the risk criteria used in this assessment to confirm that specific locations merit consideration of the more aggressive soil remediation measures listed below:

- a 2- to 3-inch organic mulch surface application (80 percent coverage) of woodchips, logging slash, and/or straw;
- adaptive seed mixes and vegetation to better fit site conditions;
- deep subsoil decompaction with hydraulic excavators that leave constructed corridor mounded and rough with maximum water infiltration so that water cannot flow downhill for any appreciable distance;
- more aggressive use of constructed surface water runoff dispersion structures such as closely placed and more pronounced slope dips and water bars, etc.;
- more aggressive use of constructed surface runoff entrapments such as silt fencing, sediment settling basins, or straw bale structures, etc.;
- more aggressive placement (100 percent coverage) and depth (3 to 4 inches) of ground cover using woodchips, logging slash, straw bales, wattles, etc.; and
- priority monitoring of results as needed to measure success or make future recommendations.

4.2.4 Conclusion

Constructing the Project would result in both short-term and long-term permanent impacts on soils, including soils characterized for reclamation sensitivity. However, based on the applicants' proposed construction and operations procedures, methods, and plans to address known and unanticipated soil contamination, and the implementation of impact minimization and mitigation measures, we conclude that constructing and operating the Project would not significantly affect soils.

4.3 WATER RESOURCES AND WETLANDS

4.3.1 Groundwater

4.3.1.1 Jordan Cove LNG Project

The Jordan Cove LNG Project area is underlain by the unconfined Dune-Sand Aquifer. This aquifer is located within unconsolidated deposits of sand and gravel, which may also contain variable quantities of silt and clay (USGS 2009b). The Dune-Sand Aquifer is generally 100 feet thick (USGS 1992). The aquifer extends to a depth of -160 feet below sea level. Groundwater has been found within about 8 to 10 feet depth at the terminal and fluctuates with the tides and seasonal precipitation. Because the terminal site is bordered on three sides by saltwater bodies, saltwater intrudes into the aquifer and influences groundwater quality (GSI 2017). Iron concentration is also an existing groundwater concern in the area.

High concentrations of iron in shallow groundwater arise from leaching that occurs as rainfall percolates through vegetative litter (such as leaves and pine needles) and into the underlying dunal sands (GSI 2017). Once the percolating water reaches the water table, the iron remains dissolved in the shallow groundwater and can migrate deeper into the aquifer at and near the CBNBWB production wells, which are all screened at depths of 50 feet and greater. Historically, the CBNBWB has observed higher iron concentrations in water from some of its production wells at the northern end of the west wellfield. As part of its wellfield management plan, pumping from these wells was terminated indefinitely to reduce the downward migration of high-iron groundwater from the shallow portion of the aquifer in that area. CBNBWB would not use those wells to meet the Jordan Cove LNG Project's water supply needs.

Information maintained by the OWRD indicates that there are four groundwater wells permitted for industrial use and fire protection by the Roseburg Forest Products located within or near the disturbance area. Additionally, the CBNBWB maintains 18 non-potable, groundwater withdrawal wells north of the terminal site. The closest CBNBWB well is about 3,500 feet north of the terminal site.

A review of EPA's sole source aquifer (SSA) mapping revealed that the closest SSA is approximately 40 miles north-northeast of the Jordan Cove LNG Project.[66] Additionally, a review of ODEQ data showed that the site would not overlie any Groundwater Management Areas where groundwater contamination from non-point source activities warrants state intervention.

Impacts and Mitigation

Jordan Cove would obtain water from the CBNBWB to construct and operate the Jordan Cove LNG Project. As shown in table 4.3.1.1-1, Jordan Cove estimates that it would need a total of about 667 million gallons of water for construction and operation of the Jordan Cove LNG Project.

[66] EPA defines an SSA area as one that supplies at least 50 percent of the drinking water consumed in the area overlying the aquifer. EPA guidelines also stipulate that these areas can have no alternative drinking water source(s) that could physically, legally, and economically supply all those who depend upon the aquifer from drinking water (EPA 2013).

TABLE 4.3.1.1-1

Projected Water Usage for the Proposed Jordan Cove LNG Project

Construction			
Activity	**Total (million gallons)**	**Peak Use (thousand gallons per month)**	**Potable (Y/N)**
General Construction Activities	11.3	382.0	N
Grading Activities	488.4	21,861.0	N
LNG Tank Hydro	60.0	30,000.0	N
Drinking Water	1.7	57.0	Y
Concrete Batch Plant	7.2	275.0	Y
Workforce Housing	26.9	1,102.0	Y
TOTAL	**595.5**		
Operation			
Source of Operation- Phase Water Demand	**Annual Water Demand (million gallons)**	**Average Instantaneous Flowrate (gallons per minute)**	**Potable (Y/N)**
Process Water Makeup	36.3	69	Y
Quench Water	15.8	30	Y
Plant Water	15.8	30	Y
Buildings	3.7	7	Y
TOTAL	**71.5**		

Constructing and operating the Jordan Cove LNG Project could affect groundwater, because of the shallow depth to groundwater and the permeability of the overlying sands and gravels across the site. Site stabilization, excavation, pile driving, and the installation of permanent aboveground facilities could all affect groundwater. In addition to the permanent modification of site topography which could affect underlying groundwater characteristics (quantity, flow, and quality); an inadvertent release of equipment-related fluids, such as lubricating oil, gasoline, and diesel fuel, could affect groundwater. Installing piles to support the Jordan Cove LNG Project could create vertical conduits further affecting underlying groundwater characteristics. Additionally, these conduits could also transmit contaminants.

Three of four Roseburg Forest Products wells would be buried to create a construction staging area and would be permanently abandoned in accordance with state regulations. Jordan Cove would drill new wells to the east to replace the buried wells. The fourth well would remain in place. We conclude that neither construction nor operation of the Project would impact the CBNBWB wells to the north due to the distance of the wells from the Project (the closest CBNBWB well is about 3,500 feet north of the terminal).

The excavation and grading required to create the marine slip could cause local groundwater elevations to shift as a result of the change in topography; however, this change would be minor and localized. Creating the marine slip would also shift the seawater interface inland, but it would not affect the water supply wells.

Based on the depth to groundwater, dewatering would be required during construction of the marine slip. The anticipated method for dewatering is the use of well-points, which consist of a closely spaced series of small-diameter shallow wells connected to a dewatering pump via a common headermain (i.e., a pipe that context to the dewatering pump). The contractor would determine the most appropriate method for dewatering excavations and obtain appropriate permits prior to construction. All water associated with dewatering would be allowed to infiltrate elsewhere onsite and return to the groundwater table. Water associated with construction dewatering would not be directly discharged to waterbodies until either filtered or directed to a settling pond before discharge in accordance with Jordan Cove's ESCP and their *Plan* and *Procedures*. A monitoring program would be conducted prior to, during, and after construction to monitor potential impacts on ground and surface waters. Dewatering would have temporary, localized effects on groundwater movement, but flow patterns would return to normal soon after construction.

An inadvertent equipment-related fluid spill could adversely affect groundwater quality. The significance of the effect would vary depending on fluid, quantity spilled, and location of the spill. To prevent and reduce the potential of a spill and the resulting impact on groundwater, Jordan Cove would implement measures as described in its SPCC Plan.[67] These measures include refueling procedures; spill response procedures, spill response materials, and training; countermeasures/contingency plan; and hazardous liquids storage, and disposal. Spill-related impacts during operation of the Jordan Cove LNG Project would mainly be associated with fuel storage, facilities use, equipment refueling, and equipment maintenance, which would be prevented or minimized with the implementation of Jordan Cove's SPCC Plan.

The terminal site would have a system of curbs, drains, and basins to collect and contain any spills of LNG during operation. In the unlikely event that LNG is spilled, the cryogenic liquid would vaporize rapidly upon contact with the warm air and water. Because LNG is not soluble in water and would completely vaporize shortly after being spilled, the LNG could not mix with or contaminate groundwater.

During operation, the LNG terminal would cover about 100 acres with impervious surface materials, such as asphalt, concrete, and compacted gravel. The conversion of pervious surface to impervious surface can typically cause a decrease in the local recharge of shallow groundwater (by converting infiltration to runoff); however, Jordan Cove would capture most runoff for infiltration into the ground on-site with only high flows expected to run off directly to the bay. Additionally, in comparison to the total 12,480-acre area of the Dune-Sand Aquifer, this 0.8 percent area reduction would not likely result in an adverse effect on the level of groundwater in the area. Through use of the measures discussed above, we conclude that impacts on groundwater resources at the Jordan Cove LNG Project would be minimized to the extent practicable and would not be significant.

Five domestic supply wells in the vicinity of the Kentuck project were evaluated for their vulnerability to saltwater intrusion caused by inundation of the former golf course area as part of the Project wetland mitigation. Of the five wells, two were determined to be moderately to highly vulnerable to Project impacts, and a third was found to have low to moderate vulnerability. Jordan Cove has initiated discussions with the landowners regarding mitigation strategies to offset potential effects on these wells, including well replacement, and other means of settlement.

[67] The preliminary SPCC Plan was included in Jordan Cove's September 2017 application to the FERC as Appendix F.2 to Resource Report 2. The preliminary Spill Plan provides general content but would be updated prior to the start of construction to final detail.

4.3.1.2 Pacific Connector Pipeline Project

The Pacific Connector pipeline (and associated facilities) would be located above four general aquifer types: unconsolidated-deposit; pre-Miocene rock; volcanic and sedimentary rock; and Pliocene and younger basaltic rock.

Unconsolidated-deposit Aquifers – The pipeline would overlie unconsolidated-deposit aquifers for approximately 7.6 miles in and around Coos Bay (between MPs 3.0 and 23.4), 3.1 miles in Douglas County between MPs 55.3 and 69.7, and 23.0 miles in the Klamath Basin between MPs 191.9 and 214.9. These aquifers consist primarily of sand and gravel and are the most productive and widespread aquifers in Oregon. These unconsolidated-deposit aquifers typically provide freshwater for most public-supply, domestic, commercial, and industrial purposes (USGS 1994).

Pre-Miocene Rock Aquifers – The majority of the pipeline route between MPs 23.5 and 155.8 would overlie aquifers in pre-Miocene rocks. These aquifers consist of undifferentiated volcanic rocks, undifferentiated consolidated sedimentary rocks, and undifferentiated igneous and metamorphic rocks principally in the mountainous areas crossed by the pipeline. Within and west of the Cascade Range, the consolidated sedimentary rocks are of marine origin and commonly yield salt water. At depth, the salt water can contaminate overlying freshwater aquifers. Permeability of the aquifers varies greatly. Water from wells completed in these aquifers is used mostly for domestic and agricultural (livestock watering) supplies (USGS 1994).

Volcanic and Sedimentary Rock Aquifers – Northeast of Medford, the pipeline route enters a groundwater area of volcanic and sedimentary rock aquifers for about 8.2 miles between MPs 134.2 and 156.9. These aquifers consist of a variety of volcanic and sedimentary rocks that generally yield fresh water but locally can yield salt water. About 30 percent of the fresh groundwater withdrawals are used for public supply, about 20 percent are used for domestic and commercial, and about 50 percent are used for agricultural (primarily irrigation) purposes (USGS 1994).

Pliocene and Younger Basaltic-rock Aquifers – In the Klamath Basin, between MPs 191.9 and 228.8, the pipeline route passes through an area of Pliocene and younger basaltic-rock aquifers for about 51 miles while also passing in and out of unconsolidated deposit aquifers. Pliocene and younger basaltic-rock aquifers yield fresh water that is used mostly for agricultural (primarily irrigation) purposes (USGS 1994).

Depth to groundwater varies throughout the Project area. Approximately 26 miles (or 13 percent) of the pipeline route would cross areas of shallow groundwater where the water table ranges from zero to 6 feet bgs. Approximately 16 of those 26 pipeline miles would be in areas that have seasonally high groundwater (fall through spring) and the remaining 10 pipeline miles, primarily in the Klamath Basin, would be located in areas with shallow groundwater year-round.

Groundwater-fed springs and seeps were identified along the pipeline route during wetland surveys and by review of aerial photos. Additional springs and seeps may be identified by landowners during easement negotiations and through contact with adjacent property owners. The owners would be asked to identify springs and seeps and their uses. For springs and seeps located within

200 feet of the construction disturbance, Pacific Connector would implement its *Groundwater Supply Monitoring and Mitigation Plan*.[68]

No EPA-designated SSAs would be crossed by the Pacific Connector pipeline. The nearest EPA-designated SSA is located approximately 40 miles to the north.

The 1996 federal Safe Drinking Water Act (SDWA) requires Source Water Assessments for all public water systems that have at least 15 hookups, or serve more than 25 people year-round. About 80 percent of Oregonians get their drinking water from public water systems. The Oregon Health Authority and the ODEQ Drinking Water Protection Program jointly manage the SDWA assessment requirements. ODEQ maintains the Drinking Water Protection database[69], which includes public drinking water source areas for groundwater and surface water, as well as the locations of public water system intakes and public groundwater wells. ODEQ has identified and established wellhead protection areas (WHPAs) to protect public drinking water sources. The SDWA defines a WHPA within the recharge area of a well as the surface and subsurface area surrounding a water well or well field, supplying a public water system, through which contaminants are reasonably likely to move toward and reach such a water well or well field. The pipeline would cross six WHPAs as shown in table 4.3.1.2-1 (ODEQ 2017e). One pipe yard is located within the Klamath Auction Cafeteria WHPA, and one rock source and disposal site (Rum Rye/MP 160.41) is located within the Medford Water Commission WHPA.

TABLE 4.3.1.2-1

Wellhead Protection Areas Crossed by the Pacific Connector Pipeline Project

Starting Milepost	Ending Milepost	County	Public Groundwater Source Area	Public Drinking Water System ID
6.38R	6.74R	Coos	Kentuck Golf Course	4190858
195.09	196.29	Klamath	Production Metal Forming, Inc	4195058
197.43	197.77	Klamath	Green Diamond Resources Services LLC	4193994
198.45	199.62	Klamath	Collins Products LLC	4193995
199.26	199.66	Klamath	Columbia Plywood Corp	4194403
200.54	201.12	Klamath	Crossroads Mobile Home Park	4100446

There are also numerous private wells located along the pipeline route that are exempt from water rights permitting and the locations are not known. To identify these unmapped wells, Pacific Connector would ask the property owners to identify their wells and the water use. For wells located within 200 feet of the construction disturbance, Pacific Connector would implement its *Groundwater Supply Monitoring and Mitigation Plan*. Table 4.3.1.2-2 lists the seven private wells within 200 feet of the construction work area for which location information was available (OWRD 2017).

[68] Included in Pacific Connector's application to the FERC as Appendix F.2 of Resource Report 2.
[69] According to the ODEQ water quality mapping and GIS data page, for security reasons, the agency restricts access to the GIS layers with latitude/longitude readings of wells, springs and intakes (ODEQ 2017e).

TABLE 4.3.1.2-2

Private Wells Within 200 Feet of Construction Work Space for the Pacific Connector Pipeline Project

Milepost	Permit Number	Use	Distance to Construction Area (feet)
190.8	10354	Irrigation	85
201.1	15997	Supplemental Irrigation	116 a/
202.5	15120	Irrigation	175
203.8	15818	Irrigation	31
205.7	15134	Irrigation	118
217.3	3957	Irrigation	62
NA	15245	Industrial	55 b/

a/ Well located 50 feet of a temporary extra work space
b/ Well located 55 feet from Millington 1 Yard

Impacts and Mitigation

Construction activities such as; grading, trenching, dewatering, and backfilling could cause minor fluctuations in shallow groundwater levels, increase turbidity within shallow groundwater and alter the flow path of springs and seeps.

As described previously, approximately 26 miles of the pipeline route would cross areas where groundwater can be found at or very near the surface. In areas with a high groundwater table where standard dewatering may be insufficient, Pacific Connector may use “push-pull” or “float” techniques to install the pipeline. While the installation of trench breakers and trench dewatering by pumps to an upland area may be feasible for small areas of seasonally high groundwater, we note that some of these shallow groundwater areas could extend over 1.6 miles (see table H-4 in appendix H). For longer stretches of the pipeline route, trench dewatering through a well point pumping system with a groundwater treatment plan (such as controlled discharging to a straw bale structure or filter bag) may be required. Dewatering may locally lower the groundwater table and alter flow paths; however, these impacts would be temporary, and the dewatering typically occurs over a few days. If there are wells, seeps, or springs near the dewatering activities, they would be monitored for effects.

Near-surface soil compaction caused by heavy construction vehicles could reduce a soil’s ability to absorb water, which would affect infiltration/groundwater recharge rates and could affect underlying groundwater flow and quality. To minimize these impacts excavated topsoil and subsoils would be segregated within wetlands, agricultural areas, and at the request of landowners, and returned as closely as practical to their original soil horizon and slope position. Following construction, restoration of compacted soils would include regrading, recontouring, scarifying (or ripping), and final cleanup activities. Decompacting soils would restore water infiltration, reduce surface water runoff, minimize erosion, and support revegetation efforts.

There are 116 sites with cleaned-up, potential, or confirmed soil and/or groundwater contamination within 0.25 mile of the pipeline route where there is the potential to encounter contaminated soil or groundwater during construction. The potential to encounter previously contaminated soils and groundwater is evaluated and discussed in the Contaminated Soils and Groundwater section under section 4.2.2.3.

A spill or inadvertent release of equipment-related fluids could adversely affect underlying groundwater quality and use. To minimize the potential for a spill or inadvertent release, Pacific Connector would implement numerous measures as described in its SPCC Plan.[70] These measures include, but are not limited to:

- regular inspection of containers and tanks;
- use of secondary containment of fuel storage tanks and hazardous materials containers 55-gallons or greater;
- implementation of emergency response procedures, including spill reporting procedures; and
- use of standard procedures for excavation and off-site disposal of any soils contaminated by spillage.

Prior to construction, Pacific Connector would include in the SPCC Plan the types and quantities of hazardous materials that would be stored or used during construction. Project personnel would be trained and prepared to demonstrate their ability to implement the SPCC Plan to federal, state, or local inspectors.

In addition to the SPCC Plan, Pacific Connector would implement the measures described in its *Contaminated Substances Discovery Plan*[71] to address an unanticipated discovery of contaminants during construction. As described previously, this plan outlines practices to protect human health and worker safety and measures that would be taken to prevent further contamination.

As described in section 4.1, Pacific Connector has identified numerous locations where blasting may be required for pipeline installation. Blasting could temporarily increase turbidity in groundwater. Pacific Connector has developed a *Blasting Plan*[72] to minimize potential adverse impacts on the environment, nearby water sources, structures, or utilities. As stated in the *Blasting Plan*, licensed blasting contractors would conduct the blasting activities in accordance with all applicable federal, state, and local regulations. Pacific Connector would obtain all necessary permits if blasting is required.

Constructing the Project could affect springs, seeps, and wells. Depending on the location of a well, spring or seep relative to the pipeline, the flow of the feature could be temporarily or permanently affected. These resources could be redirected and experience changes in quantity and quality. To minimize potential impacts, prior to construction, Pacific Connector would implement the measures described in its *Groundwater Supply Monitoring and Mitigation Plan.* Landowners would be supplied with documentation that explains the proposed pipeline construction methods, and outlines the pre-construction field investigation for the identification and monitoring of groundwater supplies. Pre-construction surveys would be conducted to confirm the presence and locations of all groundwater supplies for landowners within and adjacent to construction workspace. Pacific Connector would conduct post-construction sampling if requested by the landowner or in disputed situations to determine the effects of construction, if any, on the

[70] The SPCC Plan was included in Pacific Connector's September 2017 application to the FERC as Appendix B.2 to Resource Report 2.
[71] Included in Pacific Connector's September 2017 application to the FERC as Appendix E of the POD.
[72] The *Blasting Plan* was included in Pacific Connector's September 2017 application to the FERC as Appendix C of the POD.

groundwater supply. The landowner would be provided with a point of contact with Pacific Connector to report potential problems with wells, springs, and seeps believed to be the result of construction. If a groundwater supply is affected by the Project, Pacific Connector would work with the landowner to provide a temporary supply of water; if determined necessary, Pacific Connector would provide a permanent water supply to replace affected groundwater supplies. Mitigation measures would be coordinated with the individual landowner to meet the landowner's specific needs and be specific to each property.

Operation of the aboveground pipeline facilities would include connections to fixed belowground pipes. Pacific Connector would conduct monitoring in accordance with the DOT requirements during operations to minimize the potential of corrosion and leaks that could affect groundwater. Additionally, Pacific Connector would implement BMPs as detailed in the ECRP and SPCC Plan to avoid, minimize, and mitigate the spill of any hazardous substances that could affect shallow groundwater and/or unconsolidated aquifers.

4.3.1.3 Conclusion

The construction of the Project would temporarily affect groundwater. However, based on the characteristics of underlying groundwater, the applicant's proposed construction and operations procedures and methods, and their implementation of impact minimization and mitigation measures, we conclude that constructing and operating the Project would not significantly affect groundwater resources.

4.3.2 Surface Water

The surface waters in the Project area include marine waters along the shipping route within 3 nautical miles of the coast, Coos Bay, and adjoining surface waters, and streams crossed by or near Project facilities extending from Coos Bay about 229 miles to the connecting point of the proposed pipeline in Klamath County in eastern Oregon. State and federal laws and regulations that will affect Project actions related to surface waters are discussed in chapter 1. Waters having special status relative to some of these laws and regulations are discussed below. The discussion is separated into two sections, the first dealing with effects on waters from actions relating to the development and operation of the Jordan Cove LNG Project and the second addressing actions related to the development and operation of the Pacific Connector pipeline.

4.3.2.1 Jordan Cove LNG Project

The Jordan Cove LNG Project would be located in Coos Bay, Oregon. Coos Bay is a major coastal estuary with a surface area of about 12,380 acres at mean high water. Coos Bay is fed by about 30 tributaries, including the Coos River, Millicoma River, Catching Slough, Isthmus Slough, Pony Slough, South Slough, North Slough, Kentuck Slough, and Haynes Inlet. The estimated average annual discharge at the mouth of Coos Bay is 2.2 million acre-feet of fresh water (Roye 1979). The Coos Bay watershed covers an area of approximately 739 square miles of Oregon's southern coastal range and is included in the larger South Coast Watershed Basin (ODEQ 2012b).

The existing Federal Navigational Channel is used by recreational, fishing, and major transport vessels to access multiple locations within Coos Bay from the open ocean and coastal marine waters. Four areas adjacent to the Federal Navigation Channel would be modified (see chapter 2 of this EIS) and used by LNG carriers transiting to the Jordan Cove LNG Project. Between the existing navigation channel and the terminal marine slip, Jordan Cove would create a new access channel. The Oregon Institute of Marine Biology (OIMB) sampled physical oceanographic data in Coos Bay, near the proposed location of the terminal access channel, from August 2009 through December 2010 (Shanks et al. 2010, 2011). The OIMB data set included salinity, temperature, and Chlorophyll a. The OIMB data show there is little variation exhibited in salinity during the tidal cycle, but slightly lower salinity levels occur during low tides and slightly higher salinity levels during high tides. In contrast, temperatures are markedly higher during low tides than high tides. In effect, the results of the OIMB sampling program indicate that there is a great amount of seasonal, but only moderate daily, variability in the physical oceanographic data of the waters of Coos Bay near the Jordan Cove LNG Project.

Impact and Mitigation

The potential impacts and mitigation associated with the construction of the Jordan Cove LNG Project and LNG carrier traffic are related primarily to Project-related dredging, stormwater management, carrier travel, and carrier water use. The effects are related to increases in turbidity, suspended and deposited sediment, bottom and shoreline erosion, toxic substance releases, and water temperature changes.

Jordan Cove would not use surface water sources during construction[73] or operation of the terminal, and all waters discharged from the site would be treated prior to release, including decant water[74] returning from on-land dredge deposits. Permits would be obtained for all wastewater discharges as required by ODEQ. A more detailed presentation of water supply needs for both construction and operation is provided in section 4.3.1.1 and table 4.3.1.1-1.

There are no process water discharges anticipated from the liquefaction process. There would be some wastewater discharges from the oil-water separators that would be directed to the industrial wastewater pipeline. There are no anticipated changes to water quality in Coos Bay from the release of wastewater from the Jordan Cove LNG Project.

The ODEQ's Integrated Report includes Coos Bay on the Section 303(d) list of waterbodies not meeting the criteria for shellfish growing since 2004, due to elevated fecal coliform measurements. Coos Bay is listed as Category 5, water quality limited, and a Total Maximum Daily Load (TMDL) is needed (ODEQ 2012c). Wastewater generated during construction and operation of the Jordan Cove LNG Project would be treated by the City of North Bend's wastewater treatment system via a new sewer line, and therefore the Project is not likely to add fecal coliform to Coos Bay.

<u>Turbidity and Sedimentation</u>

Dredging and construction activities at the Jordan Cove LNG Project would result in temporary increases in turbidity and sedimentation in Coos Bay. Details on marine facility construction, including dredging activities, are provided in chapter 2 of this EIS. Dredging activity, primarily associated with slip, access channel, temporary material barge berth, MOF, and marine waterway modifications would be the major sources of turbidity and suspended sediment in Coos Bay. The

[73] Water from Coos Bay would be included with estuarine dredged bottom sediment transported to land storage areas; no reduction in Coos Bay water volume would occur from this water use.
[74] Water that is included with dredge bottom material from the bay that goes to on-land deposition areas will be held until sediment settles before it is returned to the access slip or adjacent bay areas. ESCP procedures will be implemented to meet turbidity discharge standards.

construction of the marine slip would have most of the slip dredging separated from the bay by an earthen berm and would not affect bay turbidity. Other sources of turbidity would include a dike rock pile apron, Trans-Pacific Parkway/U.S. 101 intersection widening, and various construction-related tailing lines placements.

All work in the bay would be done during the ODFW recommended in-water window between October 1 to February 15. Within the access channel, dredging would be conducted using a hydraulic (e.g., suction) dredge with a cutterhead or mechanical (e.g., clamshell) dredge. The applicant has indicated that the hydraulic cutter suction dredge is their preferred dredging method (due to the lower turbidity that would be generation) and would be used as the primary method; however, the mechanical dredge would need to be used in certain locations due to the presence of buried woody debris or other materials in the substrates that could not be removed using hydraulic methods (e.g., the mechanical dredging methods would be used in parts of the access channel near the shoreline and along the proposed modifications to the marine waterway).

Jordan Cove commissioned modeling efforts to estimate the range of turbidity and suspended sediment that would result from Project-related dredging (Moffatt and Nichol 2006a, 2017c). The models were developed based on a sediment analysis conducted at the site of the dredging and took into consideration wind, tidal currents, and seasonal flows. Moffatt & Nichol (2006a) indicated that constructing the access channel via mechanical dredging would result in a maximum concentration of turbidity of 600 to 6,000 mg/l depending on tidal velocity, decreasing substantially farther away from the site. The latest model (i.e., Moffat & Nichol 2017c) addresses suspended sediment concentrations from the proposed dredging operations. Constructing the slip and access channel would result in suspended sediment that would exceed about 20 mg/l over background levels within about 0.2 to 0.3 mile of the dredging site and exceed about 500 mg/l within about 0.1 mile with either dredging method (clamshell or cutter suction dredge) (Moffat & Nichol 2017c). Moffat & Nichol (2006a) noted maximum concentrations outside of the specific dredge location would only occur for about 2 hours or less over the daily tidal cycle with the plume moving upstream or downstream of the dredge site on flood or ebb tide, respectively. Moffatt & Nichol (2006a) indicated that due to this limited period of elevated suspended sediment in any site-specific area of the plume, other than the actual dredge area, average daily turbidity levels would remain near background values for the mechanical dredge at the slip during active dredging.

Turbidity models for both construction and maintenance of the four Marine Waterway Modifications areas were developed using the three possible dredging methods. Generally, suspended sediment levels would be similar to those modeled for the access channel, but distribution of sediment plumes would be more extensive. The cutter suction dredge would generally have lower concentrations of sediment than other options, but the overall maximum distribution of areas over background suspended sediment (about 20 mg/l) would be similar, averaging about 1.2 miles[75] from the specific active dredging site of the four channel expansion areas with any dredging methods. Turbidity levels and distribution would be similar for both construction or maintenance dredging. Overall levels of peak concentration dependent on method used, with cutter suction the lowest and hopper dredge the highest. Areas of high concentrations, over about 500 mg/l, would generally extend about 0.1 mile from dredge site for cutter suction and clamshell dredges and 1.0 mile for hopper dredge. Based on the Moffat & Nichol (2006a) model

[75] Plume distance noted includes total spread both upstream and downstream of dredge site.

of the access channel dredging, it would be expected that these peak levels would be short lived at any specific location. Given that, as noted above, tides would move the location of the sediment plume, higher concentrations in any location, other than near actual dredge location, would only last about 2 hours.

The model of the Eelgrass Mitigation site (Moffat & Nichol 2017c) assumed an excavator would be used, which would result in a confined area of elevated suspended sediment extending less than 0.1 mile from point of dredging. The more limited effect of tidal flow over the area would help confine the distribution of the elevated sediment plume. These elevated levels would be short term and highly localized to the nearshore area.

As noted above, sedimentation and turbidity would be higher during clamshell dredging than during hydraulic dredging operation. Clamshell dredging is also proposed for maintenance dredging of the slip and access channel, and potential effects are discussed below. Construction and maintenance dredging at the four marine waterway modification areas would be done via hydraulic dredging (cutter suction or hopper) or clamshell dredging, or a combination of these. Hydraulic placement of materials at the upland sites (e.g., APCO Sites 1 and 2, and Kentuck project site) is the preferred method for dredging including material transport with temporary subtidal dredge material transport pipelines (see *Dredged Material Management Plan).*[76]

As discussed above, the modeling conducted by Moffatt and Nichol (2017d) was done to determine the potential effects of all proposed actions including slip and access channel excavation, marine waterway modifications, and Eelgrass Mitigation site dredging on flow hydraulics in the bay. Construction in these areas would produce no or negligible impacts on overall tidal flow, tidal range, current velocity, and circulation in Coos Bay. Additionally, the result of the tidal flow circulation modeling and analysis predicts that there would be localized velocity reduction as well as localized small increases in velocity in portions of the bay. These would include slight velocity increases near the pile dikes at the eastern corner of the access channel. The deepening of the channel near the mouth of the bay (NRI 1 channel deepening area) at the entrance turn also appears to have resulted in locally increased currents to the north in Log-Spiral Bay. However, the model did not include effects of ocean waves that influence current velocity in this outer region of Coos Bay. Overall the effects of Project actions on the Coos Bay tidal prism were unsubstantial, and effects on tidal current velocity changes were also negligible except for a few localized areas.

Using available information on Coos Bay characteristics and the output from the hydrodynamic model, the MIKE-21 sediment transport simulation model was used to determine Project channel modification effects on the rate of sedimentation in the bay (Moffat and Nichols 2017e). The model found that overall sedimentation shoaling rates in the navigation channel within the bay would not change, although there were some local changes associated with project-related actions including a slight increase in deposition by the constructed MOF and some erosion sedimentation on the western side of the slip. While some changes in sedimentation were predicted near the two northernmost pile dikes, the projected changes in this area and rest of the bay from the Project actions were within the natural range of sedimentation rate variability.

[76] Included as Appendix N.7 of Resource Report 7 as part of Jordan Cove's September 2017 application to the FERC.

Based on the turbidity modeling conducted for both construction and maintenance dredging, the effects of maintenance dredging and disposal are predicted to be localized and relatively short term. Effects of maintenance dredging on suspended sediment concentrations and distribution in the slip, access channel, and Federal Navigation Channel would be similar to those discussed for the respective type of dredging methods used (Moffat & Nichol 2017c). However, the duration would be shorter for maintenance as less material would be removed than during construction.

Propeller wash from LNG carriers and tug boats associated with the Project, as well as ship wakes (waves) breaking on shore, could increase erosion along the shoreline and resuspend loose sediment along the shallow shoreline area, resulting in temporary increases of turbidity and sedimentation in the bay, both of which would affect water quality. The effects of these actions relating to sediment, bottom disturbance, and wave actions on marine aquatic resources are discussed in section 4.5 of this EIS.

Jordan Cove developed two models to assess propeller wash effect along the channel (Moffat & Nichol 2008; CHE 2011). The Moffat & Nichol (2008) model indicated propeller wash–induced bottom velocity along most of the main channel would be similar to the maximum velocity of peak tides (about 4 fps) whereas the CHE (2011) model indicated higher bottom velocities (13 fps) but in a very narrow range (about 80 feet wide). Both models, however, indicated that along most of the route, because the bottom of the channel consists of coarse materials (sand and sandstone), bottom material suspension would be limited and would settle rapidly, and elevated turbidity would be unlikely to occur. Moffat & Nichol (2008) estimated that near the docking location (about 0.5 mile), estimated bottom velocity would increase to about 7 to 8 fps. Some increased bottom scour and locally elevated turbidity may occur in this area, but the effects would be limited in dimension. This disturbance would occur below the intertidal area. CHE (2011) also modeled likely bottom disturbance from existing large vessel transit (assumed 106 round trips [212 channel passages] annually) in the bay and found that bottom velocity from these would be slightly greater than that of the LNG carriers (projected 120 round trips [240 channel passages] annually) so LNG effects on disturbance would be less than existing vessel traffic.

An additional model by Moffat and Nichol (2017g) estimated potential for scour and elevated turbidity while carriers are berthing and unberthing at the access channel and slip. The model assumed the LNG carrier engines and propeller would be used in addition to that of tugs for this action. While berthing had low potential for scour, unberthing, with the use of LNG carrier propeller engagement, could cause high potential for scour in the access channel and slip area. They estimate that maximum bottom velocity could be about 13.6 fps during unberthing, but less than 5.4 fps during berthing in the slip and access channel. They estimated that scour depth, with a substrate consisting of mostly medium size sand, could be up to 0.46 foot in the eastern portion of the access channel. Overall, about 12 acres of bottom could be scoured to a depth over 0.2 foot in general on a periodic basis. The bank areas of the slip would be armored, which would prevent scour there. Likely plumes of turbidity could occur briefly near the slip and access channel primarily near the bottom during the period of unberthing. The turbidity increase would be local and settle once the propellers stopped.

Jordan Cove modeled the likely effects of LNG carrier traffic on shoreline waves (Moffatt and Nichol 2017f). Wave height effects were evaluated from the access channel and slip to the mouth of the navigation channel. Moffat & Nichol estimated that the existing large bulk carriers would cause shoreline wave heights of about 0.3-0.6 foot under existing conditions. The LNG carrier transit wave height would be less under proposed channel changes, about 0.2 to 0.3 foot. These vessels' induced waves would likely occur for about 106 bulk carrier and 120 LNG carrier round trips a year CHE (2011). Tug vessels traveling at the same speed as LNG carriers would have similar wave height, but when tug vessels depart Coos Bay to bring in large vessels they may travel at about 10 knots, resulting in shoreline wave heights of about 0.5 to 0.8 foot. Day-to-day natural wave heights near the more protected bay area near the slip entrance are about 0.3 to 0.4 foot, while under windy conditions, much of Coos Bay's shoreline would have shoreline waves of 0.8 to 0.9 foot, and under severe storms even the area near the slip entrance would have wave height of about 2 feet (CHE 2011). CHE (2011) estimated that, considering the annual frequency of LNG carriers, shoreline sediment transport potential may increase by 5 to 8 percent and, considering natural range of variable wave energy, would be unmeasurable. This model assessment did not, however, consider higher speed tug transit. The tug vessel trips at these higher speeds would be about equal to LNG carrier entries (about 120 channel trips) but may not all be made at speeds as high as 10 knots. Each vessel passage would generate some form of wave for about 15 minutes (CHE 2011), with the peak wave period much less in duration. This compares to a natural wave frequency that would last much longer (e.g., hours or days). The induced waves from these additional vessels, with the possible exception of outgoing tugs, would have an unsubstantial effect on shoreline erosion as they are well within the naturally occurring, wind-generated wave heights (CHE 2011). The NMFS has concerns that higher vessel speeds may adversely increase shoreline erosion and fish stranding, potentially adversely affecting marine habitat. The NMFS recommended that vessel speeds not exceeding 8 knots within Coos Bay would be more protective. The FERC does not have the regulatory ability to dictate operational speeds of LNG carriers or tugs; however, the independent carrier operators would be required to follow all Coast Guard requirements regarding the operation of LNG carriers, including carrier speeds.

Spills or Leaks of Hazardous Materials

Project-related fluids that enter Coos Bay could affect state water quality standards. During construction of the Jordan Cove LNG Project, stormwater runoff could transport sediment and hazardous materials into Coos Bay. The introduction of sediment into Coos Bay would increase turbidity and sedimentation as discussed above and the introduction of hazardous materials would affect local water quality. To minimize stormwater runoff, construction activities would be conducted in compliance with the State of Oregon's General NPDES permit (1200-C). Additionally, stormwater runoff would be managed in accordance with a site-specific SPCC Plan. Stormwater collected in areas that have no potential for contamination would be allowed to flow or be pumped to ditches that ultimately drain to the slip or Coos Bay. Stormwater collected in areas that are potentially contaminated with oil or grease would be pumped or would flow to the oily water collection sumps. Collected stormwater from these sumps would flow to the oil-water separator packages before discharge to the industrial wastewater pipeline. Jordan Cove would apply for a new NPDES permit for this discharge prior to Project initiation. No untreated stormwater collected in areas that are potentially contaminated with oil or grease would be allowed to enter federal or state surface waters.

An inadvertent release of construction equipment–related fluids (fuel storage, equipment refueling, and equipment maintenance) could adversely affect water quality in Coos Bay. As described previously, Jordan Cove has prepared a site-specific SPCC Plan. The purpose of this SPCC Plan is to minimize the potential for accidental releases of hazardous materials and to establish proper protocols for minimization, containment, remediation, and reporting of any releases that might occur. Jordan

Cove's proposed measures to reduce the risk of hazardous material spills and minimize impacts should a spill occur include, but are not limited to:

- establishing training requirements for all employees handling fuels and other hazardous substances;
- providing storage location requirements for all hazardous substances, including chemicals, oils, and fuels, of a minimum of 150 feet from a waterbody or wetland boundary;
- requiring overnight equipment parking or any refueling operations to be located a minimum of 150 feet from a waterbody or a wetland boundary;
- requiring containment or diversionary devices for any container with a capacity of 55 gallons or larger, and providing discharge prevention measures like dikes, retaining walls, curbing, weirs, booms, diversion ponds, retention ponds, and absorbent materials;
- stipulating all secondary containment systems be capable of containing a volume equivalent to the largest container plus sufficient freeboard for precipitation (i.e., 110 percent); and
- providing for inspections to ensure no visible sheen is present on accumulated stormwater in containment systems, and the condition documented, prior to discharge.

While a hazardous material spill has the potential for significant adverse environmental impacts, adherence to the SPCC Plan would greatly reduce the likelihood of such impacts, as well as minimize the resulting impacts should a spill occur. As such, significant adverse impacts on surface water due to contamination from hazardous material spills or releases are not expected to occur.

Numerous commenters expressed concern about the impacts of an LNG spill into Coos Bay. If LNG spilled or leaked, it would turn to vapor when exposed to the warmer atmosphere, and these vapors would rise as they would be lighter than air. LNG is not soluble, would not mix with water, and would not contaminate surface water. Spills or releases of fuel or other oils into surface waters from LNG carriers are more likely to occur during fueling or bunkering at the dock when the materials are being transferred onto the carrier.

In compliance with guidelines outlined by the International Maritime Organization (IMO) under the Marine Environmental Protection Committee, vessels with 400 gross tonnage and above, like LNG carriers, are also required to develop and implement a Shipboard Oil Pollution Emergency Plan, which includes measures to be taken when an oil pollution incident has occurred or a ship is at risk of one. With the implementation each LNG carrier's shipboard oil pollution emergency plan, impacts resulting from the spill of fuel, or oil, or other hazardous liquids would be minimized.

Temperature, Chemical, and Biological Effects

While berthed, LNG carriers would release ballast water and engine cooling water into the marine slip. No wastewater would be discharged from the LNG carriers into the slip. The LNG carriers may arrange with licensed private entities for refueling, provisioning, and collection of sanitary and other waste waters contained within the carrier. The licensed private entities would transport the waste to a permitted treatment facility. Discharges from vessels are subject to regulation by EPA. EPA currently regulates these discharges via the Vessel General Permit.

Once arriving in Coos Bay, LNG carriers at the terminal slip would discharge ballast concurrently with the LNG cargo loading. The amount of ballast water discharged must, at a minimum, be adequate to maintain the LNG carrier in a condition of positive stability and with an adequate operating draft while the LNG cargo is loaded. Each LNG carrier would discharge approximately 9.2 million gallons of ballast water during the loading cycle to compensate for 50 percent of the mass of LNG cargo loaded.[77]

The LNG loading rate is designed to be 10,000 m^3/hr (with a peak capacity of 12,000 m^3/hr), or 4,600 metric tons per hour (t/hr) (5,520 t/hr peak), consequently the ballast water discharge rate would be approximately 20,250 gallons per minute (gpm). The typical ballast water discharge port is approximately 3.5 to 4.2 square meters covered by a screen with 4.5 mm bars, spaced every 20 to 25 mm.

LNG carriers and marine barges utilized for this Project must meet the requirements of the EPA and Coast Guard regulations. Coast Guard regulations (33 CFR 151, subpart D and 46 CFR 162.060 on "Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters; Final Rule" [77 FR 17254 (Mar. 23, 2012)] and Navigation and Vessel Inspection Circular 01 18) provide guidance to the maritime industry and Coast Guard personnel relative to the implementation of Ballast Water Management (BWM) system requirements. These governing regulations apply to all vessels that enter or operate within U.S. waters and are equipped with a ballast water system that has been approved by the Coast Guard and meets the applicable ballast water discharge standards.

The Coast Guard regulations require the same discharge standards as the IMO regulations, but the Coast Guard regulations also contain some requirements pertaining to a ship's operational procedures that are additional to the IMO's regulations (DNV GL 2018). These include the following:

- ballast tanks must be cleaned regularly to remove sediments;
- when retrieved, anchors and chains must be rinsed;
- fouling must be removed from the hull, piping, and tanks on a regular basis;
- a BWM Plan that includes the above in addition to BWM must be maintained (however, there is no requirement that the BWM Plan be approved);
- records of ballast and fouling management must be maintained; and
- a report form must be submitted 24 hours before calling at a U.S. port.

The EPA has additional requirements for periodic sampling, including calibration of sensors, sampling of biological indicators, and sampling of residual biocides.

The Coast Guard requires that vessels equipped with ballast tanks and bound for ports or places in the United States (except for the Great Lakes), regardless of whether the vessel operated outside the Exclusive Economic Zone (EEZ), submit the ships' BWM information to the Coast Guard no

[77] One cubic meter of LNG is 0.46 metric tons (t), which for the maximum size of LNG carrier authorized to call on the LNG terminal (148,000 m^3) would be 68,080 t of LNG per ship. Assuming 1 t of seawater is 1.027 m^3, the amount of seawater ballast discharged (50 percent of the weight of the LNG loaded) would be approximately 34,959 m^3 (approximately 9.2 million gallons).

later than 6 hours after arrival at the port or place of destination, or prior to departure from that port or place of destination, whichever is earlier.

In 2017, the International Convention for the Control and Management of Ships' Ballast Water and Sediments developed measures that must be implemented to minimize the potential for introduction of non-native species through ballast water. These measures have since been adopted by the IMO and are required to be implemented in all ships engaged in international trade. While the open sea exchange of ballast water has been used in the past and reduces the potential for non-native species introductions, on-board ballast water treatment systems are more effective at removing potential non-native species from ballast water. There are two different standards that ships must meet. All new ships must meet the "D-2" performance standard, which establishes the maximum number of viable organisms allowed to be discharged in ballast water. Conformity with the D-2 standard requires ships to utilize on-board ballast water treatment systems. Existing ships that do not currently have on-board ballast water treatment systems must continue to, at a minimum, conduct open sea exchanges of ballast water ("D-1" standard). Eventually, all ships will be required to conform with the D-2 standard. The timetable for conformity with the D-2 standard for existing ships is based on the date of the ship's International Oil Pollution Prevention Certificate renewal survey, which occurs every five years (IMO 2017). Therefore, most ships calling on the Project, estimated to begin in 2023 at the earliest, would be expected to have conformed to D-2 standards.

Any discharge of a pollutant into the navigable waters of the United States requires authorization under the CWA. Although discharges of ballast waters were historically excluded from the CWA, in 2013 the EPA issued a NPDES permit, the General Permit for Discharges Incidental to the Normal Operation of Vessels (VGP). The VGP, effective December 19, 2013, sets numeric effluent limits for ballast water discharges from certain large commercial vessels under a staggered implementation schedule. The standard is expressed as the maximum concentrations of living organisms in ballast water. The permit also includes maximum discharge limitations for biocides and residues.

Coast Guard regulations (46 CFR 162.060) were enacted in June 2012 in an effort to phase out ballast water exchange practices. The ballast water discharge standard (33 CFR 151.2030(a)) requires vessels calling at all U.S. ports to be equipped with a Coast Guard-approved BWM system. This applies to all new ships constructed on or after December 2013. All vessels over 300 gross tons or that have the capacity to discharge 2,113 gallons of ballast water must submit a notice of intent to the EPA requesting authorization under the 2013 VGP.

Discharging ballast water would not substantially affect water quality in Coos Bay. At the point of discharge, the interface with Coos Bay would experience temporary changes in salinity, temperature, pH, and dissolved oxygen. However, these changes to water quality would be highly localized and would quickly dissipate. While open ocean water has generally higher salinity (e.g., 35 practical salinity units [psu]) than typically occurs in Coos Bay (range 16 to 33 psu; Shanks et al. 2010, 2011) due to the high volume of water passing by the loading area, the contribution of ballast water would be only about 0.3 percent of the water passing by the terminal. Therefore, no measurable changes in salinity, other than directly at the discharge port, would occur.

Water temperatures are also unlikely to be significantly altered from release of ballast water. The temperature of the water in Coos Bay undergoes both seasonal and diurnal fluctuations. In

December and March, the ocean and fresh water entering the estuary had similar temperatures, around 50°F. In summer, low stream flows results in a rise of temperatures in the bay, to above 60°F in September at NCM 8 (Roye 1979). Based on LNG carrier design, a significant difference in temperature between ballast water and ambient waters is not anticipated. LNG carriers are constructed with double hulls, which increases the structural integrity of the hull system and provides protection for the cargo tanks in case of an incident. The space between the inner and outer hulls is used for water ballast. Because ballast water is stored in the ship's outer hull below the waterline, discharged water temperatures would not be expected to deviate significantly from ambient water temperatures; rather, it is anticipated that the ballast water would be equilibrated to the surrounding water temperature before being discharged. Therefore, thermal impacts from LNG carrier ballast water discharge would not be anticipated. The pH of the ballast water (reflective of open ocean conditions) may be slightly higher as compared to that of freshwater estuaries; however, this slight variation is not expected to have any impacts on existing marine organisms.

Dissolved oxygen levels are a critical component for the respiration of aquatic organisms. Among other factors, dissolved oxygen levels in water can be influenced by water temperature, water depth, phytoplankton, wind, and current. Typical water column profiles indicate a decrease in dissolved oxygen with an increase in depth. Some factors that often influence this stratification include sunlight attenuation for photosynthetic organisms that can produce oxygen, wind, wave, and current that results in mixing. Water that is collected within the ballast tanks of a ship would lack many of these important influences and could suppress dissolved oxygen levels. However, ballast water that is discharged is not expected to be anoxic (i.e., lacking all oxygen), just lower than what levels would likely be at the surface. In addition, ballast water would be discharged near the bottom of the slip where dissolved oxygen levels may already be lower. Therefore, no significant impacts are likely to occur as a result of discharging ocean water with potentially suppressed dissolved oxygen levels.

Cooling water flows while at the berth are approximately 11,000 cubic meters per hour (m^3/hr; 2.91 million gallons per hour or 48,000 gpm). For a 148,000 m^3 vessel, this would total approximately 69.7 million gallons while at berth (for 24 hours). Although LNG carriers vary in design, generally the intake port for this engine cooling water is approximately the same size and at the same location as the ballast water intake port and approximately 32 feet below the water line, or 5.6 feet from the keel of the LNG carrier. The size may vary but it is generally 3.5 to 4.2 square meters covered by a screen with 4.5 mm bars, spaced every 25 mm. The engines would be running to provide power for standard hoteling activities as well as running the ballast water pumps.

Using the numerical thermal plume dispersal model from EPA (2003) in combination with the Coos Bay hydrodynamic model (Moffat and Nichol 2017d), Jordan Cove modeled possible slip temperature changes resulting from the discharge of engine cooling water by an LNG carrier. The model assessed the temperature effects of eight different combinations of vessel type, ambient temperature, volume discharged, temperature, and velocity of discharge water were run (Moffat and Nichol 2017h). The modeling results showed that for typical ambient flow conditions the estimated water temperature of the discharged water would be up to about 2 to 3 degrees Celsius (°C; 3.6 to 5.4°F) warmer at the discharge port than ambient water. At about 40 to 80 feet from the discharge port (LNG carrier sea chest), temperatures would not exceed 0.3°C (0.54°F) above the ambient temperature (CHE 2011; Moffat and Nichol 2017h). The model results for the steam turbine power vessels typically were in the upper portion of these distance ranges. This temperature difference would decrease further with distance from the point of discharge. The average water temperature increases for the total slip volume for one day when an LNG carrier using the larger volume (steam turbine vessel) is at dock would range from 0.03 to 0.06°F. Tidal mixing would also decrease maximum slip temperature.

Potential effects of temperature increase from elevated cooling water releases would be further reduced from the cold LNG temperature entering the LNG carrier while at the terminal berth. Because of the extreme differential of the temperature of the cargo in the LNG carrier (-260°F) and that of the surrounding bay water (nominally 50°F), there is a constant uptake of heat by the LNG carrier while loading. This heat uptake is affected by LNG cargo that changes states from liquid to vapor daily. The typical LNG carrier sees 0.25 percent of its liquid cargo converted to the gaseous state each 24 hours, which requires heat uptake from the surrounding environment. It is reasonable to assume that 50 percent or more of the heat uptake by the carrier is extracted from the water during the full 24 hours of stay. Considering the volume of water in the Jordan Cove marine slip (an estimated 384 million gallons), tidal mixing in Coos Bay, and vessel hull cooling from the gas, the release of heated water from LNG carrier engine cooling operations would not substantially increase ambient bay water temperatures. In addition, ballast water discharged from the LNG carrier would also comprise some portion of the water withdrawn for cooling and affected by its discharge. The predicted temperature increases from the release of engine cooling water at the edge of the mixing zone (about 40 to 80 feet from the vessel) is only about 0.5°F above ambient temperature and that increase would be reduced farther away from the LNG carrier. We conclude that the thermal effect of LNG carrier operations at the berth would have very minimal impact on background water temperatures.

4.3.2.2 Pacific Connector Pipeline Project

The pipeline, associated workspace, and equipment bridges would be located across 19 Hydrologic Unit Code (HUC) level-5 watersheds (see table 4.3.2.2-1). An additional 5 watersheds would be crossed by the proposed access roads.

TABLE 4.3.2.2-1

Subbasins and Watersheds Crossed by Proposed Pacific Connector Pipeline

	Level 5 Watershed		
Subbasin	**Watershed Name**	**HUC a/**	**Miles Crossed b/**
Coos	Coos Bay- Frontal Pacific Ocean	1710030403	15.4
	South Fork Coos River c/	1710030401	2.0
Coquille	North Fork Coquille River	1710030504	11.5
	East Fork Coquille River	1710030503	9.7
	Middle Fork Coquille River	1710030501	15.8
South Umpqua	Olalla Creek-Lookingglass Creek	1710030212	8.8
	Clark Branch - South Umpqua River	1710030211	12.8
	Myrtle Creek	1710030210	8.9
	Days Creek - South Umpqua River	1710030205	19.2
	Elk Creek c/	1710030204	3.3
	Upper Cow Creek	1710030206	5.3

TABLE 4.3.2.2-1

Subbasins and Watersheds Crossed by Proposed Pacific Connector Pipeline

	Level 5 Watershed		
Subbasin	**Watershed Name**	**HUC a/**	**Miles Crossed b/**
Upper Rogue	Trail Creek	1710030706	10.7
	Shady Cove - Rogue River	1710030707	8.1
	Big Butte Creek	1710030704	5.1
	Little Butte Creek	1710030708	32.9
Upper Klamath	Spencer Creek	1801020601	15.1
	John C. Boyle Reservoir - Klamath River-	1801020602	5.4
Lost River	Lake Ewauna-Upper Klamath River	1801020412	16.3
	Mills Creek - Lost River	1801020409	23.0
		Total	**229.1**

a/ Hydrologic Unit Code (USGS 1987).
b/ Total miles of watershed area crossed by the pipeline in each HUC, rounded to nearest tenth of a mile.
c/ There are no waterbodies crossed in these watersheds.

The pipeline would be constructed across or near 352 waterbodies. Of the 352 waterbodies, only about 20 percent (69) are identified as perennial streams. Of the remaining affected waterbodies, 270 are intermittent streams (which includes 99 intermittent ditches[78]), 9 are perennial ponds (including stock ponds, an industrial pond, and excavated depressions), and 4 are estuaries. In Coos County, the Project would affect 52 waterbodies, in Douglas County 94 waterbodies, in Jackson County 91 waterbodies, and in Klamath County 117 waterbodies. A table of waterbody crossings, including the proposed crossing method, is included in appendix H (table H-3).

Pacific Connector proposes to use several different methods to install the pipeline across waterbodies depending on site-specific conditions (see chapter 2). Many of the waterbodies crossed by the pipeline are minor intermittent streams or ditches that are expected to be dry or non-flowing at the time of construction. For all waterbodies without flow at the time of construction, Pacific Connector would utilize standard upland, cross-country construction methods identified in Pacific Connector's ECRP. Waterbody crossing methods are characterized as dry open cut, wet open cut, diverted open cut, direct pipe, bore, and HDD. Most streams would be crossed with dry open-cut methods using dam-and-pump or flume methods which generally allow trenching across streams in the dry, minimizing potential turbidity. HDD crossings are primarily used on the largest streams and estuarine crossings in the Project area (see table 4.3.2.2-2). Only one diverted open-cut crossing would be done (South Umpqua River, table 4.3.2.2-2). No planned wet open-cut crossing, where pipeline trenching occurs with flowing water present, is planned. However, a wet open-cut crossing method may be required if all other crossing methods are attempted and fail. If a wet open-cut crossing method is required, then additional permitting and impact analysis may be required.

[78] "Ditches" include irrigation canals and laterals, roadside ditches, and pasture ditches.

TABLE 4.3.2.2-2

FERC Designated Major Waterbodies Crossed by Pacific Connector Pipeline by County and Fifth-Field Watershed a/

County - Fifth-Field Watershed (Fifth-Field HUC)	Major Waterbody	Approximate Milepost	Water Type	Length of Crossing (feet)	Crossing Type
Coos County - Coos Bay Frontal (1710030403)	Coos Bay	0.28-1.00	Estuarine	3,751	HDD
	Coos Bay	1.46-3.02	Estuarine	8,170	HDD
	Coos River	11.13R	Estuarine	516	HDD
Douglas County - Clark Branch-South Umpqua River (1710030211)	South Umpqua River	71.27	Perennial	200	Direct Pipe
Douglas County - Days Cr. South Umpqua River (1710030205)	South Umpqua River	94.73	Perennial	123	Diverted Open Cut
Jackson County - Rogue River-Shady Cove (1710030707)	Rough River	122.65	Perennial	143	HDD
Lake Ewauna-Upper Klamath (1801020412)	Klamath River	199.38	Perennial	973	HDD

a/ FERC designated major waterbodies are those greater than 100 feet wide at the water's edge at the time of construction.

Oregon Water Quality Regulations and Standards

Section 303(c) of the CWA requires states to establish, review, and revise water quality standards for all surface waters. To comply with these standards, the ODEQ has developed a classification system to describe the highest beneficial use(s) and associated minimum water quality standards of identified surface waterbodies within the state. The Oregon Water Quality Standards include beneficial use(s), fish use designations, narrative and numeric criteria to support the beneficial use(s), and anti-degradation policies. The purpose of the Anti-degradation Policy is to guide decisions that affect water quality such that unnecessary further degradation from new or increased point and nonpoint sources of pollution is prevented, and to protect, maintain, and enhance existing surface water quality to ensure the full protection of all existing beneficial uses. The state-designated beneficial use classifications for the basins crossed by the proposed Pacific Connector pipeline are similar among the basins. They include beneficial uses such as domestic and irrigation and livestock water use (excluding Coos Bay waters), industrial water, fishing and boating, wildlife and hunting, fish and aquatic life, and in some basins navigation and transportation (e.g., Coos Bay), as well as varied other uses.

Each state is required, under Section 305(b) of the CWA, to submit a report to the EPA describing the status of surface waters in the state biennially. Waterbodies are assessed to determine if their use is "fully supported," "fully supported but threatened," "partially supported," or "not supported" in accordance with the water quality standards. A use is said to be "impaired" when it is not supported or only partially supported. A list of waters that are impaired is required by Section 303(d) of the CWA, and it is provided in the 305(b) report (ODEQ 2016). To restore a waterbody to its use classification, a state may elect to impose restrictions more stringent than those normally required by the NPDES or other permitting programs, or even deny a permit for activities that could adversely affect an "impaired" waterbody.

States are also required to develop TMDLs for the impaired waterbodies. TMDLs describe the amount of each pollutant a waterbody can receive and not violate water quality standards. To comply with EPA requirements, the State of Oregon produced a combined report entitled Oregon's 2012 Integrated Report on Water Quality (Integrated Report).

The GIS coverage for the 2010 Integrated Report was reviewed to determine the locations of the water quality limited waters for Water Quality Assessment Categories 4 and 5 to determine if they are in the vicinity of Project components. Based on the ODEQ 2012 Integrated Report GIS coverage, 31 Category 4 and 5 water quality impaired waterbodies would be crossed by the pipeline and are listed in table H-5 in appendix H (ODEQ 2012c).

- TMDLs for the South Umpqua subbasin were completed in October 2006.
- TMDLs for the Upper Rogue subbasin were completed in December 2008.
- TMDLs for the Upper Klamath River, and Lost River subbasins were approved in December 2010.
- TMDLs for the Coos and Coquille Subbasins are currently in progress.

Pacific Connector proposes to cross 26 impaired waterbodies using dry/diverted open-cut crossing techniques. Conventional boring, DP, or HDD methods would be used to cross 5 of the impaired waterbodies.

Contaminated Surface Water or Sediments

As discussed in chapter 2 as well as sections 4.2 and 4.4 of this EIS, Pacific Connector has BMPs and plans in place to control runoff of any potential hazardous material found at all Project areas including TEWAs, pipe storage sites, hydrostatic test discharge sites, and right-of-way clearing areas. These procedures are intended to prevent unacceptable quantities of material (sediment, toxic substances, oils, concrete water) from entering surface waters. Additionally, sites along the pipeline project route were assessed for their potential to contain hazardous substances.

As discussed in section 4.2, a review of ODEQ's Environmental Cleanup Site Information (ECSI) database and EPA's EnviroMapper - Facility Detail Report indicated there are numerous locations within 0.25 mile of the route (see table 4.2.2.3-2) primarily considered pipeline storage sites with either cleaned-up, potential, or confirmed soil and/or groundwater contamination. As noted in section 4.2, many of these sites have the potential to encounter contaminated soil or groundwater during construction. This includes about 12 considered pipe storage sites and three near (but not on) the pipeline route. The FERC has made recommendations that Pacific Connector consult with the ODEQ regarding existing soil and groundwater contamination at these sites (see section 4.2 for the complete list of sites).

Pacific Connector's SPCC Plan is intended to prevent contamination from pipeline activities. Pacific Connector has developed a *Contaminated Substances Discovery Plan* that specifies the measures that would be implemented if unanticipated contaminated soil, surface water, or groundwater are encountered during construction. Some of the measures outlined in that plan include that all construction work in the immediate vicinity of areas where hazardous or unknown wastes are encountered would be halted. The procedures would greatly reduce the risk of hazardous substance entering water bodies along the route.

Additionally, a site with elevated natural mercury levels was found on the originally proposed pipeline route crossing East Fork Cow Creek (MP 109), and concern was expressed that disturbed soil from the crossing could cause human health risk or enter the adjacent stream. Thomason mining claims near East Fork Cow Creek have been determined to have very low concentrations of naturally occurring mercury mineralization (GeoEngineers 2017k). The pipeline route subsequently was rerouted approximately 2,500 feet from where the elevated mercury samples were taken. GeoEngineers (2017k) stated that the soils underlying the currently proposed crossing of East Fork Cow Creek would likely avoid the elevated mercury areas. The ECRP has a number of temporary and permanent erosion control and equipment-cleaning measures to minimize the potential for sediment or contaminated substances to enter wetlands or waterbodies, further reducing potential mercury contamination concerns at this crossing. Additionally, Pacific Connector would implement various site-specific actions at this crossing as recommended by the Forest Service, including:

- Provide 100 percent post-construction ground cover on all disturbed areas. Wood fiber is the preferred material. In addition, construct water bars at 50-foot intervals.
- Ensure that erosion control measures are in place before the fall rains and monitor for rilling, gullying, and other forms of active erosion and issues improve erosion control measures to preclude sedimentation.
- Inspect the construction corridor for sedimentation after each substantial storm event and, if erosion issues are found, correct them

Drinking Water Source Areas and Public Intakes

As identified in table 4.3.2.2-3, the pipeline would cross or be adjacent to 12 public drinking water source areas (DWSAs) (ODEQ 2012e). In some locations, the pipeline would be located within a particular source area for several miles, but in other locations the pipeline would be located along ridgelines meandering in and out of source areas.

TABLE 4.3.2.2-3

Surface Water Public DWSAs Crossed by the Proposed Pacific Connector Pipeline

Starting Milepost	Ending Milepost	County	Drinking Water Source Area a/	Public Drinking Water System ID	Source Water
20.06BR	35.81	Coos	City of Myrtle Point	4100551	N. F. Coquille River
35.81	41.69	Coos	City of Coquille	4100213	Coquille River
			City of Myrtle Point	4100551	Coquille River
41.69	53.21	Coos	City of Coquille	4100213	N.F. Coquille River
53.21	64.71	Douglas	Winston-Dillard Water District	4100957	S. Umpqua River
64.71	70.51	Douglas	Roseburg Forest Products-Dillard	4194300	S. Umpqua River
70.51	73.37	Douglas	Clarks Branch Water Association	4100548	S. Umpqua River
73.37	74.27	Douglas	Roseburg Forest Products-Dillard	4194300	S. Umpqua River
74.27	82.94	Douglas	Clarks Branch Water Association	4100548	S. Umpqua River
82.94	95.41	Douglas	Tri-City Water District	4100549	S. Umpqua River
95.41	101.79	Douglas	Milo Academy	4100250	S. Umpqua River
			Tri-City Water District	4100549	S. Umpqua River
101.79	101.94	Douglas	Tri-City Water District	4100549	S. Umpqua River
101.94	102.74	Douglas	Tri-City Water District	4100549	Cow Creek
			Tiller Elementary SD #15	4192139	S. Umpqua River
102.74	108.96	Douglas	City of Glendale	4192139	Cow Creek
			Tiller Elementary SD #15	4192139	S. Umpqua River
108.97	111.11	Douglas	City of Glendale	4192139	Cow Creek
111.11	125.82	Jackson	Country View Mountain Home Estates	4100808	Rogue River

TABLE 4.3.2.2-3

Surface Water Public DWSAs Crossed by the Proposed Pacific Connector Pipeline

Starting Milepost	Ending Milepost	County	Drinking Water Source Area a/	Public Drinking Water System ID	Source Water
125.82	130.00	Jackson	Anglers Cover /SCHWC	4100808	Rogue River
			Country View Mountain Home Estates	4100513	Rogue River
135.00	168.01	Jackson	Medford Water Commission	4100513	Rogue River

a/ The proposed route meanders in and out of Surface Water DWSAs where there are two DWSAs listed.

Table 4.3.2.2-4 lists the public water systems with surface water intakes within 3 miles downstream of waterbodies that would be crossed by the pipeline (ODEQ 2013a).

TABLE 4.3.2.2-4

Surface Water Intakes for Potable Drinking Water Supply

Intake	Public Water System	Source Water for Intake	Waterbody Crossing	Intake Distance Downstream a/	County
4194300	Roseburg Forest Products – Dillard	S. Umpqua River	Rice Creek – MP 65.76 Tributary to S. Umpqua River	0.8 mile	Douglas
4194300	Roseburg Forest Products – Dillard	S. Umpqua River	Willis Creek MP 66.95 Tributary to S. Umpqua River	1.8 miles	Douglas
4100808	Country View Mountain Home Estates	Rogue River	Rogue River MP 122.65	1.4 miles	Jackson
4101483	Anglers Cove Subdivision	Rogue River	Rogue River MP 122.65	Approx. 3 miles	Jackson

Note: All intakes located within 3 miles downstream of proposed waterbody crossings for the Pacific Connector pipeline.
a/ Location of intake downstream from proposed waterbody crossing.

Points of Diversion

Surface water diversions for irrigation, livestock watering, and industry are located within 150 feet of 44 waterbody crossings (see table 4.3.2.2-5).

TABLE 4.3.2.2-5

Points of Diversion within 150 feet of Pacific Connector Construction Work Area

Water Right Type	Water Right Owner	County	Nearest Milepost	Permit/ Certificate Number	Type of Diversion	Diversion Source	Usage Description	Distance to Construction Work Area (feet)	Type of Construction Work Area Containing Points of Diversion a/	Number of Water Rights
Storage	Private	Douglas	60.73	44288	Stream	Perron Creek	Livestock	35.90	-	1
			65.35	T 6708	Stream	South Umpqua River/Reservoir 1	Industrial/manufacturing uses	0.00	Pipe Yards	1
			67.12	R 14589	Stream	Unnamed Stream	Multiple purpose	108.39	-	2
			74.20	69536	Winter Runoff	Runoff/Reservoir 13	Fire protection	0.00	Construction Right-of-Way	1
			74.20	69536	Winter Runoff	Runoff/Reservoir 13	Livestock	0.00	Construction Right-of-Way	1
			75.49	17241	Stream	Sutherlin Creek	Industrial/manufacturing uses	0.00	Pipe Yards	1
			75.49	30362	Stream	Sutherlin Creek	Industrial/manufacturing uses	0.00	Pipe Yards	1
									Storage Total	***8***
Surface Water	Private	Coos	12.07	53679	Stream	Unnamed Stream	Domestic including Lawn and Garden	79.83	-	1
			13.80	36042	Spring	A spring	Domestic	0.00	Construction Right-of-Way	1
			29.48	S 44450	Stream	Stemmler Creek	Domestic including Lawn and Garden	134.81	-	1
			29.48	S 44450	Stream	Stemmler Creek	Livestock	134.81	-	1
			29.86	60877	Stream	East Fork Coquille River	Irrigation	56.92	-	1
			30.00	39940	Stream	East Fork Coquille River	Irrigation	0.00	Construction Right-of-Way	1
		Douglas	49.53	44065	Stream	Lang Creek	Irrigation	109.26	-	1
			58.64	S 54735	Stream	Olalla Creek	Domestic Expanded	117.96	-	1
			67.19	15423	Stream	South Umpqua River	Irrigation	132.51	-	1
			67.19	22390	Stream	South Umpqua River	Irrigation	67.80	-	1
			67.19	23826	Stream	South Umpqua River	Industrial/Manufacturing Uses	0.00	Pipe Yards	1
			70.36	29340	Stream	South Umpqua River	Irrigation	120.06	-	1
			70.36	65231	Stream	South Umpqua River	Irrigation	64.53	-	1
			70.36	68634	Stream	South Umpqua River	Irrigation	64.53	-	1
			75.49	15598	Stream	Sutherlin Creek	Industrial/Manufacturing Uses	0.00	Pipe Yards	2
			75.49	17292	Stream	Camas Swale/Log Pond	Industrial/Manufacturing Uses	0.00	Pipe Yards	1
			75.49	30363	Stream	Sutherlin Cr/Pond	Industrial/Manufacturing Uses	0.00	Pipe Yards	1
			81.23	55163	Stream	South Myrtle Creek	Irrigation	67.96	-	1
			82.27	80544	Stream	South Umpqua River	Irrigation	0.00	Pipe Yards	1
			88.16	43561	Stream	Fate Creek	Irrigation	90.46	-	1
			88.16	52977	Stream	Fate Creek	Irrigation	90.46	-	1
			88.52	56872	Stream	Fate Creek	Irrigation	147.03	-	1

TABLE 4.3.2.2-5 (continued)

Points of Diversion within 150 feet of Pacific Connector Construction Work Area

Water Right Type	Water Right Owner	County	Nearest Milepost	Permit/ Certificate Number	Type of Diversion	Diversion Source	Usage Description	Distance to Construction Work Area (feet)	Type of Construction Work Area Containing Points of Diversion a/	Number of Water Rights
Surface Water (cont.)		Jackson	122.67	34473	Stream	Rogue River	Irrigation	132.95	-	1
			122.83	65482	Stream	Rogue River	Irrigation	22.39	-	1
			145.77	2170	Stream	Little Butte Creek	Irrigation	100.10	-	1
			145.77	2470	Stream	Little Butte Creek	Irrigation	129.80	-	1
			145.77	57753	Stream	North Fork Little Butte Creek	Irrigation	129.80	-	1
			145.82	17215	Stream	North Fork Little Butte Creek	Irrigation	103.16	-	1
		Klamath	199.96	67512	Stream	Klamath River	Fire Protection	23.69	-	1
	State	Coos	22.30	9712	Spring	A spring	Domestic	119.11	-	1
			27.20	60812	Stream	Middle Creek	Irrigation	127.86	-	1
		Douglas	67.19	S 51632	Stream	South Umpqua River/Con 18714	Primary and Supplemental Irrigation	0.00	Pipe Yards	1
			67.30	S 51924	Reservoir	South Umpqua/Galesville	Supplemental Irrigation	0.00	Pipe Yards	1
			70.36	S 52930	Stream	South Umpqua River	Primary and Supplemental Irrigation	0.00	Pipe Yards	1
			71.31	S 51924	Stream	South Umpqua River	Irrigation	0.00	Temporary Extra Work Space	1
		Jackson	128.61	73043	Stream	Indian Creek	Anadromous and Resident Fish Rearing	9.87	-	12
			135.65	41308	Reservoir	Reservoir	Wildlife	100.42	-	1
									Surface Water Total	***49***
									Grand Total	**57**

a/ Dash indicated a facility (e.g., pipe yard, ROW, TEWA) that does not intersect a water right location.

Nationwide Rivers Inventory

The Nationwide Rivers Inventory lists more than 3,400 free-flowing river segments in the United States characterized as possessing one or more "outstandingly remarkable" natural or cultural values judged to be of more than local or regional significance. The proposed pipeline would cross three rivers that are listed on the Nationwide Rivers Inventory (NPS 2013):

- The **North Fork of the Coquille River** listing includes its headwaters in Section 16, T.26S., R.10W. and extends to the confluence with the South Fork Coquille River in Section 5, T.29S., R.12W. This segment was added to the list in 1993 for outstandingly remarkable fish, wildlife, and cultural (prehistoric Indian sites) values. The pipeline would cross this river segment at MP 23.1.
- The **East Fork of the Coquille River** listing extends from its headwaters in Section 18, T.28S., R.8W. to the confluence with the North Fork of the Coquille River in Section 36, T.28S., R.12W. It was added to the list in 1993 for outstandingly remarkable fish, wildlife, boating and fishing. The pipeline would cross this river at MP 29.9.
- The **South Umpqua River** listing includes the reach from Tiller (Section 33, T.30S., R.2W.) downstream to the confluence with the North Umpqua River at River Forks (Sections 31 and 32, T.26S., R.6W.). This reach was added to the list in 1993 for outstanding and remarkable fish and historical values. The pipeline would cross this section of river in two locations, MP 71.3 and MP 94.7.

Impacts and Mitigation

Impacts resulting from the pipeline's construction (see chapter 2 for a description of the pipeline's construction techniques) would be temporary and would affect crossed waterbodies. Construction actions may affect the following parameters:

- turbidity and sedimentation;
- channel and streambank integrity and stability
- in-stream flow
- risk of hazardous material spills and
- waterbody status and water use related to:
  - Oregon Water Quality Regulations and Standards effects
  - contaminated surface water or sediment effects
  - drinking water sources areas and public intakes effects
  - point of diversion effects
  - National Rivers Inventory effects

To minimize potential adverse impacts along the construction right-of-way and at waterbody crossings, Pacific Connector would implement its ECRP during construction, restoration, and operation of its proposed facilities.

Project-specific stream crossing evaluations have been conducted and crossing procedures and mitigative actions would also be implemented. Pacific Connector conducted an initial assessment of crossing conditions of all streams suitable for this analysis (GeoEngineers 2017d, 2018a, 2018b). GeoEngineers (2017d) applied the FWS's Stream Crossing Screening Matrix to all stream crossings that display fluvial characteristics. This assessment was intended to determine where stream crossings may pose a substantial risk of increasing streambank erosion and streambed instability. GeoEngineers, using a combination of field and GIS data, rated the 173 fluvial pipeline stream crossings based on the matrix (GeoEngineers 2018a). Some streams could not be accessed, and evaluation was based on desktop analysis for those streams. The matrix has two axes rating the crossing based on the potential Project effects on the crossing and the relative stream response at the crossing. Each crossing was rated as low, medium, or high for each of the two axes (all stream crossings were placed into one of nine categories, such as Low–Low, Low–Medium, or Medium–High).

No crossing was rated as having both high risk of Project impact potential (i.e., high risk of Project impacts) and high risk of site response potential (high risk of stream and site response). If any crossing had been in this category, Pacific Connector indicated that a site-specific crossing plan would be developed. Should later assessment of the crossings (see below) find that a crossing is in this category, a site-specific plan would be developed prior to construction.

GeoEngineers (2017d, 2018b) grouped the nine risk categories into five categories based on generally similar risk of streams being affected and labeled these as color management categories (Blue, Green, Yellow, Orange, and Red). The assessments included an initial survey and follow-up surveys that resulted in the current assessment of streams into these categories.

After the follow-up surveys, stream crossings with the lowest stream response potential and a low or moderate project impact potential (94 total) were designated as the Blue category and would be crossed using project-typical BMPs. These project-typical BMPs would be applied to all streams while additional BMPs would be applied to the other crossings depending on their rated category of risk. The remaining stream crossings (79) included 68 Yellow and 11 Orange crossings with some greater risk potential at the crossings than Blue crossings. These two categories would have specific additional BMPs applied in addition to the project typical BMPs with the purpose of protecting stream and bank processes following pipeline installation at sites with this category of potential risks. The details of these category specific actions are described in GeoEngineers (2017d, 2018b). After follow-up survey some additional BMPs were added to some of these streams including seven surveyed Orange category crossings (Middle Creek [MP 27.04], Elk Creek [MP 32.40], Tributary to Big Creek [MP 37.35], Upper Rock Creek [MP 44.21], East Fork Cow Creek [MP 109.47], West Fork Trail Creek [MP 118.89], and South Fork Little Butte Creek [MP 162.45]), and had specific crossing plans developed that designate the types of bed and bank restoration that would occur at each of these sites GeoEngineers (2017b, 2018a). Additional specific actions would occur at some streams on federal lands (see section 4.7 and appendix F).

Substrate characteristics and physical habitat features have been or would be determined through pre-construction surveys[79], and the upper 1 foot of existing substrate would be replaced, and other physical conditions matched during reconstruction after pipe installation. Clean spawning gravel would be top dressed as appropriate, and composition would be based on pebble counts or other appropriate methods on a site-specific basis; this would require review and approval by agency staff prior to implementation. Many of these actions would be determined prior to construction based on results of the pre-construction survey (see below) and determined by a qualified EI

[79] Some stream crossings were not accessible and would be surveyed prior to construction once approval and land owner access agreements are obtained.

specifically trained to determine proper restoration actions to implement based on river channel processes or a suitably trained professional. On non-federal lands, this person would have the authority to select appropriate additional BMP construction methods, bank stability actions, revegetation types and methods to help reduce the risk of instability of the crossing and potential for future erosion (GeoEngineers 2017d, 2018a).

A pre-construction survey[80] would be conducted by a technically qualified team on all stream crossings to confirm and clarify conditions developed in the aforementioned matrix analysis. This would include surveys of sites currently not accessible due to property ownership issues. Following these surveys, if significant changes were to occur to parameters of the risk matrix for a crossing, changes would be made to risk level and appropriate final methods of crossing and BMPs made at each stream crossing. If any crossing is moved into the "high" project impact and "high" stream response risk matrix category, a site-specific crossing design would be developed for that site. Following the final surveys, special additional BMPs, as described in GeoEngineers (2017d, 2018a), would be implemented depending on individual site conditions and may include such actions as changes in bank material and bank angle modifications, specific substrate composition used, plants used on the bank, artificial stabilizing bank material, rootwad enhancement, type of bed and bank restoration structure, and various other actions.

The approach described above, which would include more site-specific information and possibly more site-specific designs based on the pre-construction survey, is expected to be suitable for the protection of aquatic resources at waterbody crossings. The final procedures would ultimately need to obtain other permit-process approval (e.g., Section 401 water quality certification) before construction is conducted at specific sites.

As a measure to help ensure crossing actions would not adversely affect stream bank and channel structure, Pacific Connector, as part of their pipeline integrity monitoring, would observe all stream crossings, regardless of risk, annually for the life of the Project and note any obvious signs of channel erosion, pipeline exposure, or major shifts in restoration elements. Where any problems were noted during this annual assessment, a follow-up visit by geo-professionals would occur (GeoEngineers 2018a). On a quarterly basis, over two years after construction at all perennial crossings on federal lands as well as the highest risk sites identified on non-federal lands (Orange category), monitoring of vegetation success, stability of restoration elements, fish passage status, channel migration, erosion, head cutting, and other channel characteristics would be conducted. Additional forms of monitoring (e.g., vegetation, animal browse, and continued channel/restoration status) would occur at varied sites over varied intermittent periods over a 10-year period, with the highest frequency and intensity of monitoring effort at those sites of greatest risk of channel and bank instability. Frequency and type of monitoring may be adjusted based on site-specific conditions. In addition, flow and rainfall events would be recorded to understand the response of sites to flow events. Additional monitoring would occur on streams on federal lands. Remediation of adverse conditions with channel stability or habitat found during the monitoring would occur. Reports of the monitoring would be developed for years 1, 2, 3, 5, 7, and 10 after construction describing observations made and any remedial actions taken.

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[80] Some stream crossing were not accessible and will be surveyed prior to construction once approval and land owner access agreements are obtained

Construction of New TARs, New PARs, Existing Access Roads (EAR), and TEWAs

Construction of roads and facilities have the potential to contribute sediment to streams. Of the existing roads that would be used for construction, approximately 47 would cross waterbodies. All access roads would use the existing crossing facility (e.g., bridge, culvert, ford), except for one that would use a temporary bridge and another with a temporary culvert. It is possible that other crossings may need to be improved or replaced, once final plans are developed prior to construction. These crossings would have to be reviewed and approved by the applicable agencies prior to their implementation.

Currently, there are 8 TARs and 11 PARs that would be built in the range of coho salmon–bearing watersheds along the proposed route. Of these, 2 PARs would directly cross streams and 4 TARs and 3 PARs would be within 200 feet of streams in these watersheds. There would be about 23 EAR segments that would be improved (e.g., by widening, resurfacing, or brush removal) that are within 200 feet of coho salmon-bearing streams, 7 of which would directly cross streams. While there are additional roads that are near or cross streams in other areas along the Project, their numbers are few, especially where fish would potentially be present. Potential sediment delivery to streams would occur from gravel and dirt roads, either newly built or improved ones. Dube et al. (2004) provided a summary table of distance categories for sediment delivery. The table indicated that where roads directly cross streams all sediment (100 percent) that runs off the road at the crossing would be considered to enter the streams, while potential sediment delivery to streams from road runoff decreases exponentially by distance from a stream. Dube et al. (2004) indicated that, from about 1 to 100 feet from a stream, 35 percent of road runoff would reach a stream; between 100 and 200 feet about 10 percent; and beyond 200 feet, no runoff would be considered to reach a stream. Given the locations of these roads, a total of 4 TARs, 3 PARs, and 21 EAR road segments related to the Project could potentially deliver sediment to streams, either from directly crossing streams or being with 200 feet upslope of them. Such sediment delivery would increase turbidity and fine sediment deposits, especially if BMPs were not properly instituted in these areas.

Several actions would be taken to reduce sediment runoff from roads and stream crossing structures. Where road improvements would be required, Pacific Connector would ensure that existing drainage features (e.g., culverts, ditches, dips, and grade sags) continue to function properly or they would employ suitable substitute measures to ensure that drainage is controlled to prevent off-site erosion or other resource damage. Surfaces of all new PARs would be graveled, thereby decreasing their erosion potential. Further, PARs and TARs would meet land-managing agencies' engineering design and road management standards consistent with the intended use of the road, and all applicable agency BMPs for erosion control would be implemented. All TARs would also be restored to preconstruction conditions following completion of construction.

TEWAs, which are common along the route, many near streams, represent another potential source of elevated sediment runoff. To reduce the chance of sediment entry to streams from TEWAs, Pacific Connector would install BMPs according to their ECRP for all related construction actions. BMPs may include silt fence/straw bale, sediment barriers, temporary slope breakers, or prefabricated construction mats to prevent rutting/compaction impacts and mulch, dust control, and permanent erosion control measures that would further minimize sediment discharges from a site after construction is complete. In forested areas, slash-filter windrows may be constructed on the downhill edge of the construction right-of-way and TEWAs, as directed by the EI.

While some additional sediment may enter streams, several factors would minimize or eliminate these occurrences:

- the relatively small area that would be disturbed from these actions,
- the provisions in the *Transportation Management Plan* that would be followed, and
- the ECRP and BMPs that would be implemented for Project roads, right-of-way clearing, and TEWAs.

The result would be that noticeable adverse effects on stream sediment or water quality are unlikely to occur.

Turbidity and Sedimentation

Turbidity and sedimentation affect water clarity and future substrate characteristics. Increases in both can be detrimental to drinking water quality and adversely affect aquatic organisms by impeding light penetration, benthic organism survival, and quality of substrate for invertebrate production and fish spawning success (see section 4.5). Turbidity in streams is often regulated, and levels allowed are usually designated in state water quality certification permits. To minimize increases in turbidity and suspended sediment at waterbody crossings, Pacific Connector would utilize the dry crossing methods (i.e., flume and dam-and-pump) for most of the flowing waterbodies crossed by the pipeline (as discussed above). The remainder would be crossed by conventional bore, diverted open-cut, HDD, and DP. Turbidity and sedimentation resulting from dry open-cut methods are generally minor and temporary and are associated with (1) installation and removal of the upstream and downstream dams used to isolate the construction area; (2) water leaking through the upstream dam and collecting sediments as it flows across the work area and continues through the downstream dam; (3) movement of in-stream rocks and boulders to allow proper alignment and installation of the flume and dams; and (4) when streamflow is returned to the construction work area after the crossing is complete and the dams and flume are removed. Dry methods have been reported to produce one-seventh the suspended sediment in streams than "wet" methods (Reid et al. 2002). According to Pacific Connector, during construction of Williams Northwest Pipeline's Capacity Replacement Project in Washington State (completed in 2006), a total of 67 waterbodies were crossed using dry open-cut crossing methods (fluming and/or dam and pump). During these crossings, there was only one event where state water quality turbidity limits were exceeded. The exceedance occurred through a failure of the pumps during the night when a monitor was not on site to restart the pump.

Some turbidity would result during instream activities and when the water is diverted to the backfilled areas. GeoEngineers (2017e) evaluated the potential risk of turbidity during construction across waterbodies and assigned waterbodies a score from 1 (low) to 5 (high). Of 299 waterbodies evaluated[81], 110 were scored with a low risk (score of 1 or 2) of turbidity increase over a 24-hour period and 189 were scored with a moderate risk (score of 3 or 4), generally due to soil erosion potential, presence of clay or mud, and/or the presence of steep slope or an incised channel that would require construction of a deep trench.

Monitoring studies of varied dry stream crossing pipeline activities have found moderately elevated suspended sediment near these crossings sites. Reid et al. (2004) measured suspended

[81] Excludes ponds, estuaries, streams and canals crossed using trenchless methods and water bodies in right way not crossed.

sediment downstream from 12 flumed pipeline crossings and 23 dam-and-pump crossings in North American streams. The study estimated that suspended sediment concentrations averaged 99 mg/l for flumed crossings and 23 mg/l at the dam-and-pump crossings. Reid et al. (2002) found that below four separate dam-and-pump crossings, mean suspended sediment was less than 20 mg/l within 30 meters (100 feet) downstream.

For Project area streams, average watershed suspended sediment values within 50 meters downstream of the stream crossings were modeled.[82] During a standard crossing using dam-and-pump or flumed crossing methods, when water diversion and sediment control methods are in place, values would range from 27 to 153 mg/l for flumed crossing and 7 to 35 mg/l with dam-and-pump crossings for the affected watersheds. These values are similar to those found by Reid et al. (2004) noted above. However, values would be much higher should the crossing sediment control method fail, with modeled suspended sediment values ranging from 712 to 4,102 mg/l if wet open cut methods were used during crossing failure. Duration of elevated values from failure would likely be short, less than about 2 to 4 hours for small streams and possibly up to about 6 hours for large stream crossings. While failures of diversion control systems during crossings are uncommon (Reid et al. 2004), they would likely occur at some crossings during construction. Suspended sediment concentrations from any crossing method would decrease to background levels (about 2 mg/l) within about 0.6 to 19 km (approximately 0.4 to 11.8 miles) downstream of a crossing, among the 14 watersheds.

The South Umpqua River diverted open-cut crossing would have similar effects on downstream sediment and turbidity, in the short term, to those from other dry crossings. These effects would mostly end once the diversion is in place as stream construction would occur in the dry. There would be short-term turbidity increases for short distances, lasting for several hours during portions of the installation and removal of the diversion structures for the proposed diverted open-cut crossing. Suspended sediment generated during construction at this crossing would likely be low and limited in distribution and downstream transport distance because of the very coarse pebble substrate at the crossing.

Temporary bridge installation may occasionally add turbidity to streams. Temporary stream crossings may occur outside of the fish in-water work window. Pacific Connector's crossing plans include installing temporary bridges from the bank without entering the water. These may include such items as flat-beds that are typically 30 to 40 feet long, some as long as 90 feet. If such bridges are not considered safe to install from the bank, only the equipment needed to cross the stream to install the bridge would cross the stream. Once installed, no further vehicle passage would occur in the channel. Therefore, while a small number of stream channels may be disturbed during installation causing elevated sediment levels, the limited vehicle traffic and number of such crossing locations would minimize water quality effects from turbidity in location and duration along the proposed route.

Potential effects from turbidity from construction across streams are expected to be temporary and minor for the following reasons:

- all but one crossing of perennial streams would be completed either using dry open-cut crossing methods or methods that avoid impacts altogether;

[82] See Pacific Connector's response to a FERC information request related to Resource Report 2, filed May 4, 2018.

- crossings would be completed during ODFW and NMFS recommended in-water work periods when the flow volumes and velocities will be low;
- most dry open-cut crossings would be completed in less than 48 hours;
- headwater streams are typically dominated by gravel/cobble substrates reducing the potential to generate turbidity during crossings; crossings would be scheduled individually, several days apart, and not completed concurrently;
- erosion control BMPs, as outlined in Pacific Connector's ECRP, would be implemented to minimize the potential for erosion and sedimentation; and
- bridge installation where vehicles enter streams would only occur in limited locations and duration, with most areas spanned by bridges without water entry, and Pacific Connector would follow BMPs and procedures approved by state and applicable federal agencies where temporary bridges would be installed.

The *Turbidity-Nutrients-Metals Water Quality Impact Analysis* (GeoEngineers 2017e) concluded that turbidity may exceed Oregon numerical water quality standards for short distances and short durations downstream from each crossing, either during and shortly after construction (in perennial waterbodies) or after fall rains begin (for intermittent and ephemeral streams). Such exceedances are allowed as part of the narrative turbidity standard if recognized in a CWA Section 401 water quality certification if every practicable means to control turbidity has been used.

Contribution of turbidity or sediment from other crossing methods, including DP, bore, and HDD, would be unlikely. DPs and bores would go under waterbodies and avoid contact with flowing streams. Start and end points would be back from the stream banks so standard BMPs for erosion control would reduce potential for sediment to enter streams from their use.

The details of the HDD crossing are described in chapter 2. Pacific Connector proposes to use the HDD method to cross under two spans of 0.7 and 1.6 miles of Coos Bay, and also the Coos, Rogue, and Klamath Rivers. Generally, an HDD would avoid direct effects on the bay and associated estuarine resources; stream habitat and water quality. However, an HDD requires the use of drilling mud as a lubricant during the process. This fluid is under pressure and there is a possibility of an inadvertent release of drilling mud through a substrata fracture, allowing it to rise to the surface (frac-out). The drilling fluid is typically comprised of inert muds, so an inadvertent release would likely be benign. Drilling mud may accumulate locally and be washed downstream, temporarily increasing rates of turbidity and sedimentation. In addition, inadvertent releases most often occur near the entry and exit locations, which are often landward of the stream or estuarine channels, reducing the likelihood that drilling mud would enter surface waters. Pacific Connector prepared detailed surveys and crossing plans[83] for each of the HDD crossing sites, further reducing the chances of HDD crossing problems. To prevent an inadvertent release or address impacts should one occur, Pacific Connector developed its *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations*[84] as discussed in chapter 2.

[83] See Appendix G.2 of Pacific Connector's Resource Report 2.
[84] This plan was attached as Appendix 2.H of Resource Report 2, in Pacific Connector's September 2017 application to the FERC.

Overall, drilling mud releases to any waterbody would be short term and would be diluted from large river water volumes and swift flows. We conclude that an inadvertent release of drilling mud from an HDD would have minor, short-term adverse effects on resources in estuarine channels or rivers.

Trench spoil excavated from within the waterbody would be placed at least 10 feet from the water's edge or in a TEWA and may have the potential to contribute sediment and turbidity to streams. In some waterbodies, native washed streambed boulders, cobbles, and gravels removed from the surface of the trench may be stored within the construction right-of-way in the streambed in areas isolated from streamflow (i.e., within the dammed area for flumes or dam-and-pump crossing). Storing this material in the streambed would minimize handling and help to ensure the material would be available for backfill and streambed restoration. This storage procedure requires a modification from Section V.B.4.a. of the FERC's *Procedures* (which require spoil store more than 10 feet from the edge of waterbody). This modification has been requested as part of the license application (see appendix E). Staging areas and additional spoil storage areas would be located at least 50 feet away from waterbody boundaries, where topographic conditions and other site-specific conditions allow. Where topographic conditions do not allow a 50-foot setback, spoil storage areas would be located at least 10 feet from the water's edge. Sediment control devices, such as silt fences and straw bales, would be placed around the spoil piles to prevent spoil flow back into the waterbody reducing the chance of increasing turbidity.

<u>Channel and Stream Bank Integrity</u>

Constructing the pipeline would modify streambanks, resulting in an increase in the rates of erosion, turbidity, and sedimentation into the crossed waterbody. An increase in soil compaction and vegetation clearing could also potentially increase runoff and subsequent streamflow or peak flows. The extent of these impacts would depend on streambank composition and vegetation stream type, velocity, and sediment particle size.

To minimize these impacts, equipment bridges and mats would be used, as necessary, to provide stable work areas and isolate equipment from waterbodies. TEWAs for spoil storage and pipe staging would be set back from the bank as discussed below, and temporary sediment barriers would be installed around disturbed areas, where necessary, in accordance with Pacific Connector's ECRP.

To restore streambanks on non-federal lands, Pacific Connector would return affected lands to preconstruction contours or shaped to a stable angle (see section 4.3.4 for a discussion of requirements on federal lands). Erosion control measures including fiber fabric or matting would be installed on slopes adjacent to streams. On some banks, depending on site-specific conditions, fiber rolls may also be installed to stabilize bank toes. The streambanks would be seeded, and woody riparian vegetation planted for stabilization according to Pacific Connector's ECRP. Pacific Connector does not anticipate that riprap would be required for streambank stabilization, but if used would be limited to the areas where flow conditions preclude effective vegetation stabilization techniques. Pacific Connector may also implement tree revetments, stream barbs/flow deflectors, toe-rock, and vegetation riprap before using hard bank protection. The NMFS has expressed concern with the potential use of riprap or barb/flow deflectors for this Project and has requested that only bioengineered methods (such as LWD) be used for bank protection or flow control for the Project. This NMFS request may also become a condition within their BO for the Project or a requirement during the NMFS permitting process.

Fluvial erosion represents a potential hazard to the pipeline where streams can expose the pipe as a result of channel migration, avulsion, widening, and/or streambed scour. The pipeline would be designed to ensure it does not become exposed from bed scour or channel migration, which may include increasing the depth of cover to more than the 5-foot minimum to accommodate the potential for long-term channel changes. A channel migration and scour analysis was performed and rated crossings as to their risk of pipe exposure. Those sites considered to have potential risk of pipe exposure were evaluated in more detail including site-specific data and, where deemed necessary, would have additional procedures taken to ensure that likelihood of pipe exposure is eliminated. Ten crossings were identified as Level 2 (listed below on table 4.3.2.2-6), which have large or complex channels with a high potential for migration, avulsion, or scour, and required site-specific additional analyses. From the results of the channel migration and scour analysis, Pacific Connector would design all crossings that were assessed in detail to bury the pipe below the 100-year scour depth or into competent bedrock, whichever is shallower, and, for streams likely to have channel migration, outside and below the 50-year channel migration zone. Additional analysis prior to construction would be needed for sites that were not accessible due to property rights. All crossing sites would have pre- and post-construction surveys conducted to document (by post-construction conditions monitoring) that each crossing has been restored to pre-construction conditions (or better) after project construction. A summary of the survey findings would be filed with the FERC. Crossing of various risk categories would have additional BMPs as described below.

TABLE 4.3.2.2-6

Streams Crossed by the Pacific Connector Pipeline Route That Have a High Potential for Scour or Migration

Watershed	Stream Name	MP	Maximum Scour Depth a/	Other Hazards	Mitigation Measures
Coquille	Middle Park Creek	27.0	10.5 feet	Channel widening	Dry open-cut
Coquille	South Fork Elk Creek	34.5	6.0 feet	Channel widening	Bury in bedrock
S. Umpqua	Olalla Creek	58.8	7.5 feet	Migration	Bury in bedrock
S. Umpqua	Western Crossing of the South Fork Umpqua River	71.3	unknown	unknown	DP
S. Umpqua	North Myrtle Creek	79.1	6.5 feet	Migration	Bury in bedrock
S. Umpqua	South Myrtle Creek	81.2	unknown	Migration	Bury in bedrock
S. Umpqua	Eastern Crossing of the South Fork Umpqua River	94.7	18.0 feet	unknown	Diverted open-cut
Rogue	West Fork Trail Creek	118.9	unknown	unknown	Bury in bedrock
Rogue	Rogue River	122.7	20.5 feet	Channel widening	HDD
Rogue	North Fork Little Butte Creek	145.7	unknown	unknown	Dry open-cut

a/ 100-year flood recurrence

Pacific Connector would follow the procedures described in chapter 2 for placement of sediment cover in streams but has requested a modification, where the existing substrate is not gravel or cobbles and site access is limited, only native materials removed from the stream be used for backfilling. Pacific Connector has provided site-specific modification to our *Procedures* (see appendix E). Any subsequent need to place fill within a stream would require a permit from the COE under Section 404 of the CWA and from the ODSL under the ORS.

In-Stream Flow

Flow changes because of Project actions can have effects on water user's access to water and physical and biological conditions of streams. Flow reductions can partially affect stream temperature as well as aquatic habitat.

Project water withdrawal from waterbodies would occur from two main activities: hydrostatic testing and water needed for project dust control. Pacific Connector estimates between 31 and 65 million gallons of water would be required to test the pipeline during hydrostatic testing (see table 4.3.2.2-7).

Water for hydrostatic testing would be primarily obtained from surface water sources, but some private supply wells or other surface water rights may be drawn upon as well (see table 4.3.2.2-7). If water for hydrostatic testing would be acquired from any source other than a municipality, including surface water sources as noted in table 4.3.2.2-7, Pacific Connector would obtain all necessary appropriations and withdrawal permits, including from the ODWR, prior to use.

Pacific Connector would apply for permission from ODEQ to discharge the hydrostatic test water. Where test water cannot be returned to its withdrawal source, the water would be treated with a mild chlorine treatment and discharged to an upland location (at least 150 feet from streams with no direct discharge features) through a dewatering structure at a rate to prevent scour and erosion and to promote infiltration. Hydrostatic discharge points have been located in upland areas where feasible, and at an appropriate distance from wetlands and waterbodies to promote infiltration and to ensure that sedimentation of wetlands, waterbodies, or other sensitive areas do not occur (identified in table D-3 in appendix D). Pacific Connector's EIs would visually monitor the release of hydrostatic test water and trench dewatering activities to ensure that no erosion or sedimentation occurs. In addition, the EIs would ensure that turbid water is not discharged to waters of the state. If an EI determines that a discharge is occurring from trench dewatering, the receiving water would be visually monitored for turbidity. If a turbidity plume is observed, the trench dewatering operations would be immediately adjusted/reinstalled/maintained to ensure that the discharge of sediment to surface water is stopped and water quality standards are not exceeded. In addition, a total of 32 test header section breaks where water would be discharged are located within the construction right-of-way or TEWAs (identified in table D-3 in appendix D).

TABLE 4.3.2.2-7

Potential Hydrostatic Test Water Quantity and Source Locations

Spread	Test Sections	MP Range	Estimated Volume (gal) a/	Additional Water Required for HDD/Direct Pipe Pre-Test	Minimum + Additional Pre-Test Water b/	Source c/	Additional Potential Sources Recently Sited by Construction Management Team
South Coast Water Basin (MP 0.00 – 53.15)							
EW.	1-2	0.00-8.35R	1,547,000	757,000	1,938,000	MP 0.00 – North Spit Pump House (Coos Bay) MP 1.31 – Fire Hydrant on Westside of Hwy 101 Bridge	–
1	3-6	8.35R-29.54	6,836,000	276,000	2,825,000	MP 11.08R – Coos River MP 29.64 – East Fork Coquille River	Steinnon Creek: North Fork of Coquille River
2	7-10	29.5451.58	6,154,000	85,000	2,458,000	MP 29.64 – East Fork Coquille River MP 50.28 – Middle Fork Coquille River	Upper Rock Creek
Umpqua Water Basin (MP 53.15 – 111.11)							
3	11-12	51.58-71.37	5.692.000	75,000	4,042000	MP 57.30 – Ben Irving Reservoir MP 58.79 – Ollala Creek MP 71.25 – South Umpqua River	Middle Fork Coquille
4	13-17	71.37-94.65	6,499,000	106,000	2,878,000	MP 71.25 – South Umpqua River MP 94.70 – South Umpqua River	South Myrtle Creek
5	18-20	94.65-110.23	4,350,000	–	2,535,000	MP 94.70 – South Umpqua River	South Myrtle Creek; Indian Lake
Rogue Water Basin (MP 111.11 – 167.58)							
5	21-24	110.23-132.50	6,218,000	164,000	2,872,000	MP 122.80 – Roque River	South Myrtle Creek; Indian Lake
6	25-27	132.50-162.00	8,348,000	–	3,060,000	MP 141 .00 – Star Lake MP 133.4 – Medford Aquifer (if this is used, will have to cut in another test)	–
7	28	162.00-179.00	1,635,000	124,000	4,817,000	MP 199.2 – Klamath River MP 212.00 – Lost River	–
Klamath Water Basin (MP 167.58–228.81)							
7	29-32	179.00-228.81	13,906,000	124,000	4,817,000	MP 199.2 – Klamath River MP 212.00 – Lost River	Lost River Anthony Blair Deep Well Gavin Rajnus Deep Well Ryan Hartmen Deep Well
Total			**64,896,000**	**1,722,000**	**32,242,000**		

a/ Total amount of water needed without any cascading of water between sections, which would not occur.
b/ Total assuming likely cascading of water between test section
c/ Currently expected sources of water but alternative or additions sources may be used as noted.
Source: Data response table based on April 12, 2018 design (Pacific Connector Response date May 24, 2018 from Attachment – FERC-PCGP-RR10-1)

To address concerns regarding water withdrawals and hydrostatic testing, Pacific Connector developed a *Hydrostatic Testing Plan*.[85] The plan would be updated in consultation with the BLM and Forest Service, as well as the Center for Lakes and Reservoirs and Aquatic Bioinvasion Research and Policy Institute (Portland State University). The plan includes measures to prevent the transfer of aquatic invasive species and pathogens from one watershed to another. Where possible, test water would be released within the same basin from which it was withdrawn. However, cascading water from one test section to another to minimize water withdrawal requirements may make it impractical to release water within the same basin where the water was withdrawn in all cases. If hydrostatic test source water cannot be returned to the same water basin from where it was withdrawn, Pacific Connector would disinfect the water that would be transferred across water basin boundaries. The hydrostatic test water treatment process would incorporate screening during water withdrawal that would meet NMFS and ODFW criteria to prevent the entrainment of small fish. Water would be discharged according to ODEQ requirements for chlorinated water discharges as noted in the *Hydrostatic Testing Plan*. All discharge locations would be monitored after construction for potential noxious weed establishment and treated if necessary.

Potential effects on stream flow associated with hydrostatic testing include reduced downstream flows, erosion and scouring at release points, and the transfer of aquatic nuisance species through the test water from one water basin to another. Estimates of potential water intake amounts from streams indicate flows below intake would be reduced by less than 10 percent of typical monthly instantaneous flow rates during the month of withdrawal for all but one (at 35 percent of flow) potential locations during withdrawal (duration about 6 to 11 days at each potential location; Ambrose 2018, see also table 4.5.2.3-6 in section 4.5 for withdrawal amounts by stream). Final selection of intake rates and sites would be reviewed by ODFW and OWRD prior to testing, so that potential effects from flow reductions would be unlikely.

While it is not possible to know how much water would be needed for dust suppression on the pipeline construction right-of-way, during dry seasons, Pacific Connector estimates that there would be approximately five 3,000-gallon water trucks per construction spread on a given day. Pacific Connector anticipates using five construction spreads, which would total 75,000 gallons for 25 water trucks per day. While the total amount of water needed is unknown, the amount needed for each truck is relatively small. For example, if filling one truck occurred in 30 minutes of water withdrawal, the rate would be about 1.7 gallons per second or 0.2 cfs. This flow reduction would be a small portion of the flow of perennial streams or rivers that are likely to be used for water supply. Therefore, the overall change in any specific reduction in streamflow from this water use would likely be unsubstantial.

Watering trucks would spray only enough water to control the dust or to reach the optimum soil moisture content to create a surface crust. Runoff should not be generated during this operation. All appropriate permits/approvals would be obtained prior to withdrawal. Table 4.3.2.2-8 lists potential dust control water sources that have been identified by Pacific Connector.

[85] Included as Appendix M to Pacific Connector's POD.

TABLE 4.3.2.2-8

Potential Dust Control Water Sources for the Pacific Connector Pipeline

County	Nearest PM	Source
Coos	16.5	Aqueduct Lake
Coos	37.0	Brewster Lake (WI-602)
Douglas	50.2	Lang Creek Reservoir
Douglas	79.0	Big Lick Reservoir
Jackson	128.5	Indian Lake Reservoir
Jackson	133.4	Eagle Point Irrigation Canal Crossing
Jackson	141.0	Star Ranch Lake
Jackson	144.0	Unnamed Reservoir
Jackson	145.0	Gardener Reservoir
Klamath	228.5	High Line Canal
Klamath	228.7	Capek Reservoir
Klamath	229.4	Low Line Canal

Additionally, Pacific Connector has indicated it may utilize a synthetic product such as Dustlock®, in addition to water, for dust control. Dustlock is a naturally occurring byproduct of the vegetable oil refining process. Dustlock penetrates the bed of the material and bonds to make a barrier that is naturally biodegradable, ensuring that the surrounding ground and water are not contaminated, and minimizing any potential effects on fish and wildlife. However, Pacific Connector would not use Dustlock within 150 feet of riparian areas or wetlands.

For dust control water use Pacific connector would be restricted to water withdrawal from permitted waterbodies where flows would not be adversely affected as they would obtain. If water for dust control would be acquired from any source other than a municipality, including surface water sources as noted in table 4.3.2.2-8, Pacific Connector would obtain all necessary appropriations and withdrawal permits, including from the ODWR, prior to use.

According to the Forest Service, vegetation clearing and management that creates sizable canopy openings can increase water yields and subsequently, waterbody flows (Forest Service 2000). Sizeable canopy openings can result in other factors affecting watershed water storage and runoff amount, peak amount and time of runoff (Forest Service 2008). The relatively small percentage of the watersheds affected by the right-of-way and the total area of the watershed within the transient snow zone would, however, greatly limit this potential effect. Although permanent canopy removal in forested areas along the right-of-way would increase the potential for snow accumulation, the forest clearing within any of the watersheds would be so small as to not have a measurable influence on peak flows.

Surface waters could be affected due to alteration of groundwater flow where the pipeline intersects waterbodies. The hyporheic zone is a region beneath and alongside a stream bed where there is mixing of shallow groundwater and surface water. The flow dynamics and behavior in this zone is recognized to be important for surface water and groundwater interactions, as well as fish spawning, among other processes. Pacific Connector conducted a hyporheic exchange analysis on the waterbodies crossed by the pipeline (GeoEngineers 2017g). The assessment focused on determining if construction has the potential to affect the structure and function of the hyporheic zone, and if so, which stream crossing may be most sensitive to changes in hyporheic zone structure and organization. Historically, pipeline construction has not typically been considered as having a potential effect on hyporheic zone function, presumably because of the nature of the construction process having relatively limited, localized and temporary change to the subsurface conditions under streams and rivers. It is difficult to measure hyporheic exchange without detailed site-specific study, but qualitative observations of bed and bank material, stream gradient, location within a watershed, and morphological features can help indicate whether a stream has an active and functional hyporheic zone. GeoEngineers (2017g) developed weighting factors to assign criteria of high, moderate, and low sensitivity to the crossing locations. The analysis used these qualitative parameters to rank how sensitive a stream crossing may be to potential hyporheic zone alteration.

Fifteen stream crossings were categorized as having a high sensitivity to hyporheic zone alteration, which would suggest a high likelihood of a functioning hyporheic zone, mostly associated with larger waterbodies with greater floodplain widths and instream morphologic features. Two of the 'high' sensitivity crossings, including the Coos River crossing at MP 11.13R and the Rogue River crossing at MP 122.65, would be crossed by HDD rather than open trenching across the stream channel.

A "moderate" sensitivity indicates that the stream crossing displays some indicators that a hyporheic zone is active and functional; approximately 66 crossings fit this category, most of them upper to middle watershed streams. A "low" sensitivity indicates that the stream crossing does not likely support either an extensive or functional hyporheic zone; approximately 123 stream crossings fit into this category. Many of these low scoring stream crossings are bedrock-controlled, are dominated by finer-grained material, or are canals and ditches. Eleven stream crossings were not assigned any point values or ranking due to there being no channel or channel forming processes observed at the crossing location in the field.

Water quality parameters, including water temperature and intragravel dissolved oxygen, might potentially be affected at crossings where hyporheic exchange is extensive and active. Thus, streams with a "high" and "moderate" sensitivity would be the streams where water quality could potentially be compromised due to alteration of the hyporheic zone. Those crossings with a 'low' sensitivity indicate that little hyporheic exchange is currently operating in the stream, and thus would not likely impact water quality. Overall, most of the Pacific Connector pipeline crossings fall into a "low" sensitivity category, where water quality (including water temperature and intragravel dissolved oxygen) is unlikely to be significantly or measurably altered by pipeline construction.

The pipeline construction methods and BMPs described in the GeoEngineers (2017g) report, as well as the site-specific restoration plans for crossings of perennial stream on federal lands (NSR 2014) further reduce the potential for pipeline construction to adversely alter the hyporheic zone. Specifically, the BMPs which are of importance to reduce the potential impacts on the hyporheic zone include the following:

- native material that is removed from the pipeline trench during excavation across stream channels would be used to backfill once the pipe is in place to minimize potential changes to preconstruction permeability; and
- trench plugs would be installed at the base of slopes adjacent to wetlands and waterbodies and where needed to avoid draining of wetlands or affecting the original wetland or waterbody hydrology.

While the potential impact of pipeline construction on hyporheic exchange is considered to be low, Pacific Connector would implement the following measures to further reduce this potential:

- Document streambed stratigraphy prior to construction to aid in site restoration.
- As described in the *Stream Crossing Risk Analysis* and *Stream Crossing Risk Analysis Addendum* (GeoEngineers 2017d, 2018a), implement additional site-specific stream crossing restorations plans, of streams not yet field surveyed, after final pre-construction surveys.
- Segregate actively movable streambed gravels and cobbles from underlying streambed materials (including fractured bedrock; i.e., do not mix actively moveable stream bed material with that below that depth). Replace all removed material to their natural pre-construction depths, including removed gravels/cobbles.
- Below active stream gravels, replace native material in a manner to match upstream and downstream stratigraphy and permeability to the maximum extent practicable.

Blasting could alter the in-channel characteristics and hydrology of the stream, potentially decreasing flows due to increased infiltration where bedrock would be fractured. Where blasting is required in streambeds, Pacific Connector would use the dam-and-pump crossing method so that blasting activities can be completed in the dry. For further discussion on minimizing impacts related to blasting, see the *Blasting Plan* discussed in chapter 2.

Stream Temperature

Several comments received by the Commission expressed concern that the removal of vegetation near waterbodies would result in changes to waterbody temperatures. However, available information on the effects of linear pipeline crossings of streams on water temperature indicates there is little to no change. Water has a very high specific heat capacity. That is, the amount of heat needed to raise its temperature is relatively high. Typically pipeline rights-of-way are narrow, and water would flow quickly through the crossing locations, Smaller, slower moving streams have a longer exposure time, but typically do not support temperature sensitive fish species. In general, streamwater exposure to the lack of shade at pipeline crossings would be temporary and limited (see an expanded discussion in section 4.3.4.2 for federal lands).

Pacific Connector conducted research on the potential for its pipeline crossings to increase stream water temperatures (GeoEngineers 2017d). This analysis also used the Stream Segment Temperature Model (SSTEMP) by Bartholow (2002) to estimate potential temperature effects at 15 pipeline crossing locations (each a 75-to 95-foot-wide clearing) along the whole route (table 4.3.2.2-9). The streams selected varied in size from 2 to 135 feet wide with only eight of these having less than a 10-foot flowing width. Conditions modeled were based on conditions measured during late August 2010. The average modeled temperature increase across a cleared right-of-way for these 15 streams were slight, 0.03°F, and the maximum increase among the streams was 0.3°F.

TABLE 4.3.2.2-9

Predicted Modeled Temperatures at Selected Stream Crossings Along the Pacific Connector Pipeline Route

MP	Watershed	Stream	Width (feet)	Ambient Water Temperature (°F)	Post-Construction Water Temperature (°F)	Temperature Change (°F)
10.3 a/	Coos	Stock Slough	18	56.30	56.32	0.01
17.5 a/	Coos	Catching Creek	7	56.30	56.30	<0.01
23.1	Coquille	North Fork Coquille River	44	74.30	74.23	-0.07
29.2 a/	Coquille	Tributary to East Fork Coquille River	9	58.82	58.78	-0.04
29.5 a/	Coquille	Tributary to East Fork Coquille River	6	59.72	59.72	<0.01
29.9	Coquille	East Fork Coquille River	74	64.22	64.24	0.02
32.4	Coquille	Elk Creek	7	58.46	58.47	0.01
58.8	South Umpqua	Ollalla Creek	84	58.46	58.48	0.02
73.2	South Umpqua	Tributary to South Umpqua River	2	58.46	58.59	0.13
84.2	South Umpqua	Wood Creek	7	58.46	58.5	0.04
94.7	South Umpqua	South Fork Umpqua River	135	58.46	58.49	0.03
109.5	South Umpqua	East Fork Cow Creek	6	55.40	55.44	0.04
132.8	Rogue	Quartz Creek	6	58.64	58.94	0.30
162.5	Upper Rogue	South Fork Little Butte Creek	13			0.01
212.1	Lost River	Lost Rover	73	70.70	70.68	-0.02

a/ Not crossed with current route

The total amount of riparian vegetation within one site potential tree height that would be reduced during construction and operations is discussed in section 4.5.2 of this EIS. The reduction occurs primarily from construction of the pipeline right-of-way clearing over streams but also includes right-of-way clearing that does not cross streams, and development of TARs, PARs, and TEWAs outside of the right-of-way clearing. This would include loss of about of forest during construction and operations, which would remain as non-forested habitat along the route (see table 4.5.2.3-5 in section 4.5.2 of this EIS). This cleared acreage is spread across the entire pipeline route and includes loss from all sources of construction and operations as well as vegetation that would potentially help shade streams. As discussed below, loss of this vegetation is not likely to have a marked cumulative effect on stream temperature, although some local stream increases may occur.

Potential cumulative watershed temperature increases from project riparian clearing would be unlikely. The number of crossings resulting in riparian shade area cleared in any watershed would be slight. No more than nine perennial streams would be crossed in any one of the 19 watersheds crossed by the pipeline route. Primarily perennial stream clearings are likely to have effects on temperature during the warmest part of the year, because many intermittent streams would be dry during the peak temperature periods (July–September). Thus, peak seasonal temperatures would be unlikely to affect many intermittent streams. Even considering the total number of streams crossed in watersheds, which ranges from 3 to 44 crossings per watershed, most watersheds would have less than 16 crossings (see section 4.5.2.3). The riparian area lost that could affect watershed stream temperature relative to all available riparian areas in the watershed would be slight. About

9 linear stream miles of streambank could be affected along the whole Project route (GeoEngineers 2017f; note this counts both banks separately so stream length affected would be half of this value).

To minimize the potential effects of pipeline construction on stream temperatures by the removal of riparian vegetation, Pacific Connector has incorporated the following measures into its Project design:

- narrowing the construction right-of-way at waterbody crossings to 75 feet where feasible based on site-specific topographic conditions;
- locating TEWAs 50 feet back from waterbody crossings to minimize impacts on riparian vegetation, where feasible;
- replanting the streambanks after construction to stabilize banks and to re-establish a riparian strip across the right-of-way for a minimum width of 25 feet back from the streambanks; and
- replanting riparian areas equal to 1:1 ratio to temporary riparian shading vegetation losses and 2:1 ratio for permanent riparian losses from the 30-foot operational easement clearing.

Based on these measures and the studies summarized above, we conclude that the construction and operation of the pipeline would have no discernible effect on stream temperature.

Spills of Hazardous Materials

An inadvertent release of equipment-related fluids would temporarily impact surface water quality. Equipment fluids such as gas and oil can be toxic to aquatic organisms and can affect downstream water uses including drinking water and crop irrigation. Pacific Connector has developed a SPCC Plan that describes measures to be implemented by Project personnel and contractors to prevent and, if necessary, control any inadvertent spill of hazardous materials.

Waterbody Status and Water Use

The construction and operation of the pipeline route could have effects on the status of special features including the water quality limited conditions and special uses, including water diversions and national river status. Actions described below indicate potential effects on these and Project mitigative actions implemented to aid in maintaining the current conditions and regulatory requirements relative to surface waters.

Oregon Water Quality Regulations and Standards Effects

Studies requested by ODEQ are part of a broad evaluation of potential impacts on water quality, stream channel stability, and riparian zones resulting from pipeline construction and maintenance activities. GeoEngineers conducted studies to help evaluate potential impacts including a stream crossing risk analysis, a hyporheic exchange impacts analysis, and a study of the impact to water quality from additional turbidity, nutrients, and metals caused by pipeline construction activities at stream crossings (GeoEngineers 2013a, 2013b, 2013c, and 2018a). The intent of the evaluations is to help focus management resources on those waterbody crossings to which the pipeline would present the greatest risk of impacting beneficial uses. ODEQ's regulatory authority under the CWA and OAR is provided to maintain beneficial uses through enforcement of water quality standards.

During the ODEQ CWA Section 401 process, Pacific Connector would develop a source-specific implementation plan in accordance with OAR 340-042-0080 for areas with existing TMDLs, and Pacific Connector would be identified as a new nonpoint source. The source-specific implementation plan would be reviewed and approved by ODEQ.

BMPs to minimize sedimentation during construction would be employed on all streams. However, to reduce potential stream channel impacts, including increased erosion/sedimentation, additional site-specific BMPs would be installed at sites considered to be at higher potential risk, as discussed earlier under "Impacts and Mitigation" based on the risk matrix analysis. These additional protections may include such items as additional upslope bank protections, hillslope drainage structures, additional wood instream or on bank, wood armoring, enhanced substrate, or reduction in bank slope to further ensure reduced erosion. The plans to keep riparian stream crossing clearing to a minimum (75 feet wide at most crossings) would also result in less removal of woody riparian vegetation and help temperature-impaired streams. Because of the water quality and stream habitat benefits, the NMFS endorses keeping near stream riparian vegetation clearing to a minimum, as is currently proposed; this NMFS request may become a condition within their BO for the Project or a requirement during the NMFS permitting process. Overall, the small reduction in shade is not likely to change stream temperatures substantially downstream of the pipeline crossing in temperature limited streams. However, removal of vegetation that once shaded the stream could cause slight local and temporary (daily) increases in temperature, in small streams with low flow discharge rates during the warm summer months. However, discernible temperature changes are very unlikely due to the limited exposure time as water passes through the 75-foot-wide clearing and the high specific heat capacity of water.

A potential new nonpoint source of nutrients and/or oxygen-demanding pollutants would be the use of fertilizer for revegetation of disturbed areas. Pacific Connector plans to apply fertilizer to disturbed areas to be reseeded, as needed. Additionally, some BLM districts along the Project route have specific recommendation for slow release fertilizer application in specific soil types in planting holes as part of any reforestation. Fertilizer would only be applied at the recommended rates of the land-managing agencies and, if applied by broadcast spreader, worked into the upper 2 inches of soil as soon as practical (see Pacific Connector's ECRP). Application would need approval by the land-managing agency or landowner. No application would occur within 100 feet of flowing water and would be avoided during heavy rain and windy conditions. Aerial broadcast spreaders would only occur with federal land-managing agency approval. Fertilizer would be added directly to hydroseeding slurry. Fertilizer would be stored away from streams and outside of federal Riparian Reserves. The NMFS has expressed concern that fertilizer application has the potential to enter waters and recommends that no application within 150 feet of waterbodies occur; this NMFS request may become a condition within their BO for the Project or a requirement during the NMFS permitting process. Any monitoring required for nutrients at locations where fertilizer is likely to contribute to run-off to waterbodies will be addressed in the state permit process and be included in a source-specific implementation plan as required by OAR 340-042-0080.

Drinking Water Sources Areas and Public Intakes Effects

Prior to construction, Pacific Connector would consult with all surface water intake operators listed in table 4.3.2.2-5 that are still active and establish a process for advanced notification of instream work. A summary of the consultations will be filed with the FERC prior to construction of the pipeline. In the event of an inadvertent spill, or a disruption of flow and/or a possible introduction of sediments into waters upstream of the intakes, Pacific Connector would notify potable water intake users of the conditions so that necessary precautions could be implemented.

Point of Diversion Effects

Pacific Connector would consult with the landowner if impacts on a water supply's point of diversion cannot be avoided, and prior to construction would work together to identify an alternate location to establish the diversion. Should that landowner determined that there has been an impact on the water supply, Pacific Connector would work with the landowner to ensure a temporary supply of water. In addition, if deemed necessary, Pacific Connector would replace the affected water supply with a replacement, permanent water supply. Mitigation measures would be specific to each property and would be determined during landowner negotiations. Points of diversion (both public and private) beyond 150 feet of the construction work areas are not expected to be affected by the pipeline.

National Rivers Inventory Effects

As noted earlier, the pipeline would cross three rivers that are listed on the Nationwide Rivers Inventory. Pacific Connector has developed specific plans for each of these crossing to maintain the quality of these rivers. For the North Fork of the Coquille River and East Fork of the Coquille River, Pacific Connector has developed a site-specific crossing plan for both rivers using a dry open-cut method to contain disturbed sediments. The western South Umpqua River crossing would use a DP installation process to eliminate an open-cut and minimize impacts by drilling under both the river and I-5 in a single operation. The site-specific crossing plan developed for the eastern South Umpqua River crossing would use a diverted open-cut method to limit water quality impacts by creating a "dry" working area isolated from the river. These procedures would maintain stream conditions and quality, and would not adversely affecting the streams' river status(i..e, the National River Inventory status).

4.3.2.3 Conclusion

Constructing and operating the Project would result in short-term and long-term impacts to surface water resources. However, based on Jordan Cove's proposed dredging and vessel operation methods and its impact minimization and mitigation measures (including its implementation of erosion controls, dredging procedures, construction and stormwater management procedures, and construction timing), as well as Pacific Connector's proposed waterbody crossing and restoration methods and its impact minimization and mitigation measures, we conclude that the Project would result in short-term, localized, construction-related water quality impacts, but would not significantly affect surface water resources.

4.3.3 Wetlands

Wetlands are defined by the *Corps of Engineers Wetland Delineation Manual* (Environmental Laboratory 1987) as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wetlands are regulated at the federal, state, and local level. At the federal level, wetlands may be deemed Waters of the United States (33 CFR 328.3) and may be subject to regulation through Sections 401 and 404 of the CWA. Section 401 of the CWA requires that proposed dredge and fill activities under Section 404 be reviewed and certified by the designated state agency and that the project meets state water quality standards. In this case, the ODEQ has been delegated this authority and is charged with verifying that the project meets state water quality standards. In Oregon, wetlands are also regulated at the state level by the ODSL and at the local level by some city and county land-use ordinances. ODSL administers Oregon's Removal-Fill Law (ORS 196.800) to protect waterways and wetlands (see sections 1.3.6 and 1.5.1 for additional details).

Through the state's notification process, provisions for wetlands are included under the ODF's Forest Practices Act and rules will be addressed, if applicable. Details would be submitted to the ODF in either a written plan or alternate plan to include specific provisions for meeting the Forest Practices Act, including those related to wetlands.

On federally managed land, EO 11990, amended in 42 U.S.C. 4321 *et seq*., requires the federal agencies "to avoid adverse impacts associated with the destruction or modification of wetlands wherever there is a practicable alternative" and to "include all practicable measures to minimize harm to wetlands." Further, the agencies are required to preserve and enhance the natural and beneficial values of wetlands in carrying out their responsibilities.

The *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987), the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region* (COE 2010) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region (Version 2.0)* (COE 2008) provide the standards for wetlands determinations. Wetland delineations for the Project were conducted in accordance with these federal regulations and methodologies.

4.3.3.1 Jordan Cove LNG Project

Wetlands identified during surveys of the terminal site and associated sites between 2013 and 2017 are shown in figure 4.3-1.[86] Wetlands identified in the area include estuarine subtidal, estuarine intertidal, palustrine unconsolidated bottom, palustrine aquatic bed, palustrine emergent, palustrine scrub-shrub, and palustrine forested wetlands.

[86] The COE reviewed Jordan Cove's 2013 and 2016 wetland delineation and determinations, and provided Preliminary Jurisdictional Determinations on March 13, 2014, October 28, 2014, and March 16, 2017. Requests for Preliminary Jurisdictional Determinations for delineations conducted in 2017 have been submitted to the COE. Additionally, because it has been several years since the Preliminary Jurisdictional Determinations have been issued, Jordan Cove has requested new or revised Jurisdictional Determinations from the COE.

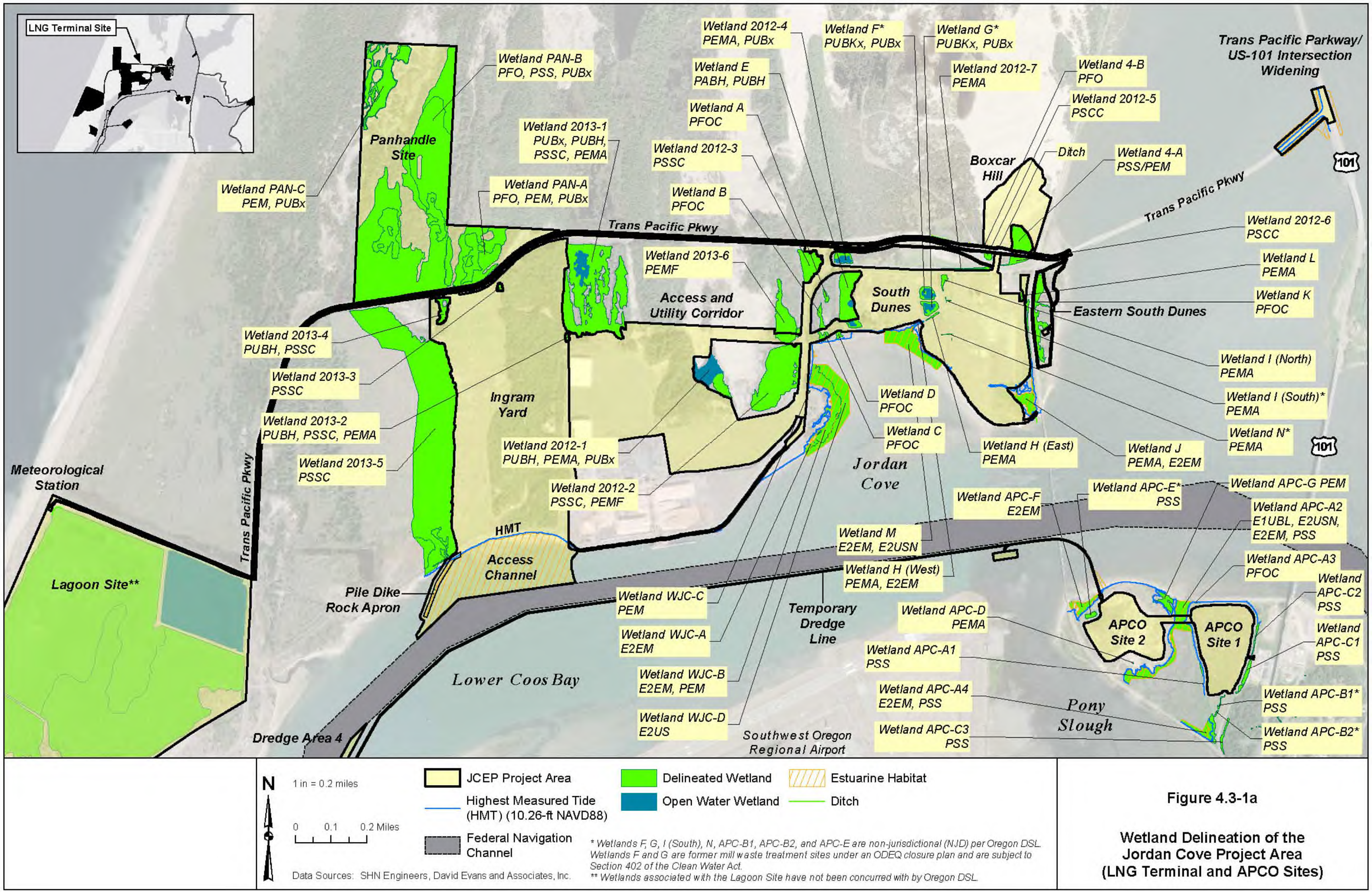


Figure 4.3-1a

Wetland Delineation of the
Jordan Cove Project Area
(LNG Terminal and APCO Sites)

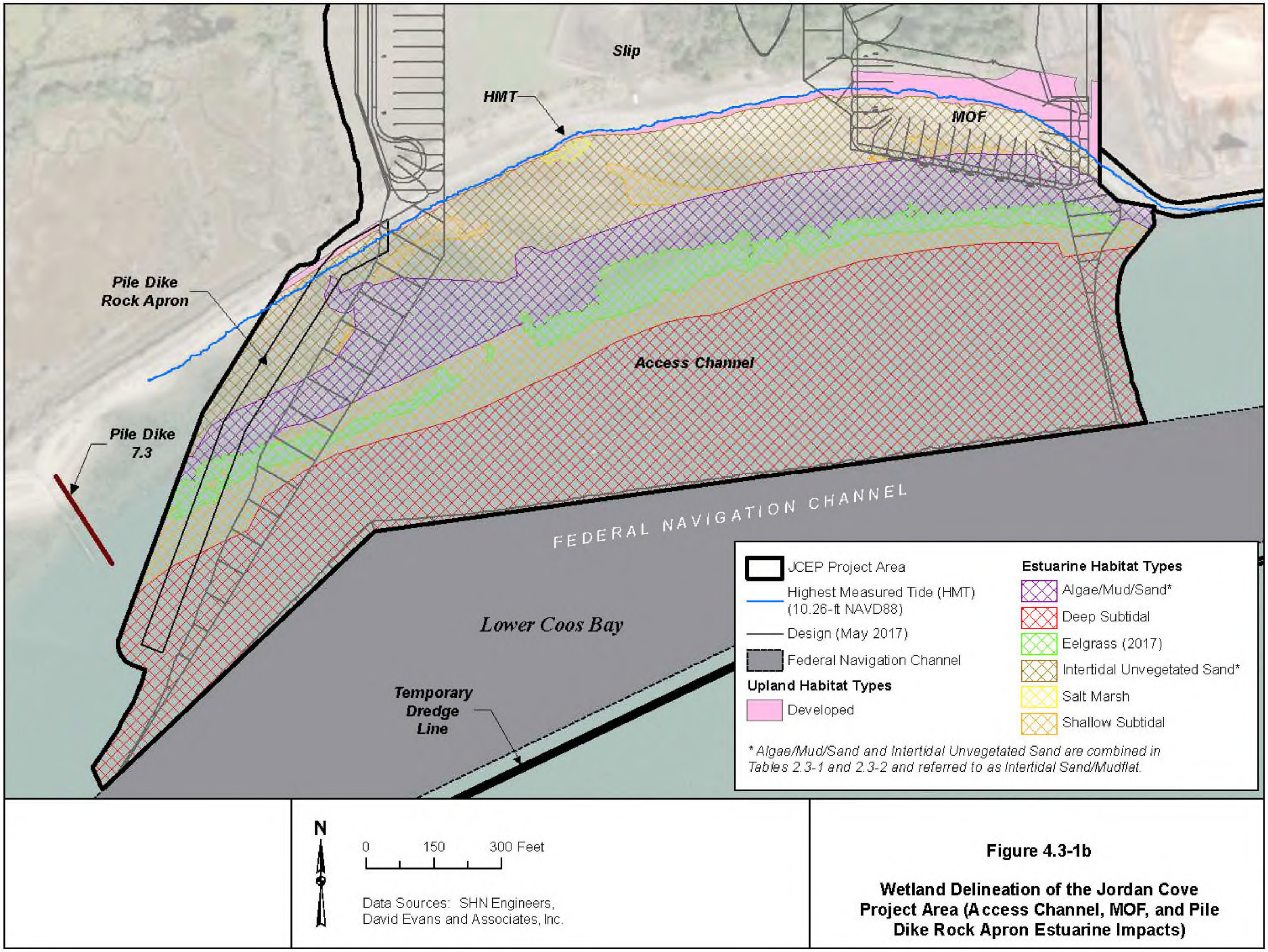


Figure 4.3-1b

Wetland Delineation of the Jordan Cove Project Area (Access Channel, MOF, and Pile Dike Rock Apron Estuarine Impacts)

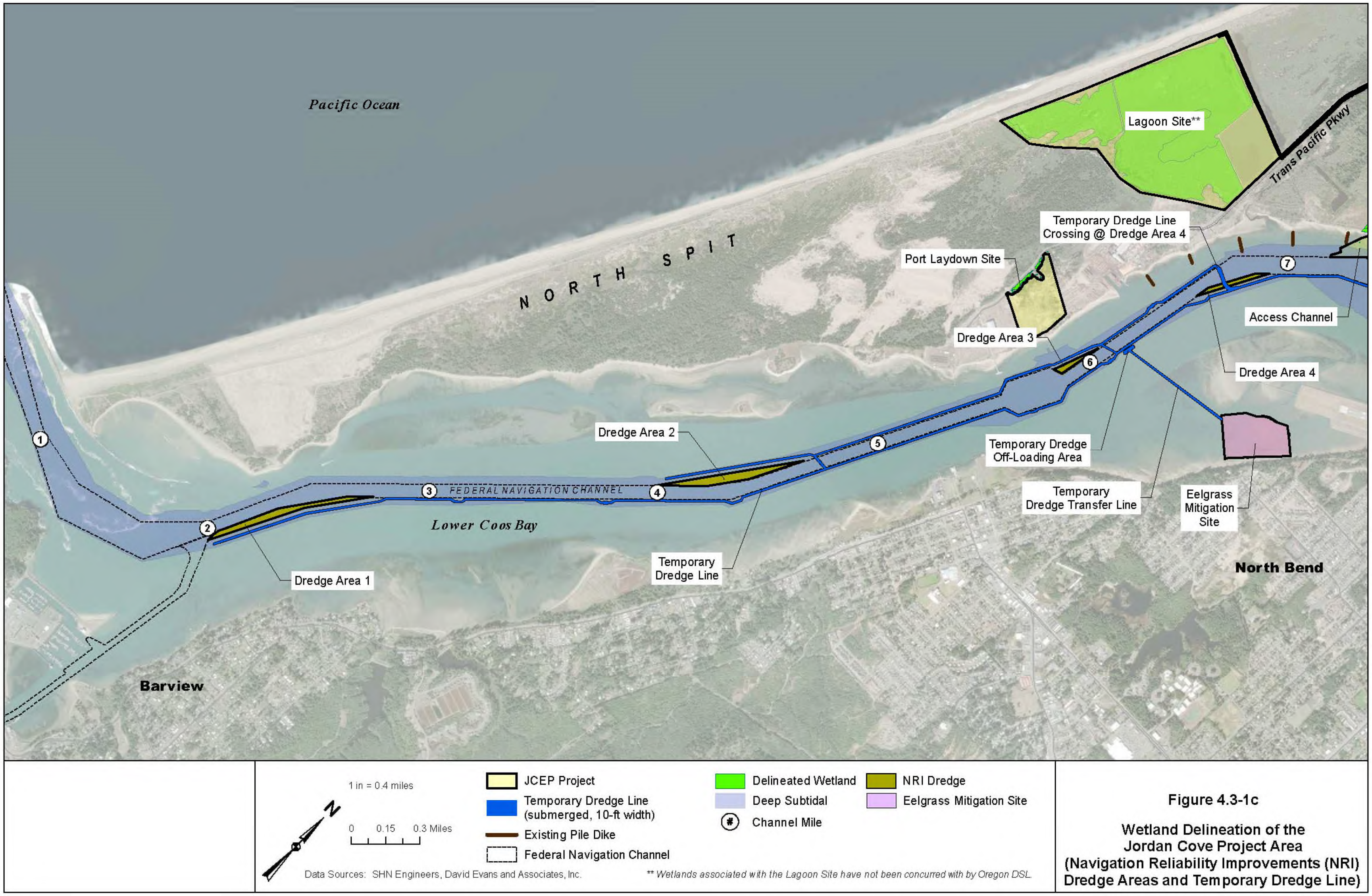
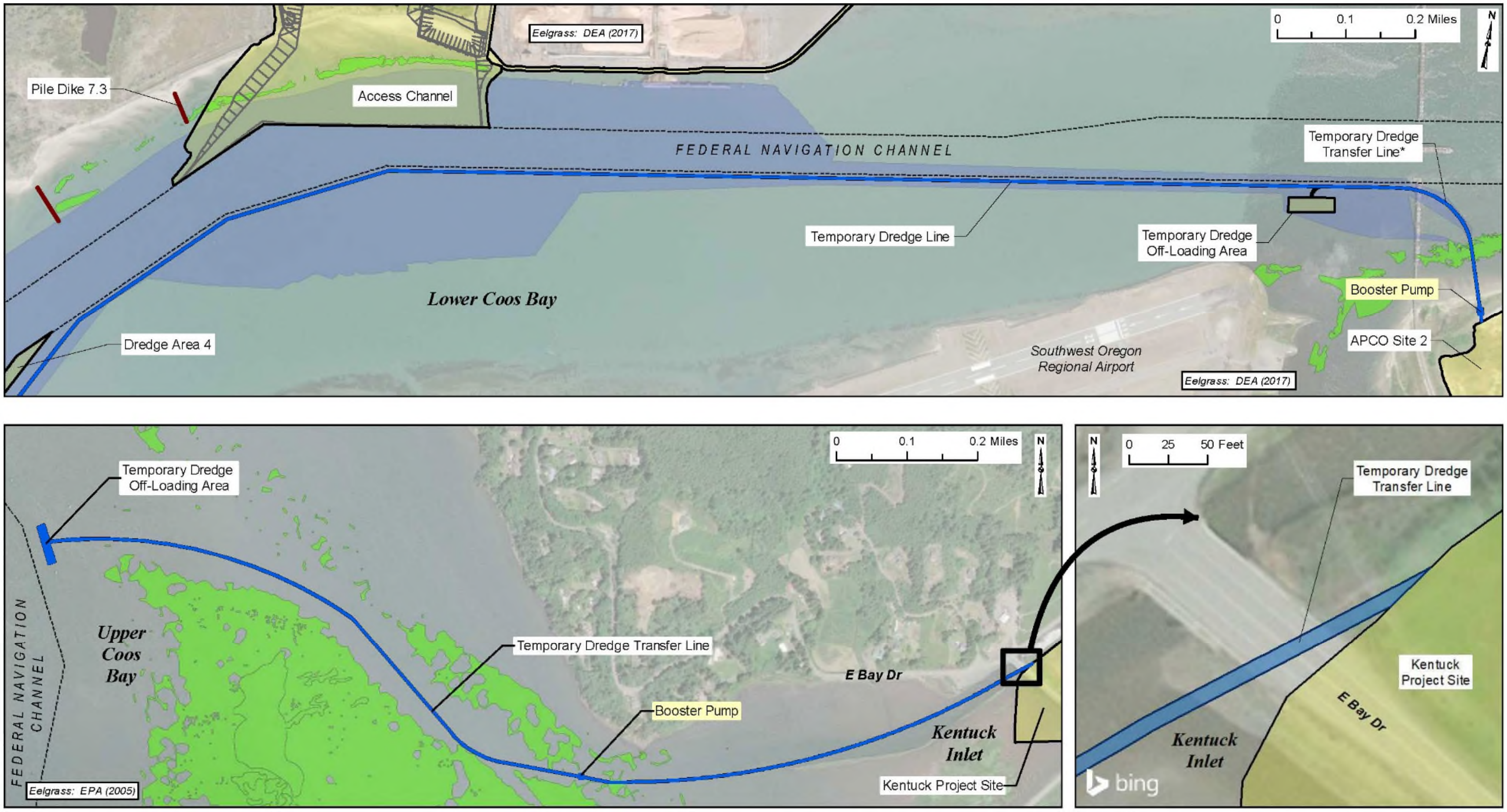


Figure 4.3-1c

Wetland Delineation of the Jordan Cove Project Area (Navigation Reliability Improvements (NRI) Dredge Areas and Temporary Dredge Line)



JCEP Project Area
Design (May 2017)
Temporary Dredge Line (submerged, 10-ft width)*
Existing Pile Dike
Federal Navigation Channel
Eelgrass
Deep Subtidal
Channel Mile

* Temporary Dredge Transfer Line will be suspended where it crosses the eelgrass at the entrance to APCO Site 2

Data Sources: SHN Engineers, David Evans and Associates, Inc.

Figure 4.3-1d

Wetland Delineation of the Jordan Cove Project Area (Temporary Dredge Line to APCO Site 2 and Kentuck Temporary Dredge Transfer Line)

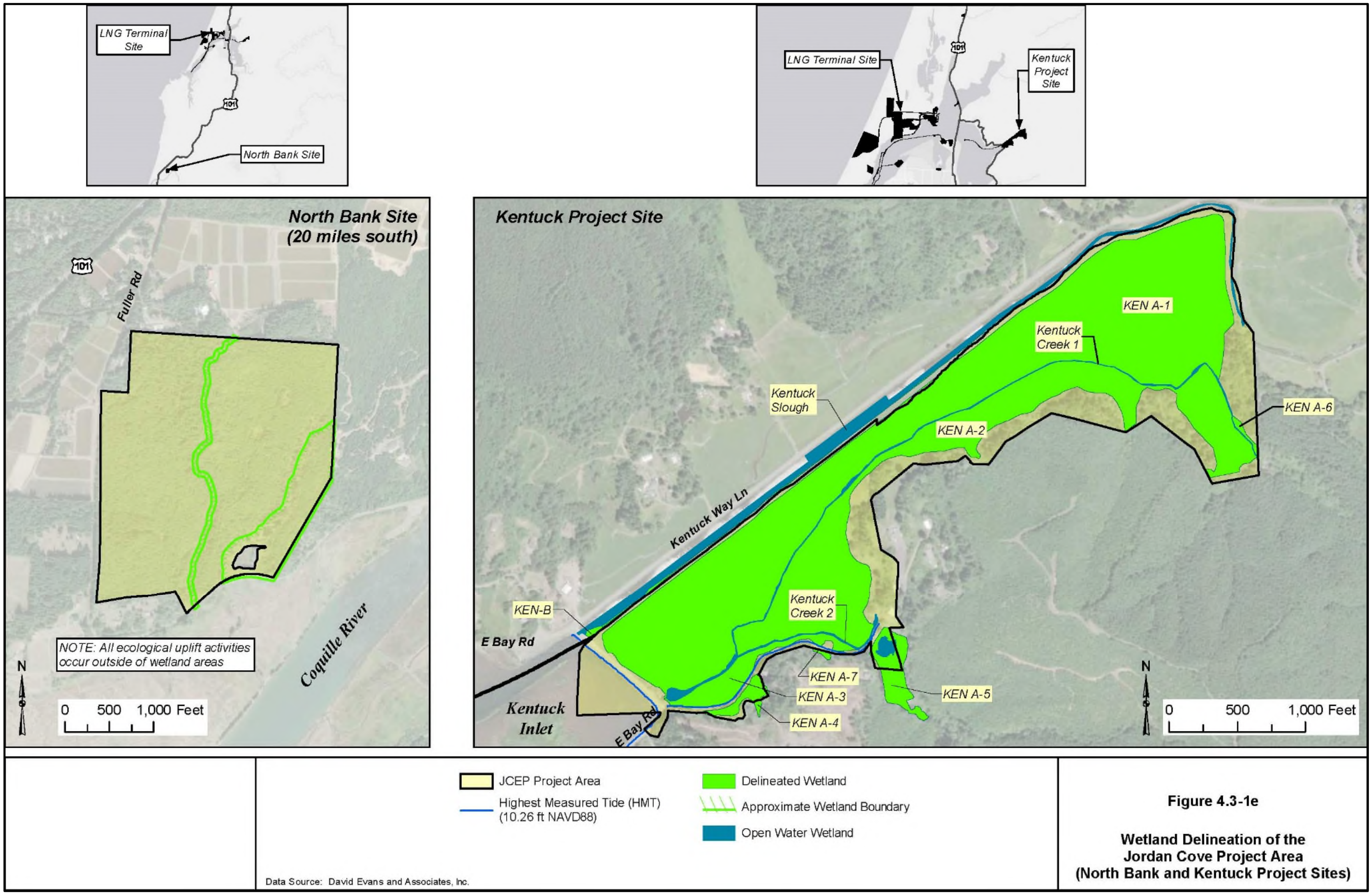


Figure 4.3-1e

Wetland Delineation of the Jordan Cove Project Area (North Bank and Kentuck Project Sites)

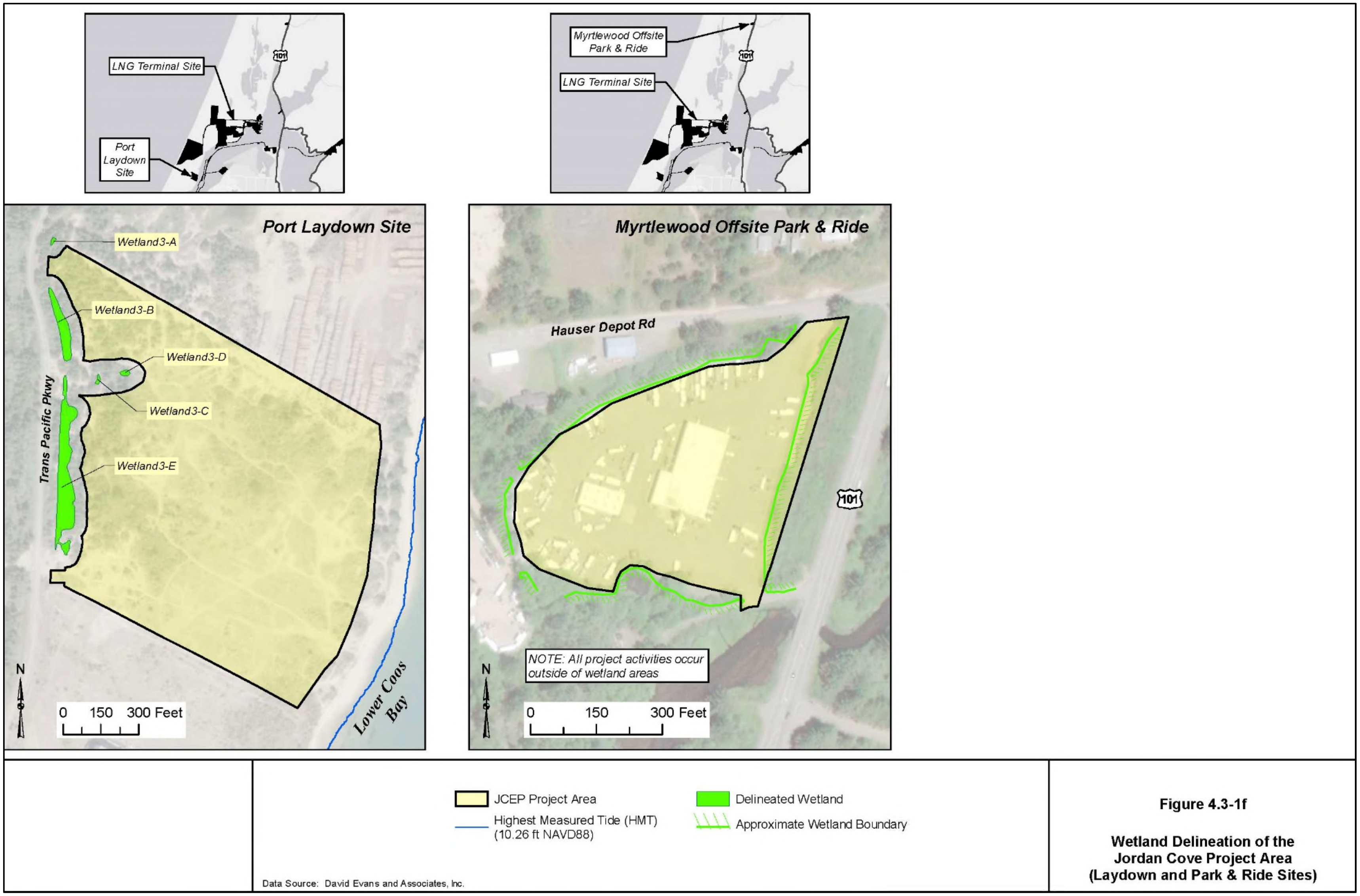


Figure 4.3-1f

Wetland Delineation of the Jordan Cove Project Area (Laydown and Park & Ride Sites)

Estuarine intertidal wetlands are intertidal systems that are regularly flooded and have an unconsolidated shore (i.e., tidal mud/sand flats). Vegetation in tidal flats, with the exception of sea grass beds and algal mats, is generally restricted to small areas of accretion in the tidal marsh-mudflat boundary (Seliskar and Gallagher 1983). Estuarine subtidal wetlands occur below mean low tide and are adjacent to tidal mudflats. Subtidal wetlands provide important ecological functions including providing fish and invertebrate shelter during low tides, supporting sea grass communities and acting as nursery areas for some aquatic species (ODFW 2017a). Estuarine wetlands within Coos Bay are characterized by sandy, muddy, or rocky substrates that are regularly inundated by brackish water and influenced by tidal flux, resulting in cycles of saturation and exposure. Plant life is not typically abundant within these types of wetlands, though macro- and microalgae and phytoplankton can be present. Estuarine intertidal and subtidal wetlands occur throughout Coos Bay.

Palustrine unconsolidated bottom wetlands are wetlands have less than 30 percent vegetation cover and a surface with less than 25 percent of the particles smaller than stones. The closely related aquatic bed wetland class has less than 30 percent vegetation cover of plants growing on or below the water's surface for most of the growing season. These wetland types occur along the South Dunes Site and the access/utility corridor.

Palustrine emergent wetlands are freshwater wetlands dominated by erect, rooted, herbaceous wetland plants that generally persist for most of the growing season. Plant species found in emergent wetlands on the Jordan Cove LNG Project area include slough sedge (*Carex obnupta*), Hooker's willow (*Salix hookeriana*), toad rush (*Juncus bufonius*), dagger-leaved rush (*Juncus ensifolius*), tinker's penny (*Hypericum anagalloides*), devil's beggartick (*Bidens frondosa*), knotgrass (*Paspalum distichum*), Yorkshire fog (*Holcus lanatus*), creeping bent-grass (*Agrostis stolonifera*), yellow pond lily (*Nuphar lutea* ssp. *polysepala*), and floating-leaved pondweed (*Potamogeton natans*). Emergent wetlands occur in various portions of the LNG terminal area as well as at the APCO and Kentuck project sites.

Palustrine scrub-shrub wetlands are freshwater wetlands that include areas dominated by woody vegetation less than 20 feet tall and are vegetated with true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. Species found within scrub-shrub wetlands on the LNG terminal area include Hooker's willow, Sitka willow (*Salix sitchensis*), Douglas spiraea (*Spiraea douglasii*), twinberry (*Lonicera involucrata*), slough sedge, soft rush (*Juncus effusus*), dagger-leaved rush, toad rush, western bent-grass (*Agrostis exarata*), creeping bent-grass, reed canary grass (*Phalaris arundinacea*), northern willowherb (*Epilobium ciliatum*), tall mannagrass (*Glyceria striata* [*G. elata*]), and lowland cudweed (*Gnaphalium palustre*). Scrub-shrub wetlands occur in the various portions of the LNG terminal area, and at the APCO site.

Palustrine forested wetlands are freshwater wetlands that contain woody vegetation that is 20 feet or taller. Coniferous species found in the forested wetlands on the LNG terminal area include shore pine (*Pinus contorta*), Douglas-fir (*Pseudotsuga menziesii*), Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*) and scattered Port-Orford cedar (*Chamaecyparis lawsoniana*). Shrubs within the forest wetland areas include scotch broom (*Cytisus scoparius*), coyote brush (*Baccharis pilularis*), hairy manzanita (*Arctostaphylos columbiana*), evergreen huckleberry (*Vaccinium ovatum*), salal (*Gaultheria shallon*), wax myrtle (*Morella* [*Myrica*] *californica*) and scattered rhododendron (*Rhododendron macrophyllum*). Herbaceous species include European beachgrass (*Ammophila arenaria*), silver hairgrass (*Aira caryophyllea*), little hairgrass (*A. praecox*), hairy cat's ear (*Hypochaeris radicata*), bracken fern (*Pteridium aquilinum*), sheep sorrel (*Rumex acetosella*), candy-stick (*Allotropa virgata*), and rattlesnake plantain (*Goodyera oblongifolia*). Forested wetlands occur in the north-central portion of the LNG terminal area and at the APCO and Kentuck project sites.

Impacts and Mitigation

Table 4.3.3.1-1 identifies the wetlands located at Jordan Cove's terminal site and associated sites. Approximately 86.1 acres of wetlands would be affected by construction of the proposed Jordan Cove LNG Project and approximately 22.3 acres of wetlands would be permanently lost due to construction and operation of the Project (see table 4.3.3.1-1). Approximately 0.5 acre of this impact would occur to wetlands as a result on non-jurisdictional facilities (e.g., the Trans-Pacific Parkway/U.S. 101 intersection and the industrial wastewater pipeline). The vast majority of impacts are associated with wetlands affected by construction of the ship and access channel and MOF and navigation reliability improvement dredge areas (which would impact 77.4 acres of wetlands).

TABLE 4.3.3.1-1

Wetlands Impacts on the LNG Project Area

Wetland Type	Acres Affected By Construction a/	Acres Affected By Operation
Slip and Access Channel and Material Offloading Facility (MOF)		
Estuarine b/, c/	37.3	18.3
Subtotal	**37.3**	**18.3**
Access /Utility Corridor		
Palustrine Emergent	0.8	0.6
Palustrine Scrub-Shrub	<0.1	<0.1
Subtotal	**0.9**	**0.6**
South Dunes Site		
Estuarine	0.1	0.1
Palustrine Aquatic Bed and Palustrine Unconsolidated Bottom	2.3	2.1
Palustrine Emergent	0.5	0.5
Palustrine Scrub-shrub	<0.1	<0.1
Palustrine Forested	0.3	0.3
Subtotal	**3.1**	**2.9**
Hydraulic Dredge Pipeline		
Estuarine	0.2	0.0
Subtotal	**0.2**	**0.0**
Industrial Wastewater Pipeline (IWWP)		
Palustrine Scrub-shrub	<0.1	0.0
Subtotal	**<0.1**	**0.0**
Trans Pacific Parkway/US-101 Intersection		
Estuarine	0.5	0.5
Subtotal	**0.5**	**0.5**
Marine Waterway Modifications – Dredge Areas 1 - 4		
Estuarine c/	27.0	0.0
Subtotal	**27.0**	**0.0**
Marine Waterway Modifications – Temporary Dredge Line		
Estuarine b/, c/	13.1	0.0
Subtotal	**13.1**	**0.0**
APCO Site d/		
Estuarine	<0.1	0.0
Subtotal	**<0.1**	**0.0**
Temporary Dredge Off-loading Area at APCO Site		
Estuarine c/	0.9	0.0
Subtotal	**0.9**	**0.0**
Temporary Dredge Transfer Line and Off-loading Area at Kentuck Site e/		
Estuarine b/, c/	2.2	0.0
Subtotal	**2.2**	**0.0**

TABLE 4.3.3.1-1 (continued)

Wetlands Impacts on the LNG Project Area

Wetland Type	Acres Affected By Construction a/	Acres Affected By Operation
Temporary Dredge Transfer Line and Loading Area at Eelgrass Mitigation Site f/		
Estuarine b/, c/	1.1	0.0
Subtotal	**1.1**	**0.0**
Ingram Yard g/	0.0	0.0
Port Laydown Site g/	0.0	0.0
Additional Offsite Park & Ride g/	0.0	0.0
Myrtlewood Offsite Park & Ride g/	0.0	0.0
Subtotal	**0.0**	**0.0**
Total Freshwater Wetland Impacts	3.9	3.4 g/
Total Estuarine Wetland Impacts	82.2 b/	18.9
Total All Wetland Impacts	**86.1**	**22.3**

Note that values may not sum correctly due to rounding. Acreages for wetlands are rounded to the nearest tenth of an acre; values below 0.1 acre are noted as <0.1.

a/ Acres affected by construction include acres affected by operation.
b/ Acreage of eelgrass and adjacent estuarine habitats subject to change based on field mapping conducted in late August 2018, which is currently under review.
c/ Impacts to deep subtidal habitat are not expected during operation, because natural recovery of benthic communities within this habitat is expected within a relatively short time frame following construction.; therefore, impacts are recorded as construction-phase only.
d/ APCO Site wetland and estuarine construction impacts are due to temporary bridge pilings.
e/ Wetlands associated with proposed mitigation areas (Panhandle, Lagoon, North Bank upland mitigation sites; Kentuck project site and Eelgrass Mitigation site) are not included in this table. Some correlated impacts to wetlands will occur at the Kentuck project site, but they will be offset by the overall mitigation project. A full accounting of correlated impacts will be included in the 404 permit application submitted to the COE.
f/ There are no wetlands within Ingram Yard, Port Laydown site, or Myrtlewood Offsite Park & Ride.
g/ Total freshwater wetland acreage includes 0.3 acre of operational forested wetland.

To satisfy COE and state permitting, Jordan Cove assessed the function and values of wetlands permanently affected by the Jordan Cove LNG Project to determine high value wetlands. The criteria used to assess wetlands were their water quality and quantity, the value of their fish and wildlife habitat, their native plant communities and species diversity, and their value for recreation and educational purposes. Four wetlands (wetlands 2013-6, 2012-2, Wetland C, and Wetland E), totaling less than two acres, are considered high value wetlands. The COE may also require additional compensatory mitigation for impacts on Aquatic Resources of Special Concern (ARSC), which are defined as “aquatic resources that are unique, difficult to replace, and/or have high ecological function” (COE 2018). ARSCs that may be affected by the Jordan Cove LNG Project may include estuarine wetlands, rocky substrate in tidal waters, and native eelgrass (*Zostera marina*) beds. As identified above, constructing and operating the Jordan Cove LNG Project would temporarily and permanently impact wetlands. In addition to the permanent loss of wetlands, temporary impacts on wetlands include loss of vegetation, and modification of wetland hydrology and soils characteristics. Disturbed wetlands are also susceptible to the introduction of exotic and invasive plant species. Based on assessments evaluating impacts on wetland habitats from dewatering activities, it is expected that groundwater movement and levels would return to pre-disturbance conditions following construction (DEA 2015, 2018a; GSI 2017). A monitoring program would be conducted prior to, during, and after construction to monitor potential impacts on ground and surface waters, as well as wetlands. In addition to impacts on wetlands listed in table 4.3.3.1-1, Henderson Marsh, which is located directly to the west of the terminal, may be affected due to a minor reduction in water entering the marsh due to the construction of the tsunami berm on the west side of the slip.

All impacts associated with mitigation sites are not part of the proposed action and are proposed only as necessary compensation for unavoidable impacts. Approximately 108.7 acres of wetlands (6.0 acres of estuarine wetlands and 102.7 acres of freshwater wetlands and open water) would be temporarily affected at the Kentuck project site in association with wetland restoration and mitigation activities. Potential impacts at the Kentuck project site include a temporary reduction in water quality due to an increase in sedimentation (e.g., resulting from import and grading of dredge material), temporary disturbances to adjacent wildlife, and a temporary impact on vegetation removed during restoration activities at the site. However, these impacts would be part of an overall long-term enhancement of the wetland habitat. Dredging for construction of the Eelgrass Mitigation site could result in approximately 10.3 acres of temporary short-term impacts; potential impacts include a temporary reduction in water quality due to an increase in sedimentation during dredging activities and a temporary loss of benthic organisms. Benthic organisms could re-establish within the area once eelgrass revegetation was complete (see section 4.5 of this EIS).

When unavoidable wetland impacts are proposed, the COE, EPA, and ODSL require that all practicable actions be taken to avoid, minimize, and then compensate for those impacts. The COE would determine the specific type and amount of compensatory mitigation that would be required to offset the loss of wetland acreage and functions that cannot be avoided or minimized as part of the CWA Section 404 permit process and by the ODSL as part of the state Removal-Fill permit process.[87]

Prior to COE authorization, the COE must ensure aquatic resource impact avoidance and minimization have been identified, outlined, and promulgated by an applicant. The COE uses a mitigation sequence to assess the need for aquatic resource impacts. This mitigation sequence contains a primary structure centered on avoidance of aquatic resource impacts, minimization of aquatic resource impacts, restoration of aquatic resource functions and services, and compensation for the loss of aquatic resource impacts that could not be avoided. If, after outlining project aquatic resource avoidance and minimization to the degree practicable, an applicant may mitigate for subsequent aquatic resource impacts. Mitigation for aquatic resource impacts is carried out via the development of a compensatory mitigation plan. A compensatory mitigation plan must be developed to meet the requirements of the 2008 Compensatory Mitigation Rule as outlined in the Final Rule on Compensatory Mitigation for Losses of Aquatic Resources (73 [70] FR 19594-19705 [April 10, 2008]) and in 33 CFR Part 232.4.

A compensatory mitigation plan must replace lost aquatic functions and values, and must contain the following required components:

- goals and objectives;
- site selection criteria;
- site protection instrument;
- baseline environmental information;

[87] The Oregon International Port of Coos Bay received a removal-fill permit from the ODSL to construct the slip and access channel for development of a new terminal (DSL permit 37712-RF). A new application will be submitted to ODSL for the remaining portions of the Jordan Cove Project area not covered by ODSL permit 37712-RF. A permit application that covers the entire Jordan Cove Project area will also be submitted to the COE.

- determination of credit methodology;
- mitigation work plan;
- maintenance plan;
- performance standards;
- monitoring requirements;
- long-term management plan;
- adaptive management plan; and
- financial assurances.

Jordan Cove developed a *Compensatory Wetland Mitigation Plan* to address unavoidable impacts on wetlands and other aquatic resource types.[88] Impacts on freshwater wetland resources would be mitigated via the Kentuck project site. Approximately 9.1 acres of the Kentuck project site would be enhanced and restored to mitigate for permanent impacts on freshwater wetlands (see Table 4 of Jordan Cove's *Compensatory Wetland Mitigation Plan*). Impacts on estuarine wetland and aquatic resources would be mitigated via the Eelgrass Mitigation site and Kentuck project site. Approximately 91.5 acres would be enhanced and restored at the Kentuck project site, and approximately 7.7 acres would be enhanced at the Eelgrass Mitigation site for a total of approximately 99.1 acres of mitigation for permanent impacts on estuarine wetlands and aquatic resources (see Table 4 of Jordan Cove's *Compensatory Wetland Mitigation Plan*). These mitigation plans are still being reviewed by the COE, ODSL, and applicable federal and state agencies. Approval of these mitigation plans by these agencies would be required prior to issuance of federal and state wetland permits. Restoration efforts at the Kentuck project and Eelgrass Mitigation sites would result in some short-term and permanent impacts; however, the *Compensatory Wetland Mitigation Plan* accounts for these impacts and provides mitigation to offset these impacts.

4.3.3.2 Pacific Connector Pipeline Project

Pacific Connector conducted wetland delineations of pipeline related workspaces. For areas where on-site delineation was not possible due to lack of landowner permission, Pacific Connector used USGS topographic maps, NRCS soil surveys, FWS NWI maps, and aerial photography to identify wetland type and boundaries. Wetland types identified along the proposed route included estuarine intertidal flats, estuarine subtidal channels, estuarine emergent, palustrine unconsolidated bottom, palustrine aquatic bed, palustrine emergent, palustrine scrub-shrub, palustrine forested, and riverine.

Along the proposed pipeline route, PEM wetlands, which are commonly disturbed by agricultural and grazing activities, are dominated by hydrophytic pasture grasses such as meadow foxtail (*Alopecurus pratensis*), rough bluegrass (*Poa trivialis*), and various bentgrasses (*Agrostis* spp.). Soft rush and white clover (*Trifolium repens*) are also commonly present in these disturbed wetlands. Within Douglas and Jackson Counties, pennyroyal (*Mentha pulegium*) is also a common dominant species in emergent wetlands. Emergent wetlands dominated by native species are uncommon, but when they occur (primarily within swales and irrigation canals) they generally contain cattail (*Typha latifolia*), small-fruited bulrush (*Scirpus microcarpus*), hardstem bulrush (*Schoenoplectus* [*Scirpus*] *acutus*), manna grass (*Glyceria striata* [*G. elata*]), American

[88] See *Jordan Cove Energy Project Compensatory Wetland Mitigation Plan* filed with the FERC in May 2018.

sloughgrass (*Beckmannia syzigachne*), and various sedges (*Carex* spp.). Vernal pool wetlands, which occur along the proposed pipeline route, are also defined as palustrine emergent wetlands.

Scrub-shrub wetland communities along the proposed pipeline route consist of two primary types: disturbed wetlands associated with grazing or development activities and relatively undisturbed wetlands. Common species within disturbed wetlands tend to support invasive species such as Himalayan blackberry (*Rubus laciniatus*) and sweetbriar rose (*Rosa rubiginosa* [*R. eglanteria*]). Common species in undisturbed wetlands include a mixture of Douglas' spirea, Pacific willow (*Salix lasiandra*), salmonberry (*Rubus spectabilis*), and Pacific ninebark (*Physocarpus capitatus*).

The majority of delineated forested wetlands along the proposed pipeline route contain Oregon ash (*Fraxinus latifolia*). Red alder (*Alnus rubra*) and black cottonwood (*Populus trichocarpa*) are more common along the western part of the pipeline route in Coos and Douglas Counties. Western red-cedar (*Thuja plicata*) and Sitka spruce are common in the coast range forested wetlands. Skunk cabbage (*Lysichiton americanum*) and salmonberry are common in the understory of coast range forested wetlands and lady fern (*Athyrium filix-femina*) and horsetails (*Equisetum* spp.) are often present in the understory in other parts of the pipeline route. Forested wetlands are uncommon along the southeastern portions of the pipeline route, but are generally in swales or depressions. They are dominated by Oregon ash with an understory of Himalayan blackberry, slough sedge, and spreading rush (*Juncus patens*).

Riverine wetlands are freshwater wetland habitats contained within a channel. The riverine wetlands along the proposed pipeline route include species similar to those found in the palustrine emergent, scrub-shrub, and forested wetlands.

Intertidal flats are the predominant estuarine wetland type crossed by the pipeline route. These wetlands are intertidal systems that are regularly flooded and have an unconsolidated shore (i.e., tidal mud/sand flats). Vegetation in estuarine tidal flats, with the exception of sea grass beds and algal mats, is generally restricted to small areas of accretion in the tidal marsh-mudflat boundary (Seliskar and Gallagher 1983). Estuarine subtidal channels occur below mean low tide and are adjacent to tidal mudflats. Subtidal channels provide important ecological functions including providing fish and invertebrate shelter during low tides, supporting sea grass communities and acting as nursery areas for some aquatic species (ODFW 2017a).

Estuarine emergent wetlands, also called estuarine marshes, occur along the outer edges of the tidal mudflats. Vegetation in these wetlands are typically erect, perennial species such as arrow grasses (*Triclochin* spp.), cordgrasses (*Spartina* spp.), bulrushes (*Scirpus* spp.), and alkali grasses (*Puccinellia* spp.).

Impacts and Mitigation

Constructing the pipeline would temporarily and permanently impact wetlands. Clearing wetland vegetation could alter several wetland functions including their ability to provide fish and wildlife habitats, sediment and nutrient trapping, and other water quality functions. Additionally, soil disturbance and removal of vegetation could temporarily affect a wetland's capacity to moderate flood flow, control sediment, or facilitate surface water flow. Removing vegetation could also increase water and soil temperatures and alter species composition within forested and shrub wetlands to a more shade intolerant composition. Digging a trench through an impervious layer of soil in a wetland would alter the hydrologic character of the wetland. Failure to segregate topsoil from the trench could result in altered biological and chemical functions in the wetland soil and could affect the re-establishment of vegetation, recruitment of native vegetation, or success of plantings. Improper operation of equipment or transport of pipe in wetlands could inadvertently rut or compact the soil and affect natural hydrologic patterns of the wetlands and may lead to inhibited seed germination or increase the potential for siltation. Improper sediment controls could lead to sediment deposition in wetlands (including those wetlands located downslope or outside of the right-of-way or construction disturbance footprint), which could lead to the release of chemical and nutrient pollutants from sediments.

The range and intensity of wetland impacts would vary depending on the type of wetland affected. In general, impacts on herbaceous wetlands would be short term, while impacts on scrub-shrub and forested wetlands would be long term. Impacts on herbaceous wetlands would be considered short term because herbaceous vegetation generally regenerates quickly. Scrub-shrub and forested wetlands may take several years to decades to reach functionality similar to pre-construction conditions, depending on the age and complexity of the system. Also, some wetlands would be permanently converted from one type to another (e.g., forested to scrub-shrub and/or herbaceous) as a result of pipeline maintenance activities.

As identified in table 4.3.3.2-1, constructing the pipeline would impact 112.2 acres of wetlands. Of this 112.2 acres, operation of the pipeline would permanently impact approximately 4.9 acres of wetlands. This includes 4.0 acres of long-term impacts on scrub-shrub and forested wetlands and 0.9 acres of wetlands that would be permanently converted to a different wetland type. Tables H-1a and H-1b in appendix H of this EIS list the wetlands crossed by the pipeline by wetland type, ecoregion, subbasin, and fifth-field watershed, and list the acres of impacts that would occur to each of these wetlands.

TABLE 4.3.3.2-1

Summary of Wetland Impacts along the Pacific Connector Pipeline

Wetland Type	Total Acres Affected by Construction	Total Acres Affected by Operation a/, b/
Palustrine unconsolidated bottom and aquatic beds	0.6	0.0
Palustrine emergent wetlands	106.7	0.0
Palustrine forested wetlands	2.6	2.6 (0.7)
Palustrine scrub-shrub wetlands	2.3	2.3 (0.2)
Total Wetland Impact	**112.2**	**4.9 (0.9)**

Note that values may not sum correctly due to rounding. Acreages for wetlands are rounded to the nearest tenth of an acre; values below 0.1 acre are noted as <0.1.

a/ Includes wetlands that would be allowed to restore to preconstruction conditions (i.e., they would not be filled, nor would they be located within the permanent 10-foot-wide operational corridor); however, it could take many decades for conditions within these wetlands to restore to preconstruction conditions.

b/ The numbers in parentheses represent the permanent conversion of forested wetlands within the 30-foot-wide maintenance corridor and scrub-shrub wetlands within the 10-foot-wide maintenance corridor.

The pipeline would cross 18 (fifth-field) watersheds; however, approximately 78 percent (87.3 acres) of the pipeline's total impact on wetlands would occur in two watersheds: the Lake Ewauna Upper Klamath River watershed and the Coos Bay Frontal watershed. The remaining 24.9 acres of wetland impacts would occur primarily in small palustrine emergent wetlands and intermittent drainages where impacts would be temporary and short term. As described previously, to satisfy COE and state permitting, Pacific Connecter assessed the function and values of wetlands to determine which affected wetlands were high value wetlands. Constructing the pipeline would impact approximately 7.1 acres of high value wetlands, with the majority of these impacts (about 4.1 acres) occurring to two palustrine emergent wetlands (Wetland ID EW-33 and EW-35) associated with the floodplain of Salt Creek in Jackson County. As stated above, the COE may also require additional compensatory mitigation for impacts on ARSCs (COE 2018). ARSCs that may be affected by the proposed pipeline include alkali wetlands, mature forested wetlands, vernal pools, and Willamette Valley wet prairie wetlands.

To minimize impacts on wetlands, Pacific Connector would implement the construction and restoration measures contained in its ECRP. Section VI.A.3 of the FERC's *Procedures* requires that the construction right-of-way width be limited to 75 feet across wetlands, while Section VI.B.1.a requires that TEWAs be located at least 50 feet away from wetland boundaries. However, Pacific Connector has submitted modifications for these requirements associated with where the applicant requested a 95-foot-wide construction right-of-way in a wetland or that TEWAs be located less than 50 feet away from a wetland (table E-1 in appendix E). Their justifications for the modifications at specific locations vary, but include reasons such as: 1) necking-down the right-of-way in emergent wetland would require use of TEWAs that would be located 50 feet back from the waterbody, which could result in these work areas being located within forested or shrub wetlands that can have a higher function and value than the disturbed emergent wetland, and 2) where the pipeline traverses disturbed emergent wetlands, such as in agricultural areas (cropland and hayfields), the typical 95-foot-wide construction footprint in uplands will be maintained because these wetlands are degraded systems that are expected to fully recover within one full growing season. Pacific Connector's proposed modifications to FERC's *Plan* and *Procedures* are provided in appendix E, also see discussion in section 2. Based on our *Procedures* and as described in its ECRP, Pacific Connector would implement the following measures in wetlands

- the top 1 foot of topsoil would be segregated from the subsoil in the area disturbed by trenching, except where standing water is present, or soils are saturated or frozen. Immediately after backfilling, the segregated soil would be restored to its original location;
- vegetation would be cut just above ground level to leave the existing root system in place. Tree stump removal and grading would occur directly over the trenchline. Stumps would not be removed from the rest of the right-of-way unless required for safety reasons;
- construction equipment operating would be limited to that needed to clear vegetation, dig trenches, install the pipe, backfill, and restore the right-of-way. Other equipment would use upland access roads to the maximum extent possible. Travel would be restricted across wetlands where topsoil was restored;
- low ground-weight equipment would be used in saturated wetlands or the normal equipment would be operated on prefabricated equipment mats;
- slope breakers and sediment controls would be installed and maintained on slopes greater than 5 percent that are less than 50 feet from a wetland;
- erosion control devices would be installed and maintained as necessary to prevent sedimentation and runoff from entering wetlands;
- trench breakers would be installed, or the bottom of the trench would be sealed as necessary, to maintain the original wetland hydrology;
- appropriate weed-free live seed mixtures would be used for revegetation. No fertilizers would be used in wetlands;

- appropriate native trees and shrubs would be replanted during restoration of wetlands within riparian areas;
- wetlands would be monitored after revegetation for three years after construction or until the revegetation is successful. Revegetation would be considered successful when 80 percent of the type, density, and distribution of species are similar to that of adjacent unaltered wetlands. If revegetation is not successful at the end of three years, Pacific Connector would develop and implement a remedial revegetation plan to actively revegetate the wetland and would continue revegetation efforts until wetland revegetation is successful; and
- vegetation maintenance would not be conducted over the full width of the operational right-of-way within wetlands, but limited to a 10-foot-wide corridor.[89]

The COE and ODSL may require additional mitigation (beyond what is required in this EIS) during their permitting process, which could include creating, restoring, or enhancing wetlands to replace the wetland functions and areas connectivity lost due to Project activities, or purchasing credits from a mitigation bank. ODSL administrative rules (OAR 141-085-0690) include minimum ratios for acres required for compensation that varies by type of mitigation proposed (e.g., restoration is 1 acre for each acre lost, creation is 1.5 for 1, and enhancement is 3 for 1). Pacific Connector has developed a *Compensatory Wetland Mitigation Plan* to mitigate for unavoidable impacts on wetlands affected by construction and operation of the pipeline (see section 4.3.3.1). The adequacy of wetland mitigation, including the scope and location of mitigation, would be determined by the COE.

4.3.3.3 Conclusion

In total the Project would impact a total of about 198 acres of wetlands, about 27 acres of which would be permanently lost. Based on our review of the Project and Jordan Cove and Pacific Connector's implementation of measure to reduce impacts on wetlands, we conclude that constructing and operating the Project would not significantly affect wetlands. Additionally, to mitigate wetlands impacts, Jordan Cove and Pacific Connector have prepared a Compensatory Wetland Mitigation Plan.

4.3.4 Environmental Consequences on Federal Lands

4.3.4.1 Groundwater

Shallow Groundwater

As indicated in section 4.3.1.2, the Pacific Connector Pipeline Project would cross areas where the groundwater is 0-6 feet bgs. The BLM and Forest Service may require that trench dewatering through a well point pumping system with a groundwater treatment plan be used, depending on if the groundwater is emanating from a pressurized or non-pressurized source point. On federal lands, dewatering activities would be coordinated with the BLM or Forest Service.

[89] Additionally, trees may be selectively removed if they are within 15 feet of the pipeline that could compromise the pipeline coating integrity.

Springs, Seeps, and Drains

Pacific Connector surveys have identified a number of springs and seeps, as noted in appendix H of this EIS. Pacific Connector has stated that it would further verify exact locations of springs and seeps during easement negotiations with land managers. Nearby springs and seeps supplied by deeper pressurized groundwater zones would generally not be affected by the trenching activities or trench plugs. Spring and seeps supplied by shallow groundwater, however, may be effected by the pipeline project, particularly if the pipeline is directly up-gradient of a spring or seep location.

The BLM has disclosed that French drains, similar in function to drain tiles, were installed to stabilize Elk Creek Road, which the proposed route would cross six times between MPs 34.02 and 37.15. These crossings are all within BLM lands. Pacific Connector would ensure that any French drains damaged by the pipeline would be repaired before backfilling. If either damage or repair causes a discharge to waterways under federal jurisdiction, a water quality permit would be required under Section 404 of the CWA. All French drains crossed by the Pacific Connector pipeline would be probed prior to right-of-way restoration to check for damage, and a qualified specialist would test for damage and conduct any necessary repairs. Pacific Connector would restore any damaged drains to the same condition that existed prior to construction. In order to identify, monitor, minimize, and mitigate for potential effects to groundwater, Pacific Connector has developed a *Groundwater Supply Monitoring and Mitigation Plan.* Land managers would be supplied with documentation that explains the pipeline construction Project and outlines the pre-construction field investigation for the identification and monitoring of groundwater supplies. Pre-construction surveys would be conducted to confirm the presence and locations of all groundwater supplies within and adjacent to the pipeline right-of-way.

Soil Compaction

Near-surface soil compaction caused by heavy construction vehicles could locally reduce the soil's ability to absorb water, which would increase surface runoff and the potential for ponding. To avoid long-term changes in water table elevation and subsurface hydrology, excavated topsoil and subsoils would be segregated (on non-federal lands) within wetlands, agricultural areas, and at the request of landowners, and returned as closely as practical to their original soil horizon and slope position. Following construction, restoration of compacted soils would include regrading, recontouring, scarifying (or ripping), and final cleanup activities. Decompacting soils would restore water infiltration, reduce surface water runoff, minimize erosion, and support revegetation efforts. The EI would be responsible for conducting soil compaction testing and determining corrective measures on non-federal lands, including localized deep scarification or ripping to an average depth of up to 8 inches where feasible, utilizing appropriate winged-tipped rippers. On federal lands, remediation and corrective measures to address compaction would be consistent with specific requirements of the BLM RMP Best Management Practices (e.g., R-91, TH-18) and Forest Service requirements (see NSR 2015a for details).

Accidental Spills of Hazardous Materials

Pipeline construction necessitates the use of heavy equipment and associated fuels, lubricants, and other potentially hazardous substances that, if spilled, could affect shallow groundwater and/or unconsolidated aquifers, throughout different aquifer layers. Accidental spills or leaks of hazardous materials associated with vehicle fueling, vehicle maintenance, and construction materials storage would present the greatest potential contamination threat to groundwater resources. Soil contamination resulting from these spills or leaks could continue to add pollutants to the groundwater long after a spill occurs. Implementation of proper storage, containment, and handling procedures would minimize the chance of such releases. Pacific Connector will follow the procedures outline in the *SPCC Plan* to minimize the potential of a spill, properly contain a spill in the event that one occurs, and to protect areas of environmental concern.

4.3.4.2 Surface Water

The Pacific Connector pipeline route would cross 19 fifth-field watersheds, and proposed access roads would cross an additional 5 watersheds. Of these, the Pacific Connector would cross NFS land in 6 fifth-field watersheds subject to ACS.

Riparian Reserves and the ACS

The 1994 NWFP set forth detailed requirements that describe how land managers should treat the forest lands within the range of the northern spotted owl (through implementation of the Standards and Guidelines – Attachment A to the 1994 NWFP ROD [Forest Service and BLM 1994a]). Some standards and guidelines apply to all lands and others to a specific land allocation. The 1994 NWFP ROD described the ACS, which was developed to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within them on public lands. The strategy would protect salmon and steelhead habitat on federal lands managed by the Forest Service within the range of the NSO. In August 2016, the BLM issued two RODs for two new RMPs (BLM 2016a and 2016b). These two plans supersede the NWFP on BLM lands. BLM retained a Riparian Reserve allocation but provided new management direction, thus eliminating the ACS requirements on BLM lands. The following discussion is specific to the Forest Service.

To achieve ACS objectives in the 1994 NWFP ROD, the ACS included areas defined as Riparian Reserves and Key Watersheds, specified analytical procedures for evaluating watersheds, and defined a program for watershed restoration. While the ACS focus was primarily on the conservation of anadromous salmon and steelhead, the nine objectives listed for the ACS include maintaining and restoring aquatic systems, floodplains, wetlands, upslope habitats, and riparian zones to support invertebrate and vertebrate species dependent on those habitats.

The existing conditions and range of variability within the fifth-field watersheds that would be crossed by the Pacific Connector pipeline are provided in the watershed analyses that were prepared by the Forest Service having jurisdiction over the NFS lands within the watersheds. Watershed assessments are a necessary component of a monitoring program in order to determine what degraded or impaired areas may exist in the watershed. Table 4.3.4.2-1 lists the fifth-field watersheds subject to ACS that would be crossed by the proposed route.

TABLE 4.3.4.2-1

Fifth-Field Watersheds Crossed by the Pacific Connector Pipeline on Forest Service Lands

Jurisdiction	Watershed (Name)	Approximate Miles Crossed	Watershed Analysis Completed
Forest Service – Umpqua National Forest (NF)	Days Creek-South Umpqua River a/ Elk Creek a/ Upper Cow Creek a/ Trail Creek a/	1.6 2.7 4.5 2.1	2001 1995 a/ 1995 a/ 1995 a/
Forest Service – Rogue River NF	Little Butte Creek	13.7	1997
Forest Service –Winema NF	Spencer Creek	6.1	1995
	Total Watersheds Crossed on NFS Lands	**30.7**	

Note that mileages may not sum correctly due to rounding. Mileages are rounded to the nearest tenth of a unit; values below 0.1 are noted as <0.1.
Source: BLM 2006; Forest Service 2006a
a/ The Elk Creek Watershed Analysis (Forest Service 1996) and the Cow Creek Watershed Analysis (Forest Service 1995a) encompass the Umpqua National Forest lands crossed by the pipeline.

The following subsection discusses acres of impacts to Key Watersheds and the mitigation measures that would be implemented on NFS land to compensate for impacts. Key Watersheds are defined as either Tier 1 or Tier 2. Tier 1 (Aquatic Conservation Emphasis) Key Watersheds contribute directly to conservation of at-risk anadromous salmonids, bull trout, and resident fish species. They also have a high potential of being restored as part of a watershed restoration program. While Tier 2 (other) Key Watersheds may not contain at-risk fish stocks, they are important sources of high-quality water. Riparian Reserves are lands along streams, wetlands, ponds, lakes, reservoirs and unstable and potentially unstable areas where special standards and guidelines direct land use on NFS lands.

Four watersheds that encompass NFS lands that would be crossed by the Pacific Connector pipeline are designated as Key Watersheds: (1) Days Creek-South Umpqua River (Tier 1); (2) Elk Creek-South Umpqua River (Tier 1); (3) Little Butte Creek; and (4) Spencer Creek (Tier 1. Key Watersheds that would be crossed by the Pacific Connector pipeline are listed in table 4.3.4.2-2.

TABLE 4.3.4.2-2

Key Watersheds Crossed by the Proposed Pacific Connector Pipeline

Key Watershed	Jurisdiction	Approximate Miles Crossed	Approximate Construction Disturbance (acres) a/	Approximate Operational Easement (acres) b/
Days Creek-South Umpqua River (Tier 1), MP 82.71-102.59	Umpqua National Forest	1.56	53	10
Elk Creek-South Umpqua River (Tier 1), MP 101.8-109	Umpqua National Forest	2.67	30	16
Little Butte Creek (Tier 1), MP 135.04-168	Rogue River National Forest	13.75	277	83
Spence Creek (Tier 1), MP 168-183.02	Winema National Forest	6.05	92	37
	Total	**24**	**452**	**146**

Note that values may not sum correctly due to rounding. Mileages are rounded to the nearest tenth of a unit; values below 0.1 are noted as <0.1. Acreages are rounded to the nearest whole acre; values less than 1 are noted as <1.
a/ Includes uncleared storage areas.
b/ Assumes 50-foot-wide long-term easement.

The pipeline would not cross any roadless areas and would not require any new roads to be constructed within Tier 1 Watersheds. Although the pipeline would cause temporary disturbance within Tier 1 watersheds, all disturbed areas associated with the pipeline would be restored after construction. No adverse, long-term effects are anticipated to the water resources. The 30-foot operational maintenance corridor along the pipeline centerline would create a long-term vegetation type conversion impact within forested vegetation types, but the vegetation conversion is not expected to measurably alter hydrologic functions. Restoration of all areas disturbed by the Pacific Connector pipeline would include shaping to the approximate original contour to restore drainage patterns, scarification to relieve compaction, and revegetation for stabilization and to restore habitats and land use functions. The compensatory mitigation measures outlined for LSRs and Riparian Reserves on NFS lands would benefit Key Watersheds if the mitigation projects such as road decommissioning occur within these watersheds.

On NFS lands where Riparian Reserves would be affected, up to a 100-foot riparian strip or to the edge of the existing riparian vegetation would be planted to ensure that the "maintain and restore" objectives of the ACS are accomplished for native riparian vegetation.

Impacts on Streams on Federal Lands and Mitigation

Temporary Equipment Crossings

For any temporary equipment crossings on any stream channel (whether intermittent or perennial, wet or dry) on federal lands, equipment crossings must be accomplished using (1) a bridge, (2) a temporary culvert with temporary road fill to be removed after work is completed, or (3) a low water ford with a rock mat. Although the FERC's *Procedures* allow clearing equipment and equipment necessary for installation of the temporary bridges to cross waterbodies prior to bridge installation, Pacific Connector would not allow clearing equipment to cross waterbodies prior to bridge placement. Furthermore, where feasible, Pacific Connector's contractor would attempt to lift, span, and set the bridges from the streambanks. Where it is not feasible to install or safely set the temporary bridges from the streambanks, only the equipment necessary to install the bridge or temporary support pier would cross the waterbody. Any equipment required to enter a waterbody to set a bridge would be inspected to ensure it is clean and free of dirt or hydrocarbons.

No waterbodies or riparian reserves on federal lands would be affected by temporary or permanent access roads.

Water Use During Pipeline Construction

Water withdrawals and releases on federal lands for dust suppression or hydrostatic testing would require site-specific approval from the agency that manages the specific water resources (federal or state). Site-specific approval by the authorized Forest Service officer on NFS lands, and similar authorizations by BLM and Reclamation would be coordinated through the development of the POD to support the Right-of-Way Grant. Withdrawals and releases of hydrostatic test water would be done in accordance with Pacific Connector's *Hydrostatic Test Plan*, included with the POD.

Potential Encounters with Contaminated Sediments

On federal land, hazardous substances, including chemicals, oils, and fuels, would not be stored within 150 feet of a waterbody or wetland boundary. As noted in the ECRP, any variance on federal lands would require prior approval by an authorized agency representative. In instances where it is not possible to maintain the 150-foot distance, the EI would request a variance that would require approval from the authorized agency representative. To reduce impacts from potential encounters with contaminated sediments, Pacific Connector would implement the measures outlined in its *Contaminated Substances Discovery Plan,* which was included as part of its Spill Prevention, Containment, and Countermeasures Plan.

East Fork Cow Creek Crossing

The Forest Service expressed concerns about the potential for naturally occurring mercury to reach the aquatic environment during construction of the pipeline near the historic Thomason claim group (near MP 109). To address this concern, Pacific Connector conducted a mine hazard evaluation and mercury testing study for the proposed 2007 route on the Umpqua National Forest at the crossing of East Fork Cow Creek, which crossed the Thomason claim group (GeoEngineers 2007b).[90] Soil samples were collected along the proposed alignment in an area believed to be outside the zone of mineralization where mercury deposits occur, in the stream system in the vicinity of the East Fork of Cow Creek, and from mine workings in proximity to the Pacific Connector right-of-way in 2007. The samples did not contain concentrations of mercury that exceeded human health risk screening criteria.

Subsequently, Pacific Connector moved its proposed route to the east to avoid a NSO nest site. GeoEngineers (2009)[91] conducted an additional assessment of the relocated route, approximately 3,300 feet upstream and east of the original 2007 crossing to address the continued concerns of the Forest Service regarding the potential for naturally-occurring mercury within the East Fork Cow Creek drainage. That study concluded that the soils underlying the current proposed crossing of East Fork Cow Creek are unlikely to have concentrations of naturally occurring mercury exceeding those measured in samples obtained from the previous 2007 crossing location and most likely will have lower levels than those reported in GeoEngineers' (2007b) mine evaluation.

In addition to the GeoEngineers (2009) report, the Forest Service contracted with a geologist consultant (Broeker 2010)[92] to collect soil and stream sediment samples for analytical testing and reporting of mercury and other naturally occurring minerals along a 2,000-foot section of the proposed pipeline route between MP 109 and the East Fork Cow Creek. The Broeker study also concluded that construction activities along the revised pipeline route are not likely to encounter soils with elevated mercury concentrations.

In order to prevent this naturally occurring mercury from entering the aquatic environment during and after construction, additional erosion control measures and monitoring would be conducted along the pipeline route in the vicinity of the East Fork Cow Creek. If sediments containing high

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[90] GeoEngineers, Inc., 23 August 2007, *Mine Hazards Evaluation and Mercury Testing at the Red Cloud, Mother Lode, Nivinson, and Elkhorn Mining Groups, Jackson and Douglas Counties, Oregon*, prepared by A. Bauer and T. Hoyles, filed as stand-alone report with Pacific Connector's June 2013 application to the FERC.
[91] GeoEngineers, Inc., 2 October 2009, *Addendum to Mine Hazards Evaluation and Mercury Testing at the Red Cloud, Mother Lode, Nivinson, and Elkhorn Mining Group*, prepared by A. Bauer and T. Hoyles, filed as stand-alone report with Pacific Connector's June 2013 application to the FERC.
[92] Broeker, L., 3 February 2010, *Potential for Natural-Occurring Mercury Mineralization to Enter the Aquatic Environment between MP 109 and East Fork Cow Creek Williams' Pacific Connector Pipeline Project*, filed as a stand-alone report with Pacific Connector's September 2017 application to the FERC.

levels of mercury are encountered in the East Fork Cow Creek drainage during Project construction, Pacific Connector would implement the measures outlined in its *Contaminated Substances Discovery Plan*.[93]

Hyporheic Exchange at South Fork Little Butte Creek

The Forest Service has expressed concern that the crossing of South Fork Little Butte Creek would go through basalt and andesite bedrock, and therefore a site-specific crossing would need to address the potential for groundwater interception and flow at and near the crossing. A site-specific drawing for Little Butte Creek located on NFS land was included in Appendix 2E of Resource Report 2 with Pacific Connector's September 2017 application to the FERC. The crossing would need to address the potential for groundwater interception and flow at and near the crossing since it is a critical coho stream which flows through andesite and basalt. The *Stream Crossing Hyporheic Analysis* (GeoEngineers 2013c; 2017g) determined that South Fork Little Butte Creek crossing had high hyporheic sensitivity. Therefore, BMPs would be implemented to mitigate for this possible effect.

Given the potential for disruption of hyporheic processes at crossings with a "high" sensitivity ranking, in addition to the pre-construction survey, a qualified geotechnical professional would be on-site to observe trenching/excavation associated with pipeline installation to document subsurface conditions, including the presence of fractured bedrock or the low probability of the presence of lava tubes. The geotechnical professional would make recommendations for backfill composition, including the use of trench plugs or other mitigation measures, to ensure that disruption to groundwater pathways are minimized. These recommendations would be pre-approved by an authorized Forest Service representative.

Stream Temperature Assessment

Project-specific temperature modeling was conducted on federal lands stream crossings. Temperature modeling, using Stream Segment Temperature Model (SSTEMP) (Bartholow 2002), was conducted at the perennial stream crossings on BLM lands at Middle Creek Deep Creek and Big Creek, and NFS lands at multiple crossing on the East Fork Cow Creek in 2009 and again in 2013 to reflect new pipeline alignment and lower flow conditions (NSR 2009, 2015b,c). During 2013, temperature data recorders were placed at selected locations relative to each crossing during the warmest low-flow summer period to help validate the model. Flows in 2013 represented drought conditions and were about 33 percent of those modeled in 2009 at MP 109.69 in the East Fork Cow Creek. When compared to measured existing conditions, the SSTEMP model overestimated the lower flowing stream's actual existing stream temperature slightly (about 0.2 to 0.4°F) (NSR 2015b,c), indicating the inherent uncertainty in modeling stream temperatures in very small stream channels, and the potential to overestimate temperature changes in small streams.

Model analysis of right-of-way clearing effects predicted slight temperature increases on the BLM channel crossings in Middle Creek and a small tributary to Big Creek (NSR 2014), with these limited temperature changes likely due to relatively higher flows (Middle Creek), cooler air temperatures and relative channel orientations (NSR 2015b). During the drought conditions of 2013, modeled 7-day maximum stream temperature just below in the multiple East Fork Cow

[93] Appendix E of the POD filed as a stand-alone report in Pacific Connector's September 2017 application to the FERC.

Creek crossings showed potential temperature increases of 1.2°F to 4.2°F under the rare drought flow conditions that occurred in 2013 (NSR 2015c). Measured stream volumes ranged from 0.045 cubic feet per second to 0.115 cubic feet per second with modeled total vegetation removal in the whole 75-foot right-of-way for post-construction shade levels ranging from 1.2 to 3.7 percent. Under the drought conditions of 2013 (high temperature and low flow), modeled results suggest temperatures may exceed the TMDL thresholds (0.1°C or 0.18°F at the point of maximum impact) or ODEQ Core Cold-Water Habitat temperature criteria of 16°C (61°F) in small perennial channels in the East Fork Cow Creek. This occurrence likely overestimates temperature changes that would most often occur, because of the drought conditions that occurred in 2013 and potential to overestimate of temperature in low-flow channels from the SSTEMP model as noted above. The 2014 analysis showed larger temperature increases than those reported in NSR (2009) primarily due to much lower flows during 2013.

Although exposure to solar radiation may cause temperature increases, temperatures downstream from limited stream-side forested clearings have often been found to cool rapidly once the stream re-enters forested regions (Zwieniecki and Newton 1999). Other studies have noted downstream cooling below timber harvest areas as well, but the extent of this cooling is not entirely clear and varies by stream (Moore et al. 2005; Poole 2001). Although there is some debate on the magnitude of cooling provided by riparian vegetation and the extent to which stream temperatures return to non-cleared temperature levels after exiting a cleared area, studies emphasize that riparian buffers assist in maintaining water temperatures (Correll 1997; Gomi et al. 2006). Generally, changes in temperature, especially in small streams, may recover quickly from cooler surrounding conditions downstream (e.g., streambed cooling, evaporation, hyporheic inflows, shade). This was validated by stream temperature data recorded on the Umpqua National Forest in 2013. The updated temperature assessment prepared for the Forest Service at this location (NSR 2014) incorporated field measurements of existing conditions on the Umpqua National Forest that showed decreasing stream temperatures of as much as -7.6°F per 100 feet with an overall average over 2,040 feet of the East Fork Cow Creek of -0.1°F per 100 feet (NSR 2015c). The presence of numerous small wetlands adjacent to the stream channel provide evidence of likely groundwater interactions. Most of this 2,040-foot reach also has substantial shade, suggesting the retention of shading structures, or at least partial shade, may greatly reduce increases in stream temperature. The 2014 assessment also supports the NSR (2009) finding that potential temperature increases are partially offset by cooling from groundwater interactions in the stream channel.

Observations of these streams suggest that LWD and low-growing willows, huckleberries, and other brush species can provide effective shade for small, narrow channels. Blann et al. (2002) noted that riparian grasses and forbs supply as much shade as wooded buffers for streams less than 8 feet (2.5 meters) wide. In many cases during pipeline crossing construction, low-growing brush outside of the immediate crossing construction area could be retained minimizing shade loss. In the mainstem of the East Fork Cow Creek, LWD provides significant shade that helps maintain cooler water temperatures. As described in the ECRP and waterbody crossing requirements for the project, all LWD and boulders removed from the crossing area would be replaced during site restoration and low-growing brush would be retained where possible (NSR 2015). Many of the channels crossed by the Pacific Connector pipeline on federal lands are very small, and could easily be shaded by the placement of LWD and willow plantings. Where site-specific modeling on NFS perennial stream crossings suggests temperature increases over natural pre-project levels, a plan would be prepared to reestablish pre-crossing shade conditions using items such as willows, boulders, and LWD.

With the retention of existing shading brush on small channels, the placement of LWD, and the replanting of willows and other brush species, downstream temperatures are expected to be comparable to the existing condition and to remain below ODEQ thresholds on the East Fork Cow Creek. Additionally, any temperature increases in small streams would likely be masked by the assimilative capacity of larger streams at the stream network scale (NSR 2009).

During the ODEQ CWA Section 401 process, Pacific Connector would develop a source-specific implementation plan in accordance with OAR 340-042-0080 for areas with existing TMDLs and Pacific Connector would be identified as a new nonpoint source. For perennial stream crossings on federal lands, this plan would incorporate the requirements of the site-specific restoration plans (NSR 2015b, c). The source-specific implementation plan would outline mitigation for predicted thermal impacts (GeoEngineers 2013i). This mitigation would have as its goal restoring shade along affected stream channels and nearby channels within the same fourth-field HUCs. Mitigation for construction-related impacts would occur to the extent allowed by landowners on the affected streambanks. This mitigation would incorporate riparian revegetation required by the Forest Service for impacts to riparian reserves on NFS lands. The length of channel banks planted by Pacific Connector would be determined prior to pipeline construction once a clear understanding of landowner wishes regarding streambank planting are known. Contiguous lengths of streambank planting would be preferred over planting on multiple small parcels, particularly for mitigation of permanent impacts. Mitigation ratios of 1:1 for construction-phase impacts or 2:1 for permanent impacts would be applied as outlined in ODEQ's September 2011 letter. Prior to construction, Pacific Connector would also provide the implementation plan to FERC.

Where TMDL thermal load allocations have not yet been established, ODEQ's 401 Water Quality Certification would require the development of a Water Protection Plan, consistent with the source specific implementation plan, and a mitigation plan to address project impacts on thermal loading.

On NFS lands, the Forest Service has requested that the riparian vegetation strip be extended up to 100 feet on either side of waterbodies in Riparian Reserves. Pacific Connector has agreed to implement this measure on both NFS lands and BLM lands. The riparian strip would generally be replanted with species such as willow cuttings and dogwood to provide a quick cover for shading and streambank stability. Quick cover plantings may be shorter in height than vegetation removed during constructions, thus providing less shade. Plantings/seeding would be done with native vegetation of a local source. The riparian strip would be maintained to allow an herbaceous cover 10 feet in width centered over the pipeline to facilitate corrosion and leak surveys. The remaining area of the construction right-of-way within the riparian strip would be replanted with trees that would provide greater height and stream shading over time.

<u>Restoration</u>

Near-surface soil compaction caused by heavy construction vehicles could locally reduce the soil's ability to absorb water, which would increase surface runoff and the potential for ponding. To avoid long-term changes in water table elevation and subsurface hydrology, excavated topsoil and subsoils would be segregated within wetlands, agricultural areas, and at the request of landowners, and returned as closely as practical to their original soil horizon and slope position. Following construction, restoration of compacted soils would include regrading, recontouring, scarifying (or ripping), and final clean-up activities. Decompacting soils would restore water infiltration, reduce surface water runoff, minimize erosion, and support revegetation efforts. Pacific Connector would test for soil compaction in agricultural (e.g., active croplands, hayfields, and pastures), residential areas, and on federal lands. The EI would be responsible for conducting soil compaction testing and determining corrective measures on non-federal lands, including localized deep scarification or ripping to an average depth of up to 8 inches where feasible, utilizing appropriate winged-tipped rippers. On federal lands, remediation and corrective measures to address compaction will be consistent with specific requirements of the BLM, Forest Service, and Reclamation (see NSR 2015a for details). In response to a Forest Service request, Pacific Connector would stabilize intermittent stream crossings (whether flowing or not) on NFS lands with temporary sediment barriers and reseed as described for other waterbodies. Streambanks and stream beds would be revegetated with native species and "armored" as needed with LWD and boulders to ensure stability. Channel breakers would be installed on each side of the trench to ensure that subsurface flows are not captured by the pipeline trench.

As discussed in section 4.3.2, Pacific Connector has requested a modification to the FERC's *Procedures* requirement that the upper 1 foot of the trench to be backfilled with clean gravel or native cobbles in all waterbodies that contain cold water fisheries. Pacific Connector has requested that for instances where the existing substrate is not gravel or cobbles, and site access is limited and would require unreasonable efforts to transport clean gravel to the waterbody, that only native materials removed from the stream be used for backfill.

For crossings of perennial streams on BLM and NFS lands, the site-specific restoration plans included as a supplement to appendix F.4 (NSR 2014)[94] will be used as directed by BLM and Forest Service monitors in conjunction with FERC's EIs. These restoration plans have been designed to ensure that restoration and revegetation of these crossings are consistent with ACS objectives as described in the relevant Forest Service land management plans.

All disturbed areas on federal lands would be monitored following construction to verify successful revegetation and to implement corrective action. Pacific Connector would also adhere to its mitigation plan (developed to mitigate for impacts to all riparian and upland habitats), which would be followed in areas with severe to soil erosion potential. Throughout operation of the pipeline, Pacific Connector would continue to monitor and maintain the right-of-way. The Forest Service, in consultation with Pacific Connector, has prepared a list of mitigation actions to address unavoidable impacts on NFS lands.

4.3.4.3 Wetlands

The Pacific Connector pipeline would cross approximately 0.2 mile of wetlands on federally managed land, affecting a total of approximately 2.2 acres (see table H-1a in appendix H). Permanent wetland vegetation conversion on federally managed lands would occur in approximately 0.2 acre of wetlands as a result of vegetation management on the operational right-of-way. This 0.2 acre of permanent conversion would occur to three wetlands: palustrine forested wetland CW010 located on lands managed by the BLM Coos Bay District, palustrine forested

[94] These site-specific restoration plans for BLM and Forest Service stream crossings are also incorporated into the Wetland and Waterbody Crossing Plan that is part of the POD.

wetland AW309 located on lands managed by the BLM Medford District, and palustrine scrub-shrub/emergent wetland GW-14/FS-HF-CWWW-111-001 (i.e., a tributary to East Fork Cow Creek) managed by the Forest Service (on the Umpqua National Forest).

There would be no permanent wetland loss or wetland impacts on federally managed land due to the construction of aboveground facilities. Impacts resulting from use of existing roads would be minimized through the implementation of Pacific Connector's ECRP and the mitigation measures described above for the pipeline on all lands.

In order to prevent or limit the spread of invasive species and noxious weeds into wetlands on federally managed lands, Pacific Connector would inspect all construction equipment prior to transporting equipment to the construction right-of-way to ensure that it is clean and free of potential weed seed. Because of the contiguous pattern of NFS lands crossed by the pipeline, equipment would be inspected and cleaned at cleaning stations located at the borders of each National Forest, prior to clearing and grading activities, in addition to being cleaned at cleaning stations associated with any mapped infestation of noxious weed of priority A and T and selected B listed weeds within each National Forest (see section 4.4 for more details regarding noxious weeds). Because the BLM lands crossed by the pipeline are not contiguous but are instead spread out in a checkerboard pattern, Pacific Connector feels that is not practical to set up inspection and cleaning stations at each entry point. Instead, Pacific Connector proposed that where BLM lands are contiguous to NFS lands, the cleaning stations would be located to include the adjacent BLM lands. The location of any additional cleaning stations required in areas where BLM- or Reclamation-managed lands are not contiguous with NFS lands would be coordinated with the agency of jurisdiction. Additional measures to prevent the spread of invasive weed and wildlife species into wetlands and waterbodies are addressed within sections 4.4 and 4.5 of this EIS.

Measures to avoid or minimize impacts on wetlands that would be implemented on federally managed lands, in addition to those described above for the entire pipeline, include the following:

- Where straw is to be used on federally managed lands during seeding operations, the authorized officer for the agency of jurisdiction may inspect and approve straw material to verify that the straw is weed-free. Any gravel or rock used on federal lands would be from weed-free sources as well, and approved by the authorized representative for the agency of jurisdiction.
- Hazardous materials, fuels, and oils would not be stored in a wetland/Riparian Reserve or within 150 feet of a wetland/Riparian Reserve. Storage of hazardous materials on NFS lands would not occur without prior authorization from the BLM, Forest Service or Reclamation.
- During revegetation efforts, specific mixtures specified by the agency with jurisdiction would be used on federally managed lands. No fertilizers would be used during the revegetation of wetlands.

Based on available information, with the implementation of appropriate plans, the use of additional BMPs, and mitigation, substantial effects to waterbodies on federal lands are not expected.

4.4 UPLAND VEGETATION

The vegetation affected by construction and operation of the Project represents arguably the largest and most permanent impact, particularly the forested vegetation. Forests in the Project area support multiple interacting layers of organisms that include plants, animals, fungi, and bacteria. Old-growth forests provide vital habitat for many native species of plants and wildlife, including many federally listed threatened or endangered species, as well as providing a variety of environmental services. Old-growth trees occupied about half of the forest area in Oregon when the first comprehensive forest surveys were made in the 1930s and 1940s. By 1992, only about 20.5 percent of the forest area was old growth (Bolsinger and Waddell 1993). These resources have particular value based on their contribution to other organisms and the fact that much of this habitat has been lost.

In the following sections, we describe the vegetation communities that may be affected by construction and operation of the proposed terminal and pipeline. We also discuss the ways in which construction and operation would affect these resources.

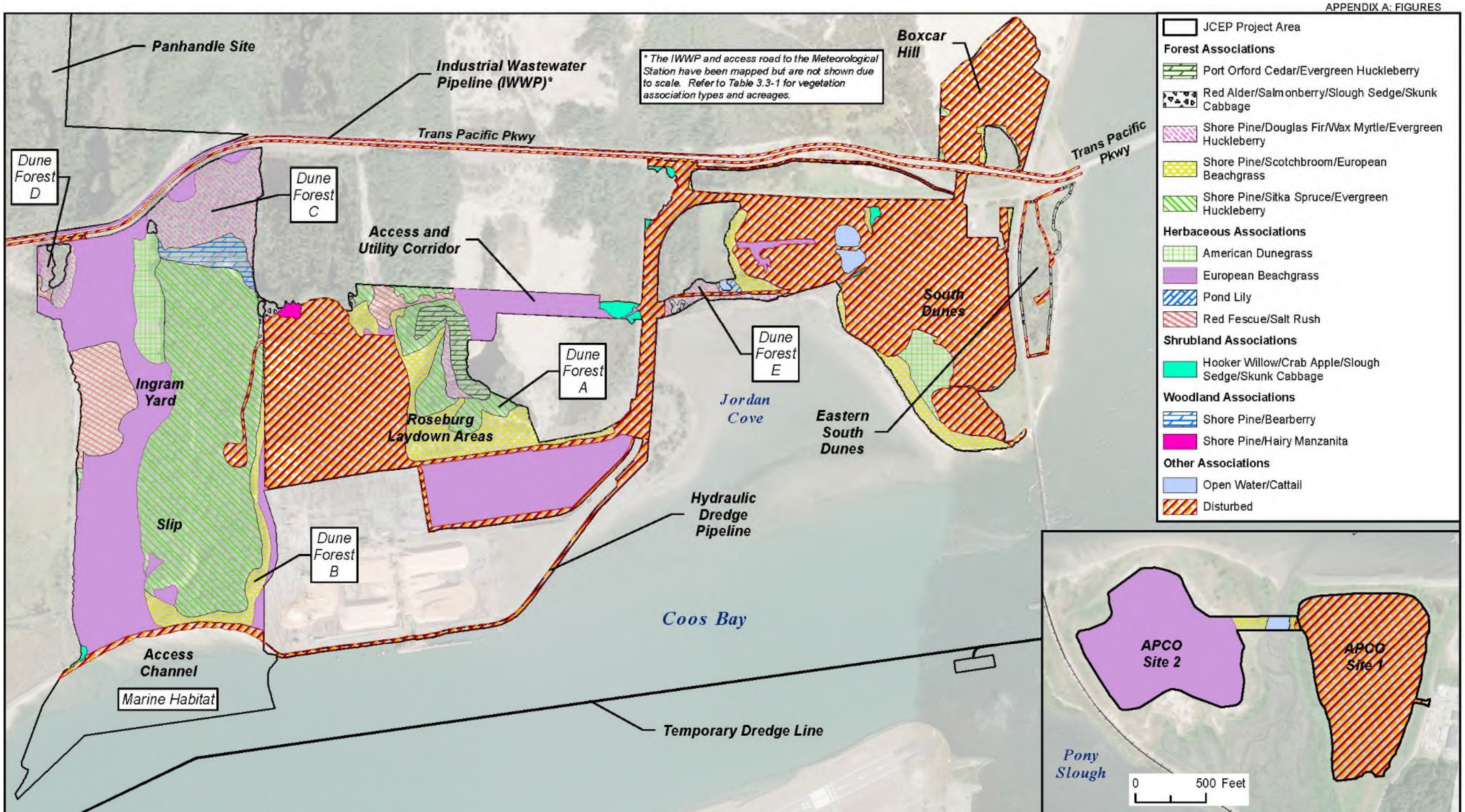
4.4.1 Jordan Cove LNG Project

As depicted in figures 4.4-1a and 4.4-1b, vegetation within the Jordan Cove LNG Project area includes forest, woodland, shrubland, and herbaceous vegetation types (as described in Christy et al. 1998). In addition, multiple areas consisting of disturbed vegetation are located within the area affected by the Project.

4.4.1.1 Forest Vegetation

Forested vegetation is defined as areas where tree species comprise at least 60 percent of the vegetation cover and canopy cover is generally 60 to 100 percent. Forested vegetation within the Jordan Cove LNG Project area varies in age and is dominated by coniferous species with scattered hardwoods. Five forested vegetation types occur within the Jordan Cove LNG Project area, as described below. Generally, the forested vegetation in this area is referred to as dune forest. Five different dune forests have been identified within the Jordan Cove LNG Project area (Dune Forest A through Dune Forest E, see figure 4.4-1a).

The Shore Pine–Douglas-Fir/Wax Myrtle-Evergreen Huckleberry vegetation type typically occurs near previously developed areas such as roads, fill sites, or industrial sites. It occurs most frequently on warm, dry ridges, and slopes on the dunes; primarily with south to west facing aspects (Christy et al. 1998). This vegetation type is characteristic of younger forest sites north of Jordan Cove and occurs in areas where dune stabilization has been achieved through recruitment of vegetation, most notably European beachgrass (*Ammophila arenaria*) and Scotch broom (*Cytisus scoparius*). This vegetation type has an open overstory dominated by shore pine (*Pinus contorta*) with scattered Douglas-fir (*Pseudotsuga menziesii*). The shrub layer is dominated by Scotch broom and coyote bush (*Baccharis pilularis*), with scattered hairy manzanita (*Arctostaphylos columbiana*), wax myrtle (*Morella* [*Myrica*] *californica*), and evergreen huckleberry (*Vaccinium ovatum*). Dominant herbaceous species include non-native species, including European beachgrass, silver hairgrass (*Aira caryophyllea*), little hairgrass (*A. praecox*), hairy cat's ear (*Hypochaeris radicata*), and sheep sorrel (*Rumex acetosella*), as well as native bracken fern (*Pteridium aquilinum*). This vegetation type can be found in portions of Dune Forests A, B, and C where adjacent landscapes have been altered by human or natural influences.



Associations used are based on the USDA Publication National Vegetation Classification System (NVCS).

Source: SHN Engineers, David Evans and Associates, Inc.

Figure 4.4-1a

Vegetation Associations

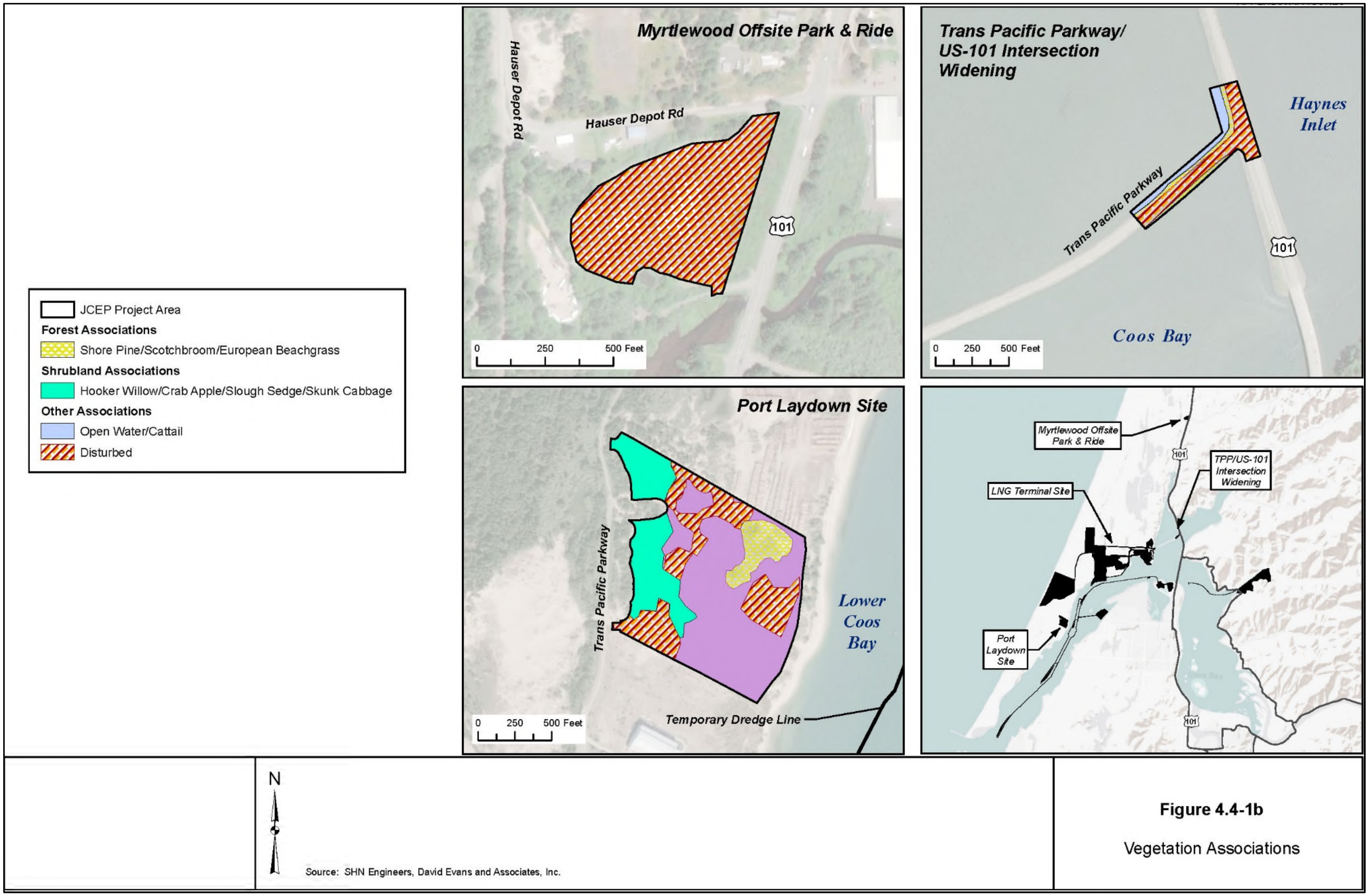


Figure 4.4-1b

Vegetation Associations

The Shore Pine-Sitka Spruce/Evergreen Huckleberry vegetation type is common in more successionally mature forests. Stands are generally dominated by shore pine and Douglas-fir, but also include Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and scattered Port Orford cedar (*Chamaecyparis lawsoniana*). The dense shrub understory in this vegetation type is dominated by evergreen huckleberry, salal (*Gaultheria shallon*), and wax myrtle, with scattered Pacific rhododendron (*Rhododendron macrophyllum*) also present. The herbaceous layer varies from sparse to moderately covered with candy-stick (*Allotropa virgata*), rattlesnake plantain (*Goodyera oblongifolia*), and bracken fern along edges or gaps in the overstory. Dune Forest B occurs in this vegetation type.

The Port Orford Cedar/Evergreen-Huckleberry vegetation type is dominated by Port Orford cedar and is considered unique because it is being decimated throughout its limited range by the Port Orford cedar root rot disease which is caused by the fungal root rot *Phytopthora lateralis* (Christy et al. 1998). A small area of well-developed Port Orford cedar/evergreen huckleberry vegetation is located upslope from the southwestern shore of Jordan Lake. Port Orford cedar observed at this location includes two trees upslope from the existing access trail that travels from the Roseburg Forest Products facility to Jordan Lake. Additionally, 23 Port Orford cedars were observed at sites located adjacent to Jordan Lake, in areas that would be preserved as part of the Jordan Cove LNG Project. This vegetation type can be found in portions of Dune Forest A.

The Red Alder/Salmonberry/Slough Sedge-Skunk Cabbage vegetation type occurs in wetland vegetation adjacent to upland forested vegetation, and in low flat areas adjacent to inundated wetlands. In this vegetation type, the overstory consists entirely of red alder (*Alnus rubra*) around wet areas, but transitions to shore pine in adjacent areas. Canopy cover varies from moderate (i.e., more than 50 percent canopy cover) to closed. Scattered clusters of dense shrubs, including salmonberry (*Rubus spectabilis*) and Hooker's willow (*Salix hookeriana*), are located in the understory. Herbaceous coverage is generally found in wet areas and consists almost entirely of slough sedge, with scattered skunk cabbage (*Lysichiton americanus*). This vegetation type occurs in Dune Forest E and adjacent to Dune Forest B.

Although the Shore Pine/Scotch Broom/European Beachgrass vegetation type contains shore pine, it is also described as a shrubland due to the high density of shrubby species, including Scotch broom. This vegetation type is relatively widespread throughout the Jordan Cove LNG Project site and is associated with roads and other disturbed areas. The overstory is generally open, averaging less than 50 percent cover of shore pine. Scotch broom cover varies from moderately to very dense in areas that lack a substantial canopy cover. Dominant herbaceous species include European beachgrass, red fescue (*Festuca rubra*), tall fescue (*Schedonorus arundinaceus* [*Festuca arundinacea*]), silver hairgrass, hairy cat's ear, and sheep sorrel. This vegetation type occurs west of the South Dunes site, north of the Roseburg Forest Products property, along previous road cuts for the Trans-Pacific Parkway, and along the edges of the shore pine-Sitka spruce/evergreen huckleberry community at the Port Laydown, Boxcar Hill, and APCO sites.

4.4.1.2 Woodland Vegetation

Woodland vegetation includes areas of open tree stands with cover generally varying from 25 percent to 60 percent. They occur on all aspects of dry, well drained, partially stabilized dune ridges, slopes, and flats between the sand and the forest edge (Christy et al. 1998). Two woodland vegetation types occur within the Jordan Cove LNG Project site.

The overstory of the shore pine/bearberry (*Arctostaphylos uva-ursi*) woodland vegetation type consists entirely of shore pine. The shrub layer is dominated by the low growing shrub bearberry with hairy manzanita in scattered patches. The understory is comprised almost entirely of moss and lichen species except for scattered little hairgrass, hairy cat's ear, and shrub starts. This vegetation type is restricted to a thin band adjacent to the coastline and is easily damaged by human disturbances. Shore pine/bearberry vegetation is scattered throughout the LNG terminal site, with the most substantial occurrence between Dune Forests B and C.

The overstory of the shore pine/hairy manzanita woodland vegetation type is moderately open and is dominated by shore pine with scattered Douglas-fir trees. The shrub layer varies from moderate to dense in areas where the canopy is patchy. Hairy manzanita is the dominant shrub species with scattered evergreen huckleberry and bearberry along edges. A small area of this vegetation type can be found along the eastern boundary of Dune Forest B along the access and utility corridor.

4.4.1.3 Shrubland Vegetation

Shrubland vegetation types generally consist of greater than 25 percent cover of shrubs more than 0.5 meter tall and generally less than 25 percent tree cover. A single shrubland vegetation type was identified within the Jordan Cove LNG Project area.

The overstory within the Hooker Willow/Crabapple/Slough Sedge-Skunk Cabbage vegetation type is dominated by Hooker willow, Sitka willow (*Salix sitchensis*), and Douglas spiraea (*Spiraea douglasii*), with scattered twinberry (*Lonicera involucrata*). Evergreen trees are mostly absent but may include scattered shore pine and Sitka spruce. Slough sedge is the most abundant herbaceous species. Other herbaceous species include common rush (*Juncus effusus*), dagger-leaved rush (*Juncus ensifolius*), toad rush (*J. bufonius*), western bent-grass (*Agrostis exarata*), creeping bent-grass (*A. stolonifera*), reed canarygrass (*Phalaris arundinacea)*, northern willowherb (*Epilobium ciliatum*), tall mannagrass (*Glyceria striata* [*G. elata*]), and lowland cudweed (*Gnaphalium palustre*). This vegetation type occurs throughout the wetland areas west of Jordan Cove Road, in the access and utility corridor, and at the South Dunes site.

4.4.1.4 Herbaceous Vegetation

Herbaceous vegetation types are communities with less than 25 percent shrub cover and greater than 25 percent herbaceous cover. Five herbaceous vegetation types occur within the Jordan Cove LNG Project area.

Dominant species within the European beachgrass vegetation type include European beachgrass, red fescue, silver burweed (*Ambrosia chamissonis*), sand pea (*Lathyrus japonicus*), seashore lupine (*Lupinus littoralis*), beach silvertop (*Glehnia littoralis*), and beach evening primrose (*Camissonia cheiranthifolia*). This vegetation type occurs where the terminal marine slip would be located. It was also observed in patches north of Jordan Lake where the access/utility corridor is proposed and at the Port Laydown site and is the dominant vegetation type at the APCO Site 2.

The Red Fescue/Salt Rush vegetation type is generally found in grasslands on sand or fill material. Red fescue is the dominant species in this association. Scattered red fescue was observed on fill west of the South Dunes site and on sand north of the Roseburg Forest Products export facility. At the South Dunes site, in an area surrounded by scattered red fescue, a portion of a small dune was dominated by salt rush (*Juncus lesuerii*). Red fescue/salt rush was also observed at sites where sand burial by wind driven forces limits species diversity, including the western part of the LNG terminal site.

The American dunegrass vegetation type includes dune lands with the single dominant species American dunegrass (*Leymus mollis*). It can be found on beaches and in foredunes, and to a lesser extent on open deflation plains and in upper estuaries. Continual sand burial and inputs of salt spray seem necessary for American dunegrass to thrive. Scattered American dunegrass was observed west of Dune Forest B, in the LNG terminal grassland vegetation east of Henderson Marsh on previous fill deposits, and the western half of APCO Site 1.

Dominant species in the Pond Lily vegetation type include yellow pond lily (*Nuphar lutea* ssp. *polysepala),* floating water-pennywort *(Hydrocotyle ranunculoides)*, floating-leaved pondweed (*Potamogeton natans*), parrotfeather (*Myriophyllum aquaticum*), water shield (*Brasenia schreberi*), and common bladderwort (*Utricularia macrorhiza*). Pond lily vegetation has been observed in deep freshwater wetlands located at the LNG terminal site.

The Common Cattail/Open-Water vegetation type includes wetland fringe sites observed adjacent to open bodies of water. Open water and areas dominated by common cattails can be found surrounding the existing sludge ponds at the South Dunes site as well as around wetlands observed south of the Trans-Pacific Parkway in the eastern portion of the LNG terminal site.

Disturbed vegetation occurs in previously human-disturbed areas, where extensive grading and gravel and dredge spoils deposition has occurred. These areas often contain non-native upland shrubs with small patches of young coastal forest dominated by shore pine, and herbaceous communities dominated by European beachgrass. Disturbed vegetation within the Jordan Cove LNG Project site typically consists of ruderal shrub, such as Scotch broom, and herbaceous vegetation. Dominant herbaceous species include silver hairgrass, hairy cat's ear, bracken fern sheep sorrel, red fescue, and seashore lupine. Disturbed vegetation is common in many areas of the Jordan Cove LNG Project site including the South Dunes site, the Port Laydown site, and the APCO Site 1.

4.4.1.5 General Impacts on Vegetation

Table 4.4.1.5-1 identifies the amount of vegetation affected by construction and operation of the Jordan Cove LNG Project. Constructing the Jordan Cove Project would result in 499 acres of vegetation clearing, which includes the permanent clearing of 168 acres of vegetation. Construction of the Kentuck project and Eelgrass Mitigation sites would result in an additional 127 acres of vegetation clearing not included in table 4.4.1.5-1.

Approximately 73 acres of forested vegetation, 59 acres of which consists of the shore pine-Sitka spruce/evergreen huckleberry vegetation type, would be permanently affected. All of Dune Forests A and B, the majority of Dune Forest C, and portions of Dune Forest D and E would be permanently affected. The clearing of dune forest vegetation during construction would affect the vegetation at the newly exposed edge of the coniferous forest by changing the micro-climate factors (wind, light, salt spray, organisms that prefer edges). The vegetation found within the forest interior would be exposed to the environmental elements experienced by a forest edge, which could lead to a change in species composition.

TABLE 4.4.1.5-1

Impacts on Vegetation Type from the Jordan Cove LNG Project a/

Vegetation Type	Land Cleared during Construction (acres) b/, c/	Land Permanently Cleared due to Operations (acres) b/
Jordan Cove LNG Project Facilities		
Forested Vegetation	75	71
Woodland Vegetation	<1	<1
Shrubland Vegetation	1	<1
Herbaceous Vegetation	72	64
Disturbed Vegetation	24	21
Total Impacts from Project Facilities	***172***	***157***
Temporary Construction Areas d/		
Forested Vegetation	58	2
Woodland Vegetation	4	0
Shrubland Vegetation	8	<1
Herbaceous Vegetation	71	<1
Disturbed Vegetation	186	9
Total Impacts from Temporary Construction Areas	***327***	***11***
Grand Total for All Impacts		
Impact Grand Total	**499**	**168**

See table 2.3.1-1 in chapter 2 for the acreage of each individual Project component.

a/ Table does not include impacts on unvegetated upland areas or impacts on estuarine vegetation (impacts on estuarine vegetation is discussed in section 4.3).

b/ Values may not sum exactly due to rounding of significant digits. Acreages are rounded to the nearest whole acre; acreages less than 1 acre are reported as <1.

c/ Values include land permanently cleared due to operations.

d/ Temporary Construction Facilities include the Ingram Yard perimeter, North Ingram Yard, IWWP, Hydraulic Dredge Pipeline, Roseburg site laydown areas, APCO Sites, Boxcar Hill, Port Laydown site, South Dunes site, Workforce Housing Facility, parking, and Laydown area, the Trans-Pacific Parkway/U.S. Highway 101 Intersection Widening, the Additional Park & Ride site, and the Myrtlewood Off-site Park & Ride.

4.4.1.6 Noxious Weeds and Invasive Species

Noxious weeds and invasive plant species are non-native or introduced species that are able to exclude and out-compete desirable native species, and thereby decrease overall species diversity. Noxious weeds often invade and persist in areas after the vegetation and ground have been disturbed and can hinder restoration. Noxious weeds can adversely affect an area either when invasive plants become established or when an existing species' population size increases. Invasive or noxious plants can negatively affect native vegetation by competing for resources such as water and light, changing the community composition, eliminating or reducing native plants, or changing the vegetation structure. The changes in community composition or vegetation structure can reduce native plant populations and can also negatively affect wildlife habitat. Additionally, the movement of equipment to and from construction work areas can also increase the spread of noxious weeds and invasive species. In general, grasslands, riparian areas, and relatively dry or open forests, are more susceptible to invasion than are dense, moist forests, high montane areas, and serpentine areas that have relatively closed canopy cover or have extreme climate or soils that are tolerated by fewer invasive plant species.

Noxious weeds are classified by the Oregon State Weed Board (OSWB) as any plant that is injurious to public health, agriculture, recreation, wildlife, or any public or private property. The ODA Noxious Weed Control Program and the Oregon State Weed Board (OSWB) maintain the State Noxious Weed List. There are three categories of listed noxious weeds under the ODA Noxious

Weed Control Classification System (i.e., A Listed, B Listed, and List T weeds[95]). Species listed in the Noxious Weed Policy and Classification System that have been documented or could occur within the LNG terminal area are summarized in table 4.4.1.6-1.

TABLE 4.4.1.6-1

Noxious Weeds and Invasive Aquatic Species Documented or with Potential to Occur in the Jordan Cove LNG Project Area

Common Name	Scientific Name	LNG Terminal a/	Boxcar Hill	APCO Sites	Kentuck Project Site	Port Laydown
"A" List Weeds						
cordgrass (T)	*Spartina angelica, S. alterniflora, S. densiflora, S. patens*	D				
"B" List Weeds						
bull thistle	*Cirsium vulgare*	L			L	
butterfly bush	*Buddleja davidii*	L		L	L	D
Canada thistle	*Cirsium arvense*	D	D	L	D	D
English ivy	*Hedera helix*	D	D	L	L	
field bindweed (T) (morning glory)	*Convolvulus arvensis*	L		L		
French broom	*Cytisus monspessulana*	L		L		
gorse (T)	*Ulex europaeus*	D				
Himalayan blackberry	*Rubus armeniacus (R. discolor, R. procerus, R. fruticosa)*	D	D	D	D	
Jubata grass (Pampas grass)	*Cortaderia jubata*	D			L	
meadow knapweed	*Centaurea moncktonii*				L	
parrot feather	*Myriophyllum aquaticum*	D				
poison hemlock	*Conium maculatum*	D			D	
Scotch broom	*Cytisus scoparius*	D	D	D	D	D

"D" – indicates species has been documented at the Project site.
"L" – indicates species is likely to occur at the Project site.
"(T)" – indicates target species designated for removal and control in Oregon
a/ Includes LNG terminal, access and utility corridor, South Dunes site, and Roseburg Laydown area.

To avoid introducing or spreading invasive species, Jordan Cove would follow the recommendations outlined in the Oregon Invasive Species Council (OISC) Action Plan for 2017-2019, BLM's multi-state EIS Northwest Area Noxious Weed Control Program (BLM 1985) and its supplements, the BLM's *Final Vegetation Treatments on Bureau of Land Management Lands in 17 Western States Programmatic Environmental Report* (2007), and the BLM's *Final North Spit Plan* (2005). These documents focus on detection, containment, and/or reduction of invasive plant infestations with an integrated pest management approach (e.g., chemical, mechanical, manual, and/or biological) as well as implementation of measures to avoid the introduction and spread of noxious weeds.

[95] A Listed – Weeds of known economic importance which occur in small enough infestations to make eradication or containment possible; or are not known to occur in Oregon but are present in neighboring states making future occurrence in Oregon seem imminent.
B Listed – Weeds of economic importance which are regionally abundant, but which may have limited distribution in some counties in Oregon.
T List – Priority noxious weeds designated as target species that will be the focus of prevention and control by the Noxious Weed Control Program and for which the ODA will develop and implement statewide management plans. Species selected from either the "A" or "B" list.

Jordan Cove would conduct a pre-construction survey of the Project area to identify noxious species listed by the ODA that persist despite recent and previous control efforts. Following the survey, Jordan Cove would employ standard removal practices (BLM 1985) for the weed species identified on the Project area. Methods for removal that would not aid in the dispersal of these species would be used and would include the use of integrated BMPs such as fire, mechanical or manual removal, and herbicide application, as appropriate. Treated areas would be restored by spreading native seeds and planting native plants.

Jordan Cove would also use herbaceous and native dune seed mixes to limit germination of noxious weeds during the stabilization and restoration of the site during and following construction. Once the site is stabilized and in operation, Jordan Cove would check the site for noxious weed infestations and control measures would be implemented that are consistent with ODA, OISC, and BLM noxious weed control plans and policies, as applicable.

4.4.1.7 Vegetative Pathogens

Port Orford cedar root rot disease is caused by the fungus *Phytophthora lateralis*. The disease was first discovered in Port Orford cedar's natural range in 1952 and since has spread throughout its range. Port Orford cedar root rot disease affects both seedlings and mature trees. The spores live in the soil and are spread through contact with contaminated soil or via free water. The disease is primarily spread through soil disturbance and moving water. Spread of the disease over long distances occurs from contaminated equipment and livestock.

Jordan Cove would take precautions during construction to minimize the introduction or spread of Port Orford cedar root rot disease from contaminated earth moving equipment. To ensure adequate conservation measures to address Port Orford cedar root rot disease are in place and implemented, Jordan Cove would follow the measures and recommendations found in the Forest Service and BLM's Final Supplemental EIS regarding the management of Port Orford cedar in southwest Oregon (Forest Service and BLM 2004).

4.4.2 Pacific Connector Pipeline Project

Vegetation types that would be crossed by the pipeline include forests and woodlands, shrublands, grasslands, wetland, and agricultural (see table 4.4.2-1). Wetland vegetation types found along the pipeline route are discussed in section 4.3.

TABLE 4.4.2-1

Vegetation Types Crossed by the Pacific Connector Pipeline Project a/

General Vegetation Type	Mapped Vegetation Category	Late Successional or Old-Growth Forest Crossed (miles)	Mid-Seral Forest Crossed (miles)	Clearcut/ Regenerating Forest Crossed (miles)	Total Miles b/	Percent of Total Vegetation
Forest-Woodland	Douglas-fir-W. Hemlock-W. Red-Cedar Forest	2.2	4.3	10.8	17.2	8.2
	Douglas-Fir-Mixed Deciduous Forest	5.4	14.5	7.5	27.4	13.1
	Alder-Cottonwood	0.0	<0.1	0.0	<0.1	<0.1
	Mixed Conifer/Mixed Deciduous Forest	1.8	4.0	9.5	15.4	7.4
	Shasta Red Fir – Mountain Hemlock Forest	1.4	0.9	4.0	6.3	3.0
	Douglas-fir-White Fir/Tanoak-Madrone Mixed Forest	0.7	0.9	0.3	1.8	0.9
	Douglas-fir Dominant-Mixed Conifer Forest	20.8	8.4	18.2	47.5	22.7
	Ponderosa Pine/White Oak Forest and Woodland	3.4	1.5	2.5	7.4	3.5
	Ponderosa Pine Forest and Woodland	1.1	2.7	3.0	6.7	3.2
	Oregon White Oak Forest	2.2	2.1	0.0	4.4	2.1
	Western Juniper Woodland	0.2	2.9	0.0	3.1	1.5
	Ponderosa Pine/Western Juniper Woodland	0.0	1.4	3.7	5.0	2.4
	Forest-Woodland Subtotal	**39.3**	**43.6**	**59.4**	**142.2**	**68.1**
Shrubland	Sagebrush Steppe	n/a	n/a	n/a	7.1	3.4
	Shrublands	n/a	n/a	n/a	10.7	5.1
	Shrubland Subtotal	n/a	n/a	n/a	**17.8**	**8.5**
Grassland	Grasslands (West of Cascades)	n/a	n/a	n/a	11.8	5.7
	Grasslands (East of Cascades)	n/a	n/a	n/a	4.5	2.2
	Grassland Subtotal	**n/a**	**n/a**	**n/a**	**16.3**	**7.8**
Wetland	Wetland	0.0	0.1	0.1	5.9	2.8
	Wetland Subtotal	**0.0**	**0.1**	**0.1**	**5.9**	**2.8**
Agriculture	Agriculture	0.0	0.0	0.0	26.6	12.7
	Agriculture Subtotal	**0.0**	**0.0**	**0.0**	**26.6**	**12.7**
	Project Total	**39.3**	**43.7**	**59.5**	**208.8**	**100.0**
	Percent of Project Total	**18.8**	**20.9**	**28.5**		

General: Mileages may not sum correctly due to rounding. Mileages are rounded to nearest tenth of a mile; values less than 0.1 are shown as "<0.1".)

a/ Table does not include impacts on unvegetated areas (e.g., urban, industrial, beaches, roads, open water).

b/ Total miles crossed include the 0.9 mile of pipeline that would not disturb vegetation because of the HDD method and direct pipe method used to install pipeline below six waterbodies: Coos Estuary (2 crossings), Coos River, South Umpqua River, Rogue River, and Klamath River.

4.4.2.1 Forest and Woodland Vegetation

Forests vegetation found along the Pacific Connector pipeline route were assigned an age class using available GIS data (BLM 2016c; Moeur et al. 2005, 2006, and 2011; Davis et al. 2015).[97] Age classes were categorized within various age ranges: clearcut (0-5 years), regenerating (5-40 years), mid-seral (40-80 years), as well as LSOG (80+ years).

- Clearcut/Regenerating forest:
  - Clearcut forest includes areas that were harvested within the past five years but presently are non-stocked. This age class generally has a canopy cover of less than 10 percent (Moeur et al. 2005).
  - Regenerating forest generally includes areas with canopy cover greater than 10 percent and tree size less than 10 inches diameter at breast height (dbh; Moeur et al. 2005). This category was further refined to identify early regenerating forest (harvested within the last 10 to 15 years) and regenerating forest for interior forest analyses described later in this section.
- Mid-seral forest includes stands within the current harvest rotation and generally includes small single- and multi-storied trees with canopy cover greater than 10 percent and tree size between 10 and 20 inches dbh (Moeur et al. 2005).
- LSOG:
  - Late successional forest includes forest stands greater than 80 years old. This age range is consistent with definitions used in the NWFP and as described in Moeur et al. (2005) and Davis et al. (2015). This age class generally includes medium and large single- or multi-storied trees with canopy cover greater than 10 percent and average tree size between 20 and 30 inches dbh.
  - Old-growth forest includes forest stands greater than 175 years and dominated by coniferous forest. This correlates well with Moeur et al. (2005), Franklin et al. (1981, 1986), and Franklin and Spies (1991) descriptions that consider primary size and canopy structure characteristics of old-growth Douglas-fir to develop between 175 and 250. This age class generally includes large, multi-storied stands with canopy cover greater than 10 percent and average tree dbh greater than 30 inches (Moeur et al. 2005). Mature deciduous-dominated forests were also included in this forest age classification.

The following text describes dominant vegetation communities in the Project area, lists the common species, and discusses the general distribution:

The Douglas-fir–Western Hemlock–Western Redcedar Forest type occurs at low to middle elevations and has a multi-storied canopy dominated by Douglas-fir, with western hemlock, western redcedar (*Thuja plicata*), and grand fir (*Abies grandis*) as co-dominants. In addition, Pacific yew (*Taxus brevifolia*) may be present in the subcanopy (Kagan et al. 1999). Port Orford cedar can also be a dominant tree species within Douglas-fir–Western hemlock–Western redcedar forest types within the pipeline Project area (Johnson and O'Neil 2001). Within riparian areas, and non-conifer dominated stands, bigleaf maple (*Acer macrophyllum*) and red alder are common. Large stature shrubs, such as vine maple (*Acer circinatum*), Pacific rhododendron, and evergreen

[97] Age class was also reviewed by BLM and Forest Service biologists on their respective lands between 2007 and 2008, with specific focus on verifying/classifying late seral forest stands, as well as by Siskiyou BioSurvey LLC.

and red huckleberry (*Vaccinium ovatum* and *V. parvifolium*), are frequently present. Ferns dominate the rich and diverse herbaceous layer. It is located within Coos and Douglas Counties.

The Douglas-Fir–Mixed Deciduous Forest type is a low to mid-elevation conifer and mixed deciduous forest found primarily in southwestern Oregon. The upper tree layer always contains Douglas-fir, with the sub-canopy consisting of a mix of shade tolerant conifers and deciduous trees including: tanoak (*Notholithocarpus densiflorus*), Pacific madrone (*Arbutus menziesii*), golden chinquapin (*Chrysolepis chrysophylla*), and Pacific dogwood (*Cornus nuttallii*). Indicative shrubs of this cover type include dwarf Oregon-grape (*Mahonia nervosa*), pacific blackberry (*Rubus ursinus*), oceanspray (*Holodiscus discolor*), California hazelnut (*Corylus cornuta*), and others (Kagan et al. 1999). This forest type is found within Douglas, Jackson, and Klamath Counties.

The Alder–Cottonwood Forest type is found along the margin of flowing streams in the foothills and mountains throughout much of Oregon. It is prevalent along high gradient stream systems that flood frequently and deposit bed-load sand and gravel. Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*) is always present in the overstory of this forest type. West of the Cascade crest, other dominant species in the overstory include red alder and big leaf maple, and conifers could include Douglas-fir, western hemlock, western redcedar, and Port Orford cedar. East of the Cascade crest, the other dominant species is typically white alder (*Alnus rhombifolia*), with other deciduous trees present including mountain alder (*Alnus incana* ssp. *tenuifolia*), Pacific willow (*Salix lucida* ssp. *lasiandra*), non-native black locust (*Robinia pseudoacacia*), and quaking aspen (*Populus tremuloides*). Associated conifers east of the Cascades include ponderosa pine (*Pinus ponderosa*), Douglas-fir, Engelmann spruce (*Picea engelmannii*), and lodgepole pine (Kagan et al. 1999). It is found within Coos, Douglas, Jackson, and Klamath Counties.

The Mixed Conifer/Mixed Deciduous Forest type is generally composed of co-dominant conifer (e.g., Douglas-fir) and deciduous (e.g., red alder and/or bigleaf maple) trees in a single-layered canopy forest (Kagan et al. 1999). Port Orford cedar may also be the dominant tree species within this forest type (Johnson and O'Neil 2001). This forest type is found in low- to mid-elevations (Kagan et al. 1999) within Coos County.

The Shasta Red Fir–Mountain Hemlock Forest type is a mid-to-upper elevation conifer forest mostly found above 4,000 feet. Overstory species generally include Shasta red fir (*Abies magnifica* var. *shastensis*), mountain hemlock (*Tsuga mertenxiana*), white fir (*Abies concolor*), and lodgepole pine. It often is a closed, multi-story canopy with dense understory of shrubs, forbs, and ferns, including dwarf bramble (*Rubus lasiococcus*), Oregon boxwood (*Paxistima myrsinites*), pinemat manzanita (*Arctostaphylos nevadensis*), and Sadler's oak (*Quercus sadleriana;* Kagan et al. 1999). It is found within Jackson and Klamath Counties.

The Douglas-fir–White Fir/Tanoak–Madrone Mixed Forest type is a multi-layered forest of mixed conifer and mixed deciduous species. It always contains Douglas-fir, with other co-dominants (e.g., white fir, incense cedar (*Calocedrus* [*Libocedrus*] *decurrens*), sugar pine [*Pinus lambertiana*] and western white pine [*Pinus monticola*]). Subcanopy layers contain shade-tolerant trees, including tanoak, Pacific madrone, golden chinquapin, Pacific dogwood, and California laurel (*Umbellularia californica*). Shrub and herb layers are generally well represented. This forest type is found at low to mid elevations (Kagan et al. 1999) within Jackson County.

The Douglas-fir Dominant-Mixed Conifer Forest type typically consists of a single-layer forest canopy, although stand structure can be diverse in undisturbed late seral stands. There is a wide range of canopy closure based on management practice, disturbance history, and microsite. Douglas-fir is dominant, with a variety of coniferous trees including, white fir, incense cedar, western white pine, ponderosa pine, and sugar pine. Understory vegetation is usually diverse and rich in species. This forest type is found at mid elevations (Kagan et al. 1999) within Coos, Douglas, Jackson, and Klamath Counties.

Ponderosa pine and white oak (*Quercus garryana*) are the dominant overstory species within the Ponderosa Pine/White Oak Forest and Woodland type. Shrub cover is typically sparse, but herbaceous and grass species tend to be abundant. This forest type is found at low elevations (Kagan et al. 1999) within Jackson and Klamath Counties.

Ponderosa pine is exclusively the overstory tree at low elevations within the Ponderosa Pine Forest and Woodland type. White fir, grand fir, western larch, incense cedar, Douglas-fir, subalpine fir, and Engelmann spruce are common at higher elevations. Understory and regeneration layers reflect similar composition as overstory. Lower elevations have fewer shrubs, with shrubs increasing in diversity and abundance with elevation and improved soil moisture conditions. This forest type is found at low to middle elevations (Kagan et al. 1999) within Jackson and Klamath Counties.

The Oregon White Oak Forest type contains deciduous woodland/forest dominated by Oregon white oak. Other canopy trees can be Douglas-fir and ponderosa pine in upland settings, and Oregon ash (*Fraxinus latifolia*), black cottonwood, and bigleaf maple on valley floors. The subcanopy often consists of California black oak (*Quercus kelloggii*). Understory typically contains tall deciduous shrubs and smaller stature deciduous trees. This forest type is a highly desirable wildlife habitat that has been decreasing as a result of fire suppression. It is found at low elevations (Kagan et al. 1999). This forest type can require more than 100 years to reach full productivity and function as wildlife habitat, and these types of wildlife habitats are limited within the region (see section 4.5). It is found within Douglas and Jackson \Counties.

The Grass-shrub-sapling or Regenerating Young Forest type is characteristic of successional conditions following timber harvest, which can include ground scarification and slash/large woody debris, a variety of shrubs and forbs typical of the area, and then conifer saplings which form a continuous canopy above the shrub layer (Kagan et al. 1999). It is found within Coos, Douglas, Jackson, and Klamath Counties.

The Western Juniper Woodland type is dominated by western juniper (*Juniperus occidentalis*) and has an open canopy (less than 30 percent crown closure) and single story, short stature (6 to 20 feet tall) trees. Understory vegetation is dominated by sagebrush species, such as big sagebrush (*Artemisia tridentata*), rigid sagebrush (*Artemisia rigida*), and low sagebrush (*Artemisia arbuscula*), as well as mountain mahogany (*Cercocarpus ledifolius*), bitterbrush (*Purshia tridentata*), and rabbitbrush (*Ericameria* ssp; *Chrysothamnus* spp.). Grasses characterize the herbaceous layer. This woodland type is found at a wide range of elevations (Kagan et al. 1999) within Klamath County.

The Ponderosa Pine/Western Juniper and Woodland type is typically found in the foothill margins bordering upland conifer types and sagebrush dominant lowlands. This forest type has a two-story canopy with widely spaced overstory ponderosa pine and a subcanopy of western juniper. Canopy cover is generally between 10 and 50 percent. The understory is dominated by a shrub layer, including big sagebrush, low sagebrush, rabbitbrush, mountain mahogany, and bitterbrush, and is interspersed with non-native grasses (typically in areas that are overgrazed) and native bunchgrasses (Kagan et al. 1999). It is found within Klamath County.

Late Successional and Old-growth Forest

Many of the forested and woodland vegetation types discussed above include areas that contain late-successional and mature old-growth vegetation (i.e., old-growth forests). Historic logging practices within the Pacific Northwest have dramatically reduced the size and health of old-growth forests. There is no single definition of old growth and multiple definitions have been used, depending on the forest type (deciduous or evergreen) being considered and the agency/organization managing the land. The NWFP defines old growth as "(a) forest stand usually at least 180 to 220 years old with moderate to high canopy closure; a multilayered, multi species canopy dominated by large overstory trees; high incidence of large trees, some with broken tops and other indications of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground" (FEMAT 1993). In addition, old-growth forests typically contain moderate-to-high accumulations of nonvascular vegetation such as fungi, lichens, and bryophytes (Forest Service and BLM 1994b).

LSOG forests west of the Cascade Range typically consist of old large overstory trees, such as Douglas-fir and western hemlock, multiple tree canopy levels, shade-tolerant tree species in the understory, large course woody debris and snags, a lush understory shrub layer, and infrequent stand replacement fire events (BLM 2008a, ODFW 2016a). The drier LSOG forests of eastern and southwest Oregon generally contain widely spaced or small groups of large overstory trees, such as ponderosa pine, with a more open grassy understory maintained by frequent low-intensity fire (BLM 2008a).

LSOG forests provide vital habitat for many native plant and animal species, including many federally-listed threatened or endangered species (Forest Service and BLM 1994b). Bird species that are obligates of old-growth forests include the federally threatened northern spotted owl and marbled murrelet (see section 4.6). LSOG forests have been greatly reduced in size and connectivity, which impacts plant and wildlife species adapted to LSOG conditions and/or wildlife species with limited ability to travel over long distances to find new suitable areas (ODFW 2016a). Additionally, many of the species supported by LSOG forests require large patches of older or mature forests to survive and may be sensitive to changes in the seral stage of the forest (ODFW 2016a). LSOG forests also provide a variety of other environmental services, including clean water, carbon sequestration, and a variety of recreational opportunities (BLM 2008a). Additionally, the complexity of LSOG forests increases the resiliency of these forest to disturbance (BLM 2008a). The loss of LSOG forests since 1850 in the Coast Range, West Cascades, and Klamath Mountains ecoregions of Oregon is estimated to be almost 90 percent (ODFW 2016a).

4.4.2.2 Shrubland Vegetation

The Sagebrush Steppe vegetation type is a mosaic of grasses (mostly introduced) and shrubs that include sagebrush subspecies, such as Wyoming (*Artemisia tridentata* ssp. *wyomingensis*), basin (*A. tridentata* ssp. *tridentata*), and mountain (*A. tridentata* ssp. *vaseyana*). Other shrubs include low, silver, and three-tip sagebrush, and rabbitbrush. A variety of bunchgrasses are scattered with the shrubs, although overgrazing has limited their presence (Kagan et al. 1999). Sagebrush steppe vegetation is a valuable natural resource and many species of wildlife (including ungulates, birds, reptiles, and invertebrates) rely on sagebrush steppe vegetation (Monsen and Shaw 2000; FWS 2014a). Vast areas of sagebrush steppe vegetation have been altered or lost through grazing, agriculture or other development, conversion to non-native annual or perennial grasslands through artificial seeding or invasion of annual grasses, and wildfire; and sagebrush steppe is now considered one of the most imperiled ecosystems in the United States (Monsen and Shaw 2000; FWS 2014a). Sagebrush steppe is found within Klamath County.

The Shrublands vegetation type consists of a mosaic of grasses and shrubs. It may include sagebrush but is not dominated by this species and species composition can vary greatly based on location along the pipeline. Common shrubs may include rabbitbrush (*Ericameria nauseosa* and *Chrysothamnus viscidiflorus*), bitterbrush, and manazanita (*Arctostaphylos* spp.) east of the Cascades. West of the Cascades native shrubs may include salmonberry (*Rubus spectabilis*), thimbleberry (*Rubus parviflorus*), as well as non-native shrubs including Scotch broom. It typically occurs within revegetated utility corridors and transitional areas, such as reclaimed industrial sites. It is located within Coos, Douglas, Jackson, and Klamath counties.

4.4.2.3 Herbaceous Vegetation

Grasslands (west of Cascades) are found at lower elevations and contain less than 30 percent tree or shrub cover and is generally used for livestock grazing. Native-dominated sites consist primarily of bunchgrasses, with mosses, lichens, and native forbs occurring throughout. Native westside grasslands (i.e., native prairie) have largely been disturbed through grazing activities and are typically vegetated with a mix of native and non-native perennial and annual grasses and forbs. Patches of native remnant prairie still occur, but their distribution is limited. It is found within Coos, Douglas, and Jackson Counties.

Grasslands (east of Cascades) contain a mosaic of various bunchgrasses, typically dominated by Idaho fescue (*Festuca idahoensis*). Other co-dominant grass species include bluebunch wheatgrass (*Pseudoroegneria spicata*), junegrass (*Koeleria* spp.), Sandberg bluegrass (*Poa secunda*), and western needlegrass (*Achnatherum occidentale*). In heavily grazed stands, cheatgrass (*Bromus tectorum*) and bottlebrush squirreltail (*Elymus elymoides* ssp. *elymoides*) can be dominant. This vegetation type is found at low to middle elevations (Kagan et al. 1999) within Klamath County.

Agricultural vegetation includes crop land, orchards, hay fields, and managed pastures. These areas consist of lands that have been cleared of native vegetation and modified for growing crops.

4.4.2.4 General Impacts on Vegetation

Constructing the pipeline would temporarily and permanently impact approximately 4,186 acres of vegetation (table 4.4.2.4-1). Operating the pipeline would permanently impact approximately 782 acres of vegetation (table 4.4.2.4-2). Permanent impacts would occur in association with aboveground facilities, new permanent access roads, and areas of road improvements. In these locations, vegetation would be removed during construction and the areas would not be revegetated during restoration. Permanent impacts would also occur within the 30-foot-wide operational right-of-way maintenance corridor. While this corridor would be revegetated following construction, it would be maintained in an herbaceous and/or low-growing shrub state during the life of the pipeline. Finally, the clearing of mature forested vegetation is also a permanent impact because restoration to preconstruction conditions would not happen during the life of the Project.

As indicated in tables 4.4.2.4-1 and 4.4.2.4-2, constructing and operating the pipeline would require the temporary and permanent clearing of vegetation, including clearing of unique or sensitive vegetation (i.e., LSOG forest, native prairie grasslands, and sagebrush steppe). Removal of vegetation would increase the potential for soil erosion, edge effects, and introduction and spread of noxious weeds and invasive species, and would reduce the amount of available wildlife habitat. The degree of impact depends on the type and amount of vegetation affected, the rate of vegetation regeneration following construction, and the frequency of vegetation maintenance conducted within the 30-foot-wide maintenance corridor within the operational pipeline easement. Additionally, site-specific conditions, such as grazing, precipitation, soil type, and presence of noxious weeds and invasive plants, would influence the length of time required to achieve successful revegetation. Clearing of agricultural and grassland areas would be considered a short-term impact because revegetation of these areas would typically occur within three growing seasons. Clearing of forested and shrubland areas would be considered a long-term impact because affected areas would not resemble adjacent undisturbed areas for many years to many decades; and, as stated above, clearing of mature forests (e.g., LSOG forest) would be considered a permanent impact.

Additional long-term impacts would include the cutting of danger trees or hazard trees, which are defined as trees located outside approved construction areas that are at risk of falling on workers or vehicles and thus would need to be removed. The removal of these trees would result in an additional long-term impact to adjacent vegetation. The extent or existence of danger trees would be identified, to the extent possible, following creation of the construction right-of-way, TEWAs, new access roads, and on roads that have not triggered land-managing agency danger tree removal due to limited road use. Pacific Connector would compensate the respective land manager/owner for any merchantable danger trees that are felled. Danger trees are discussed further in section 4.7.2.5 of this EIS.

TABLE 4.4.2.4-1

Construction Impacts on Vegetation by the Pacific Connector Pipeline Project (acres)

General Vegetation Type	Mapped Vegetation Type	Forest Stand by Age a/	Pipeline Facilities: Construction Right-of-Way	Pipeline Facilities: Temporary Extra Work Areas	Pipeline Facilities: Uncleared Storage Areas	Pipeline Facilities: Rock Source/ Disposal	Pipeline Facilities: Access Roads (TARs/PARs/ Improvements) b/	Pipeline Facilities: Pipe Yards	Pipeline Facilities: Aboveground Facilities - Klamath Compressor Station c/	Subtotals: Subtotal Late Successional – Old Growth	Subtotals: Subtotal Mid-Seral	Subtotals: Subtotal Clearcut or Regenerating	Subtotals: Subtotal by Vegetation Type	Subtotals: *Percent of Total Vegetation Impacted*
Forest-Woodland	Douglas-fir-W. Hemlock-W. Redcedar Forest	L-O	25	1	5	0	0	0	0					
		M-S	52	14	9	1	0	0	0	31	76	210	318	*7.6*
		C-R	124	60	21	5	0	0	0					
	Douglas-fir – Mixed Deciduous Forest	L-O	67	19	75	0	0	0	0					
		M-S	165	40	104	0	<1	<1	0	162	309	231	701	*16.7*
		C-R	87	35	108	0	<1	0	0					
	Alder-Cottonwood	L-O	0	0	0	0	0	0	0					
		M-S	<1	<1	0	0	<1	0	0	0	<1	0	<1	*<0.1*
		C-R	0	0	0	0	0	0	0					
	Mixed Conifer/Mixed Deciduous Forest	L-O	22	5	9	0	0	0	0					
		M-S	47	13	10	0	0	0	0	36	71	171	277	*6.6*
		C-R	112	34	25	0	<1	0	0					
	Shasta Red Fir – Mountain Hemlock Forest	L-O	16	<1	6	0	0	0	0					
		M-S	9	<1	4	0	0	0	0	22	14	78	114	*2.7*
		C-R	45	17	16	0	0	0	0					
	Douglas-fir-White Fir/Tanoak-Madrone Mixed Forest	L-O	7	2	5	0	0	0	0					
		M-S	12	3	6	0	0	0	0	14	20	5	39	*0.9*
		C-R	4	<1	1	0	0	0	0					
	Douglas-fir Dominant-Mixed Conifer Forest	L-O	245	40	107	1	<1	0	0					
		M-S	97	34	28	<1	<1	0	0	393	159	349	900	*21.5*
		C-R	207	61	81	0	<1	0	0					
	Ponderosa Pine/White Oak Forest and Woodland	L-O	39	14	6	0	0	0	0					
		M-S	19	7	<1	0	0	0	0	59	26	42	126	*3.0*
		C-R	28	7	7	0	0	0	0					
	Ponderosa Pine Forest and Woodland	L-O	12	2	0	0	0	0	0					
		M-S	32	2	0	<1	0	0	0	14	35	45	94	*2.2*
		C-R	35	9	<1	1	0	0	0					
	Oregon White Oak Forest	L-O	27	9	4	0	0	0	0					
		M-S	25	7	2	0	<1	0	0	40	34	0	74	*1.8*
		C-R	0	0	0	0	0	0	0					
	Western Juniper Woodland	L-O	2	<1	0	0	0	0	0					
		M-S	33	6	0	0	<1	0	0	3	39	0	42	*1.0*
		C-R	0	0	0	0	0	0	0					

TABLE 4.4.2.4-1 (continued)

Summary of Construction-Related Disturbance to Vegetation by the Pacific Connector Pipeline Project (acres)

			Pipeline Facilities							**Subtotals**				
General Vegetation Type	**Mapped Vegetation Type**	**Forest Stand by Age a/**	**Construction Right-of-Way**	**Temporary Extra Work Areas**	**Uncleared Storage Areas**	**Rock Source/ Disposal**	**Access Roads (TARs/PARs/ Improvements) b/**	**Pipe Yards**	**Aboveground Facilities - Klamath Compressor Station c/**	**Subtotal Late Successional – Old Growth**	**Subtotal Mid-Seral**	**Subtotal Clearcut or Regenerating**	**Subtotal by Vegetation Type**	***Percent of Total Vegetation Impacted***
Forest - Woodland	Ponderosa Pine/Western Juniper Woodland	L-O	0	0	0	0	0	0	0					
		M-S	16	2	0	0	0	0	0	0	17	46	63	*1.5*
		C-R	42	3	0	0	0	0	0					
Subtotal Forest-Woodland by Age Class		***L-O***	***461***	***93***	***218***	***1***	***<1***	***0***	***0***					
		M-S	***507***	***128***	***163***	***1***	***<1***	***<1***	***0***	***773***	***800***	***1,177***	***2,750***	***65.7***
		C-R	***684***	***227***	***260***	***6***	***<1***	***0***	***0***					
Subtotal Forest-Woodland			**1,652**	**448**	**641**	**8**	**1**	**<1**	**0**	**773** [d/]	**800**	**1,177**	**2,750**	
Percent of All Forest-Woodland			***59.9***	***16.3***	***23.4***	***0.3***	***<0.1***	***<0.1***	***0.0***	***28.1***	***29.1***	***42.8***	***100.0***	
Shrubland	Sagebrush Steppe	n/a	78	33	0	0	<1	0	21	n/a	n/a	n/a	133	*3.2*
	Shrublands	n/a	122	41	11	0	<1	0	0	n/a	n/a	n/a	174	*4.1*
Subtotal Shrubland		n/a	**200**	**74**	**11**	**0**	**1**	**0**	**21**	**n/a**	**n/a**	**n/a**	**307**	***7.3***
Grassland	Grasslands (West of Cascades)	n/a	132	87	6	<1	2	148	0	n/a	n/a	n/a	376	*9.0*
	Grasslands (East of Cascades)	n/a	51	9	0	1	0	122	0	n/a	n/a	n/a	183	*4.4*
Subtotal Grasslands			**183**	**96**	**6**	**2**	**2**	**270**	**0**	n/a	n/a	n/a	**559**	**13.4**
Wetland	Wetland	n/a	64	47	<1	0	<1	<1	0	n/a	n/a	n/a	112	*2.7*
Subtotal Wetland			**64**	**47**	**<1**	**0**	**<1**	**<1**	**0**	**0**	**<1**	**<1**	**112**	***2.7***
Agriculture	Agriculture	n/a	306	132	<1	3	2	14	0	n/a	n/a	n/a	458	*10.9*
Subtotal Agriculture			**306**	**132**	**<1**	**3**	**2**	**14**	**0**	n/a	n/a	n/a	**458**	***10.9***
Subtotal Non-Forest			**752**	**349**	**18**	**5**	**5**	**284**	**21**	**0**	**<1**	**<1**	**1,436**	***34.4***
Percent of All Non-Forest			***52.4***	***24.3***	***1.3***	***0.3***	***0.3***	***19.8***	***1.5***	***0.0***	***<0.1***	***<0.1***	***100.0***	
Project Total		n/a	**2,404**	**797**	**659**	**13**	**6**	**284**	**21**	**773** [d/]	**801**	**1,177**	**4,186**	
Percent of Pipeline Facilities		n/a	***57.4***	***19.0***	***15.7***	***0.3***	***0.1***	***6.8***	***0.5***	***15.6***	***18.5***	***28.1***		

General: Rows and columns may not sum correctly due to rounding. Acres rounded to nearest whole acre (values below 1 are shown as "<1").

a/ "L-O" = Late Successional and Old-Growth; M-S = Mid-Seral; "C-R" = Clearcut or Regenerating

b/ Road improvements will affect approximately 22.52 acres along the margins of existing access roads; all acres of disturbance have been included in vegetation type "roads."

c/ Construction disturbance associated with aboveground facilities (mainline block valves and meter stations) is included in construction right-of-way and/or TEWA acres of disturbance. Approximately 1.61 acres associated with communication towers is not included in this table (previously disturbed sites).

d/ Approximately 658 acres of construction-related disturbance to LSOG forests would occur on lands managed by the BLM and Forest Service.

TABLE 4.4.2.4-2

Operation Impacts on Vegetation by the Pacific Connector Pipeline Project

General Vegetation Type	Mapped Vegetation Type	Forest Stand by Age b/	Pipeline Facilities (acres a/): *30-foot-wide Maintenance Corridor*	Pipeline Facilities (acres a/): Permanent Access Roads	Pipeline Facilities (acres a/): Subtotal LSOG	Pipeline Facilities (acres a/): Subtotal Mid-Seral Forest	Pipeline Facilities (acres a/): Subtotal Clearcut / Regenerating Forest	Permanent Easement (50-foot) c/	Aboveground Facilities d/ (acres a/)	Total Operation Impacts by Vegetation Type e/
Forest-Woodland	Douglas-fir-W. Hemlock-W. Redcedar Forest	L-O	8	0	8	16	39	14	0	**63**
		M-S	16	0				27		
		C-R	39	0				65		
	Douglas-fir – Mixed Deciduous Forest	L-O	20	0	20	52	27	34	<1	**99**
		M-S	52	<1				87		
		C-R	27	<1				46		
	Alder-Cottonwood	L-O	0	0	0	<1	0	*0*	0	**<1**
		M-S	<1	0				<1		
		C-R	0	0				*0*		
	Mixed Conifer/Mixed Deciduous Forest	L-O	7	0	7	15	35	11	0	**56**
		M-S	15	0				24		
		C-R	35	<1				59		
	Shasta Red Fir – Mountain Hemlock Forest	L-O	5	0	5	3	14	9	<1	**23**
		M-S	3	0				5		
		C-R	14	0				24		
	Douglas-fir-White Fir/Tanoak-Madrone Mixed Forest	L-O	3	0	3	3	1	4	0	**7**
		M-S	3	0				6		
		C-R	1	0				2		
	Douglas-fir Dominant-Mixed Conifer Forest	L-O	75	0	76	31	67	126	<1	**173**
		M-S	31	0				51		
		C-R	67	<1				112		
	Ponderosa Pine/White Oak Forest and Woodland	L-O	12	0	12	6	9	21	0	**27**
		M-S	6	0				9		
		C-R	9	0				15		
	Ponderosa Pine Forest and Woodland	L-O	4	0	4	10	11	6	0	**25**
		M-S	10	0				17		
		C-R	11	0				18		
	Oregon White Oak Forest	L-O	8	0	8	8	0	14	0	**16**
		M-S	8	0				13		
		C-R	0	0				0		
	Western Juniper Woodland	L-O	<1	0	<1	10	0	1	0	**11**
		M-S	10	0				16		
		C-R	0	0				0		
	Ponderosa Pine/Western Juniper Woodland	L-O	0	0	0	5	13	0	<1	**19**
		M-S	5	0				8		
		C-R	13	0				22		
Subtotal Forest-Woodland by Age Class		***L-O***	**143**	**0**	**143**	**158**	**216**	**239**	***<1***	***143***
		M-S	**158**	**<1**				**264**	***<1***	***158***
		C-R	**216**	**<1**				**363**	***<1***	***217***
Subtotal Forest-Woodland			**517**	**<1**	**143**	**158**	**216**	***866***	**<1**	**517**

TABLE 4.4.2.4-2 (continued)

Operation Impacts on Vegetation by the Pacific Connector Pipeline Project

General Vegetation Type	Mapped Vegetation Type	Forest Stand by Age b/	Pipeline Facilities (acres a/): *30-foot-wide Maintenance Corridor*	Pipeline Facilities (acres a/): Permanent Access Roads	Pipeline Facilities (acres a/): Subtotal LSOG	Pipeline Facilities (acres a/): Subtotal Mid-Seral Forest	Pipeline Facilities (acres a/): Subtotal Clearcut / Regenerating Forest	Permanent Easement (50-foot) c/	Aboveground Facilities d/ (acres a/)	Total Operation Impacts by Vegetation Type e/
Shrubland	Sagebrush Steppe	n/a	26	<1	n/a	n/a	n/a	44	21	**48**
	Shrublands	n/a	39	<1	n/a	n/a	n/a	65	<1	**39**
	Subtotal Shrubland		**65**	**<1**	n/a	n/a	n/a	***109***	**21**	**86**
Grassland	Grasslands (West of the Cascades)	n/a	42	1	n/a	n/a	n/a	71	1	**45**
	Grasslands (East of the Cascades)	n/a	16	0	n/a	n/a	n/a	27	0	**16**
	Subtotal Grassland		**58**	**1**	n/a	n/a	n/a	***98***	**1**	**61**
Wetland	Wetland	n/a	21	<1	0	<1	<1	<1	0	**20**
	Subtotal Wetland/Riparian		**21**	**<1**	0	<1	<1	***35***	**<1**	**21**
Agriculture	Agriculture	n/a	97	<1	n/a	n/a	n/a	161	<1	**97**
	Subtotal Agriculture		**97**	**<1**	n/a	n/a	n/a	***161***	**<1**	**97**
	Subtotal Non-Forest		**241**	**2**	**n/a**	**n/a**	**n/a**	**403**	**23**	**266**
	Project Total		**758**	**1**	**143**	**158**	**216**	**1,269**	**23**	**782**

General: Rows and columns may not sum correctly due to rounding. Acres rounded to nearest whole acre (values below 1 are shown as "<1").

a/ Acres disturbed were evaluated using GIS; footprints for each component (aboveground facilities, 50-foot-wide permanent easement, and 30-foot-wide maintenance corridor) were overlaid on the digitized vegetation coverage.

b/ "L-O" = Late Successional and Old-Growth; "M-S" = Mid-Seral; "C-R" = Clearcut or Regenerating Young Forest.

c/ Shaded cells identify acres of vegetation type within the defined area but are not included in the overall Project total because: 1) only the 30-foot-wide Maintenance Corridor included within the 50-foot-wide Permanent Easement is expected to be affected during operations and maintenance activities, and 2) no additional maintenance would occur on access roads improved for construction of the Project.

d/ Aboveground facilities include block valve assemblies (BVAs), the Jordan Cove, Clarks Branch, and Klamath meter stations, and the Klamath Compressor Station.

e/ Total by Vegetation Type includes the 30-foot-wide maintenance corridor and permanent access roads, and only aboveground facilities with a meter station or compression station (mainline block valves are located within the 30-foot-wide maintenance corridor).

Acres of impacts only include impacts on vegetated areas; therefore, impacts in this table may not reflect impact values reported in other sections of this EIS. Shaded cells identify acres of vegetation type within the defined area but are not included in the overall Project total because: 1) only the 30-foot-wide Maintenance Corridor included within the 50-foot-wide Permanent Easement is expected to be affected during operations and maintenance activities, and 2) no additional maintenance would occur on access roads improved for construction of the Project.

The Pacific Connector Pipeline Project would impact approximately 133 acres of sagebrush steppe habitat. Impacts on sagebrush steppe would be long term because big sagebrush only regenerates from seed and may take 20 years or more to become reestablished (West 1988). Constructing and operating the pipeline would also impact approximately 773 acres of LSOG forests, 800 acres of mid-seral forest, and 1,177 acres of clearcut/regenerating forests.

Throughout our environmental review of this Project, we have received comments not only from the public, but from the tribes, and federal and state resource agencies expressing concern about impacts on forests, specifically "old-growth" forests. Since implementation of the Northwest Forest Plan (NWFP) in 1994, periodic monitoring of the amount, distribution, and spatial arrangement of LSOG forest within the range of the NWFP has been conducted. Based on monitoring conducted in 2012, there was approximately 6,460,900 acres of LSOG forests within the NWFP boundary in the four physiographic provinces in Oregon (Coast Range, Western Cascades, Eastern Cascades and Klamath) crossed by the pipeline (Davis et al. 2015). The impacts to 773 acres of LSOG forests from construction and operation of the Project would represents a loss of only 0.01 percent of the remaining LSOG forest in the four physiographic provinces crossed by the pipeline. As stated above, LSOG forests provide vital habitat for many native species of plants and wildlife, including many federally-listed threatened or endangered species, as well as providing a variety of environmental services (Forest Service and BLM 1994b; BLM 2008a). The loss of this forest vegetation would reduce the amount of habitat available to species dependent on LSOG vegetation and would potentially alter existing vegetation composition and soil and hydrologic characteristics and the ecosystem services provided by LSOG forests.

Additionally, constructing the pipeline would result in forest fragmentation and edge effects. The pipeline would fragment or "break-up" large tracts of contiguous forest and further the fragmentation of tracts broken up previously due to other forest practices (timber harvest, access roads), and other development (urban growth, agricultural development, utility corridors). Fragmentation reduces forest size and can reduce the size and increase the spatial isolation of local plant populations, including rare or endangered species (Jules et al. 1999). Fragmented forests also affect wildlife movement and its ability to successfully function as wildlife habitat (see section 4.5).

Fragmentation also results in new forest "edges" which play a crucial role in ecosystem interactions and landscape function, including the distribution of plants and animals, fire spread, vegetation structure, and wildlife habitat. New forest edges would affect microclimate factors such as wind, humidity, and light, and can lead to a change in species composition within the adjacent forest or increase invasion by invasive species. Compared to the forest interior, vegetation edges receive more direct solar radiation during the day, lose more light and heat at night, and experience less humidity. Increased solar radiation (e.g., light and heat) and wind can desiccate vegetation by increasing evapotranspiration, which can affect which species survive along the edge (typically favoring shade intolerant species) and can impact soil characteristics. The orientation of a fragment's edge can affect the extent and magnitude of edge effects because the amount of solar radiation that falls on the newly created edge would depend on the direction it faces, its latitude, time of year and time of day, and height of trees in the area that would cast shadows on the new edge (Chen et al. 1995). Because these values constantly change temporally and spatially, the edge effects would also constantly change along the pipeline, as tree shadows would extend different distances across the right-of-way depending on the time of year or aspect of the edge. This would result as some areas would be in shade at one point in the year (reducing edge effects) and in sunlight during another portion of the year (increasing edge effects).[98]

Harper et al. (2005) reported that the mean distance of edge influence could occur up to 300 feet (approximately 100 meters); however, the study also found that the development of a sidewall of dense vegetation along the new edge can affect the overall mean distance of edge effects.. This may reduce the depth of penetration of energy and matter into the forest, shortening the length of the gradient (distance) while the magnitude of edge influence remains strong (Harper et al. 2005). In general, the greater distances were not found in the North American sites, where the influence associated with maintained clearings was less than 150 feet; however, these studies were done in boreal forests (Harper et al. 2015) which may not be directly applicable to the temperate old-growth forests in the Pacific Northwest. A study on edge influence in old-growth Douglas-fir forests in the Pacific Northwest found that the edge influence on microclimatic variables (air temperature, soil temperature, relative humidity, short-wave radiation, and wind speed) extended between 98 feet (30 meters) to more than 785 feet (240 meters) depending on the microclimatic variable (Chen et al. 1995). Additionally, Jules et al. (1999) found that the depth of edge influence on forest understory species in the Klamath ecoregion ranged from 0 feet to more than 197 feet (60 meters) depending on the species. In younger coniferous forests or mixed forests with deciduous species, edge effects compared to interior forests have been much less pronounced (Heithecker and Halpern 2007; Harper and Macdonald 2002).

Although any vegetation type can be fragmented, of the vegetation types crossed by the pipeline, forested and woodland vegetation and their associated species are likely the most sensitive to fragmentation. Existing patch size, patch isolation, and edge characteristic (i.e., the contrast or the relative difference among adjacent patches) of coniferous and/or mixed forest patches of different age classes were evaluated along the pipeline's centerline to determine the acreage of interior forests that would be fragmented and experience new edge effects. Based on this assessment, approximately 430 acres of interior forest would be affected by construction of the pipeline, while between 1,752 and 3,504 acres would be indirectly affected (i.e., would be within 50 to 100 meters of newly created edges). This includes effects on approximately 185 acres of LSOG forests, 126 acres of mid-seral forests, and 119 acres of regenerating forests, and indirect effects on approximately 1,449 acres of LSOG forest, 1,010 acres of mid-seral forests, and 1,046 acres of regenerating forests.

To minimize forest fragmentation and edge effects, Douglas-fir or western hemlock would be planted during restoration of temporary work areas, including TEWAs, in the pipeline right-of-way (except in the 30-foot-wide maintenance corridor centered on the pipe), where conifers would be removed during construction activities. By revegetating the area, the edge along the fragment would be reduced, thereby reducing the effects of fragmentation and edge effects. If 12-inch- tall Douglas-firs and western hemlocks are planted during restoration and they are not harvested later,

[98] For example, assume the 95-foot-wide pipeline construction corridor is oriented northwest to southeast at 135 degrees from north. At a location in the vicinity of the pipeline (longitude=123.0 degrees West, latitude=42.5 degrees North) on June 21, the sun would be shining from the east (azimuth ≈91.5 degrees) at 0815 (Pacific Standard Time [PST]) with solar altitude of ≈ 37.6 degrees. A tree 100 feet tall on the southwest-facing edge of the right-of-way would cast a shadow 130 feet which, given the angle and width of the right-of-way, would fall short of reaching the opposite side (northeast-facing edge) by about 5 feet. On May 21, however, the sun in the same position would have cast a shadow of about 170 feet at 0745 (PST) and on July 21 at 0800 (PST) the shadow would extend about 160 feet. In both instances, the edge opposite the eastern sun would be in shadow.

trees of both species could, depending on site conditions, range between about 20 and 120 feet tall in 50 years at the end of the Project's operational life. Douglas-fir and western hemlock planted adjacent to edges of clearcut and/or early regenerating stands (assuming conifers from 1 to 10 feet tall at the time of construction) would modify edges of the seral stands from hard, to soft, to no edge as they grow. As the replanted trees grow, edge contrasts would decrease, as would effects on forest interiors, because taller trees would reduce direct solar radiation and increase soil moisture and humidity along the edges of stand interiors (Chen et al. 1993; Heithecker and Halpern 2007).

The Project's proposed vegetation clearing in forested vegetation has the potential to exacerbate the rate of windthrow in adjacent forest stands. Long-term forest stand degradation due to windthrow could potentially occur in local areas along the proposed right-of-way where the route is exposed to strong winds, especially where it runs perpendicular to the direction of the prevailing wind.

UCSAs would not be cleared of vegetation during construction but would be located in areas of woodlands and dense, mature forest. Within UCSAs located in forests and woodlands, some damage to understory vegetation and minor damage to trees would occur. Trees that are damaged at the time of construction could die over time (e.g., from severed roots, damage to lateral or anchoring roots, broken tops, or damage to more than 50 percent of the circumference of the tree). In these cases, the impact would be long term, i.e., the death of a tree would be considered a long-term or permanent impact. Vegetation disturbance would generally depend on the site-specific vegetation characteristics, with younger regenerating forests being potentially more susceptible to damage such as limb breakage. To protect trees within UCSAs, Pacific Connector would implement the measures outlined in its *Leave Tree Protection Plan*.[99] After construction, Pacific Connector would assess potential tree damage within the UCSAs and would appropriately compensate the landowner for damage.

Pacific Connector would implement numerous measures to minimize impacts on vegetation and ensure successful revegetation of disturbed areas. These measures include those found in the ECRP, *Leave Tree Protection Plan*, *Integrated Pest Management Plan*, *Fire Prevention and Suppression Plan*, and the *SPCC Plan* (see the POD, appendix F.10). These measures would be applied to all lands crossed by the pipeline route. However, as part of their ROW grant, the Forest Service and BLM would require additional measures to minimize and mitigate impacts on vegetation, including LSOG forests, on federal lands. Measures specific to federally managed lands are addressed below in section 4.4.3.3, as well as in the *BLM and Forest Service Compensatory Mitigation Plan and Amendment* (appendix F.2) and *Late Successional Reserves Crossed by the PGCP Project* (appendix F.3).

4.4.2.5 Noxious Weeds and Invasive Species

Section 4.4.1.6 describes and defines what noxious weeds and other invasive plant species are, as well as the general effects that they can have to a system. List "T" (i.e., target species) noxious weeds that have the potential of occurring in the area of the pipeline are listed in table 4.4.2.5-1.

[99] This plan was included as Appendix P to Pacific Connector's POD.

TABLE 4.4.2.5-1

Oregon Target Weeds (List T) Suspected within or Near the Proposed Pacific Connector Pipeline Work Area a/

Noxious Weed Common and Scientific Name	Known or Suspected Occurrences County b/	Forest Service Region 6 c/	BLM Districts c/	ODA Noxious Weed Class d/
Garlic mustard *Alliaria petiolata*	Jackson (L)		MD - D	B
Plumeless thistle *Carduus acanthoides*	Douglas e/ Klamath (L)		LV – D, RO – D	A
Woolly distaff thistle *Carthamus lanatus*	Douglas (L) Jackson e/		MD – D, RO - D	A
Spotted knapweed *Centaurea stoebe* (*C. maculosa*)	Coos (L) Douglas (L) Jackson (L) Klamath (W)	UMP - D	LV – D MD - D	B
Squarrose knapweed *Centaurea virgata*	Klamath e/		LV MD - D	A
Rush skeletonweed *Chondrilla juncea*	Douglas (W) Jackson (W) Klamath (L)	FW – D RRS – D UMP - D	LV MD - D RO - D	B
Field bindweed *Convolvulus arvensis*	Coos (W) Douglas (W) Jackson (W) Klamath (W)	FW – D	CB – D, MD – D, LV – D, RO - D	B
Portuguese broom *Cytisus striatus*	Douglas (L)	UMP – D	MD – D, RO - D	B
Paterson's curse *Echium plantagineum*	Douglas (L)			A
Leafy spurge *Euphorbia esula*	Coos e/ Jackson (L) Klamath (L)	FW - D	CB – D, LV – D, MD - D	B
Orange hawkweed *Hieracium aurantiacum*	Coos (L) Klamath (L)			A
Perennial pepperweed *Lepidium latifolium*	Jackson (L) Klamath (W)	FW – D	LV - D	B
Dalmatian Toadflax *Linaria dalmatica* (*L. genista*)	Coos (L) Douglas (L) Jackson (L) Klamath (W)	FW – D UMP – D	LV – D MD - D	B
Waterprimrose *Ludwigia grandiflora* ssp. *hexapetala; L. peploides*	Jackson (L)		MD - D	B
Matgrass *Nardus stricta*	Klamath (L)		CB	A
Yellow floating heart (*Nymphoides peltata*)	Douglas (L) Jackson (L)	RRS – D UMP - D		A
Taurian thistle *Onopordum tauricum*	Klamath (L)			A
Tansy ragwort *Senecio jacobaea*	Coos (W) Douglas (W) Jackson (L) Klamath (H)	FW – D	CB – D, LV – D, MD - D, RO - D	B
Smooth cordgrass *Spartina alterniflora*	Coos (H)			A
Dense-flowered cordgrass *Spartina densiflora*	Coos (L)			A
Saltcedar *Tamarix ramosissima*	Jackson (L) Klamath (L)		LV - D	B
Gorse *Ulex europaeus*	Coos (W) Douglas (L)	RRS – D UMP – D	CB – D, MD – D, RO - D	B

a/ Source: ODA 2018a; Forest Service 2005b and 2017b; BLM 2017

b/ Letter in parenthesis indicates distribution within the county, if provided (ODA 2018a). L = Limited, W = Widespread, and H = Historic. No letter indicates county not listed on the ODA (2018a) species fact sheet

c/ Forest Service and BLM District Codes: UPM–Umpqua NF, RRS – Rogue River Siskiyou NF, FW – Fremont-Winema NF, CB–Coos Bay BLM, LV – Lakeview BLM, MD–Medford BLM, RO - Roseburg BLM. "D" indicates that it is documented in National Forest Service or BLM District but not necessarily within county crossed by the Pacific Connector pipeline.

d/ Oregon Noxious Weed List: List "A" weeds occur in small enough infestations to make eradication or containment possible or is not known to occur in Oregon but is present in neighboring states making occurrence in Oregon seem imminent. List "B" weeds are regionally abundant but may have limited distribution in some counties. List "T" weeds are selected from the "A" or "B" lists and are designated as a target species

e/ BLM District indicated that this species is found in the listed county (BLM 2017a).

In addition to the List T weeds, other weed species (e.g., non-List T species) that are also of concern could occur along the pipeline route.[100]

All Oregon State-listed noxious weeds (List A, B, and T species) documented along the pipeline route are listed in table 4.4.2.5-2. Five List T weeds, spotted knapweed, rush skeletonweed, Dalmatian toadflax, tansy ragwort, and gorse, were documented.

TABLE 4.4.2.5-2

Summary of Noxious Weeds found within the Vicinity of the Pacific Connector Pipeline Route during Surveys a/

Common Name *Scientific Name*	**ODA Noxious Weed Class**	**ODA Target "T" Weed**
Velvetleaf *Abutilon theophrasti*	B	No
Biddy-biddy *Acaena novae-zelandiae*	B	No
False brome *Brachypodium sylvaticum*	B	No
Butterfly bush *Buddleja davidii*	B	No
Musk thistle *Carduus nutans*	B	No
Meadow knapweed *Centaurea moncktonii*	B	No
Yellow starthistle *Centaurea solstitialis*	B	No
Spotted knapweed *Centaurea stoebe* (*C. maculosa*)	B	Yes
Rush skeletonweed *Chondrilla juncea*	B	Yes
Canada thistle *Cirsium arvense*	B	No
Bull thistle *Cirsium vulgare*	B	No
Houndstongue *Cynoglossum officinale*	B	No
Scotch broom *Cytisus scoparius*	B	No
Cutleaf teasel *Dipsacus laciniatus*	B	No
French broom *Genista monspessulana*	B	No
English ivy *Hedera helix*	B	No
St. Johnswort *Hypericum perforatum*	B	No
Perennial peavine *Lathyrus latifolius*	B	No
Dalmation toadflax *Linaria dalmatica (L. genista)*	B	Yes
Purple loosestrife *Lythrum salicaria*	B	No
Scotch thistle *Onopordum acanthium*	B	No
Japanese knotweed *Polygonum cuspidatum* (*Fallopia japonica*)	B	No
Sulphur cinquefoil *Potentilla recta*	B	No
Himalayan blackberry *Rubus armeniacus (R. discolor, R. procerus, R. fruticosa)*	B	No
Tansy ragwort *Senecio jacobaea*	B	Yes
Medusahead rye *Tainiatherum caput-medusae*	B	No
Gorse *Ulex europaeus*	B	Yes

a/ Documented within 100 feet of the pipeline project route.

Pacific Connector's ECRP includes measures to control noxious weeds, soil pests, and forest pathogens. In addition, Pacific Connector developed an *Integrated Pest Management Plan,*[101] in consultation with the ODA (Butler 2017), BLM, and the Forest Service, to minimize the potential spread and infestation of weeds. This plan, applicable to all land ownerships, includes requirements for surveys to be conducted prior to construction to determine the presence of noxious weeds; determining where management or pretreatment may be necessary prior to construction to prevent the spread of noxious weeds; cleaning of construction equipment prior to moving it onto the construction right-of-way; and cleaning of vegetation clearing and grading

[100] All Oregon State noxious weeds that could potentially occur along the pipeline project (including List A and B species) are included in Table C.3-4 of Appendix C.3 in Resource Report 3 in Pacific Connector's September 2017 application to the FERC.
[101] See Appendix N to the POD submitted to the FERC January 23, 2018.

equipment if it passes through areas where weeds have been identified. Additionally, disturbed areas would be replanted with appropriate seed mixes to prevent noxious weed germination. After construction, the right-of-way would be monitored and any noxious weed infestations would be controlled. Pacific Connector would also investigate noxious weed issues raised by landowners during operation of the pipeline.

To minimize the spread of noxious weeds, construction equipment would be power washed, if necessary, as determined by the EI. In addition, initial inspections of all company and construction contractor vehicles would be performed prior to being allowed on the construction right-of-way. The EI or Pacific Connector's authorized representative would be responsible for performing inspections and registering or tagging the equipment prior to being transported or moved to the right-of-way. Any equipment used within areas where noxious weeds are present (specifically those that are classified as priority A and T as well as selected B listed weeds) would be cleaned by hand, blown down with air, or pressure washed prior to leaving the site. Equipment cleaning on the right-of-way would occur in a cleaning station approved by the EI. Infested areas and cleaning stations would be mapped to ensure that these areas are monitored during construction and to ensure that weeds at these areas are controlled and not spread.

After construction, Pacific Connector would monitor the right-of-way for infestations of noxious weeds, in compliance with its *Integrated Pest Management Plan*. Targeted weed monitoring would occur in the areas where noxious weeds were identified prior to construction and were previously mapped to ensure that potential infestations do not reestablish and/or spread. Monitoring would also occur in areas along the right-of-way where equipment cleaning stations, hydrostatic dewatering sites, and other temporary project disturbances were located to ensure that infestation at these locations do not occur. If infestations occur along the right-of-way, Pacific Connector would make an assessment of the source of the infestation, the potential for the infestation to spread, and develop a treatment plan to control the infestation. Where infestations occur on federal lands, this assessment and treatment plan would be developed cooperatively with these agencies. The treatment plan would be developed using integrated weed management principles, and if herbicides are used, all applicable approvals would be obtained prior to their use including landowner approvals. Only herbicides that are approved for use on the affected lands (private, state, or federal) would be used. Herbicide treatments would not be conducted during precipitation events or when precipitation is expected within 24 hours to minimize the risk of these chemicals moving beyond the treated areas or into waterbodies. If weeds targeted for herbicide treatments are in the vicinity of sensitive sites, proper buffers would be used in order to prevent the spread of herbicides to these areas. Pacific Connector would consult with the ODA Noxious Weed Control Program or local County Weed Programs for additional support regarding noxious weed control issues that may occur during the pipeline operations. Pacific Connector would conduct follow-up inspections of all disturbed areas until revegetation is successful. If additional infestations or other invasive/noxious weed species are found, then these would be controlled and monitored as well.

4.4.2.6 Vegetation Pathogens

In Oregon, the Forest Service and ODF conduct annual aerial surveys of all forested land to determine insect and disease activity status. These surveys indicated the following insect and/or disease activity within 0.5 mile of the pipeline route: Douglas-fir beetle, fir engraver, flatheaded borer, mountain pine beetle (ponderosa and sugar pine), western pine beetle, needle cast (lodgepole pine, ponderosa pine, and Swiss), and Port Orford cedar root disease.[102] Within the pipeline Project area, the flatheaded borer, western pine beetle, and fir engraver are most prevalent. Other diseases that may occur or have potential to occur are annosus root and butt rot, laminated root rot, dwarf mistletoe, sudden oak death, and the black stain root disease. As indicated in table 4.4.2.6-1, multiple infestations of insect parasites and tree pathogens already exist along the pipeline route.

TABLE 4.4.2.6-1

Summary of Known Infestations of Insect Parasites and Tree Diseases Along the Pacific Connector Pipeline Route a/

Tree Insect or Disease	Land Ownership	Number of Incidences Along Pipeline Route	Approximate Mileposts (MP) of Right-of-Way Affected
Douglas-fir Beetle	BLM/Private/Forest Service	7	MP 32.1-32.2; MP 48.0; MP 98.4 – 102.2
Fir Engraver	BLM/Private/Forest Service	18	MP 48.3; MP 82.0 – 84.5; MP 103.9 – 113.7; MP 152.3-177.7
Flatheaded Borer	BLM/Private/Forest Service	27	MP 30.5 – 40.9; MP 50.8 – 51.1; MP 104.4 – 158.1
Laminated Root Rot	Forest Service	1	MP 154.2 – 154.5
Mountain Pine Beetle	BLM/Private/Forest Service	9	MP 112.3; MP 159.5 – 173.8; MP 224.2 – 224.9
Needle Cast	BLM/Private/Forest Service	7	MP 6.7R – 22.0; MP 161.5 – 168.7
Pine Engraver	Private	1	126.8
Port Orford Cedar Root Disease	Private	4	MP 23.1; MP 30.4 – 30.9; MP 39.65
Western Pine Beetle	BLM/Private/Forest Service	13	MP 96.9 – 97.0; MP 116.6 – 127.1; MP 139.9 – 154.0

Mileages rounded to nearest tenth of a mile.
a/ Summarized from Table 1-2 in the *Integrated Pest Management Plan* (Appendix N to the POD).
Source Data: ODF 2004 through 2017 aerial GIS data.

The introduction and/or spread of insects and diseases from construction equipment, activities, and personnel can adversely affect vegetation. Impacts include loss, reduced species fitness and diversity, and changes to habitat characteristics and subsequent wildlife use. To minimize the introduction and spread of insects and disease, Pacific Connector would implement measures described in its *Integrated Pest Management Plan*. Pacific Connector would identify/verify areas infested with forest pathogens during timber cruises prior to construction and implement minimization measures, including but not limited to cleaning equipment and vehicles upon entering/departing infested areas, applying sporax/borax on freshly cut stumps and wounds to reduce spread of root rot, and utilizing standard logging practices that minimize or prevent damage to standing trees adjacent to the pipeline.

4.4.2.7 Fire Regimes

Fires play a substantial role in shaping the composition and structure of vegetative communities. The pipeline would pass through numerous fire regimes. Table 4.4.2.7-1 lists the mean fire return interval (i.e., mean fire frequency in the area) as well as the total acres that have burned between 2000 and 2015 (based on existing fire data) for the fifth field watersheds crossed by the pipeline. The most notable recent fire event in the region is the Stouts Creek fire, which burned 26,452 acres in and around the pipeline project area in 2015 in the Days Creek-South Umpqua River and Elk

[102] Table C.3-3 in Appendix C.3 of Pacific Connector's Resource Report 3 lists the location (by MP when known) of each identified pathogen near the pipeline route.

Creek watersheds (Northwest Interagency Coordination Center 2015). Approximately 10.7 miles (227 acres) of the pipeline crosses the area burned by the Stouts Creek fire, generally between MP 95.5 through MP 108.8.

TABLE 4.4.2.7-1

Historic Average Fire Frequency and Extent of Acreage Burned in Watersheds Crossed by the Proposed Pacific Connector Pipeline

Ecoregion	HUC – Fifth-Field Watershed	Mean Fire Return Interval a/	Total Acres Burned (2000–2015) b/
Coast Range	Coos Bay-Frontal Pacific Ocean	126-150 Years	0
	Coquille River	81-90 Years	0
	North Fork Coquille River	151-200 Years	0
	East Fork Coquille River	126-150 Years	0
	Middle Fork Coquille River	61-70 Years	827
Klamath Mountains	Olalla Creek-Lookingglass Creek	21-25 Years	0
	Clark Branch-South Umpqua River	26-30 Years	56
	Myrtle Creek	61-70 Years	0
	Days Creek-South Umpqua River	46-50 Years	17,753
	Lower Cow Creek	41-45 Years	11,551
	Upper Cow Creek	41-45 Years	897
	Elk Creek	36-40 Years	13,504
	Trail Creek	26-30 Years	835
	Shady Cove-Rogue River	21-25 Years	48,677
	Bear Creek	21-25 Years	2,379
	Gold Hill-Rogue River	21-25 Years	1,870
	Big Butte Creek	26-30 Years	986
	Little Butte Creek	26-30 Years	3,644
Eastern Cascades Slopes and Foothills	Spencer Creek	31-35 Years	0
	John C Boyle Reservoir-Klamath River	26-30 Years	5,529
	Lake Ewauna-Klamath River	61-70 Years	26
	Mills Creek-Lost River	91-100 Years	13

a/ Data from LANDFIRE (2017).

b/ Data from BLM_Fire_History shapefile (BLM 2017b). Acres rounded to nearest whole acre.

The use of heavy equipment to construct the pipeline would increase the potential for a wildfire. Specifically, prescribed burning of slash, mowing, welding, refueling with flammable liquids, and parking vehicles with hot mufflers or tailpipes on tall dry grass would increase the risk of wildfires. A wildfire would result in additional loss of vegetation.

Certain activities associated with construction and operation of the Pacific Connector project (such as prescribed burning of slash, mowing, welding, refueling with flammable liquids, and parking vehicles with hot mufflers or tailpipes on tall dry grass) could increase the risk of wildland fires, especially if these activities occur within the fire season. Even small fires, created during these activities, could have far-reaching consequences on vegetative communities. For example, large forest fires could occur if small, low-intensity surface fires, ignited within the herbaceous or low-shrub cover maintained along the permanent right-of-way, spread to ladder fuels near forest edges, allowing access to the forest's canopy. This could trigger a high intensity crown fire that could spread to adjacent areas, away from the pipeline's route. If fire frequencies were to increase due to Project activities, vegetative communities could shift over time to a species composition more adapted to higher fire frequencies. It is also possible that the cleared right-of-way could serve as a fire break for large crown fires, thereby reducing the extent of a fire's spread; however, as discussed above, the presence of the cleared right-of-way could also increase the risk of crown fires occurring in the first place.

4.4.3 Environmental Consequences on Federal Lands

The Pacific Connector pipeline route would cross lands managed by federal agencies including the Forest Service, BLM, and Reclamation. The pipeline would pass through portions of federal land designations that are intended to protect vegetation or habitats: such as Riparian Reserves and LSRs. These federal land designations, as well as the effects that the pipeline would have on these areas, are addressed in section 4.7.

4.4.3.1 BLM – Forest Operations Inventory

The BLM tracks vegetation, land management treatments, and disturbance within each district during operations inventories. These data and/or attributes are then transferred to a GIS coverage called the Forest Operations Inventory (FOI). The FOI describes and classifies forest cover (vegetation), site class, denudation cause, dominant species, understory species, treatments, age class, and stand condition (BLM 2016c).

Table I-6 in appendix I lists the acres of impact that would occur to FOIs from both construction and operation of the pipeline. As shown in table I-6, there would be approximately 893 acres of impact during construction of the pipeline to FOIs, which includes about 285 acres on the Coos Bay District (approximately 238 acres of conifer forest, 7 acres of hardwood forest, 31 acres of mixed conifer and hardwood forest, and 9 acres of non-forest/other), 316 acres on the Roseburg District (approximately 273 acres of conifer forest, 37 acres of mixed conifer and hardwood forest, and 7 acres of non-forest/other), 274 acres on the Medford District (approximately 107 acres of conifer forest, 34 acres of hardwood forest, 83 acres of mixed conifer and hardwood forest, and 50 acres of non-forest/other), and 18 acres on the Lakeview District (all conifer forest).

4.4.3.2 Forest Service – Plant Series and Plant Association Groups

The Forest Service classifies potential vegetation based on plant series, and plant association groups (PAGs). Plant series are based on the climax dominant trees of a stand (e.g., the Douglas-fir series). Plant series can be subdivided into PAGs, which are described primarily by the presence or absence of plant species, as well as the abundance of a species based on environmental variables, including soil, aspect, slope, slope position, and moisture. Not all of the three National Forests crossed by the Pacific Connector pipeline route have identified PAGs or plant series, and these unidentified areas are noted as "not in series" (Forest Service 1996a). Table I-7 lists the acres of impact that would occur on PAGs and plant series from both construction and operation of the pipeline. As shown in table I-7, there would be approximately 585 acres of impacts during construction of the pipeline on PAGs and plant series, which includes about 211 acres on the Umpqua National Forest, 276 acres on the Rogue River-Siskiyou National Forest, and 98 acres on the Fremont-Winema National Forest. White fir and Douglas-fir series would be the most heavily affected PAGs.

The following describes the seven plant series that would be crossed by the pipeline, based on GIS coverage.

Douglas-Fir Series

Douglas-fir occurs in all PAG series within elevations ranging from sea level to 5,600 feet. Usually overstory presence of Douglas-fir indicates recent ground disturbance while presence and dominance in the understory can indicate hot, dry conditions, which is characteristic of the Douglas-fir Series. Many other tree species may be present that are also tolerant of drought-like conditions, such as ponderosa pine, incense cedar, and canyon live oak (*Quercus chrysolepis*). Within Umpqua National Forest, the following shrubs/plant associations may occur within the Douglas-fir Series: poison oak (*Toxicodendron diversilobum*), canyon live oak, chinquapin, salal, and species associated with ultramafic parent materials. Potentially canyon live oak and Douglas-fir may occur on the Rogue River-Siskiyou National Forest.

Mountain Hemlock Series

In Southwest Oregon, mountain hemlock occurs at high elevations, ranging from approximately 3,950 feet to 6,690 feet in the Cascades, with cold temperatures and moderate precipitation. Associated parent material is highly variable, although pumice, andesite, and basalt are the most common. Mountain hemlock and Shasta red fir are dominant tree species in the overstory, with western white pine and Douglas-fir occasionally occurring. Within the Rogue River-Siskiyou National Forest, the Mountain Hemlock Series may be associated with grouse huckleberry (*Vacccinium scoparium*) in deep soils at higher elevations, Pacific rhododendron at lower elevations and warmer conditions, and/or with the wildflower sidebells pyrola (*Pyrola secunda*). Mountain Hemlock Series has also been documented in the Fremont-Winema National Forest.

Shasta Red Fir Series

The Shasta Red Fir Series is representative of a variety of California red fir found in southwest Oregon and northern California generally at higher elevations (4,000 to 6,900 feet) where the climate is cool and moist. Shasta red fir is typically the dominant tree in the overstory, although on warmer sites, white fir is present and, on cooler sites, mountain hemlock is present. Within the Rogue River-Siskiyou National Forest, the mountain sweet-root (*Osmorhiza berteroi*)/Shasta Red Fir Series association, which is typically located at sites with lower precipitation, may potentially be found. In the Winema National Forest, the Shasta Red Fir series is found within the Cascade Province of Southwest Oregon.

White Fir Series

This species is most abundant in southwest Oregon and will occur on a variety of sites and therefore is not specific to slope, aspect, soil type, or elevation. White Fir Series generally occurs on cool sites, with an average rainfall varying between 45 inches in drier areas of the Cascades to 102 inches near the coast. As a result of frequent disturbances, other early seral species become the dominant overstory tree in the White Fir Series, such as Douglas-fir and Shasta red fir, which are present within the Rogue River-Siskiyou National Forest. Also, dwarf Oregon-grape is common and widespread within the Series and may occur within the area crossed by the pipeline. Based on GIS coverage, white fir-Shasta red fir is crossed on the Winema National Forest.

Grand Fir Series

No specific description has been created for this series. However, based on GIS coverage, grand fir trees may be dominant within stands located in the Umpqua National Forest, with a canyon live oak association.

Jeffrey Pine Series

This species is scattered throughout Jackson and Douglas Counties and usually occurs on dry, ultramafic parent material, mainly serpentine and peridotite with high exposed gravel, surface rock, and bedrock components. As a result of the serpentine/periodotite parent material, this series is associated with many unique and rare species. This series is found within a wide elevational range, from 1,200 feet to 6,000 feet; however, most occurrences are concentrated near 2,000 feet. It can occur on all aspects and slope positions although it is most common on the southerly aspect and mid-slope position. Often Douglas-fir and incense cedar are associated with the Jeffrey Pine Series, which has an open canopy characteristic. Within the Umpqua National Forest, Jeffrey pine has the potential to occur with high grass understory coverage.

Western Hemlock Series

This plant series is known to occur in drier conditions on Umpqua National Forest, and the associations crossed by the pipeline are salal, Oregon-grape, and rhododendron. The series is associated with low to moderate elevations. Because of the frequent disturbances in southwest Oregon, the overstory of this series is generally dominated by Douglas-fir with the understory predominately western hemlock; however, within the western hemlock/salal-dwarf Oregon-grape association, both western hemlock and Douglas-fir are present in the overstory.

Lodgepole Pine Series

This plant series is widely distributed throughout forested areas of eastern Oregon, where distribution is apparently tied directly to ash and pumice deposits, mostly from Mt. Mazama. Within the area crossed by the pipeline, this series occurs within the Fremont-Winema National Forest and is associated with huckleberry (*Vaccinium* spp.) and forbs within elevations between 5,000 and 5,700 feet on lower slopes and bottoms, and shrub (cool-xeric zone) at upper elevations in well-drained soils. This series tends to dominate sites that are too wet or too dry for its competitors (ponderosa pine, white fir-grand fir, Shasta red fir, or mountain hemlock).

4.4.3.3 Measures Implemented on Federally Managed Lands

Listed below are the avoidance and minimization measures that would be implemented on federally managed lands, in addition to those described above:

- Disturbed areas would be replanted to prevent noxious weed germination, and disturbed areas would be revegetated with seed mixes described in the ECRP.
- The authorized officer for the BLM or Forest Service may inspect and approve straw material used on federal lands to verify that it is certified noxious weed free. Gravel/rock used on federal lands would be from weed-free sources as well, and approved by the agencies' authorized representative.
- Pacific Connector has agreed to plant the easement with native trees/shrubs described in the ECRP. Affected riparian areas would be replanted extending 100 feet from the streambanks on federal lands. All plantings proposed for federally administered lands must be approved by each agency's authorized representative.
- The Forest Service and Pacific Connector are currently working together to develop projects that could be implemented in order to provide compensatory mitigation for environmental impacts on Forest Service lands, as well as ensure that the Pacific Connector pipeline is consistent with the objectives of LMPs.

4.4.3.4 Noxious Weeds

Pacific Connector developed an *Integrated Pest Management Plan*, in consultation with the ODA (Butler 2017), BLM, and Forest Service, to minimize the potential spread and infestation of weeds. This plan, applicable to both public and private lands, includes requirements for surveys to be conducted prior to construction to determine the presence of noxious weeds; determining where management or pretreatment may be necessary prior to construction to prevent the spread of noxious weeds; cleaning of construction equipment prior to moving it onto the construction right-of-way; and cleaning of vegetation clearing and grading equipment if it passes through areas where weeds have been identified.

The BLM objective for weeds is Early Detection Rapid Response (EDRR) in order to avoid introduction or spread of noxious weeds, and to contain and/or reduce noxious weed infestations using an integrated pest management approach (e.g., chemical, mechanical, manual, and/or biological), as outlined in the BLM's multi-state Northwest Area Noxious Weed Control Program EIS (BLM 1985) and its supplements, as well as the BLM's (2010a) *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in Oregon*. The BLM is concerned with the impacts of weeds on special areas, including LSRs (see section 4.7), and seeks to eliminate or control weeds that adversely affect those areas. The BLM surveys for noxious weed infestations, reports them to the ODA, and coordinates with them to reduce infestations while using methods that do not conflict with the objectives of each BLM District's RMP.

The Forest Service's objective for invasive plants and noxious weeds is similar to BLM's objectives (described above). Control of noxious weeds by the Forest Service is coordinated with state, county, and private organizations through weed control districts or coordinated resource management agreements. On NFS lands, preventive management is critical to an effective control program. The agency utilizes management direction provided in the *Pacific Northwest Region Invasive Plant Program: Preventing and Managing Invasive Plants Final Environmental Impact Statement* (Forest Service 2005b). Noxious weeds classified as target species that occur on federally managed lands are listed in table 4.4.1.6-1.

In order to prevent or limit the spread of invasive species and noxious weeds, all construction equipment would be inspected to ensure that it is clean and free of potential weed seed or propagules, prior to transporting equipment to the construction right-of-way. In addition, equipment used in areas of priority A and T listed weeds, as well as selected B listed weeds, would be cleaned by hand, blown down with air, or pressure washed prior to leaving the site, as determined necessary by the EI based on the specific weed infestation, level of infestation, and stage of growth of the weed. Because of the contiguous pattern of NFS lands crossed by the pipeline, equipment that could serve as a vector for invasive species would be inspected and cleaned at cleaning stations located at the borders of each National Forest, prior to clearing and grading activities. Because the BLM lands crossed by the Project are not contiguous and are spread out in a checkerboard pattern, it is not practical to set up inspection and cleaning stations at each entry point. However, where BLM lands are contiguous to NFS lands, cleaning stations would be located to include the adjacent BLM lands. Additionally, equipment would be inspected and cleaned at cleaning stations located adjacent to mapped noxious weed infestation areas that were identified during preconstruction surveys on federal lands and where a treatment plan has been developed in consultation with the agency authorized representative.

Additionally, equipment would be inspected and cleaned at stations located adjacent to mapped noxious weed infestation areas that were identified during pre-construction surveys on federally-managed lands. The cleaning stations would be located and approved by the EIs and authorized agency representative; these locations would also be mapped for future monitoring efforts to determine if potential infestations occur at these sites and, if they do, to ensure that appropriate control treatments are applied. The BLM has indicated that cleaning of equipment should occur when leaving noxious weed sites prior to entering BLM-managed lands regardless of land continuity. Also, monitoring efforts for weed species would be similar to those described above (for all lands), except that Pacific Connector has proposed to conduct monitoring on federally managed lands annually for a period of at least three to five years. However, the BLM and Forest Service have indicated that they would require that monitoring on federally managed lands be conducted every three to five years for the life of the Project, and that this would be a condition of the Right-of-Way Grant. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, Pacific Connector should file a revised *Integrated Pest Management Plan* with the Secretary, for review and written approval by the Director of the OEP, that specifies that construction equipment would be cleaned after leaving areas of noxious weed infestations and prior to entering BLM-managed lands regardless of contiguous land owner. The revised plan should also address BLM and Forest Service requirements related to monitoring of invasive plant species on federally managed lands, and documentation that the revised plan was found acceptable by the BLM and Forest Service.**

4.4.3.5 Vegetative Pathogens

The existing conditions related to known occurrences of insects or pathogens are identical to the discussion presented in section 4.4.2. Insects or pathogens that have the potential to occur within the area that would be affected by the Project include Douglas-fir beetle, fir engraver, flatheaded borer, mountain pine beetle (ponderosa and sugar pine), western pine beetle, needle cast (lodgepole pine, ponderosa pine, and Swiss), Port Orford cedar root disease, annosus root and butt rot, laminated root rot, dwarf mistletoe, sudden oak death, and the black stain root disease (see section 4.4.2). The effects that could occur as well as the measures that would be implemented for the prevention of infestation by insects or pathogens on federally managed lands would be similar to those discussed in section 4.4.2, with the addition of the following:

- *Douglas-fir beetle*—No Douglas-fir down wood, 12 inches or larger in diameter, would be left in areas on NFS lands where there are known infestations of Douglas-fir beetle.
- *Port Orford cedar root disease*—All equipment entering NFS lands would comply with all Forest Service *P. lateralis* mitigation requirements. The Forest Service (Region 6) and BLM prepared management objectives for affected federally managed lands in 2004 to help control the spread of the fungus. The objectives focus on maintaining disease-free watersheds, preventing spread through sanitation, seasonal restrictions for activities, and reestablishing Port Orford cedar using resistant and non-resistant seedlings.
- *All pathogens*—Directional tree falling would be required on all NFS lands, including areas with no known insect/disease occurrence, to prevent residual tree damage/injury and disease infection.

4.4.3.6 Wild-Harvesting of Non-Timber Forest Products

Wild-harvesting is the act of gathering food, decorative, or medicinal botanical products that grow naturally on lands not normally associated with agriculture. The non-timber forest products harvested near the pipeline route are of three categories: floral greens, edibles, and medicinals. Some of the more common of these are salal, evergreen huckleberry, swordfern (*Polystichum munitum*), and pinemat manzanita (Forest Service 2017b). This harvesting of non-timber forest products is widespread on public lands in the Pacific Northwest and can occur year-round (OPB 2006).

The Forest Service and BLM grant permits to wild-harvest for both recreational and commercial uses. Some recreational and commercial harvesters could be temporarily displaced during pipeline construction. Additionally, some of the forest products typically harvested would be removed during vegetation clearing for the Pacific Connector pipeline. However, the pipeline right-of-way and roads would also create new access into forested areas. As a result, it is possible that wild harvesting could increase as a result of the operation of the pipeline project.

4.4.4 Conclusion

Constructing the Jordan Cove LNG Project would result in about 499 acres of impacts on vegetation, including 168 acres of permanent vegetation loss. Constructing the Pacific Connector Pipeline Project would impact approximately 4,186 acres of vegetation; this amount includes a total of approximately 133 acres of sagebrush steppe and 2,750 acres of forested lands, including 773 acres of LSOG forests.

Most of the vegetation types affected by the Project are common and widespread in the vicinity of the Project. Although constructing and operating the Project would result in the loss of 773 acres of LSOG forests, this represents only a small percentage of remaining LSOG forests in Oregon. Additionally, measures listed in section 4.4.3.3, as well as in the *BLM and Forest Service Compensatory Mitigation Plan and Amendment* (appendix F.2) and *Late Successional Reserves Crossed by the PGCP Project* (appendix F.3) would minimize or mitigate impacts to LSOG forests. Therefore, based on the types and amounts of vegetation that would be affected by the Project, the measures that would be implemented to avoid, minimize, and mitigate the resulting impacts, and the presence of similar vegetation in the affected watersheds, we conclude that constructing and operating the Project would not significantly affect vegetation.

4.5 WILDLIFE AND AQUATIC RESOURCES

4.5.1 Terrestrial Wildlife

The Project would affect suitable habitat for a number of wildlife species associated with the coastal, mid-coastal, interior foothills, and mountain terrains in southern Oregon. The types of wildlife habitat affected by the Project and the wildlife species potentially located in those habitats are described below. Endangered and threatened species and other special status species are addressed in section 4.6.

4.5.1.1 Jordan Cove LNG Project

Wildlife Habitats

Characterizations of wildlife habitats potentially affected by construction of the Project are based on resource agency consultations, on-the-ground surveys, and published reports. In accordance with its Fish and Wildlife Habitat Mitigation Policy, the ODFW has established the following six classifications for habitats, based on dominant plant, soil, and water associations of value to the support and use of fish and wildlife:

- Category 1 – irreplaceable[103], essential habitat[104] that is limited;[105]
- Category 2 – essential habitat that is limited;
- Category 3 – essential habitat, or important[106] habitat that is limited;
- Category 4 – important habitat;
- Category 5 – habitat having a high potential to become essential or important habitat; and
- Category 6 – habitat that has a low potential to become essential or important habitat.

Below we discuss the habitats found in the Jordan Cove terminal tract, their vegetation cover, associated wildlife, and ODFW habitat categories.

<u>Upland Habitats</u>

Uplands on the North Spit contain coastal dune forest, riparian forest, shrubs, grasslands (herbaceous), and unvegetated sand dunes (see section 4.4 for more details and descriptions). Dominant overstory for coastal dune forest include Douglas-fir, western hemlock, shore pine, Sitka spruce, and Port Orford cedar, with an understory including evergreen huckleberry, salal, bearberry, rhododendron, California wax myrtle, and manzanita. Shore pine and Sitka spruce forests constitute the habitat with the greatest structural complexity on the North Spit and support the greatest diversity of wildlife species. The trees, snags, and downed logs in coastal dune forests

[103] "Irreplaceable" means that successful in-kind habitat mitigation to replace lost habitat quantity and/or quality is not feasible within an acceptable period of time or location, or involves an unacceptable level of risk or uncertainty, depending on the habitat under consideration and the fish and wildlife species or populations that are affected. "Acceptable", for the purpose of this definition, means in a reasonable time frame to benefit the affected fish and wildlife species (OAR 635-415-0025).

[104] "Essential Habitat" means any habitat condition or set of habitat conditions that, if diminished in quality or quantity, would result in depletion of a fish or wildlife species (OAR 635-415-0025).

[105] "Limited habitat" means an amount insufficient or barely sufficient to sustain fish and wildlife populations over time (OAR 635-415-0025).

[106] "Important Habitat" means any habitat recognized as a contributor to sustaining fish and wildlife populations on a physiographic province basis over time (OAR 635-415-0025).

provide important breeding, foraging, and cover habitat for a variety of wildlife species: upland amphibians seek cover in downed logs, and many bird species, including raptors, woodpeckers, and songbirds, nest and forage in these habitats.

Coastal dune forest and riparian forest habitats are classified as Category 3 because they are "essential to wildlife" but are "not limited" (as defined by Oregon under OAR 635-415-0025). Species that depend on these habitat types include the Pacific marten (*Martes caurina*) (or coastal marten, addressed in section 4.6), bats, and some songbirds.

Herbaceous, herbaceous shrub, and shrub upland habitat types are all classified as Category 4 because they are not essential or limited, but they are still important to wildlife. The vast majority of these habitats lie on dredge spoils covered by weedy herbaceous and shrub species. Shrub species present within these habitats include young shore pine and invasive species such as Scotch broom and Himalayan blackberry. Herbaceous vegetation in these habitat types includes native species such as seashore lupine, small-head clover, and beach strawberry, together with invasive species such as European beachgrass, colonial bentgrass, and sweet vernal grass. These habitats have been extensively degraded historically, and only provide habitat for generalist species such as deer, small mammals, and a limited suite of songbirds (DEA 2014).

Open Water/ Wetland Habitats

Open water and wetland habitats on the LNG terminal site are composed of several freshwater lakes, ponds, forested and shrub wetlands, and emergent wetlands and marshes, together with the Coos Bay estuary and its associated shoreline, including mudflats. Habitats found in this environment support a rich terrestrial wildlife community, including mammals, birds, reptiles, and invertebrates; aquatic species found in these habitats are discussed below in section 4.5.2. Terrestrial wildlife species that use open water and wetland habitats (inland, estuarine, or marine) on the North Spit are generally specialized or are strongly associated with one habitat type. However, there are dozens of species that may occur in the area affected by the Project that are very well adapted to utilizing one, two, or all three of these open water and wetland habitats, as seasonal conditions warrant. Resident and migrant shorebirds congregate on the tidally inundated mudflats along the shore of Coos Bay, to forage on the invertebrates in the shallow waters and exposed mudflats, especially during low tides. Raptors known to use open water and shoreline habitats include the bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), northern harrier (*Circus cyaneus*), and peregrine falcon (*Falco peregrinus*). Mammals that also forage in wetlands and near shore environments include, but are not limited to, raccoon (*Procyon lotor*), mink (*Neovison vison*), and striped skunk (*Mephitis mephitis)*.

Forested, scrub-shrub, and emergent wetlands are classified as Category 2, because they are essential for wildlife, and limited, but not irreplaceable. The access channel contains open water habitat in Coos Bay (see figure 4.5-2 in section 4.5.2). This area consists of salt marsh, eelgrass, intertidal, and subtidal habitats. Open water habitat contains both Category 2 and Category 3 habitat classifications.

Developed Habitat

Developed areas include portions of the LNG terminal site that have been substantially disturbed by previous development and industrial use, including land use activities such as demolished mill foundations/concrete pads, unvegetated cut slopes, rocked yards, paved roads, parking lots, gravel roads, concrete laydown areas, log deck storage areas, and sandy roadside areas. Developed lands have limited potential to become important or essential wildlife habitat, and therefore are classified as Category 6.

Terrestrial Animals in the Project Area

Terrestrial wildlife that may occupy the area affected by the Jordan Cove LNG Project includes mammals, birds, amphibians, reptiles, and invertebrates. Approximately 178 species of amphibians, reptiles, birds, and mammals were recorded in uplands on or adjacent to the Jordan Cove Project site (i.e., the LNG terminal facility) during surveys conducted from 2005 to 2017 in support of the Project.

Mammals

Fifty-eight mammal species are known to occur on the North Spit (BLM 2005). This includes large mammals, such as mountain lion (*Puma concolor*), Roosevelt elk (*Cervus elaphus roosevelti*), American black bear (*Ursus americanus*), and black-tailed deer (*Odocoileus hemionus*). Wildlife surveys conducted for Jordan Cove in 2005, 2006, and 2012 documented 11 mammal species in the terminal tract (LBJ 2006; SHN 2013b): American beaver (*Castor canadensis*), Roosevelt elk, Virginia opossum (*Didelphis virginiana*), North American porcupine (*Erethizon dorsatum*), mountain lion, Townsend's chipmunk (*Neotamias townsendi*), black-tailed deer, harbor seal (*Phoca vitulina*), raccoon, Douglas' squirrel (*Tamiasciurus douglasii*), and American black bear. Nine species of bats are known to occur on the North Spit (BLM 2005). While bat-specific surveys were not completed by Jordan Cove, the mosaic of habitat types in the area suggests bat presence is potentially high. Unidentified bats were observed in one of the buildings on the Roseburg Forest Products property on July 21, 2005.

Birds

Migratory birds, which include all native birds in the U.S., with the exception of upland game birds, are protected under the MBTA, as described in section 1.5.1.10. Additionally, EO 13186 was enacted, in part, to ensure that the environmental analysis of a federal action evaluates the effects of that action on migratory birds, and the federal agency and its project proponents avoid, minimize effects, conserve species, and restore and enhance migratory bird habitat. EO 13186 states that emphasis should be placed on species of concern, priority habitat, and key risk factors. In March 2011, FERC and FWS finalized an MOU to implement EO 13186. Conservation of migratory bird habitats, avoiding or minimizing take of migratory birds, and developing effective mitigation measures to restore or enhance habitats on lands affected by energy projects are included as obligatory elements in the MOU. The MOU also places emphasis on, but is not exclusive to, birds of conservation concern (BCC; FWS 2008).

The Jordan Cove LNG Project is located in the Pacific Flyway path for migratory birds and is in Bird Conservation Region (BCR) 5 as defined by FWS (2008) (note that the Pacific Connector Pipeline Project is also in BCR 9 as well, as discussed in section 4.5.1.2). Birds that are known or that likely occur along the waterway and in the LNG terminal site include seabirds, shorebirds, waterfowl, passerines (songbirds), wading birds, and raptors. The number of bird species documented on or near the North Spit of Coos Bay is 277: the BLM has documented 275 avian species in this area (BLM 2005), while LBJ Enterprises (2006) documented 151 avian species during surveys of the LNG terminal tract, including two additional species not documented by the BLM. BCC that potentially occur in the area affected by the Project are listed in table 4.5.1.1-1.

Federally- or state-listed species that are also BCC are not included below, as they are discussed in more detail in sections 4.6.1 and 4.6.2.

TABLE 4.5.1.1-1

Birds of Conservation Concern in the Project Area, Timing of Potential Occurrence, and Expected Habitat

Common Name	Scientific Name	Timing of Potential Occurrence	Expected Habitat
Allen's hummingbird	*Selasphorus sasin*	Summer	Chaparral, thickets, brushy hillsides, open coniferous woodlands, and gardens near coast
Bald eagle	*Haliaeetus leucocephalus*	year-round	Near large bodies of water
Black oystercatcher	*Haematopus bachmani*	year round	Coastal beaches, bays, and estuaries
Black swift	*Cypseloides niger*	Migration	Forages over forests and open areas
Caspian tern	*Sterna caspia*	Migration	Coastal areas
Hudsonian godwit	*Limosa haemastica*	Rare	Marshes, beaches, flooded fields, and tidal mudflats
Lesser yellowlegs	*Tringa flavipes*	Migration	Marshes, ponds, wet meadows, lakes and mudflats
Long-billed curlew	*Numenius americanus*	Winter	Fields, dry prairies, mudflats
Little willow flycatcher	*Empidonax traillii brewsteri*	Summer	Low brushy vegetation in wet areas
Marbled godwit	*Limosa fedoa* (ssp. *beringiae* only)	Winter	Beaches, mudflats, shallow pools
Olive-sided flycatcher	*Contopus cooperi*	Summer	Coniferous forests
Oregon vesper sparrow	*Pooecetes gramineus* (ssp. *affinis* only)	Very unlikely to occur in vicinity of Project	Open fields and pastures
Peregrine falcon	*Falco peregrinus*	winter/year-round	Open habitats, nests on cliffs
Purple finch	*Carpodacus purpureus*	Year-round	Wooded areas
Red knot	*Calidris canutus*	Migration	Beaches and mudflats
Rufous hummingbird	*Selasphorus rufus*	summer/migration	Coniferous forests
Short-billed dowitcher	*Limnodromus griseus*	Winter	Beaches, mudflats, shallow ponds
Western grebe	*Aechmophorus occidentalis*	Winter	Marshes, lakes, and bays
Whimbrel	*Numenius phaeopus*	Migration	Coastal marshes, beaches, rocky shores

Sources: FWS (2008); Sibley (2000); NatureServe (2009, 2013)

Seabirds

Thirteen seabird species breed along Oregon's coast, with offshore rocks and islands providing critical nesting habitat and important rest-over locations. Seabirds depend on relatively undisturbed coastal nesting habitats and on the rich coastal waters for food (Oregon Ocean Resources Management Task Force 1991). Foraging habitat can differ by species; some species such as the sooty shearwater (*Puffinus griseus*) and the northern fulmar (*Fulmarus glacialis*) are found primarily along the mid and outer shelf, while California gull (*Larus californicus*) and western gull (*Larus occidentalis*) occur only in the nearshore (Oregon Ocean Resources Management Task Force 1991). Foraging sea birds can be encountered along the LNG carrier transit route, at the terminal site, and in adjacent Coos Bay water.

Shorebirds

Coos Bay is an important area for shorebirds between San Francisco Bay and British Columbia. Key areas for migrating shorebirds include Coos Bay and the beaches and deflation plains in the Oregon Dunes National Recreation Area (ODNRA). Coos Bay's extensive eelgrass beds, productive sloughs, intertidal algal flats, and substantial tidal marshes provide valuable habitat for thousands of shorebirds. Foraging habitat for shorebirds includes inter-tidal mudflats, rocky inter-tidal areas, estuaries, salt marshes, and beaches; salt marshes are used for resting and preening. The vast majority of shorebirds are migratory and non-breeders in Coos Bay. An important exception is the western snowy plover (*Charadrius alexandrinus nivosus*), which nests on the North Spit (this species is discussed in more detail in section 4.6). Shorebirds are most likely to be encountered along the beaches of the North Spit, and in the bay along tidal mudflats, salt marshes, and other exposed estuarine habitat.

Waterfowl

Waterfowl habitat varies from ocean surf to fields and open meadows to upland streams (FWS 2007a). The southern Oregon coast provides wintering and migratory habitat for waterfowl of the Pacific Flyway. Coos Bay is recognized as an important migration and wintering waterfowl location. Waterfowl are most likely to be encountered in Coos Bay and the immediate near shore habitat.

Passerines (Songbirds)

Breeding and foraging habitat for migratory passerines is associated with terrestrial and wetland habitat in Coos Bay. Important habitat includes coastal scrub-shrub, coastal dune forest and palustrine wetlands. In the case of swallows, human-made structures can be important structures for nesting colonies. Passerines are likely to occur in all habitats at the terminal site.

Neotropical migrants (birds that breed in North America and overwinter in the tropics) were observed during surveys of the waterway and LNG terminal. These are largely forest-nesting species. Examples of neotropical migrants detected at the LNG terminal site include olive-sided flycatcher (*Contopus cooperi*), Wilson's warbler (*Wilsonia pusilla*), orange-crowned warbler (*Vermivora celata*), and Swainson's thrush (*Catharus ustulatus*).

Wading Birds

Several wading bird species are resident in the Coos Bay area and the North Spit. Wading birds are typically colonial when nesting and therefore are sensitive to anthropogenic disturbance at breeding sites. Wading birds hunt in a variety of habitat types from fields and meadows to palustrine and estuarine wetlands. Wading birds are likely to occur in the shoreline habitats at the terminal site.

At least two historic great blue heron (*Ardea herodias*) rookeries occur close to the Jordan Cove LNG terminal site area. One rookery is located about 2,000 feet to the east of the LNG terminal site and about 300 feet from Jordan Cove Road (on both sides of Trans-Pacific Parkway) (LBJ 2006). The other historical rookery is located adjacent to the LNG terminal site on the south side of Henderson Marsh (BLM 2006a). No evidence of great blue heron breeding in the area was observed during the 2005, 2006, 2012, or 2013 surveys.

Raptors

Raptors are abundant year-round residents in Coos Bay. Fourteen species of raptor are known to occur on the North Spit (BLM 2005), and surveys conducted by LBJ (2006) detected both peregrine falcons and bald eagles near the Jordan Cove site. Coos Bay and the North Spit provide a mosaic of terrestrial, coastal, and nearshore habitat types with abundant prey for raptors. White-tailed kites (*Elanus leucurus*) were observed during 2005 surveys near Henderson Marsh. Osprey, falcons, and eagles may occur in the nearshore habitats along the waterway for LNG carrier transit and at the terminal site. Ospreys are relatively common near river estuaries and bays and nest on human-made structures including the Roseburg Forest Products facility lights. Falcons are likely to be associated with salt marsh and tidal mudflats where shorebirds are abundant.

Amphibians and Reptiles

Eleven species of amphibians (8 salamanders, 3 frogs) are known to occur on the North Spit (BLM 2005). Despite the presence of invasive non-native bullfrogs (*Lithobates catesbeianus*), two native amphibian species were observed in suitable habitat during the wildlife surveys conducted in 2005, 2006, and 2012 for the LNG terminal (LBJ 2006; SHN 2013b). The northern red-legged frog (*Rana aurora*) and northwestern salamander (*Ambystoma gracile*) are present in some wetlands within the terminal tract.

Ten species of reptiles are known to occur on the North Spit (BLM 2005), including the western pond turtle (*Actinemys marmorata*). However, the western pond turtle was not observed during wildlife surveys of the Jordan Cove LNG terminal area (LBJ 2006; SHN 2013b). Reptiles observed during Project surveys in 2005, 2006 and 2012 included the northern alligator lizard (*Elgaria coerulea*) and northwestern garter snake (*Thamnophis ordinoides*) (LBJ 2006; SHN 2013b).

Invertebrates

Inland sand dunes at the North Spit are used extensively by certain species of terrestrial insects, primarily beetles, centipedes, and millipedes. Flying insects are also common throughout the site and are fed upon heavily by barn swallows (*Hirundo rustica*) (BLM 2005).

Effects on Wildlife Habitat and Terrestrial Wildlife Species from Construction and Operation of the Jordan Cove LNG Project

Effects on Habitats

The area affected by the construction of the LNG terminal and associated facilities (including the Workforce Housing Facility, Ingram Yard, laydown areas, etc.) is presented by temporary and permanent acres of disturbance by habitat type in table 4.5.1.1-2. Temporary disturbances to upland habitat would be restored in consultation with landowners and to the extent possible using non-invasive native plant species. Permanent disturbance to habitat results in these areas being converted to a developed habitat type that would be occupied by Project facilities during operations.

TABLE 4.5.1.1-2

Acres of Wildlife Habitat Types Affected by Construction and Operation of the Jordan Cove LNG Project

Area	Acres of Disturbance		Grand Total
	Temporary	Permanent	
Access and Utility Corridor a/	**5.8**	**20.9**	**26.7**
Coastal Dune Forest (Category 3)	2.7	6.9	9.6
Developed (Category 6)	0.1	4.0	4.1
Herbaceous (Category 4)	0.1	0.2	0.3
Herbaceous Shrub (Category 4)	1.0	2.9	4.0
Riparian Forest (Category 3)	<0.1	0.1	0.1
Unvegetated Sand Upland (Category 3)	1.6	6.2	7.7
Emergent Wetland (Category 2)	0.2	0.6	0.8
Scrub-Shrub Wetland (Category 2)	<0.1	<0.1	0.1
Access Channel/Pile Dike Rock Apron/Slip/MOF	**21.4**	**57.8**	**79.2**
Algae/Mud/Sand (Category 2)	0.2	5.9	6.1
Deep Subtidal (Category 3)	17.9	--	17.9
Eelgrass (Category 2)	0.1	2.1	2.2
Intertidal Unvegetated Sand (Category 2)	0.5	6.1	6.6
Salt Marsh (Category 2)	--	0.1	0.1
Shallow Subtidal (Category 3)	0.29	4.1	4.4
Coastal Dune Forest (Category 3)	--	16.8	16.8
Developed (Category 6)	0.1	2.2	2.4
Herbaceous (Category 4)	1.8	19.9	21.7
Shrub (Category 4)	0.4	0.6	1.0
APCO Sites 1 and 2 b/	**40.7**	**0.0**	**40.7**
Algae/Mud/Sand (Category 2)	0.2	--	0.2
Deep Subtidal (Category 3)	0.9	--	0.9
Eelgrass (Category 2)	<0.1	--	<0.1
Salt Marsh (Category 2)	0.1	--	0.1
Shallow Subtidal (Category 3)	<0.1	--	<0.1
Developed (Category 6)	12.2	--	12.2
Herbaceous (Category 4)	14.9	--	14.9
Herbaceous Shrub (Category 4)	9.0	--	9.0
Shrub (Category 4)	3.3	--	3.3
Ingram Yard c/	**35.3**	**82.8**	**118.1**
Coastal Dune Forest (Category 3)	27.0	45.9	72.9
Developed (Category 6)	1.5	2.8	4.4
Herbaceous (Category 4)	6.7	34.0	40.7
Shrub (Category 4)	0.1	--	0.1
IWWP/Water Utility Easements	**15.2**	**0.0**	**15.2**
Coastal Dune Forest (Category 3)	0.2	--	0.2
Developed (Category 6)	8.3	--	8.3
Herbaceous (Category 4)	6.1	--	6.1
Herbaceous Shrub (Category 4)	0.3	--	0.3
Shrub (Category 4)	0.2	--	0.2
Scrub-Shrub Wetland (Category 2)	0.1	--	0.1
Meteorological Station d/	**1.5**	**0.0**	**1.5**
Developed (Category 6)	0.6	<0.1	0.6
Herbaceous (Category 4)	0.1	<0.1	0.1
Herbaceous Shrub (Category 4)	0.7	--	0.7
Marine Waterway Modification Areas and Temporary Dredge Pipeline	39.7	0.0	39.7
Algae/Mud/Sand (Category 2)	<0.1	--	<0.1
Deep Subtidal (Category 3)	39.5	--	39.5
Eelgrass (Category 2)	<0.1	--	<0.1
Shallow Subtidal (Category 3)	<0.1	--	<0.1
Herbaceous (Category 4)	<0.1	--	<0.1

TABLE 4.5.1.1-2 (continued)

Acres of Wildlife Habitat Types Affected by Construction and Operation of the Jordan Cove LNG Project

Area	Acres of Disturbance		Grand Total
	Temporary	Permanent	
South Dunes Site e/	**68.6**	**24.2**	**92.9**
Algae/Mud/Sand (Category 2)	0.1	--	0.1
Salt Marsh (Category 2)	<0.1	--	<0.1
Coastal Dune Forest (Category 3)	2.2	0.8	3.0
Developed (Category 6)	21.2	13.8	35.0
Herbaceous (Category 4)	5.2	3.8	9.0
Herbaceous Shrub (Category 4)	35.7	3.4	39.1
Riparian Forest (Category 3)	0.9	1.4	2.4
Shrub (Category 4)	1.1	<0.1	1.3
Emergent Wetland (Category 2)	1.4	0.4	1.8
Forested Wetland (Category 2)	0.1	0.2	0.3
Scrub-Shrub Wetland (Category 2)	<0.1	--	<0.1
Open Water (Category 2)	0.7	0.2	0.9
Temporary Construction Areas f/	**157.8**	**0.0**	**157.8**
Algae/Mud/Sand (Category 2)	<0.1	--	<0.1
Intertidal Unvegetated Sand (Category 2)	<0.1	--	<0.1
Shallow Subtidal (Category 3)	<0.1	--	<0.1
Coastal Dune Forest (Category 3)	24.3	--	24.3
Developed (Category 6)	59.4	--	59.4
Herbaceous (Category 4)	46.3	--	46.3
Herbaceous Shrub (Category 4)	11.8	--	11.8
Riparian Forest (Category 3)	0.1	--	0.1
Shrub (Category 4)	3.8	--	3.8
Unvegetated Sand Upland (Category 3)	11.4	--	11.4
Emergent Wetland (Category 2)	0.5	--	0.5
Scrub-Shrub Wetland (Category 2)	0.2	--	0.2
Trans Pacific Pkwy/US 101 Intersection Widening	**5.1**	**0.0**	**5.1**
Algae/Mud/Sand (Category 2)	1.4	--	1.4
Developed (Category 6)	3.7	--	3.7
GRAND TOTAL g/	**391.1**	**185.7**	**576.9**

a/ Access and Utility Corridor includes all temporary construction and permanent access roads and facilities and utilities, as well as the Fire Department (non-jurisdictional).

b/ APCO Sites 1 and 2 includes off-loading transfer platform and temporary dredge pipeline option.

c/ Ingram Yard Site includes all permanent LNG Terminal facilities. e.g., LNG tanks and liquefaction equipment, compressors, etc., and any other temporary construction facilities located on Ingram Yard.

d/ Meteorological Station includes access road.

e/ South Dunes Site includes Workforce Housing Facility, metering station, administrative building, and SORSC (non-jurisdictional), and temporary areas around the border.

f/ Temporary Construction Sites includes construction laydown/staging and off-site park & rides, i.e. Roseburg laydown site, Port laydown site, Boxcar Hill, Mill Casino, and Myrtlewood and Hydraulic Dredge Pipeline/Access Road from Jordan Cove Road to MOF.

g/ The acres disturbed as listed in this table includes vegetated and unvegetated upland and wetland habitats (excluding mitigation sites) and thus may differ from the total acreage disturbed as listed in other sections of this EIS, such as the vegetation section.

The primary effect on wildlife from construction and operation of the LNG terminal would be habitat modification or habitat loss. The natural habitats most important to wildlife that would be affected include forested dunes and open water/wetlands. Jordan Cove has indicated that upland habitat values lost to the construction of the LNG terminal and related facilities would be mitigated through the Panhandle, Lagoon, and North Bank mitigation sites. More details on these upland mitigation sites will be provided in a *Wildlife Habitat Mitigation Plan* that will be provided by the applicant as an appendix to their *Comprehensive Mitigation Plan*. Jordan Cove has indicated that estuarine habitat values lost to the construction of the LNG terminal and related facilities would be replaced in-kind at the eelgrass and Kentuck mitigation sites. Standard measures to avoid or minimize effects on wildlife, such as those presented in the ECRP and *Integrated Pest Management*

Plan, would also apply to actions taken at mitigation sites. These upland and estuarine mitigation sites include:

- The Panhandle site is approximately 133 acres and is located north of Trans-Pacific Parkway. The Panhandle site is part of a larger natural area that extends north into the ODNRA. It contains coastal dune forest, herbaceous, shrub, unvegetated sand, wetlands, and open water habitat types. The Panhandle site is home to a known population of northern red-legged frog and unique wetland types. Scotch broom would be removed at this site to promote ecological uplift.
- More than 100 acres of the 320-acre Lagoon site is proposed as mitigation. The Lagoon site is located adjacent to the meteorological station and contains shrub, herbaceous shrub, herbaceous, emergent wetland, and scrub-shrub wetland habitat types. Existing overhead power lines would be buried at the site.
- The North Bank site is approximately 156 acres and is located on the north bank of the Coquille River adjacent to the Bandon Marsh National Wildlife Refuge (NWR). It contains conifer forest, stabilized sand dunes, and scrub-shrub wetland habitat types. Forestry activities and weed control are proposed at the site that promote progress towards a mature forest setting.
- Eelgrass (Habitat Category 2) would be replaced by constructing an eelgrass mitigation site across the bay from the LNG terminal site, south of the runway for the Southwest Oregon Regional Airport;
- Estuarine resources (Habitat Category 2), including intertidal sand/mudflats, salt marsh, and shallow subtidal, would be mitigated by the construction of mudflat estuarine wetlands in the Kentuck project site; and
- Additional freshwater wetland resources (Habitat Category 2) disturbed by the construction of the LNG terminal would be mitigated out-of-kind at the Kentuck project site and in accordance with ODSL wetland mitigation requirements (OAR Chapter 141, Division 85 and Division 90) on neighboring North Spit property owned by Jordan Cove.

Effects on Terrestrial Wildlife Species

General Effects Applicable to All Terrestrial Wildlife

Constructing the project would temporarily and permanently affect wildlife. Impacts would include mortality if less mobile individuals are unable to avoid equipment or vehicles or cannot flee away from an oil or fuel spill. More mobile species would likely be displaced from the terminal area during active construction to adjacent similar habitats. Wildlife near the LNG terminal would also be disturbed by construction activities and noise and may move farther away.

An increased human presence and the resulting trash/waste could attract predators. However, the Project site would be kept clear of construction debris and food wastes. Covered, animal-proof receptacles would be provided in eating and break areas, parking lots, and at appropriate locations around the construction site. During construction, the site would be cleaned on a daily basis to remove any food or other debris left by construction workers. During operations, the Project site would be regularly inspected to ensure that no garbage is allowed to accumulate.

Noise associated with construction of the Project could also affect wildlife. Construction-related noise could affect animal behavior, foraging, or breeding patterns, and cause wildlife species to move away from the noise or relocate in order to avoid the disturbance. Noise from construction of the LNG terminal should be similar to typical commercial construction programs, which have noise levels averaging between 47 to 57 A-weighted decibels (dBA) when measured 2,000 feet away (H&K 1994). Noise from construction of the terminal is discussed in detail in section 4.12.2.4. Construction of the terminal would occur over a period of about five years. Noise associated with construction would be intermittent and may be operated on two 10-hour shifts, 6 days per week, with the potential to increase to a 24/7 schedule if required. Given the high level of current activity on the North Spit, including existing industrial operations and vehicle and rail traffic,[107] and the temporary nature of Jordan Cove's construction activities, Project-related construction noise is not expected to adversely affect wildlife in the region.

Operating the Project would also affect wildlife. For example, an LNG carrier in transit in the waterway could strike seabirds or shorebirds, an oil or fuel leak from a ship could affect both aquatic wildlife and terrestrial wildlife near the surface of the water and along the shorelines of the navigation channel, or vessel traffic may cause shoreline erosion. Jordan Cove would encourage LNG carrier operators to implement measures that would reduce the potential for oil or fuel spills. LNG carriers have a double hull that would keep fuel and oil onboard, thereby reducing the potential for a spill. Furthermore, each LNG carrier would maintain a shipboard oil pollution emergency plan. Further details on the potential effects of a spill are discussed in section 4.5.2.1. Studies conducted by Jordan Cove have shown that LNG carriers transiting at slow speeds in the Coos Bay navigation channel suggests that waves created by the vessels would be within the normal magnitude of waves that naturally occur in the bay and that any increase in shoreline erosion would be minor (section 4.5.2.1).[108]

Light being emitted from the LNG terminal facility could cause wildlife to alter their behavior to either avoid areas of artificial light or be attracted to those areas. Lighting at the LNG terminal would likely include a mixture of low-power fluorescent lighting and higher intensity security lighting that would primarily be located on shore, in and adjacent to the slip. When an LNG carrier is not in the berth, the lighting would be reduced to that required for security. Other industrial facilities on the North Spit (Roseburg, Southport, DB Western) already have night lighting. Jordan Cove has proposed including hooded or cut-off fixtures in its lighting plan to reduce glare and reduce light pollution to night skies. Because Jordan Cove has not prepared and filed a lighting plan, **we recommend that:**

- **Prior to construction, Jordan Cove should file with the Secretary, for review and written approval by the Director of OEP, its lighting plan. The plan should include measures that will reduce lighting to the minimal levels necessary to ensure safe operation of the LNG facilities and any other measures that will be implemented to minimize lighting impacts on fish and wildlife. Along with its lighting plan, Jordan Cove should file documentation that the plan was developed in consultation with the**

[107] Current ambient noise levels measured at the BLM boat ramp parking lot on the North Spit about 2 miles south of the Jordan Cove terminal site ranged from 40.8 to 47.6 dBA. See section 4.12.2.4 of this EIS.

[108] See *Technical Report – Draft, Volume 2 – Jordan Cove Energy Project and Pacific Connector Gas Pipeline, Coastal Engineering Modeling and Analysis*, filed by Jordan Cove as Appendix I.2 in Resource Report 2 included with its September 2017 application to the FERC.

FWS, NMFS, and ODFW. This lighting plan should also be in compliance with the lighting recommendations found in section 4.13.

Operational noise from the Jordan Cove Project could have long-term effects on wildlife on the North Spit. We predict that operational noise from the LNG terminal would have an equivalent sound level (L_{eq}) of 49 dBA and day-night sound level (L_{dn}) of 55 dBA when measured about 0.7 miles away, at the nearby ODNRA. This compares to current ambient L_{dn} noise levels of about 55 dBA at this location (see section 4.12.2.4 of this EIS). During operation, the ODNRA would experience a noise level of 58 dBA L_{dn} (a 3 dB increase). A small portion of the ODNRA would be subjected to day-night sound levels as high as 65 dBA. The Jordan Cove Project would result in a 3 decibel (dB) or greater increase over ambient at this recreation area. We conclude that operational noise from the terminal may affect some wildlife depending on their proximity to the terminal and each species' tolerance for increased noise.

Special status species that could be affected by the Jordan Cove Project, and relevant mitigation of those effects, are discussed in section 4.6.

Effects on Mammals

The construction and operation of the LNG terminal would reduce the amount of habitat available for big game species, and vehicle traffic related to the Project would increase the potential for collisions. However, due to the amount of previous disturbance at the site, and existing industrial activities in the area, we conclude that the Project would not significantly affect mammal species that currently occupy the North Spit.

Breeding and roosting sites for bats at the LNG terminal tract are limited due to the absence of typical bat habitat such as cliffs, rock outcrops, bridges, caves, and mines. Dune forest habitat is available on the LNG terminal site for those bat species that roost under bark. Removal of dune forest habitat would remove bat roosting habitat and likely displace individuals into nearby dune forest habitat (such as the ODNRA immediately north of the LNG terminal site). A meteorological station on the North Spit would pose a collision risk for bats, especially if guy-lines are required for operation. As with other mammals, we conclude that the Project would not significantly affect bat species.

Effects on Birds

Migratory bird species would likely experience disturbance due to the construction and operation of the Jordan Cove Project. Effects on birds would most likely be related to modification of habitat. However, areas affected by the Jordan Cove Project are relatively small in comparison to the total habitat available in Coos Bay, and in the larger BCR 5. Effects on migratory birds from both jurisdictional and non-jurisdictional facilities are included in this analysis.

Nesting habitat for migratory birds occurs in areas that would be cleared for the LNG terminal and related facilities. The Project would alter and disturb breeding and non-breeding habitat and could affect prey populations. The removal of coastal dune forest, grasslands (herbaceous), and shrublands (herbaceous shrubs and shrubs) could affect nesting and foraging opportunities for songbirds and raptors that occupy upland habitats. The effect of the construction of the slip and access channel, pile dike rock apron, and MOF on wetlands would be the permanent loss of intertidal, shallow subtidal, and eelgrass. These are all habitats utilized by seabirds, waterfowl, wading birds, and shorebirds. The loss of wetland habitat would be offset by the creation of in-kind mitigation areas proposed by Jordan Cove at the Kentuck project and eelgrass mitigation site. Table 4.5.1.1-2 presents the acreage of upland and wetland habitat disturbed during construction.

The great blue heron rookery located 300 feet from the Jordan Cove Road would be subject to potential disturbance from noise from construction traffic using Jordan Cove Road. The rookery is currently subject to noise from truck traffic delivering chips to the Roseburg wood chip export facility. Similarly, the historic rookery on the south side of Henderson Marsh could be affected by construction noise if the rookery was active during site construction. Jordan Cove would conduct spring status assessments annually of both great blue heron rookeries, as reuse by this species could occur. If biologists from other agencies (such as ODFW and BLM) conduct rookery surveys on the North Spit, Jordan Cove may use the results of these agency surveys. If either rookery becomes active, Jordan Cove, in consultation with ODFW, would develop an appropriate mitigation plan.

During operation of the Project, birds would be at risk of colliding with terminal facilities, including the LNG storage tanks and meteorological station. This risk is expected to be low given the visibility of most facilities, but could increase during storms, dense fog, at night, or at other times with reduced visibility. The meteorological station would be less visible than the terminal facilities and storage tanks and would likely pose a greater collision risk for birds that utilize beach and dunes habitat than the other facilities. If guy-lines would be required for operation of the meteorological station, they would be outfitted with bird deterrent measures to reduce the likelihood of bird strikes.

The facilities would be well lit at night, which could attract birds. There is some evidence that high intensity continuous anti-collision lights on structures may result in an increased number of bird strikes, especially at night or during fog and overcast conditions. The number of strikes can apparently be reduced by strobe or blinking the anti-collision lights. The LNG storage tanks would not be illuminated with high-intensity lighting. The intensity and number of lights would be limited to what is required for security and operations. Use of low-intensity lighting should reduce the likelihood of adverse effects on birds from collision with the LNG storage tanks compared to use of high intensity lighting.

Similar to lighting, birds can be drawn to the terminal flares. For example, some 7,500 songbirds were killed in September 2013 when they flew into the 30-meter-tall flare at the Canaport LNG import terminal in Saint John, New Brunswick, Canada (CBC News 2013). The flares at the LNG terminal are unlikely to have a similar adverse effect on birds due to design features. These flares would be lower in height and only be used for temporary periods, such as during start-up and shutdown, maintenance, and in response to unplanned pressure changes in the system to maintain safe operations. Jordan Cove can also implement measures through a lighting plan that would minimize effects on birds from terminal lighting. However, Jordan Cove would not develop its final lighting plan until final design. We have recommended above that Jordan Cove produce a final lighting plan prior to construction, for our review and approval that outlines measures to be implemented to ensure that facility lighting would not have major effects on birds and other wildlife.

Birds would also be at risk of colliding with LNG carriers in the waterway during operation of the terminal. Although the annual ship traffic would increase due to the Project, LNG carriers in the navigation channel would be traveling slowly and escorted by tugboats, and operate in compliance with Coast Guard as well as Oregon State requirements. Therefore, we conclude that LNG carrier marine traffic in the waterway would not significantly affect birds.

Jordan Cove proposes to implement various measures to avoid, minimize, and in some instances mitigate, effects on birds and their local habitats. All vegetation clearing at the LNG terminal would be conducted prior to March 1 or after August 31 to ensure most nesting birds have fledged. If construction activities must occur during the nesting season, Jordan Cove would conduct focused pre-construction surveys to determine if there are active migratory bird nests present that need to be avoided. The surveys would be conducted within the construction limits and within 100 feet (200 feet for raptors) of the construction limits. If active nests are encountered within the limits of the survey, construction and vegetation removal activities would be halted in the immediate vicinity (to approximately 20 feet away) until a qualified biologist has determined that the individuals have fledged from the nest (evacuated) or that the nest has failed from natural causes. If no active nests are encountered within the limits of the survey, construction and vegetation removal would proceed. Empty or abandoned nests would be removed; permits are not required (except for eagles and listed species) to remove an empty or abandoned nest or to remove or alter the structure the nest is built in or on (FWS 2003a, 2013a). Jordan Cove would coordinate with the FWS prior to proceeding with construction, and any consultation exchange with the FWS would be provided to the FERC. Further description of avoidance, minimization, and mitigation measures is provided in the draft *Migratory Bird Conservation Plan* filed with FERC on August 31, 2018.

Structures associated with the Project would be monitored to discourage use by avian predator species. Frequent inspections would ensure that nests are not being constructed and all nests found would be removed immediately, before birds could lay eggs. It is anticipated that there would be sufficient inspections and other activities mandated by safety and security requirements to keep the structures nest free. However, in the unlikely event that a nest becomes established and it is not discovered until eggs or young birds are present, the disposition of the nest would be handled in accordance with the provisions of the MBTA in consultation with the FWS. The FWS would require a special use permit if an active nest is encountered that would need to be removed, relocated, or transferred to a rehabilitation center. The Commission requires that all necessary permits be obtained prior to construction, including a Migratory Bird Special Use permit under 50 CFR section 21.27 if needed.

Additionally, in August 2018 both Jordan Cove and Pacific Connector jointly filed a draft *Migratory Bird Conservation Plan*. Both companies continue to consult with the FWS to finalize the plan and to prioritize conservation of migratory birds during construction and operation of all facilities. Therefore, we conclude that the Project would not significantly affect birds.

Effects on Amphibians and Reptiles

Potential Project-related effects on amphibians and reptiles would include mortality from construction if they were not able to avoid equipment or traffic, and habitat loss. Fill activity in wetlands would reduce available habitat for some amphibians and reptiles. Removal of dune forest for the Project would reduce habitat for the clouded salamander (*Aneides ferreus*), should this species occur in these areas. Jordan Lake and nearby wetlands on the east side of the terminal tract may offer suitable breeding habitat for the western toad (*Anaxyrus boreas*), although the species was not found during surveys of the site.

Jordan Cove proposed to mitigate potential effects on amphibians and by conducting pre-construction surveys for the western pond turtle, northern red-legged frog, and clouded salamander. Individuals located in the construction area would be captured and transported to suitable nearby habitats, as agreed to by the ODFW.

4.5.1.2 Pacific Connector Pipeline

Wildlife Habitats

Wildlife associations with habitats in the area that would be affected by the Pacific Connector Pipeline Project include the following (adapted from Johnson and O'Neil 2001):

- close association: a species is known to depend on a specific habitat for part or all of its life history requirements (feeding and reproduction) implying that the species has an essential need for a particular habitat for its maintenance and viability;
- general association: a highly adaptable species that is supported by a number of habitats that provide for its maintenance and viability; and
- present: a species that occasionally uses a habitat that provides marginal support for its maintenance and viability.

Sixteen wildlife habitat types (Johnson and O'Neil 2001) coincide with one or more of the vegetation types described for the Pacific Connector pipeline area in Section 4.4.1.2. Wildlife species associations with these habitat types provide a basis for evaluating Project effects on biodiversity and in some cases, on individual species. Two additional wildlife habitat types are not specifically addressed in Johnson and O'Neil (2001) but are well represented in the area affected by the Project: Grass-Shrub-Sapling or Regenerating Young Forest and Roads. Table 4.5.1.2-1 lists the miles of each of these habitat types crossed. Westside Lowland Conifer-Hardwood Forest and Southwest Oregon Mixed Conifer-Hardwood Forest are the most abundant habitats crossed, with 60.1 and 47.1 miles crossed, respectively.

Specialized habitat features also occur within the area affected by the pipeline project. Such features include cliffs that provide nesting for peregrine falcons and possibly other raptors. Snags provide roosting locations for several bat species, and nesting locations for cavity-nesting birds. LWD is present, which could be used by reptiles and amphibians.

TABLE 4.5.1.2-1

Wildlife Habitat Types Crossed by the Pacific Connector Pipeline and Wildlife Species Associated with Habitats

General Habitat Type	Mapped Habitat Type	Late Successional or Old-Growth Forest Crossed a/,f/ (miles)	Mid-Seral Forest Crossed b/,f/ (miles)	Clearcut/ Regenerating Forest Crossed c/,f/ (miles)	Total Miles	Percent of Total Project Mileage per Habitat Type	Number of Species Associated d/
Forest-Woodland	Westside Lowland Conifer-Hardwood Forest	9.5	22.8	27.8	60.1	26.2	32 – Herpetofauna 115 – Birds 66 – Mammals
	Montane Mixed Conifer Forest	1.4	0.9	4.0	6.3	2.7	22 – Herpetofauna 95 – Birds 64 – Mammals
	Southwest Oregon Mixed Conifer-Hardwood Forest g/	20.0 (1.6)	8.9 (0.4)	18.2 (0.2)	47.1 (2.2)	20.6 (1.0)	36 – Herpetofauna 127 – Birds 65 – Mammals
	Ponderosa Pine Forest and Woodlands	4.4	4.2	5.5	14.1	6.2	31 – Herpetofauna 128 – Birds 60 – Mammals
	Westside Oak and Dry Douglas-fir Forest and Woodlands	2.2	2.1	0.0	4.4	1.9	33 - Herpetofauna 116 – Birds 65 – Mammals
	Western Juniper and Mountain Mahogany Woodlands	0.2	4.2	3.7	8.1	3.5	19 - Herpetofauna 93 – Birds 40 – Mammals
	Subtotal	**39.3**	**43.6**	**59.4**	**142.2**	**62.1**	
Grasslands Shrubland	Shrub-steppe	–	–	–	17.8	7.8	23 – Herpetofauna 76 – Birds 47 – Mammals
	Westside Grasslands	–	–	–	11.8	5.1	26 – Herpetofauna 82 – Birds 38 – Mammals
	Eastside Grasslands	–	–	–	4.5	2.0	21 – Herpetofauna 80 – Birds 47 - Mammals
	Subtotal	–	–	–	**34.0**	**14.8**	
Wetland/ Riparian e/	Westside Riparian-Wetlands/Eastside Riparian-Wetlands	–	–	–	0.3	0.1	38 – Herpetofauna 156 – Birds 78 – Mammals
	Herbaceous Wetlands	–	–	–	5.6	2.5	18 – Herpetofauna 134 – Birds 44 – Mammals
	Subtotal	–	–	–	**5.9**	**2.6**	
Agriculture	Agriculture, Pastures, and Mixed Environs	–	–	–	26.6	11.6	34 – Herpetofauna 181 – Birds 78 – Mammals
	Subtotal	–	–	–	**26.6**	**11.6**	

TABLE 4.5.1.2-1 (continued)

Wildlife Habitat Types Crossed by the Pacific Connector Pipeline and Wildlife Species Associated with Habitats

General Habitat Type	Mapped Habitat Type	Late Successional or Old-Growth Forest Crossed a/,f/ (miles)	Mid-Seral Forest Crossed b/,f/ (miles)	Clearcut/ Regenerating Forest Crossed c/,f/ (miles)	Total Miles	Percent of Total Project Mileage per Habitat Type	Number of Species Associated d/
Developed/ Altered	Urban and Mixed Environs	–	–	–	2.2	1.0	37 – Herpetofauna 133 – Birds 64 – Mammals
	Roads				14.8	6.5	
	Subtotal				**17.0**	**7.4**	
Barren	Coastal Dunes and Beaches	–	–	–	<0.1	<0.1	8 – Herpetofauna 103 – Birds 26 – Mammals
	Subtotal	–	–	–	**<0.1**	**<0.1**	
Open Water	Open Water - Lakes, Rivers, and Streams	–	–	–	0.9	0.4	17 – Herpetofauna 95 – Birds 20 – Mammals
	Bays and Estuaries	–	–	–	2.4	1.0	1 – Herpetofauna 132 – Birds 12 – Mammals
	Subtotal	–	–	–	**3.3**	**1.4**	
	Project Total	**39.3**	**43.7**	**59.5**	**229.1**	**100.0**	

Note: Mileages rounded to nearest tenth of a mile; values less than 0.1 miles shown as "<0.1". Rows/columns may not sum correctly due to rounding.

a/ Late Successional (80 to 175 years) and Old-Growth Forest (175 + years).
b/ Mid-Seral Forest (40 to 80 years).
c/ Clearcut (0 to 5 years) and Regenerating Forest (5 to 40 years).
d/ Numbers of species associated with each habitat type crossed by the Pacific Connector Project were summarized from Pacific Connector's Environmental Resource Report 3, Appendix 3D, Table 3D-1.
e/ Following wetland regulation protocols, construction of the pipeline would initially affect 112.2 acres of wetlands. See section 4.3 for results of jurisdictional wetland delineation and discussion of Project effects on wetlands.
f/ Cells with no data result from the fact that non-forested habitat types did not identify seral stage; thus, miles are identified only in the "total miles" column.
g/ Distances in parentheses indicate crossing through recently burned Southwest Oregon Mixed Conifer-Hardwood Forest.

Grasslands and/or meadows provide habitats for animals that are adapted to areas dominated with perennial bunchgrasses and forbs. A wide variety of species use grasslands and meadows, including songbirds, amphibians, and reptiles. We estimate that the pipeline route would cross about 16.3 miles of grasslands (see table 4.5.1.2-1). Wetlands provide habitat for migrating and breeding waterfowl, shorebirds, waterbirds, songbirds, mammals, amphibians, and reptiles (ODFW 2006b). Riparian zones (including forested wetlands) support high species diversity (Johnson and O'Neil 2001). In total, the pipeline route would cross about 6 miles of wetlands and riparian habitats.[109]

The pipeline route would cross about 142 miles of woodlands and forest habitats. Deciduous hardwood species, such as oak and tanoak, occur in the area affected by the pipeline project. Mixed coniferous and deciduous forests, deciduous-dominated riparian areas, and oak woodlands are found most often in Douglas and Jackson Counties. In Coos County, many of the historical deciduous woodlands have been reduced as a result of conifer plantings and changes in fire frequency and intensity, as well as conversion to agricultural and residential uses. A wide variety of species use deciduous and young conifer forest habitats, including songbirds, reptiles, and small mammals.

Mature (greater than 40 years old), late successional (80 to 175 years old), and old-growth (greater than 175 years old) forests are unique, important habitat elements. Tree species common in mature to old-growth forests are western hemlock, Douglas-fir, western redcedar, Sitka spruce, red alder, and bigleaf maple (Chappell et al. 2001). Bird species that are obligates of old-growth forests include the federally threatened NSO and MAMU (further discussed in section 4.6). Old-growth forests are most common along the pipeline route in the Klamath Mountains (see section 4.4).

Terrestrial Animals in the Project Area

The areas crossed by the Pacific Connector pipeline route provide diverse habitats for wildlife, including forests, shrublands, and grasslands. These habitats support an array of wildlife species. Overall, 47 amphibian and reptile, 281 bird, and 108 mammal species are known or suspected to occur in the area affected by the Project.

Mammals

Based on their distributions in southwestern Oregon and habitat associations described by Johnson and O'Neil (2001), 108 species of mammals may be present in habitats that coincide with and/or are adjacent to the Pacific Connector pipeline. The most numerous groups likely to occur are rodents (46 species, such as Baird's shrew, coast mole, least chipmunk, and Douglas' squirrel), carnivores (19 species, such as coyote, gray fox, black bear, and mink), and bats (13 species; see subsection below). Mammal species with special state or federal status are discussed in section 4.6.

The highest diversity of mammals can be expected in the Johnson and O'Neil (2001) Agriculture, Pastures, and Mixed Environs habitat and Eastside and Westside Riparian-Wetlands habitat (78 species, respectively). Mammalian species diversity is also relatively high in Westside Lowland Conifer-Hardwood-Forest (66 species), Southwest Oregon Mixed Conifer-Hardwood Forest

[109] Following wetland regulation protocols, construction of the pipeline would initially impact 112.2 acres of wetlands. See section 4.3 for results of jurisdictional wetland delineation and discussion of Project effects on wetlands.

(65species), Westside Oak and Dry Douglas-Fir Forest and Woodlands (65), Montane Mixed Conifer Forest (64 species), as well as in Developed-Urban and Mixed Environs (64 species). The lowest species diversity of mammals is expected in Bays and Estuaries (12).

Wild Horses

The BLM and the Forest Service manage wild horses to ensure healthy herds and healthy rangelands in Oregon. The Pokegama Herd Management Area (HMA) is in the southwestern corner of Klamath County and the southeast corner of Jackson County, on both private and BLM lands in the Lakeview District. While the pipeline does not cross it, the HMA is in the general vicinity of the Project. From 1972 to 2002, the average number of horses in the HMA was 42.7, but the population has ranged from 23 to 55 horses over that time. Relative to other wild horse herds (which increase about 22 percent per year), the Pokegama herd has a low yearly increase of 4 to 5 percent. This may be due to illegal removal or mountain lion predation (BLM 2002).

Bats

A total of 15 species of bat occur in Oregon; 13 of the species potentially occur in the area affected by the Project. All of the species except for little brown myotis, big brown bat, and Brazilian free-tailed bat have some special status, whether identified by the State as sensitive, the FWS as a Species of Concern, or by the BLM or the Forest Service as a Sensitive Species. Special status species are discussed in section 4.6; special status bats are listed in table I-3 of appendix I. Uses of different habitats that may occur along the pipeline route vary between little brown myotis, big brown bat, and Brazilian free-tailed bat (table 4.5.1.2-2).

TABLE 4.5.1.2-2

Non-Special Status Bat Species and Associated Habitats Likely to Occur In the Project Area

Species	Distribution in Southern Oregon	Habitat Types	Foraging Habitat
Little brown myotis *Myotis lucifugus carissima*	Yearlong throughout Oregon	Associated with all habitats described in table 4.5.1.2-1	Forages for insects in scattered trees, along edges of dense timber, near water in shrub-grassland
Big brown bat *Eptesicus fuscus*	Yearlong throughout Oregon	Associated with all habitats described in table 4.5.1.2-1	Forages for insects over forest canopy, along roads/edges through trees, forest clearing
Brazilian free-tailed bat *Tadarida brasiliensis mexicana*	Non-migratory southern Oregon only	Westside Lowland Conifer-Hardwood Forest, Southwest Oregon Mixed Conifer-Hardwood Forest, Ponderosa Pine Forest and Woodlands, Westside Oak and Dry Douglas-fir Forest and Woodlands, Western Juniper and Mountain Mahogany Woodlands, Shrub-steppe, Westside Grasslands, Westside Riparian-Wetlands, Herbaceous Wetlands, Agriculture, Pastures, and Mixed Environs, Urban and Mixed Environs, Open Water - Lakes, Rivers, and Streams	Forages for insects in heated buildings or outside during warm spells during winter. During other periods, will forage almost anywhere from valley bottoms to Cascade / Siskiyou Mtn. crest, foraging long distances, e.g., 30+ miles round trip per night

Sources: Maser and Cross (1981), Verts and Carraway (1998), Johnson and O'Neil (2001), Weller (2008), ODFW (2013a)

All of the bat species consume insects, and most are associated with tree-dominated habitats that occur in the area affected by the pipeline project. Bats have roosts used by nursing females and young, roosts used during daylight, and hibernacula that are used to survive during winter while hibernating or in torpor. White-nose syndrome is a disease of hibernating bats, caused by a fungus that affects skin for the nose, ears, and wings of hibernating bats (USGS 2013b).

White-nose syndrome has spread from the northeastern United States to 28 states and has most recently been identified in the state of Washington in 2016; since 2006 over 6 million insect-eating bats have died from the effects of this disease. ODFW, along with other federal agencies, has been surveying caves for the disease with no positive indications that the disease is presently in Oregon bat populations (ODFW 2017b).

Birds

Based on their distributions in southwestern Oregon, 281 bird species may be present in habitats that would be crossed by the Pacific Connector pipeline (Johnson and O'Neil 2001). The highest diversity of bird species can be expected in habitats associated with agriculture, pastures, and mixed environs (181 species). Many species are also associated with riparian-wetland habitats (156 species), herbaceous wetlands (134 species), bays and estuaries (132 species), and developed-urban and mixed environs (133 species; table 4.5.1.2-1). The fewest number of bird species are associated with sagebrush shrub-steppe (76) and eastside grasslands (80).

Annual breeding bird survey (BBS) counts were used to determine additional potential bird species presence in habitats crossed by the Pacific Connector pipeline. Fewer species have been documented on BBS routes (241 species observed) than the number of species associations of wildlife habitats coinciding with the Pacific Connector Project (281 species expected). The disparity is likely due to several factors: the BBS does not usually document all of the species possibly present at the time of the survey (i.e., nocturnal owls and birds that do not sing or call regularly); species reported are present only during the season of the survey; and survey routes may not include or be representative of all habitat types crossed by the pipeline. Regardless, the BBS survey counts can be used as an index of some species' population trends over time.

The Pacific Connector pipeline crosses two BCRs: (1) BCR 5 – Northern Pacific Rainforest, from MP 1.5R to MP 168.15; and (2) BCR 9 – Great Basin, from MP 168.15 to MP 228.81. Bird species diversity and population trends in the region surrounding the Project were evaluated from data collected on 33 BBS routes that have been surveyed within 50 miles of the Project (17 routes in BCR 5, 16 routes in BCR 9). Of the 238 species observed on the BBS routes, 11 species are BCC in BCR 5 (excluding the MAMU, discussed in section 4.6) and 21 species are BCC in BCR 9. BCC in the area affected by the Pacific Connector pipeline are listed in table 4.5.1.2-3.

TABLE 4.5.1.2-3

Birds of Conservation Concern in BCR-5 and BCR-9 that Have Been Observed on BBS Routes within 50 Miles of the Pacific Connector Pipeline Project with Regional and Local Population Trends, and Breeding Dates, if Known

Common Name a/ *Scientific Name*	Regional BCR Trend 1996 to 2015 b/	Local Trend 1997 to 2016 c/	Confirmed Breeding Dates d/ Earliest	Latest
BCR-5, Northern Pacific Rainforest				
pelagic cormorant *Phalacrocorax pelagicus*	No Trend	No Data	22 Mar	26 Jul
bald eagle *Haliaeetus leucocephalus*	Increasing (p<0.05)	Insufficient Data	8 Mar	9 Aug
northern goshawk *Accipiter gentilis*	No Trend	Insufficient Data	10 May	9 Aug
peregrine falcon *Falco peregrinus*	Increasing (p<0.05)	Insufficient Data	26 Apr	26 Jul
Caspian tern *Sterna caspia*	No Trend	Insufficient Data	14 Jun	19 Jul
marbled murrelet *Brachyramphus marmoratus*	No Analysis	Insufficient Data	No Data	No Data
Rufous hummingbird *Selasphorus rufus*	Decreasing (p<0.05)	Increasing (p<0.01)	22 Mar	
olive-sided flycatcher *Contopus cooperi*	Decreasing (p<0.05)	No Trend	14 Jun	30 Aug
willow flycatcher *Empidonax traillii*	Decreasing (p<0.05)	Increasing (p<0.10)	7 Jun	9 Aug
horned lark e/ *Eremophila alpestris*	Decreasing (p<0.05)	No Data	3 May	26 Jul
Vesper sparrow f/ *Pooecetes gramineus*	No Trend	Insufficient Data	26 Apr	16 Aug
purple finch *Carpodacus purpureus*	No Trend	Increasing (p<0.01)	10 May	19 Jul
BCR-9, Great Basin				
eared grebe *Podiceps nigricollis*	No Trend	Insufficient Data	31 May	23 Aug
Bald eagle *Haliaeetus leucocephalus*	Increasing (p<0.05)	No Trend	8 Mar	9 Aug
Ferruginous hawk *Buteo regalis*	No Trend	No Data	29 Mar	19 Jul
golden eagle *Aquila chrysaetos*	No Trend	Insufficient Data	22 Feb	19 Jul
Pperegrine falcon *Falco peregrinus*	No Trend	Insufficient Data	26 Apr	26 Jul
yellow rail *Coturnicops noveboracensis*	No Analysis	Insufficient Data	7 Jun	5 Jul
Snowy plover *Charadrius alexandrinus*	No Analysis	Insufficient Data	17 May	5 Jul
long-billed curlew *Numenius americanus*	Increasing (p<0.05)	Insufficient Data	19 April	12 Jul
yellow-billed cuckoo *Coccyzus americanus*	No Analysis	No Data	No Data	No Data
Calliope hummingbird *Stellula calliope*	No Trend	No Trend	31 May	26 Jul
Lewis's woodpecker *Melanerpes lewis*	No Trend	No Trend	24 May	23 Aug
Williamson's sapsucker *Sphyrapicus thyroideus*	No Trend	Insufficient Data	17 May	26 Jul
white-headed woodpecker *Picoides albolarvatus*	Increasing (p<0.05)	Insufficient Data	24 May	26 Jul
loggerhead shrike *Lanius ludovicianus*	No Trend	Insufficient Data	10 May	19 Jul
Pinyon jay *Gymnorhinus cyanocephalus*	Decreasing (p<0.05)	Insufficient Data	7 Jun	19 Jul

TABLE 4.5.1.2-3 (continued)

Birds of Conservation Concern in BCR-5 and BCR-9 that Have Been Observed on BBS Routes within 50 Miles of the Pacific Connector Pipeline Project with Regional and Local Population Trends, and Breeding Dates, if Known

Common Name a/ *Scientific Name*	**Regional BCR Trend 1996 to 2015 b/**	**Local Trend 1997 to 2016 c/**	**Confirmed Breeding Dates d/**	
sage thrasher *Oreoscoptes montanus*	Decreasing (p<0.05)	Insufficient Data	10 May	26 Jul
Green-tailed towhee *Pipilo chlorurus*	No Trend	No Trend	17 May	9 Aug
Brewer's sparrow *Spizella breweri*	No Trend	No Trend	3 May	9 Aug
black-chinned sparrow *Spizella atrogularis*	No Analysis	No Data	No Data	No Data
Sagebrush sparrow g/ *Artemisiospiza nevadensis*	No Trend	Insufficient Data	10 May	
tricolored blackbird *Agelaius tricolor*	No Trend	Increasing (p<0.10)	12 Apr	9 Aug
eared grebe *Podiceps nigricollis*	No Trend	Insufficient Data	31 May	23 Aug

a/ BCC species listed by BCR in FWS (2008).
b/ Regional trend analyses available at https://www.mbr-pwrc.usgs.gov/bbs/bbs.html (Sauer et al. 2017).
c/ BBS data retrieved from https://www.pwrc.usgs.gov/bbs/RawData/ (Pardieck et al. 2017). Local population trends in each BCR were estimated from average number observed per BBS route if data were sufficient (average occurrence per route per year ≥1, average number of routes per year with species counted ≥5).
d/ Confirmed breeding dates from Oregon Breeding Bird Atlas (Adamus et al. 2001).
e/ Only applies to streaked horned lark (*Eremophila alpestris strigata)* subspecies not differentiated in data sources.
f/ Only applies to Oregon vesper sparrow (*Pooecetes gramineus affinis)* subspecies not differentiated in data sources.
g/ Sage sparrow was recently split into two species: Bell's sparrow (*Artemisiospiza belli*) and sagebrush sparrow (*Artemisiospiza nevadensis*). Sagebrush sparrows were observed within 50 miles of the pipeline in BCR-9 and are assumed to be BCC in that region.

For BCR 5 regional trends, peregrine falcons and bald eagles are increasing and for the rest of the birds either there is a decreasing trend (4) or no trend (5). For BCR 5 local trends, rufous hummingbird, willow flycatcher, and purple finch are increasing and for the rest of the birds either there is no data or insufficient data (7 birds), or no trend (1 bird). For BCR 9 regional trends, bald eagle, long-billed curlew, and white-headed woodpecker have increasing trends, the sage thrasher and pinyon jay display a decreasing trend, and for the rest of the birds either there is a no trend (13) or no analysis (4). The local trend for BCR 9 is increasing for tricolored blackbird. For the other birds in BCR 9, there are 4 exhibiting no local trend and the rest do not have sufficient data to report a trend.

Many migratory bird species have been observed during the annual Christmas Bird Count (CBC), sponsored by the Audubon Society in the vicinity of the Project. At least 272 bird species (common names are reported and have not been standardized) have been counted at eight locations proximate to the area affected by the Pacific Connector Pipeline Project. While 152 bird species have been reported by both BBS and CBC, 91 species have only been reported by the CBC. The species include various seabirds (auklets, murres, guillemots, jaegers, gulls, albatrosses, shearwaters, and cormorants), waterfowl (scoters, geese, swans), and shorebirds (dowitchers, sandpipers, plovers, turnstones). The local population of common ravens has been increasing during the breeding period in BCR 9 and during winter on CBC count circles near the Pacific Connector pipeline.

Several raptor species are known or suspected to nest, migrate, and seasonally reside in the general vicinity of the pipeline route. Those reported for BBS routes in the region include turkey vulture, osprey, white-tailed kite, bald eagle, northern harrier, sharp-shinned hawk, Cooper's hawk, northern goshawk, red-shouldered hawk, Swainson's hawk, red-tailed hawk, ferruginous hawk, golden eagle, American kestrel, American peregrine falcon, and prairie falcon. Several additional raptor species have only been observed during CBC surveys. Those include rough-legged hawk, gyrfalcon, and merlin. Bald eagles, northern goshawks, and peregrine falcons have nest sites within 3 miles, some much closer to the Project (data from ORBIC 2012 and 2017a; BLM 2017a; Forest Service 2017c; and pipeline surveys for the northern goshawk on Rogue River-Siskiyou National Forest). Other raptor species have been observed, some nesting, along the Project route during surveys focusing on other rare species. Bald eagles, ospreys, sharp-shinned hawks, Cooper' hawks, goshawks, golden eagles, red-shouldered hawks, red-tailed hawks, peregrine falcons, and turkey vultures have been reported during surveys in 2007 and 2008 but nest sites were not included in the documentation. Some of these raptor species have probably nested in the Project vicinity in the past.

There are also several species of owls that have been documented on BBS routes and are likely to occur in the areas crossed by the pipeline. They include barn owl (*Tyto alba*), western screech owl (*Otus kennicottii*), great horned owl (*Bubo virginianus*), northern pygmy-owl (*Glaucidium gnoma*), barred owl (*Strix varia*), great gray owl (*Strix nebulosa*), short-eared owl (*Asio flammeus*), and NSO. Owls seen only during the winter CBC surveys include northern saw-whet owls (*Aegolius acadicus*) and burrowing owls (*Athene cunicularia*). Additionally, boreal owl (*Aegolius funereus*), flammulated owl (*Otus flammeolus*), and long-eared owl (*Asio otus*) are expected to occur in habitats crossed by the Pacific Connector pipeline route. The burrowing owl, flammulated owl, and great gray owl have special state or federal status and more information on their occurrence is included in appendix I. The NSO has threatened state and federal status and is discussed in more detail in section 4.6. Great horned owls, western screech owls, NSOs, barred owls, northern pygmy owls, and great gray owls have been reported during surveys in 2007 and 2008 but nest sites were not included in the documentation.

Game Animals

Several species of mammals and birds are considered game animals and are harvested through recreational and/or subsistence hunting. Except for wildlife harvest administered and managed under tribal authorities, hunting is regulated by the ODFW in defined Wildlife Management Units. Big game species that may occur in the areas crossed by the Pacific Connector pipeline route include black-tailed deer, mule deer, Roosevelt elk, Rocky Mountain elk, black bear, and cougar. Demographic data and harvest data for game animals are compiled by ODFW and are available in online reports, listed by animals taken by each hunt unit.

Two subspecies of mule deer occur in the Pacific Connector pipeline area: the larger Rocky Mountain mule deer, usually found east of the Cascade Mountain crest, and the black-tailed deer, generally found west of the Cascades (ODFW 2008). A second species, Columbian white-tailed deer, was state and federally delisted in 2003 and may occur between MPs 56.0 and 61.0, and MPs 65.5 and 66.2, in an area mapped by ODFW as "peripheral big game range" and "impacted habitat" (ODFW 2017c, 2017d). Black-tailed deer are considered management indicator species (MIS) for both the Umpqua and Rogue River National Forests (Forest Service 1990a, 1990b).

In eastern Oregon, mule deer are mainly confined to open woods or isolated mountain ranges, although they once ranged into sagebrush plains in canyons or rimrock. During the winter, a period considered critical for the mule deer, they descend to lower elevations to browse sagebrush, bitterbrush, rabbitbrush, juniper, and mountain-mahogany, which are high in fats (ODFW 2003a, 2011; Csuti et al. 2001). In western Oregon, black-tailed deer are found in forested areas and heavy brush areas at the edges of forests and chaparral thickets. Black-tailed deer prefer early successional stages created by clear-cuts or burns, providing grasses, forbs, and shrubs (ODFW 2008; Csuti et al. 2001). Most black-tailed deer that summer in the high Cascades winter at lower elevations on the west slope, although some wintering may occur east of the Cascade crest (ODFW 2008). Winter loss of black-tailed deer is generally far less than for mule deer, because the snow does not remain on the valley floors for extended periods and a crust does not form on the surface as it does on the east side of the Cascades (ODFW 2008). In Jackson County, black-tailed deer are highly migratory and often move along well-defined migration trails at night during the months between October and March (ODFW 2007a). In Douglas County, Columbian white-tailed deer are most often associated with riparian habitats, although they are known to use a variety of lower elevation habitat types, such as grasslands, grass shrub, oak woodlands, coniferous woodlands, and mixed deciduous and coniferous woodlands (FWS 2003b).

Rocky Mountain elk inhabit most of eastern Oregon and Roosevelt elk occupy most of western Oregon with concentrations in the Cascades and Coast ranges. They are known to make significant movements in response to disturbances from humans and predators, as well as seasonal weather patterns. Rocky Mountain elk is considered an MIS for both the Umpqua and Rogue River National Forests (Forest Service 1990a, 1990b). Note that MIS species are addressed in more detail in section 4.5.1.3

Several herds of elk are known to winter on the western slopes of the Cascades (ODFW 2003b). Summer elk forage consists of a combination of lush forbs, grasses, and shrubs, which is usually attained at higher elevations in wet meadows, springs, and riparian areas in close proximity to forested stands. Forage becomes less abundant and accessible in winter and the nutritional quality declines. Winter range is usually in forested sites, which provide protection against weather as well as lichens and other plants used as forage (ODFW 2003b); however, in Jackson County, winter range also consists of other habitat types such as grassy meadows, recent clearcuts, industrial forestlands, agricultural fields, orchards and urban edges. Most elk range is on BLM and NFS lands (ODFW 2003b); however, in the Pacific Connector pipeline area, most winter range occurs on private lands (table 4.5.1.2-4). Jackson County has the most winter range affected by the Project, followed by Klamath County, then Douglas County.

ODFW delineated digital GIS coverage of deer and elk habitat in Oregon, which include big-game winter management areas in Jackson and Klamath counties in the vicinity of the pipeline (ODFW 2012b, 2012c, and 2017d). The delineated areas do not necessarily represent complete deer and elk winter ranges in each county, but designate areas that provide some level of protection for big-game winter range while allowing development to occur (Milburn 2007). Additionally, our analysis incorporates GIS coverage of big-game winter range on NFS lands, which also includes a few delineated areas in the Umpqua National Forest in Douglas County (Forest Service 2006). BLM Districts defer to winter range delineated by ODFW (Waddell 2017) Harvested small game and furbearer species that occur are beaver, bobcat, gray fox, red fox, marten, mink, muskrat, otter, raccoon, badger, coyote, nutria, opossum, spotted skunk, striped skunk, and weasel (Hiller 2011).

TABLE 4.5.1.2-4

Designated Big Game Winter Range Crossed by the Pacific Connector Pipeline

Winter Range or Management Area	Miles Crossed Per Landowner			
	BLM	**Forest Service**	**Other a/, b/**	**Total**
Douglas County				
Big Game Winter Range – Umpqua National Forest	0.0	0.6	0.0	0.6
Douglas County Total	**0.0**	**0.6**	**0.0**	**0.6**
Jackson County				
Sensitive Wildlife Area c/	2.3	0.0	2.3	4.6
Very Sensitive Wildlife Area d/	11.1	1.4	19.7	32.3
Jackson County Total	**13.5**	**1.4**	**22.0**	**36.9**
Klamath County				
Deer Low/Medium Density Winter Range e/	0.0	0.0	4.4	4.4
Deer Low/Medium Density Winter Range f/	0.3	0.0	14.2	14.5
Elk Winter Range g/	0.0	0.0	1.2	1.2
Klamath County Total	**0.3**	**0.0**	**19.8**	**20.1**
Overall County	**13.7**	**2.1**	**41.9**	**57.7**

Note: Rows/columns may not sum correctly due to rounding. Mileages rounded to the nearest tenth of a mile (values below 0.1 are shown as "<0.1").

a/ Other includes non-federal lands, such as private, county, and state.

b/ Seasonal restrictions are specific to landownership. "Other" designation is stipulated by ODFW.

c/ Sensitive Wildlife Areas coverage (ODFW 2017c) also incorporates Forest Service Deer Winter Range coverage (Trail Creek, Big Butte Creek, and Lake Creek). Occurs in Evans Creek and Rogue ODFW big game management units.

d/ Very Sensitive Wildlife Area coverage (ODFW 2017c) also incorporates BLM Deer (Camel Hump, BFRA Salt Creek, Little Butte Creek South) and Elk (Camel Hump, BFRA Salt Creek) Winter Management Area coverages, as well as Forest Service Deer Winter Range coverages (Big Butte Creek, Lake Creek). Occurs in Rogue ODFW big game management units.

e/ Deer Low/Medium Density Winter Range coverage (ODFW 2012b) includes the ODFW Keno big game management unit.

f/ Deer Low/Medium Density Winter Range (ODFW 2012a) incorporates BLM Deer Winter Management coverages (Stukel, South Bryant). Occurs in Klamath Falls big game management unit.

g/ Elk Winter Range for Eastern Oregon (ODFW 2012c).

Amphibians and Reptiles

Based on their distributions in southwestern Oregon, 23 amphibian species and 24 reptile species may be present in habitats that would be crossed by the Pacific Connector pipeline route (Leonard et al. 1993; Nussbaum et al. 1983). Habitats in the area of the pipeline that support the highest diversity of reptiles and amphibians include Wetlands/Eastside Riparian-Wetlands (38 species), Developed, Urban, and Mixed Environments (37 species), and Mixed Conifer-Hardwood Forest (36 species). One reptile species (western terrestrial garter snake) is potentially found in bays and estuarine habitats. Amphibian and reptile species that could potentially occur near the Project include, but are not limited to, clouded salamander, tailed frog, western toad, western pond turtle, sagebrush lizard, rattlesnake, king snake, western fence lizard, gopher snake, and rubber boa.

Some amphibian species potentially occurring in the area affected by the pipeline project are associated with a variety of habitats and thus are common and widespread with healthy populations, such as the Pacific tree frog and rough-skinned newt. Other species that have been documented, such as the foothill yellow-legged frog (a federal species of concern, state sensitive, BLM and Forest Service sensitive species), are declining (ODFW 2006b; Oregon Conservation Strategy 2016). Amphibians demonstrate close associations with aquatic and riparian habitats, though they may occur in other habitat types if not too distant from water, for example, the ensatina (a lungless salamander), which is found in forests. Amphibians with extremely limited distributions and relatively specific ecological requirements may be more at risk of further population declines (Walls et al. 1992).

Reptiles present along the pipeline project are also associated with a variety of habitats crossed, although not all are as closely associated with water and/or water-dominated features as amphibians.

Invertebrates

Terrestrial invertebrates occur along the Pacific Connector pipeline. Arthropods occur in all habitat types crossed by the pipeline, though terrestrial mollusks (gastropods) are considerably more restricted. With few exceptions, terrestrial mollusks are generally found in moist habitats associated with springs, seeps, decaying wood, moist mature forests, and habitats maintained in the coastal "fog" zone near the ocean. Other invertebrate species would likely be widespread and abundant throughout the area affected by the Project; some examples include *Peromyscopsylla selenis*, earthworm (*Lumbricus variegatus)*, orb weaver spider (family *Araneidae)*, and grass spiders (*Agelenopsis* spp.*)*. Some invertebrates, such as bees (from families such as *Apidae*, *Halictidae*, *Andrenidae*, *Megachilidae*, and *Colletidae*), play an important role in pollination of native plants in the area affected by the Project.

Effects on Wildlife Habitat and Terrestrial Wildlife Species from Construction and Operation of the Pacific Connector Gas Pipeline Facilities

Effects on Habitats

The acres of wildlife habitat types (from Johnson and O'Neil 2001) that would be affected by construction of the Pacific Connector pipeline are listed in table 4.5.1.2-5. Westside Lowland Conifer Forest, Southwest Oregon Mixed Conifer-Hardwood Forest, Shrublands and Grasslands, Agriculture, Pastures, and Mixed Environs, and Urban and Mixed Environs would be the wildlife habitats most affected by construction.

At aboveground facilities, native habitats would be cleared, and on private lands the area would be permanently converted into developed-industrial land. During pipeline operation, a 30-foot-wide corridor, centered over the pipe, would be kept clear of trees. As a result, areas cleared of forest during pipeline construction would be maintained in a shrub/herbaceous state within this 30-foot-wide corridor. The remainder of the temporary pipeline construction right-of-way would be revegetated with native species, although it would take years to many decades for forested and shrub-steppe habitat to regenerate. Other habitats, such as grasslands, within the temporary construction right-of-way would typically be restored within three years. A 10-foot-wide corridor centered on the pipeline may be mowed annually and maintained in an herbaceous state. The remainder of the 30-foot-wide corridor within the permanent easement may be subject to vegetation clearing every three years. The acres of wildlife habitat that would be affected by operation of the Pacific Connector Project are listed in table 4.5.1.2-6.

TABLE 4.5.1.2-5

Summary of Construction-Related Effects on Habitat by the Pacific Connector Pipeline (acres a/)

General Habitat Type	Mapped Habitat Type	Forest Stand by Age	Pipeline Facilities: Construction Right-of-Way	Temporary Extra Work Areas	Uncleared Storage Areas	Rock Source/Disposal	Access Roads (TARs/PARs/ Improvements)	Pipe Yards	Aboveground Facilities - Klamath Compressor Station	Subtotal by Age Class	Subtotals: Subtotal by Habitat Type	Percent of Total Habitat
Forest-Woodland	Westside Lowland Conifer-Hardwood Forest	L-O b/	113.5	25.6	89.9	0	0	0	0	229.1	1,297	26.2
		M-S c/	264.5	67.6	122.6	1.0	<1	<1	0	455.9		
		C-R d/	323.3	129.5	154.4	4.9	<1	0	0	612.2		
	Montane Mixed Conifer Forest	L-O b/	15.7	<1	6.1	0	0	0	0	22.5	114	*2.3*
		M-S c/	9.2	<1	4.5	0	0	0	0	14.2		
		C-R d/	45.0	16.7	15.8	0	0	0	0	77.5		
	Southwest Oregon Mixed Conifer-Hardwood Forest	L-O b/	251.5	41.3	111.7	1.5	<1	0	0	406.3	940	19.0
		M-S c/	108.7	36.4	33.9	<1	<1	0	0	179.0		
		C-R d/	210.6	61.0	82.4	0	<1	0	0	354.3		
	Ponderosa Pine Forest and Woodlands	L-O b/	50.9	15.9	6.0	0	0	0	0	72.8	220	4.5
		M-S c/	50.9	8.9	<1	<1	0	0	0	60.4		
		C-R d/	63.1	16.0	7.0	1.0	0	0	0	87.0		
	Westside Oak and Dry Douglas-fir Forest and Woodlands	L-O b/	26.7	9.0	3.9	0	0	0	0	39.6	74	*1.5*
		M-S c/	25.0	7.4	1.9	0	<1	0	0	34.3		
		C-R d/	0	0	0	0	0	0	0	0		
	Western Juniper and Mountain Mahogany Woodlands	L-O b/	2.3	<1	0	0	0	0	0	2.7	105	2.1
		M-S c/	48.7	7.6	0	0	<1	0	0	56.4		
		C-R d/	42.3	3.4	0	0	<1	0	0	45.6		
	Subtotal Forest-Woodland		**1,652**	**448**	**641**	**8**	**1**	**<1**	**0**	**2,750**	**2,750**	***55.6***
	Percent of All Forest-Woodland		***60.1***	***16.3***	***23.3***	***0.3***	**<1**	**<1**	**0.0**	***100.0***	***100.0***	
Grasslands -Shrubland	Sagebrush Steppe	n/a	78	33	0	0	<1	0	21	n/a	133	*2.7*
	Shrublands	n/a	122	41	11	0	<1	0	0	n/a	174	*3.5*
	Westside Grasslands	n/a	132	87	6	<1	2	148	0	n/a	376	*7.6*
	Eastside Grasslands	n/a	51	8	<1	1	0	122	0	n/a	183	*3.7*
	Subtotal Grasslands-Shrubland		**383**	**170**	**17**	**2**	**2**	**271**	**21**	**n/a**	**865**	***17.5***
Wetland / Riparian	Westside Riparian-Wetlands/Eastside Riparian-Wetlands	L-O b/	0	0	0	0	0	0	0	0	2	*0.0*
		M-S c/	<1	<1	0	0	0	0	0	1		
		C-R d/	1	<1	0	0	0	0	0	1		
		Shrub	1	<1	<1	0	0	0	0.4	n/a	2	*0.0*
	Herbaceous Wetlands	n/a	64	45	<1	0	<1	<1	0	n/a	111	*2.2*
	Subtotal Wetland / Riparian		**67**	**46**	**<1**	**0**	**<1**	**1**	**0**	**n/a**	**114**	***2.3***
Agriculture	Agriculture, Pastures, and Mixed Environs		306	132	<1	3	2	14	0	n/a	458	*9.3*
	Subtotal Agriculture		**306**	**132**	**<1**	**3**	**2**	**14**	**0**	**n/a**	**458**	***9.3***

TABLE 4.5.1.2-5 (continued)

Summary of Construction-Related Effects on Habitat by the Pacific Connector Pipeline (acres a/)

General Habitat Type	Mapped Habitat Type	Forest Stand by Age	Pipeline Facilities: Construction Right-of-Way	Temporary Extra Work Areas	Uncleared Storage Areas	Rock Source/Disposal	Access Roads (TARs/PARs/ Improvements)	Pipe Yards	Aboveground Facilities - Klamath Compressor Station	Subtotal by Age Class e/	Subtotals: Subtotal by Habitat Type	Percent of Total Habitat
Developed / Barren	Urban and Mixed Environs	n/a	22	54	<1	26	<1	336	0	n/a	439	8.9
	Roads	n/a	143	61	18	2	23	47	<1	n/a	295	*6.0*
	Beaches	n/a	<1	6	0	0	0	0	0	n/a	7	*0.1*
	Subtotal Developed / Barren		**166**	**122**	**18**	**28**	**23**	**383**	**<1**	**n/a**	**740**	***15.0***
Open Water	Open Water - Lakes, Rivers, Streams	n/a	8	5	1	0	<1	<1	0	n/a	14	0.3
	Bays and Estuaries	n/a	0	<1	0	0	0	5	0	n/a	5	*0.1*
	Subtotal Open Water		**8**	**5**	**1**	**0**	**<1**	**5**	**0**	**n/a**	**19**	***0.4***
	Subtotal Non-Forest		**930**	**475**	**36**	**33**	**27**	**674**	**21**		**2,197**	***44.4***
	Percent of All Non-Forest		***42.4***	***21.7***	***1.6***	***1.5***	***1.3***	***30.7***	***0.8***		***100.0***	
Project Total		n/a	**2,582**	**923**	**676**	**41**	**28**	**674**	**21**		**4,946**	
Percent of Pipeline Facilities		n/a	***52.2***	***18.7***	***13.7***	***0.8***	***0.6***	***13.6***	***0.4***		***100.0***	

General: Columns and rows do not necessarily sum correctly due to rounding. Acres rounded to nearest whole acre. Values less than 1 acre shown as "<1".
Acres of disturbance to non-vegetated areas are included in this table for consistency in values reported in this document.

a/ Acres disturbed were evaluated using GIS; footprints for each component (aboveground facilities, permanent easement, and 30-foot maintenance corridor) were overlaid on the digitized vegetation coverage.

b/ The "Late Successional and Old-Growth" category (L-O) describes those forest areas with a majority of trees over 80 years of age. Forests with stands greater than 175 years are considered to have old-growth characteristics.

c/ The "Mid-Seral" category (M-S) describes those forest areas with a majority of trees over 40 years of age but less than 80 years of age.

d/ The "Grass-shrub-sapling or Regenerating Young Forest" category (C-R) describes those forest areas that are either clear-cut (tree age 0-5 years) or regenerating (tree age 5 to 40 years). Forest areas in this category are divided into forest vegetation types based on their potential to become those types of forests.

TABLE 4.5.1.2-6

Summary of Operation-Related Effects on Habitat by the Pacific Connector Pipeline (acres a/)

			Pipeline Facilities								
General Habitat Type	**Mapped Habitat Type**	**Forest Stand by Age**	***30-foot Maintenance Corridor***	**Permanent Access Roads**	**Subtotal Late Successional Old-Growth Forest**	**Subtotal Mid-Seral Forest**	**Subtotal Clearcut / Regenerating Forest**	**Subtotal By Habitat Type e/**	**Permanent Easement (50-foot)**	**Aboveground Facilities**	**Total Operation Disturbance by Habitat Type**
Forest-Woodland	Westside Lowland Conifer-Hardwood Forest	L-O b/	35	<1					59		
		M-S c/	83	<1	35	83	101	219	139	<1	**219**
		C-R d/	101	<1					170		
	Montane Mixed Conifer Forest	L-O b/	5	0					9		
		M-S c/	3	0	5	3	15	23	5	<1	**23**
		C-R d/	14	<1					24		
	Southwest Oregon Mixed Conifer-Hardwood Forest	L-O b/	78	0					130		
		M-S c/	34	0	78	34	68	180	57	<1	**180**
		C-R d/	67	<1					113		
	Ponderosa Pine Forest and Woodlands	L-O b/	16	0					27		
		M-S c/	16	0	16	16	20	51	26	0	**51**
		C-R d/	20	0					33		
	Westside Oak and Dry Douglas-fir Forest and Woodlands	L-O b/	8	0					14		
		M-S c/	8	<1	8	8	0	16	13	0	**16**
		C-R d/	0	0					0		
	Western Juniper and Mountain Mahogany Woodlands	L-O b/	1	0					1		
		M-S c/	15	<1	1	15	13	29	24	<1	**29**
		C-R d/	13	0					22		
	Subtotal Forest-Woodland		**517**	**1**	**143**	**158**	**216**	**518**	**866**	**1**	**519**
Grasslands-Shrubland	Sagebrush Steppe	n/a	26	<1	n/a	n/a	n/a	26	44	21	**48**
	Shrublands	n/a	39	<1	n/a	n/a	n/a	39	65	<1	**39**
	Westside Grasslands	n/a	42	2	n/a	n/a	n/a	44	71	<1	**45**
	Eastside Grasslands	n/a	16	0	n/a	n/a	n/a	16	27	0	**16**
	Subtotal Grasslands-Shrubland		**101**	**<1**	**n/a**	**n/a**	**n/a**	**126**	***207***	**23**	**148**
Wetland/ Riparian	Westside Riparian-Wetlands/Eastside Riparian-Wetlands	L-O b/	0	0					*0*		
		M-S c/	<1	0	0	<1	<1	1	<1	0	**1**
		C-R d/	<1	0					<1		
		Shrub	<1	0	n/a	n/a	n/a	<1	1	0	**<1**
	Herbaceous Wetlands	n/a	20	<1	n/a	n/a	n/a	20	34	0	**20**
	Subtotal Wetland/Riparian		**21**	**<1**	**n/a**	**n/a**	**n/a**	**21**	***35***	**<1**	**21**
Agriculture	Agriculture, Pastures, and Mixed Environs	n/a	97	2	n/a	n/a	n/a	99	161	<1	**99**
	Subtotal Agriculture		**97**	**2**	**n/a**	**n/a**	**n/a**	**99**	***161***	**<1**	**99**

TABLE 4.5.1.2-6 (continued)

Summary of Operation-Related Effects on Habitat by the Pacific Connector Pipeline (acres a/)

General Habitat Type	Mapped Habitat Type	Forest Stand by Age	Pipeline Facilities: *30-foot Maintenance Corridor*	Pipeline Facilities: Permanent Access Roads	Pipeline Facilities: Subtotal Late Successional Old-Growth Forest	Pipeline Facilities: Subtotal Mid-Seral Forest	Pipeline Facilities: Subtotal Clearcut / Regenerating Forest	Pipeline Facilities: Subtotal By Habitat Type e/	Permanent Easement (50-foot)	Aboveground Facilities	Total Operation Disturbance by Habitat Type
Developed / Barren	Urban and Mixed Environs	n/a	8	<1	n/a	n/a	n/a	8	13	2	**10**
	Roads	n/a	52	<1	n/a	n/a	n/a	53	85	<1	**53**
	Beaches	n/a	<1	0	n/a	n/a	n/a	<1	<1	0	**<1**
	Subtotal Developed / Barren		**60**	**1**	**n/a**	**n/a**	**n/a**	61	***98***	**2**	**62**
Open Water	Open Water - Lakes, Rivers, and Streams	n/a	2	<1	n/a	n/a	n/a	3	4	0	**3**
	Bays and Estuaries	n/a	<1	0	n/a	n/a	n/a	<1	3	0	**<1**
	Subtotal Open Water		**3**	**<1**	**n/a**	**n/a**	**n/a**	**3**	***7***	**0**	**3**
	Subtotal Non-Forest		**304**	**5**	**0**	**<1**	**<1**	**309**	**508**	**25**	**334**
	Project Total		**821**	**6**	**143**	**159**	**217**	**827**	**1,374**	**25**	**852**

General: Columns and rows do not necessarily sum correctly due to rounding. Acres rounded to nearest whole acre. Values less than 1 acre shown as "<1".
Acres of disturbance to non-vegetated areas are included in this table for consistency in values reported in this document.

a/ Acres disturbed were evaluated using GIS; footprints for each component (aboveground facilities, permanent easement, and 30-foot maintenance corridor) were overlaid on the digitized vegetation coverage.

b/ The "Late Successional and Old-Growth" category (L-O) describes those forest areas with a majority of trees over 80 years of age. Forests with stands greater than 175 years are considered to have old-growth characteristics.

c/ The "Mid-Seral" category (M-S) describes those forest areas with a majority of trees over 40 years of age but less than 80 years of age.

d/ The "Grass-shrub-sapling or Regenerating Young Forest" category (C-R) describes those forest areas that are either clear-cut (tree age 0-5 years) or regenerating (tree age 5 to 40 years). Forest areas in this category are divided into forest vegetation types based on their potential to become those types of forests.

e/ Subtotal by Habitat Type includes the 30-foot maintenance corridor, permanent access roads, and only aboveground facilities with a meter station or compressor station (mainline block valves located within the 30-foot maintenance corridor).

During construction and restoration, Pacific Connector would implement numerous measures to minimize impacts on vegetation and ensure successful revegetation of disturbed areas (see section 4.4). These measures include those found in the ECRP, *Leave Tree Protection Plan*, *Integrated Pest Management Plan*, *Fire Prevention and Suppression Plan*, and the *SPCC Plan*. These measures would be applied to all lands crossed by the pipeline route; however, federal land-managing agencies may impose additional measures on federal lands. Measures specific to federally managed lands are addressed in the upland vegetation section 4.4.1.3.

Effects on Terrestrial Wildlife Species

General Effects Applicable to All Terrestrial Wildlife

Many species have very specific habitat requirements that may or may not be present in the area affected by the Project and would not be described in the relatively broad habitat types used in this section (habitat types described by Johnson and O'Neil 2001). Consequently, the assumption has been made that if a species' occupied range is known or likely to coincide with the area affected by the Project, and if general habitat types that would be affected by the Pacific Connector pipeline could include more specific habitat components required by that species, then the species could occur and be affected in some way by the Project.

Constructing and operating the Project could cause habitat degradation by spreading noxious weeds, herbicide use, noise, and habitat fragmentation. Wildlife may be affected by construction vehicles traveling to and from construction sites. Species most susceptible to vehicle-related injury and mortality include those that are inconspicuous (salamanders, frogs, snakes, small mammals), those with limited mobility (amphibians), burrowing species (mice and voles, weasels, beaver, frogs and toads, snakes, subterranean mollusks), and wildlife with behavioral activity patterns making them vulnerable, such as deer that are more active at dusk and dawn, and wildlife that may scavenge roadside carrion (Leedy 1975; Bennett 1991; Forman and Alexander 1998; Trombulak and Frissell 2000). Vegetation clearing during operations of the pipeline could also affect wildlife.

Other species are likely to be displaced from habitats that are cleared of vegetation (passerine birds, and tree-dependent/cavity-dependent birds and mammals such as woodpeckers and bats) and from areas adjacent to construction sites (waterfowl, raptors and medium-sized mammals). Populations may also be negatively affected if individuals emigrate from habitats affected by project-related disturbances. Displacement of mobile wildlife would most likely be a short-term effect. Once construction and restoration of the right-of-way is complete, displaced individuals are expected to return to the original area they occupied. If adjacent habitats are at carrying capacity for the species, displaced individuals would cause increased competition for resources, increased susceptibility to predation, or promote disease that may be facilitated by crowding.

Activities associated with constructing the pipeline could decrease individuals' reproductive success by increasing neonate or nest abandonment and possibly by interfering with breeding behaviors, sustenance, and growth of fetuses and/or young, conception rates, and fetal survival. These impacts may affect population growth through diminished rates of survivorship and fecundity.

Both long-term and short-term effects could occur to amphibians and reptiles associated with waterbodies and the riparian areas. Removal of riparian vegetation along stream edges that are crossed by the Project could increase sedimentation input into the waterbody and/or increase water temperatures. Changes in hydrology could also occur in wetlands and waterbodies used for breeding, limiting dispersal or reducing breeding habitat (ODFW 2006b).

Construction of the pipeline through upland forests would require removal of deciduous and coniferous trees and would remove those habitat features over the long-term. It would take decades for trees to grow to their original size in temporary workspaces in cleared forested areas that are restored and revegetated after construction. Former forested habitats in Pacific Connector's 30-foot-wide operational right-of-way would be converted to shrub-sapling dominated or herbaceous cover for an extended period of time (50 years or more). This conversion could benefit some wildlife species that characteristically inhabit shrub or grassland habitats but would be detrimental to wildlife species adapted to forest interiors. Construction through forested areas would also result in the removal of snags and LWD that are used by a variety of wildlife, including cavity nesters and bats.

Construction through existing shrub-dominated areas would mostly result in short-term habitat loss. After restoration and revegetation, grasses and shrubs would be allowed to regenerate across the entire right-of-way. There would be long-term habitat loss in some areas, where shrubs, such as species of sagebrush, would require longer than 5 years to become reestablished. Loss of this habitat type could potentially affect certain species of birds and mammals that utilize shrubs, by reducing forage and nesting opportunities.

Noxious Weeds and Invasive Species

Short- or long-term effects on wildlife habitat would also occur if the pipeline causes the establishment and spread of noxious weeds, as well as other invasive species (animals and microbes) not native to a region. In general, habitats with more bare ground, such as grasslands, riparian areas, relatively dry, open forests, and disturbed areas such as roads are more susceptible to invasive species establishment than are dense, moist forests, high mountain areas, and serpentine areas that have relatively closed plant cover or have extreme climate or soils.

Noxious weeds often out-compete native vegetation. They displace native species by spreading rapidly and utilizing resources (nutrients, water, sunlight) that can eventually lead to a weed-dominated monoculture. Such transformed habitat can be unsuitable to former wildlife inhabitants. Often, as habitat quality degenerates, wildlife diversity declines. For example, purple loosestrife forms dense monocultures that inhibit native vegetation, causing decreasing species' diversity, limit water flows and wildlife access to water, and in some instances can make waterfowl nesting areas unsuitable (Whitson 1996). A summary of noxious weed species found along the pipeline route is provided in table 4.4.1.2-4.

Clearing of vegetation from the linear right-of-way and soil disturbance from right-of-way grading would increase the chance of spreading noxious weeds through the removal of native, established species and soil disturbance, which could encourage the establishment of invasive plants. Equipment moving along the right-of-way could also bring seeds from one place to the next, aiding the spread of these species. Pacific Connector has measures in place to help prevent this as described in the ECRP.[110] Weed surveys would take place prior to vegetation removal, and infested areas would be pretreated through mechanical methods and herbicide spot treatment to minimize the spread of invasive plants. Equipment would also be inspected and cleaned of any

[110] See Appendix I to the POD, which was included in Pacific Connector's application to the FERC.

potential weed seed or propagules (i.e., soil roots or rhizomes). During restoration, disturbed areas would be revegetated with native seed mixtures. Monitoring would typically occur for a period of three to five years (as described in the *Integrated Pest Management Plan* and ECRP) to ensure that no non-native plants establish themselves in lands disturbed by pipeline activities. Due to measures that would be employed before, during, and after construction, the risk of the pipeline causing noxious weeds to spread in the area of the pipeline should be low.

Pacific Connector would mitigate for the spread of noxious weeds, forest pathogens, and soil pests by following the measures outlined in its *Integrated Pest Management Plan*.[111] Further measures for controlling the spread of noxious weeds are contained in its ECRP. See section 4.4.1.2 for more details on invasive plants and mitigation measures.

Invasive insects, mites (e.g., spruce spider mite), and terrestrial mollusks (e.g., the predatory spotted leopard slug) can similarly disperse along a newly created corridor where native vegetation formerly presented barriers to dispersion. In general, invasive exotic wildlife species can adversely affect native species and their populations through various pathways, singly or in combination that include:

- introduction of disease or parasites to native wildlife;
- interbreeding (hybridization) with native wildlife;
- competition for habitat with native wildlife;
- degradation of habitat of native wildlife; and/or
- predation on native wildlife.

The measures outlined in the *Integrated Pest Management Plan* would help decrease the adverse effects of invasive insects.

Invasive animals such as introduced bullfrogs have adversely affected various native frog populations through predation (Hayes and Jennings 1986), including populations of Oregon spotted frogs in Washington (Watson et al. 2000). Bullfrogs prey on and out-compete native frog species. They spread very quickly due to their prolific nature, lack of predators, ability to travel long distances over dry land, and wide habitat and diet preferences. Pacific Connector has developed BMPs to avoid the potential spread of the aquatic invasive species and pathogens of concern during Project hydrostatic testing operations (see the *Hydrostatic Testing Plan*[112]). While bullfrogs are not specifically addressed in the *Hydrostatic Testing Plan*, it is anticipated that the screening/filtering, chlorine treatment, and upland dewatering BMPs would be effective at eliminating the potential spread of bullfrogs and their eggs or tadpoles.

The range of the barred owl has expanded into NSO habitat, and this species competes with NSO for resources and has been known to displace NSO from suitable habitat (Kelley et al. 2003; Kelley and Forsman 2004). Barred owls negatively affect NSO populations, primarily by reducing survival and increasing local territory extinctions (Dugger et al. 2016).

[111] See Appendix N to the POD, which was included in Pacific Connector's application to the FERC.
[112] See Appendix M to the POD, which was included in Pacific Connector's application to the FERC.

Herbicides

Herbicides could affect native plant species, thereby affecting wildlife habitat and potentially the animals themselves. While adverse effects on wildlife tend to be low, some symptoms include breakdown of vital organs, reduction in numbers of healthy offspring, decreased fitness, and direct mortality (Forest Service 2005b). Amphibians can be deformed or killed by some herbicides if these chemicals get into the water. Herbicides tend to form residue on grasses more readily than other vegetation; therefore, wildlife that eats grass, as well as those species above them on the food chain, tend to be most susceptible to the effects of herbicides (Forest Service 2005b).

Pacific Connector would control all ODA A- and T-listed weeds, along with some B-listed weeds (ODA 2017b). To determine if an herbicide is to be used over hand and mechanical weed control methods, Pacific Connector would implement integrated weed management principles following BLM (2010b) and Forest Service (2005c) guidelines (see section 4.4 for more details).

In accordance with Pacific Connector's *Integrated Pest Management Plan*, only specific spots would be treated with herbicides to control noxious weeds. Because agency-approved herbicides are generally of low toxicity to animals when applied per label instructions, adverse effects on wildlife should be low.

Noise

Noise from construction and operation of the Pacific Connector Pipeline Project is discussed in detail in section 4.12.2.2 of this EIS. We estimate that noise from general construction of the pipeline would range from the L_{eq} of about 93 dBA at 50 feet, to 85 dBA at 100 feet, and 72 dBA at 300 feet. Ambient sound levels in much of the Pacific Connector pipeline route area probably would be similar to the Arcata Fish and Wildlife Office's projections (FWS 2006a). Ambient sound is defined as the sound qualities as they might exist currently and might include human-generated sources over the long term. The typical ambient sound level for forest habitats ranges from 25 dB to 44 dB. Considering ambient sound as a base, noise levels associated with some common machines and activities that would be present during pipeline construction are included in table 4.5.1.2-7. Noise from HDD drilling would range from L_{dn}[113] of about 32 to 73 dBA at NSAs, with no noise mitigation. This compares to current ambient L_{dn} levels at these NSAs ranging from about 42 to 66 dBA. Double rotor helicopters may be used for timber clearing along a portion (15.4 miles) of the Pacific Connector pipeline route. This type of helicopter generates noise of about 92 dBA within 700 feet of its area of use. Operation of the Klamath Compressor Station would result in estimated L_{dn} noise of about 51 dBA at an NSA located about 1,230 feet away. Current ambient noise at this residence is an L_{dn} level of about 43 dBA.

TABLE 4.5.1.2-7

Common Sound Levels for Equipment/Activities Potentially Associated with the Pacific Connector Pipeline

Measured Sound Source	Range of Reported dB Values (at Distance Measured 50 feet)	Relative Sound Level a/
Forest Habitats	25 – 44	Ambient
Yelling	70	Low
Chain Saw (various types/conditions)	61 – 93	Low – Very High
Pickup Truck (idle to driving)	55 – 71	Very Low – Moderate
Mowers	68 – 85	Low – High

[113] Appendix B of Pacific Connector's POD filed with the FERC on January 23, 2018.

TABLE 4.5.1.2-7

Common Sound Levels for Equipment/Activities Potentially Associated with the Pacific Connector Pipeline

Measured Sound Source	Range of Reported dB Values (at Distance Measured 50 feet)	Relative Sound Level a/
Log Truck	77 – 97	Moderate - Very High
Dump Truck	84 – 98	High - Very High
Rock Drills	82 – 98	High - Very High
Pumps, Generators, Compressors	87	High
Drill Rig	88	High
General Construction	84 – 96	High – Very High
Track Hoe	91 – 106	Very High – Extreme
Helicopter or Airplane (various types/conditions)	96 – 112	Very High – Extreme
Rock Blast	112 b/	Extreme
Logging Helicopter (Columbia double rotor)	108 – 123	Extreme

Source: FWS 2006a

a/ A general, subjective ranking of noise levels created by the sources considered when used for analysis of relative noise effects on species.
b/ Blasting required for the Pacific Connector pipeline would be underground and muffled, which should result in a lower dB value at 50 feet.

Noise could potentially affect wildlife in localized areas for a short duration during pipeline construction activities, including clearing and grading the right-of-way, and HDD operations. The average time a given point along the pipeline would be disturbed by construction noise is approximately 8 weeks. This would vary, as the speed at which a crew would be able to work would be affected by terrain, construction methods, weather, and environmental windows. HDD operations may occur 24 hours per day, seven days a week. HDD operations are estimated to last from 20 to 100 days depending on the location.

Distances at which noise would attenuate to ambient levels would depend on local conditions such as tree cover and density, topography, weather (humidity), and wind, all of which can alter background noise conditions. Consequently, short-term effects on wildlife by construction noise would vary along the length of the pipeline route.

Noise would most likely displace wildlife some distance away from noise sources especially if wildlife species are nearby. However, any short-term effects on wildlife by noise would occur simultaneously with human presence and the presence of heavy machinery normally required for pipeline construction. Most likely, any effects on wildlife due to noise could not be separated from those due to all other construction-related activities occurring concurrently. Noise and human presence would move along the construction right-of-way, albeit at a rather slow pace. Therefore, effects on wildlife because of noise would be of short duration and spatially localized.

Research has demonstrated varying short-term reactions of wildlife to noise. Most research has focused on wildlife reaction to more constant noise generated by roads and high-volume traffic (e.g., Forman and Alexander 1998). Some research has recorded wildlife reaction to airplanes, sonic booms, helicopters, artillery, and blasting that could produce similar reactions from noises associated with construction activities for the Pacific Connector Pipeline Project. For example, Golden et al. (1980) provided the following behavioral and physiological reactions of animals to known noise levels ranging between 75 and 105 dB from various disturbances, including aircraft:

- fish demonstrate reduced viability, survival, and/or growth (20 dB for 11 to 12 days);
- ungulates become nervous and/or run (82 to 95 dB) or panic (95 to 105 dB);

- waterfowl flock (80 to 85 dB), move and/or become nervous (85 to 95 dB), or startle (95 to 105 dB); and
- birds scare (85 dB).

Raptors and other forest-dwelling bird species have demonstrated more adverse effects on project-generated sound during nesting and breeding when levels substantially exceed ambient conditions existing prior to a project. For instance, the FWS has determined that sound exceeding ambient nesting conditions by 20 to 25 dB or exceeding 90 dB when added to ambient conditions may be considered take under ESA when evaluating effects on NSO and MAMU (FWS 2006a). Such sound levels could potentially result in egg failure or reduced juvenile survival, malnutrition or starvation of the young, or reducing the growth or likelihood of survival of young. However, these effects may be minimal; Awbrey and Bowles (1990) found that raptors flushed from their nests while incubating did not leave the eggs exposed for more than 10 minutes and concluded that multiple, closely spaced disturbances would be required to cause lethal egg exposure. Some raptors, for example osprey, refuse to be flushed from their nest despite closely approaching helicopters (Poole 1989).

Specific studies to determine effects on wildlife from noise generated from construction of a pipeline have not been conducted. However, it is expected that construction noise in remote areas that are relatively free from noise would have a greater potential to disrupt wildlife. Potential effects on wildlife from some noises generated from construction activities can be evaluated to an extent, such as noise from vehicles and/or increased road traffic, blasting, helicopter timber harvest or pipeline delivery, and aerial fly-overs.

Animals could flee the area because of helicopter disturbance. Pacific Connector has filed an *Air, Noise and Fugitive Dust Control Plan*[114] that describes helicopter noise and potential mitigation. In the case of birds, helicopter noise could cause adult birds to flush leaving eggs exposed to weather and predators. For all animals, helicopter disturbance could have negative energetic effects. Mitigation for helicopter noise includes operational restrictions, such as scheduling restrictions near sensitive areas, maintaining a high altitude and flight paths away from noise sensitive areas whenever possible.

The USDOT (2004) has summarized numerous studies and literature that have reported the effects of noise on wildlife, specifically focusing on noise associated with roads. Overall, existing information suggests that fish are unlikely to be adversely affected by noise levels produced from road traffic; reptiles and amphibians show some barrier effect due to roads (but no clear evidence of a noise effect alone); bird numbers and breeding can be strongly affected by the proximity of roads; large mammals can be repelled by road/vehicle noise; and small mammals do not appear to be adversely affected by road noise.

Blasting may be required for pipeline trench excavation in areas where hard, non-rippable bedrock occurs in the trench profile. Approximately 117 miles of the pipeline alignment is considered to have moderate to high blasting potential, although not all substrate in those areas identified may require blasting to achieve the required trench depth. Blasting activities may involve a single blast or a repetitive blasting sequence. Blasting during trench excavation is discussed in more detail in section 4.1.2.5.

[114] Appendix B of Pacific Connector's POD filed with the FERC on January 23, 2018.

Noise from blasting would be short-term and localized. The noise associated with blasting activities is reported to be in the range of 112 dB within 50 feet of the trench (see table 4.5.1.2-7), and may cause alarm in wildlife (e.g., birds, terrestrial mammals, etc.). With the proposed Best Management Practices and mitigation measures applied to trench blasting, the blasting noise would attenuate to 92 dB within 200 feet and 70 dB within 1,025 feet. Mitigation includes blasting methods, which reduce noise through charge placement and timing of detonation, and physical mitigation such as covering the blast areas with soil or blast mats. Pacific Connector has filed a *Blasting Plan* (Appendix C to the POD) and an *Air, Noise and Fugitive Dust Control Plan* (Appendix B to the POD) that further discusses blasting mitigation methods. Noise from blasting would disturb wildlife individuals near blast areas for short periods of time resulting in temporary changes in foraging or breeding behaviors. We conclude that the Project would not significantly affect terrestrial wildlife.

In 2005, a study was conducted during a 4,000-foot-long HDD crossing of the Nooksack River crossing in Whatcom County, Washington, to determine if drilling noise associated with the HDD (noise levels between 47 and 52 dBA at the study area) had a negative effect on wintering bald eagles. Eagles were observed from November 1, 2005, through April 7, 2006, and results indicated that bald eagles were not negatively affected by HDD rig activity (Edge Environmental, Inc. 2006).

Pacific Connector proposes to cross the Coos, Rogue, and Klamath Rivers, Coos Bay at two separate locations, and a BPA powerline corridor using HDD technology. Pacific Connector would cross the South Umpqua River using DP. Noise studies conducted for the HDD and DP of each proposed crossing determined that, with the use of mitigation measures (such as special vinyl fabric acoustic tents or other barriers), noise levels at the seven crossings are not expected to exceed the Oregon State noise regulations of 55 dBA during the day and 50 dBA at night within 25 feet of an NSA. To ensure adequate mitigation and monitoring, we are recommending Pacific Connector file HDD noise mitigation plans for review and approval prior to construction (see section 4.12.2.4). Noise effects on wildlife from the operation of the drilling equipment from the HDD crossings at Coos, South Umpqua, Rogue, and Klamath Rivers should be negligible.

A minimal increase in ambient noise levels would occur during periodic right-of-way vegetation maintenance activities (i.e., mowing, chainsaws) during operation. The major source of operational noise for the Project would be from the Klamath Compressor Station, which is located in an area surrounded by rural residences, agricultural lands, and rangelands and grasslands. Noise from the compressor station would be long-term but localized to one site. The expected increase in L_{dn} noise levels would range from 0.5 dBA to 7.2 dBA above current ambient noise at the nearby NSAs during normal station operations. In terms of environmental noise effects, an increase to the ambient sound level of 10 dBA typically results in the perception of a doubling of sound. Consequently, the Klamath Compressor Station would have noise effects on the surrounding NSAs because of the very quiet existing ambient conditions. With appropriate mitigation measures, we expect the compressor station to operate below our standard of 55 dBA for all NSAs. This sound level could have localized adverse effects on wildlife near the station.

Habitat Fragmentation and Edge

One manifestation of fragmentation is the amount of edge created through otherwise contiguous habitats. In the context of habitat fragmentation, edge is the portion of habitat (or ecosystem on a larger scale) "near its perimeter, where influences of the surroundings prevent development of interior environmental conditions" (Forman 1995). As compared to interior habitats, edge habitats generally support different species composition, structure, and species' abundance. For example, vertebrate species richness (bird and amphibian) has been positively associated with edges in fragmented Douglas-fir forests (Rosenberg and Raphael 1986), although species benefitted are typically habitat generalists. Edge habitat would no longer favors species that are dependent on forest interior conditions, allowing species that utilize the edge habitat to disperse into the forest interior which can have adverse effects on wildlife and plants through competition for resources, increased predations, spread of disease and insect infestation, and establishment of noxious weeds (Bannerman 1998).

Along with the creation of edge, pipeline construction would further fragment habitat. Habitat fragmentation has already occurred to some extent in the areas crossed by the pipeline route because of existing residential developments, tree harvests, roads, and utility corridors. These sources of habitat fragmentation are expected to increase in the foreseeable future outside of protected areas such as LSRs). Fragmentation can also affect the rate and scope of blowdowns in forested habitats (the effects of blowdowns are discussed in section 4.4).

Because the pipeline is linear, the created patch associated with the new edge would be narrow and elongated unlike edges created by forest practices (Forman and Gordon 1986). Creation of edges by the Project would affect seral stands differently. Douglas-fir or western hemlock would be replanted during restoration of temporary work areas, including TEWAs, in the pipeline right-of-way (except in the 30-foot-wide maintenance corridor centered on the pipe), where conifers would be removed during construction activities. It is anticipated that both temporary and permanently cleared areas in forest habitats would increase the occurrence of windthrow (snapping of branches and uprooting, snapping of boles), which could result in greater effects on forest habitat than just those areas identified for disturbance.

Douglas-fir and western hemlock planted adjacent to edges of clearcut and/or early regenerating stands (assuming conifers from 1 to 10 feet tall at the time of construction) would modify edges with the seral stands from hard to soft to no edge as they grow. In 50 years, which is the operational life of the Project, trees replanted in temporary workspaces outside of the 30-foot-wide maintenance corridor would similarly modify edges of regenerating and mid-seral stands adjacent to the right-of-way, from hard to soft edge characteristics as tree heights increase. As the replanted trees grow, edge contrasts would decrease, as would the effects on forest interiors, because taller trees would reduce direct solar radiation and increase soil moisture and humidity along the edges of stand interiors (Chen et al. 1993; Heithecker and Halpern 2007). During operations, Pacific Connector would use mechanical vegetation management methods or, where access of machinery is infeasible, manual clearing to maintain the existing right-of-way; this vegetation management would increase the edge effect beyond the maintained right-of-way (e.g., light and wind would be able to penetrate farther into previously "interior" forests).

Different species composition and abundance occurs in edge habitats (Forman and Gordon 1986) than in patch interiors, depending on species' tolerances for the variation in microclimatic parameters. Some terrestrial amphibians, for example, have narrow temperature and moisture tolerances (Spotila 1972; Feder 1983). Moist, cool, and stable microclimatic conditions are essential to these species. Loss of canopy cover and coarse wood can affect amphibians' microclimatic conditions. Some wildlife species use right-of-way corridors created by pipelines and other linear utilities. For example, bird species' diversity in powerline corridors through forested vegetation was found to be higher in the corridor than in the adjacent forest (Kroodsma 1984). Often present along the edge are higher levels of flower and fruit production, pollinator, and frugivore densities and seed dispersal. Also, deer and elk use of available browse in corridors or on edges of corridors that are adjacent to hiding and thermal cover have been documented (Hartley et al. 1984; Brusnyk and Westworth 1985). Increased herbivore density in edge habitat provides a food source for predators (Forman 1995); therefore, predator density is expected to increase along the edge.

Few studies have evaluated the establishment of forage in pipeline corridors and utilization by big game. The study conducted in Alberta by Brusnyk and Westworth (1985) focused on forage and browse production on a 17-year-old pipeline right-of-way and on a 2-year-old right-of-way. They compared big game use (moose, deer, and elk) of forage on the two rights-of-way to use in adjacent undisturbed forest ecotones and undisturbed forest. Deer appeared to utilize browse in the 17-year-old corridor but returned to adjacent undisturbed forest, probably utilizing available hiding or thermal cover. Deer utilized the corridors for travel in early winter prior to limiting snow depths. Elk utilized forage on the two-year-old right-of-way primarily where portions were adjacent to forested habitats. The principal conclusion of this study was that pipeline corridors increased local habitat diversity and that diversity—juxtapositions of browse or forage to undisturbed forested habitat—influenced use of the corridors by ungulates. Similarly, studies in Washington and Oregon have shown that elk prefer habitat that is close to cover-forage edges (Rowland et al. 2018).

During right-of-way restoration, Pacific Connector would create habitat diversity features in the right-of-way corridor, such as rock and brush piles, that would provide habitat for a variety of wildlife species including mollusks, amphibians, and small mammals. Such features reduce fragmentation effects of abrupt edge characteristics by creating local irregularities. LWD placed in and/or across the right-of-way may eventually contribute to microsite diversification and provide corridors for some wildlife (e.g., terrestrial mollusks) to travel across an otherwise potential barrier. Such movements would be essential to avoid potential genetic isolation of relatively non-mobile species.

Effects on Mammals

Effects discussed for "General Effects Applicable to All Terrestrial Wildlife" would be relevant to mammals. Because it will not be known where mammals are specifically located, effects can be quantified by acres of disturbance in habitats in which they could occur (see table 4.5.1.2-1). The Project would be cutting a narrow swath out of larger areas of potentially suitable habitat. Because of the low percentage of all available habitat in the area being affected, the Project is not expected to have population-level effects on mammals.

The Pacific Connector Project is not expected to affect the Pokegama wild horse herd, as the Project would not cross through or affect the HMA.

Timber clearing in winter and early spring would coincide with the bat hibernation period. Bats utilizing trees for hibernation would be killed by timber clearing. Timber clearing in spring and early summer would coincide with natal or maternity periods but would not occur between April 1 and July 15 in order to avoid the migratory bird nesting season. Females and young inhabiting roosts in tree cavities would likely be killed if occupied roost trees and/or snags were felled. Likewise, bats utilizing day roosts under loose bark or in snags with cavities could be killed by timber clearing at any time of the year. Young bats would likely be killed if roost trees were felled before they were able to fly. Most bat species, especially Townsend's big-eared bat, are sensitive to disturbance and would abandon disturbed roosts (Csuti et al. 2001; Verts and Carraway 1998; ODFW 2013a). This disturbance and subsequent abandonment would have energetic repercussions, potentially decreasing successful reproduction and survival.

Noise from traffic and other sources is believed to interfere with bats' echolocation (Jones 2008). We estimate that noise from general construction of the pipeline would be about 72 dBA at 300 feet. construction-related traffic and other pipeline construction noise would be limited to daylight hours, except for HDDs, and would mostly avoid periods when bats use echolocation to forage. Consequently, pipeline construction noise would not significantly affect bats. Pipeline construction noise is discussed in more detail in section 4.12.2.2.

Night lighting could act as barriers to bat movements (Kuijper et al. 2008), reduce bat activity in the immediate vicinity (Stone et al. 2009), or have an opposite effect by attracting nocturnal insects (Svensson and Rydell 1998; Rydell and Racey 1993). The Klamath Compressor Station would be equipped with outside lighting to support night work activities. During normal operations, nighttime work or maintenance activities would generally not be scheduled; therefore, these lights would only be used periodically and possibly for short periods during the winter when daylight hours are short.

Pacific Connector would operate 15 new communication towers ranging in height from 40 to 170 feet tall (table 2.1.2.2-2). Of the 15 new towers, 7 would be associated with new project features and Pacific Connector would attempt to co-locate the other 8 towers with existing facilities. It is possible that bats would fly into the communication towers. Placement of 8 towers within existing facility sites is not expected to affect habitat or wildlife more than has already been affected with the original construction and operation of these facilities. New towers would not significantly affect bats, as these towers would not have guy wires or lighting, which would decrease the possibility of collisions but would not entirely eliminate that risk.

Because it will not be known where bat roosts are specifically located, effects on bats are assumed to occur in forested habitat types. Timber clearing is expected to injure or cause mortality to an unknown number of individual bats. Because white-nose syndrome is not known to affect bats in Oregon, the Pacific Connector pipeline is not expected to facilitate spread of this disease. Considering the amount of available forested habitat adjacent to the pipeline, and the dispersed nature in which tree-roosting bats typically roost in the west, construction and operation of the Pacific Connector pipeline would not be expected to significantly effect these bat species.

Effects on Birds

Effects on migratory bird occupied nests, eggs, pre-fledgling young, and potentially adults would be minimized by Pacific Connector's commitment to various seasonal restrictions during construction. Tree felling and brush removal during construction would be conducted outside of the primary migratory bird nesting season, which is April 1 through July 15. The primary migratory bird nesting season is based on data from Adamus et al. (2001) and determined in consultation with FWS as described in the draft *Migratory Bird Conservation Plan*. In addition, tree felling within 0.25 mile of an NSO activity center would occur after September 30 and before March 1, and tree felling within 330 feet of MAMU stands would occur after September 15 but before April 1. Routine vegetation clearing during operations would only be done between August

1 and April 15 of any year, to reduce effects on nesting birds during the primary spring and summer breeding season. Additional restrictions for other migratory birds are listed in the draft *Migratory Bird Conservation Plan* filed with the FERC on August 31, 2018. While these timing restrictions would minimize effects on migratory birds, some mortality could occur outside of the primary nesting season.

If a species' breeding period begins or ends outside of the primary breeding season, the active nest, eggs, or unfledged juvenile birds would be at risk. Numbers of migratory birds, nests, and eggs that might be affected during vegetation clearing and/or construction on spreads 1 through 5 are estimated and summarized in table I-13 in appendix I. Construction spreads 1, 2, and 3 are in BCR 5; spread 4 is mostly in BCR 5 with about 1.5 miles in BCR 9; and spread 5 is in BCR 9.

To estimate the amount of birds and eggs affected, Pacific Connector compiled data for 33 BBS routes within 50 miles of the pipeline. Numbers of birds for species observed each year on a route were divided by the length of the BBS route (birds per mile), averaged each year for routes reporting the species, and averaged for the 20-year period 1997 to 2016. For each species that had a close or general association with habitats affected by the pipeline, the average number of birds per mile was multiplied by miles of habitat affected in each construction spread 1 through 5 (miles of habitat affected are included in table I-13 in appendix I).

Edge habitat created by the pipeline right-of-way is expected to have both positive and negative effects on bird species. Expected positive effects are increased diversity and density of bird species, increased access to a variety of food resources, and increased ground cover favoring ground-nesting species (Rosenberg and Raphael 1986). Potential negative effects include increased brood parasitism, increased nest depredation in grasslands, forests and edge habitats, and lower nesting success (Thomas and Towiell 1982; Burger et al. 1994; Vickery et al. 1994; Marini et al. 1995; Danielson et al. 1997; Brand and George 2000). There have been declines of sagebrush-dependent migratory passerine bird species with loss of sagebrush steppe vegetation and increased fragmentation in remaining sagebrush-dominated habitats (Knick and Rotenberry 1995; Knick et al. 2003). Densities of Brewer's sparrow and sagebrush sparrow, as well as other species dependent on sagebrush for nesting habitat, were greatly reduced near well-field roads and pipelines compared to densities beyond 300 feet (Ingelfinger 2001). Nest parasitism by brown-headed cowbirds is especially likely in fragmented shrub-dominated habitats (Vander Haegen and Walker 1998). Such effects would be facilitated over the long term because maintenance of the 30-foot permanent easement would create areas of early-seral habitat throughout the operational life of the project. These corridor areas would not only provide habitat used by some wildlife species, but would also connect patches of suitable habitat, allowing wildlife to move between one patch and another (Turner et al. 2001).

Corvids, including common ravens and American crows (also jays and magpies), are opportunistic predators and will prey on other species' nests (Marzluff and Neatherlin 2006; Vander Haegen et al. 2002; Luginbuhl et al. 2001). Studies have shown that corvid populations expand and nest predation increases near human developments (Marzluff and Neatherlin 2006) and corvid predation increases in habitats that have been fragmented by humans (Vander Haegen et al. 2002). Potential effects on nesting birds by predatory corvids attracted to the right-of-way would be addressed by ensuring that all construction contractors practice appropriate and responsible trash disposal every day.

Pacific Connector would apply spatial and temporal buffers to known NSO, golden eagle, peregrine falcon, and great gray owl nesting habitat. Pacific Connector would also perform eagle and buteo hawk nest surveys prior to construction or timber clearing, and any occupied nests would be subject to spatial and temporal buffers appropriate for the species. FWS has drafted *Guidelines for Raptor Conservation in the Western United States* (Whittington and Allen 2008). The draft guidelines recommend spatial buffers for nests of breeding raptors during the breeding periods, which vary by location across the western states. Table 4.5.1.2-8 lists the raptor species that have been reported along the Pacific Connector Pipeline Project route by various sources and the recommended spatial buffers during nesting periods (not included in the table). Human disturbances in spatial buffers risk nest abandonment by adults and nest failure (Whittington and Allen 2008). As previously described for migratory birds, timber clearing and project construction during the breeding period would affect raptor nests, eggs, young, and adults; many effects would be avoided or minimized through vegetation clearing timing restrictions during the breeding season, raptor nest surveys, and other conservation measures provided in the draft *Migratory Bird Conservation Plan*.

TABLE 4.5.1.2-8

FWS Recommended Spatial Buffers Surrounding Raptor Nests of Species that May Occur in the Vicinity of the Pacific Connector Pipeline

Common Name	Scientific Name	Spatial Buffer (miles) c/
Hawks, Eagles, Falcons		
Osprey	*Pandion haliaetus*	0.25
Bald Eagle a/	*Haliaeetus leucocephalus*	0.5–1.0 (0.25)
Northern Harrier b/	*Circus cyaneus*	0.25
Sharp-shinned Hawk	*Accipiter striatus*	0.25
Cooper's Hawk	*Accipiter cooperii*	0.25
Northern Goshawk	*Accipiter gentilis*	0.50
Red-shouldered Hawk	*Buteo lineatus*	0.25
Red-tailed Hawk	*Buteo jamaicensis*	0.33
Ferruginous Hawk b/	*Buteo regalis*	1.00
Golden Eagle	*Aquila chrysaetos*	0.50 (0.50)
American Kestrel b/	*Falco sparvarius*	0.125
Peregrine Falcon	*Falco peregrinus*	1.00 (1.50)
Owls		
Western Screech Owl	*Megascops kennicottii*	0.125
Great Horned Owl	*Bubo virginianus*	0.125
Northern Pygmy Owl	*Glaucidium gnoma*	0.25
Burrowing Owl b/	*Athene cunicularia*	0.25

TABLE 4.5.1.2-8

FWS Recommended Spatial Buffers Surrounding Raptor Nests of Species that May Occur in the Vicinity of the Pacific Connector Pipeline

Common Name	Scientific Name	Spatial Buffer (miles) c/
Northern Spotted Owl	*Strix occidentalis caurina*	0.50 (0.25)
Barred Owl	*Strix varia*	0.25
Great Gray Owl	*Strix nebulosa*	0.25 (0.25)
Short-eared Owl b/	*Asio flammeus*	0.25
Northern Saw-whet Owl	*Aegolius acadicus*	0.125

Source: Whittington and Allen (2008)
Note: Includes special status species that are otherwise addressed in section 4.6.
a/ Spatial buffer dependent on line-of-sight to nest.
b/ Species added to table based on occurrence on BBS routes.
c/ Spatial buffers committed to in the Draft Migratory Bird Conservation Plan are in parenthesis. Note that the National Bald Eagle Management Guidelines (FWS 2007b) recommend a 660-foot (200-meter) buffer surrounding nests during the breeding season applied to timber harvest, road construction, chain saw, and yarding operations (assumed similar to timber clearing & pipeline construction).

Pacific Connector would use eight existing communication towers and construct seven new towers (see table 2.1.2.2-2). Communications towers are estimated to kill millions of birds each year, with mortality near guyed towers greater than self-supporting towers (FCC 2006). Also, the majority of bird-tower collisions are reported from towers over 500 feet tall (Gehring 2004). Most bird-tower collisions occur at night, generally during conditions with low visibility, and during the day under foggy conditions. Bird-tower collisions may also increase with lighting on the towers. Research indicates that white strobe lights on towers may create less of a hazard to migratory birds, although these types of lights are not allowed within three nautical miles of an airport (FCC 2006). Additionally, some research has indicated that marking guy-wires to make them more visible may reduce avian mortality (FCC 2006).

Use of eight currently existing towers is not expected to affect habitat or wildlife more than has already been affected with the original construction and operation of these facilities. New towers would not have guy wires or lighting and are either 40 or 170 feet tall, which would decrease the possibility of bird collisions but would not eliminate that risk entirely. Some additional mortality could occur from collision with towers but, given the relatively low height and the fact that towers do not have lighting or guy wires, additional mortality is expected to be minimal.

As described above, the Pacific Connector Project would affect migratory bird nests, eggs, young, and adults from tree clearing occurring outside of the primary migratory bird nesting season. Where vegetation clearing cannot be avoided during the breeding season, Pacific Connector would have qualified biologists perform pre-construction surveys of the area to be disturbed, plus a 20-foot buffer adjacent to areas affected. If nests are encountered, Pacific Connector would work with the FWS to avoid nests as feasible. The FWS would require a special use permit if an active nest is encountered that would need to be removed, relocated, or transferred to a rehabilitation center.

Laws and regulations regarding the treatment of migratory birds, including the MBTA and EO 13186, are described above (see section 1.5.1.10). In accordance with the March 2011 MOU between the FERC and the FWS to implement the policies of EO 13186, a draft *Migratory Bird Conservation Plan* was filed with the FERC on August 31, 2018. The draft *Migratory Bird Conservation Plan* identifies avoidance and minimization strategies, as well as habitat restoration.

With incorporation of the draft and anticipated final *Migratory Bird Conservation Plan,* we conclude that the Project would not significantly affect migratory bird species.

Effects on Game Animals

Numerous studies have shown that both Rocky Mountain and Roosevelt elk are sensitive to human disturbances such as motorized travel on and off roads (Rowland et al. 2000). Roads are generally avoided by elk when they are open but are heavily utilized by elk as travel corridors when closed. During construction of the Pacific Connector pipeline, there would be short-term, localized effects on hunter success rates in the affected hunt units. When construction in a particular hunt unit coincides with hunting seasons, hunter utilization and success in the immediate vicinity would probably be adversely affected for the duration of construction in that area. However, hunter success rates for any species in each affected hunt unit are relatively low despite seemingly extensive hunter efforts (ODFW 2014a).

Where the Pacific Connector pipeline crosses existing roads, the newly created corridor would be potentially accessible from each road and probably more so at points crossed where access roads are adjacent to previously dense and/or forested habitats. The Project would require construction of 15 PARs. Increased hunter success as a result of those access points is likely but any changes in success cannot be predicted or estimated because so little area (the pipeline corridor) in any given hunt unit would be subject to increased hunter access.

After construction, there could potentially be a secondary effect (Comer 1982) on harvest rates because of increased access by hunters using the pipeline right-of-way to access remote areas. Increased public recreation along cleared rights-of-way in the fall hunting season, especially near crossings of existing access points, has been documented elsewhere (Crabtree 1984). Increased public access because of the cleared pipeline right-of-way could increase poaching of game animals and non-game wildlife on a local level. Enforcement of wildlife regulations is the responsibility of the Oregon State Police, Fish and Wildlife Division.

In big game winter management areas in Douglas, Jackson, and Klamath Counties, mature and regenerating forest would be converted to an herbaceous/shrub vegetative cover for the long term, increasing the amount of forage available to big game adjacent to forested stands potentially used for thermal cover (table 4.5.1.2-9). Forested areas would be the most commonly affected, followed by grasslands/shrublands. Temporary disturbance areas that are forested, regenerating, or recently clear-cut stands removed during construction on big game winter range would be replanted with trees after construction of the pipeline, eventually providing similar habitat to that present prior to construction.

TABLE 4.5.1.2-9

Acres of Habitat Types Affected in Big Game Winter Ranges by Construction and Operation of the Pacific Connector Pipeline by Landowner

			Acres of Habitat Affected in Winter Range					
Project Component	**County**	**Landowner**	**Forest – Woodland**	**Regenerating or Clear-cut Forest**	**Grasslands/ Shrublands**	**Wetland/ Riparian**	**Other Terrestrial Habitat a/**	**Total Habitat**
Pacific Connector Pipeline and Facility Construction	Douglas	Umpqua National Forest	9	<1	0	0	<1	9
	Jackson	Medford BLM	116	26	67	<1	5	214
		Rogue River National Forest	12	6	2	0	<1	20
		Private / State Forest	119	64	138	11	13	343
		Jackson County Total	*247*	*95*	*207*	*11*	*18*	*577*
	Klamath	Lakeview BLM	3	0	<1	0	0	4
		Private/Other	43	26	149	<1	30	248
		Klamath County Total	*46*	*26*	*150*	*<1*	*30*	*252*
	Total Pipeline and Facility Construction		**301**	**122**	**357**	**11**	**48**	**838**
Pacific Connector Operation/ Maintenance 30-foot Corridor b/	Douglas	Umpqua National Forest	2	0	0	0	<1	2
	Jackson	Medford BLM	28	6	15	<1	<1	49
		Rogue River National Forest	4	1	<1	0	<1	5
		Private / State Forest	29	15	31	2	2	80
		Jackson County Total	*60*	*22*	*46*	*2*	*3*	*134*
	Klamath	Lakeview BLM	<1	0	<1	0	0	1
		Private/Other	11	8	40	<1	6	65
		Klamath County Total	*12*	*8*	*41*	*<1*	*6*	*66*
	Total Operation/Maintenance Corridor		**74**	**30**	**87**	**2**	**9**	**203**
Revegetation Outside 30-foot Maintenance Corridor c/	Douglas	Umpqua National Forest	6	<1	0	0	<1	7
	Jackson	Medford BLM	89	20	52	<1	4	165
		Rogue River National Forest	8	4	2	0	<1	15
		Private / State Forest	89	48	107	8	10	261
		Jackson County Total	*186*	*73*	*161*	*8*	*15*	*443*
	Klamath	Lakeview BLM	2	0	<1	0	0	3
		Private/Other	32	19	109	<1	24	183
		Klamath County Total	*34*	*19*	*109*	*<1*	*24*	*186*
	Total Revegetation Outside Operation/ Maintenance Corridor		**227**	**92**	**270**	**8**	**39**	**636**

Note: Rows/columns may not sum correctly due to rounding. Acres rounded to nearest whole acre. Acreages less than 1 are shown as "<1".

a/ Other terrestrial habitat includes agriculture, developed, and barren. Restoration efforts will allow habitat type to be converted back to original state.

b/ Upland 30-foot Operation/Maintenance Right-of-Way will be maintained in an herbaceous/shrub state less than 6 feet in height. Riparian 30-foot Operation/Maintenance Right-of-Way will be maintained in an herbaceous/shrub state within a 10-foot corridor centered over the pipeline and the additional 10 feet either side of the pipeline will be maintained in an herbaceous/shrub/tree state less than 15 feet in height (see Typical Drawings 3430.34-X-0015, 3430.34-X-0016 and 3430.34-X-0017 in Appendix 1B to Resource Report 1).

c/ Habitat Revegetation: trees planted in forested habitats, including regenerating and clear-cut forest; grasses and shrubs planted in non-forested habitat and 30-foot maintenance corridor (except riparian areas). On private lands, revegetation will occur in consultation with the landowners.

Sources: BLM Deer and Winter Management Areas, Forest Service Deer Winter Range, ODFW 2007 GIS data delineated from County planning maps, ODFW (2012c) Elk Winter Range for Eastern Oregon.

In addition, big game are expected to be displaced from habitats adjacent to construction-related disturbance. In general, deer and elk return to habitats from which they have vacated in some relatively short period of time, which would likely depend on the time of year, available hiding cover, and duration of local disturbances. Following reclamation of the pipeline corridor, big game may utilize the corridor for travel and for foraging, depending on vegetation species planted and rapidity of successful revegetation.

Construction of the Pacific Connector pipeline may coincide with big game calving and fawning times, generally in late spring (May to early June). Calving and/or fawning areas may be close to winter ranges or may be at higher elevations than winter range. During active construction, big game would most likely avoid construction areas and may be adversely affected in one or more ways, including increased energy expense if they escape from disturbances or are displaced to areas of deeper snow accumulation, use of suboptimal habitats that do not provide adequate functions (food, shelter, escape cover), and use of habitats that increase the risk of predation. The expected consequences of these responses would be decreased over-winter survival and decreased calving/fawning success (for example, see Bradshaw et al. 1998).

The BLM, Forest Service, and ODFW recommend the application of seasonal construction restrictions on big-game winter range. Pacific Connector would apply the following ODFW, BLM, and Forest Service recommended seasonal closures for big game winter range (with the exception of big game winter range located in Klamath Basin, where a waiver would be obtained): November 1 to April 15 (BLM - Medford), December 1 to April 30 (Forest Service), and non-federal lands from December 1 to March 31 (private and state). Timber felling and construction activities may occur in ODFW, BLM, and/or Forest Service big game winter ranges in Douglas (Umpqua National Forest), Jackson, and Klamath counties to minimize or avoid effects on migratory birds, NSO, and MAMU.

The ODFW expressed concern that open trenches during construction of the Pacific Connector pipeline could entrap deer and elk. To minimize the potential effect of open trenches on big game in delineated big-game winter and summer range, Pacific Connector would leave breaks at least 5 feet wide at approximately 0.5-mile intervals, and at visible wildlife trails, to serve as routes for big game to cross the construction right-of-way until pipe is ready to be installed (Forman et al. 2003). Alternatively, Pacific Connector would install soft plugs (backfilled trench materials) in the trench after excavation at these distances to provide wildlife passage. Additionally, 20-foot-wide gaps would be left in spoil and topsoil stockpiles at all hard or soft plug locations, and a corresponding gap in the welded pipe string would be left in these locations. Suitable ramps would also be installed from the bottom of the trench to the top to allow any wildlife that enters the trench to escape.

Pacific Connector would install barriers at locations along its pipeline route to discourage unauthorized public access to the right-of-way. These barriers may include boulders, dirt berms, log barriers, signs, and locked gates. Slash from clearing operations would be redistributed on the right-of-way, to improve habitat and to make OHV travel difficult. These barriers should minimize OHV access to the right-of-way and reduce unauthorized hunting or poaching of game animals (see section 4.10.2.5 of this EIS for a further discussion about OHV traffic).

Effects on Amphibians and Reptiles

Effects discussed above under General Effects Applicable to All Terrestrial Wildlife would be relevant to amphibians and reptiles. Because it will not be known where amphibians and reptiles are specifically located, effects are assumed to occur in Wetlands/Eastside Riparian-Wetlands, Developed, Urban, and Mixed Environments, and Mixed Conifer-Hardwood Forest. Some threats to amphibians in habitats crossed by the Project include loss of habitat and its connectivity, changes in hydrology and water quality, predation, and competition with invasive species (ODFW 2006b; Oregon Conservation Strategy 2016). The primary threats to reptiles are habitat loss and fragmentation, predation, and competition with nonnative invasive species, such as turtles, fish, and bullfrogs (ODFW 2006b; Oregon Conservation Strategy 2016). The Pacific Connector Pipeline Project would be cutting a narrow swath out of larger areas of potentially suitable habitat. Because of the low percentage of all available habitat in the area being affected, we conclude that the Project would not significantly affect these species.

Effects on Invertebrates

Effects discussed above under General Effects Applicable to All Terrestrial Wildlife would be relevant to invertebrates. Invertebrates are assumed present in all habitat types crossed by the Pacific Connector Project. Because of the low percentage of all available habitat in the area being affected, we have determined that the Project would not significantly affect these species. Of specific concern to invertebrate pollinators is the use of chemical herbicides to control noxious weeds and other invasive plant species that can often colonize areas disturbed by construction activities. Implementation of Pacific Connector's *Integrated Pest Management Plan*[115] would reduce the likelihood of establishment and spread of noxious weeds from construction activities. Control of noxious weeds helps to preserve native plants that pollinators require for survival; however, some chemicals used to control noxious weeds have been shown to have a detrimental effect on pollinators when used within typical to maximum application rates, such as 2,4-D, glyphosate, and triclopyr (Forest Service 2005b). These three herbicides are included in the Pacific Connector's *Integrated Pest Management Plan* and would likely have adverse effects on pollinators when applied in the immediate vicinity of project disturbances.

4.5.1.3 Environmental Consequences on Federal Lands

Wildlife species present on federal lands crossed by the Pacific Connector pipeline would be similar to those discussed for all land ownerships above in section 4.5.1.2, including mammals, birds, amphibians, reptiles, and invertebrates. Wildlife on federal lands is managed under a variety of directives. Species managed on federal lands include NWFP Survey and Manage species, BLM and Forest Service sensitive species, and federally threatened, endangered, and proposed species. The presence of these species on federal lands and potential effects on these species are discussed in section 4.6.

The Forest Service additionally identifies MIS, which include wildlife monitored during forest plan implementation to assess the effects of management activities on their populations and the populations of other species with similar habitat needs which they may represent (Forest Service Manual [FSM] 2620.5). On the Umpqua National Forest, MIS include NSO, pileated woodpecker, primary cavity excavators (nesters), American marten, Roosevelt elk, Columbian black-tailed deer,

[115] See Appendix N to the POD, which was included in Pacific Connector's application to the FERC.

peregrine falcon, bald eagle, and steelhead (water quality indicator). On the Rogue River National Forest, MIS species include Columbian black-tailed deer, Roosevelt elk, American marten, NSO, pileated woodpecker, and primary cavity excavators (nesters). On the Winema National Forest, MIS include NSO, pileated woodpecker, northern goshawk, three-toed woodpecker or black-backed woodpecker, bald eagle, mule deer, resident trout, and American marten. Potential effects of the pipeline on MIS, and by association wildlife with similar habitat needs, are assessed in the MIS Report (appendix F.6 of this EIS). Additionally, effects on some of these species (Roosevelt elk, Columbian black-tailed deer, peregrine falcons, northern goshawks, mule deer, and bald eagles), including effects on federal lands, are discussed above in section 4.5.1.2.

Federal lands crossed by the pipeline contain 16 of the 17 wildlife habitats affected by the pipeline across all ownership; only the wildlife habitat "Bays and Estuaries" is not affected on federal lands. Wildlife species' associations with these habitats provide a basis for evaluating potential effects on wildlife. The acreage of each wildlife habitat that would be affected on federal land during pipeline construction, and the number of species of herpetofauna (i.e., amphibians and reptiles), birds, and mammals associated with those habitats are shown below in table 4.5.1.3-1. Agriculture and Westside Riparian-Wetlands/Eastside Riparian-Wetlands have the highest number of associated species (290 and 270, respectively), but have very few acres affected. Of all the forest habitats, Southwest Oregon Mixed Conifer-Hardwood Forest would be the most affected by the pipeline (most acres of disturbance) as well as being the forest habitat that supports the greatest number of wildlife species (226 species associated).

TABLE 4.5.1.3-1

Acres of Construction-Related Disturbance to Wildlife Habitat Types by the Pacific Connector Pipeline on Federal Land, and Wildlife Species Associated with Johnson and O'Neil (2001) Habitats

General Habitat Type	Mapped Habitat Type	Late Successional or Old-Growth Forest Crossed a/e/ (acres)	Mid-Seral Forest Crossed b/e/ (acres)	Clearcut/ Regenerating Forest Crossed c/e/ (acres)	Total Acres	Number of Species Associated d/
Forest-Woodland	Westside Lowland Conifer-Hardwood Forest	173	123	137	433	32 – Herpetofauna 115 – Birds 66 – Mammals
	Montane Mixed Conifer Forest	22	14	67	103	21 – Herpetofauna 94 – Birds 60 – Mammals
	Southwest Oregon Mixed Conifer-Hardwood Forest	374	118	127	619	36 – Herpetofauna 126 – Birds 64 – Mammals
	Ponderosa Pine Forest and Woodlands	58	1	23	81	31 – Herpetofauna 126 – Birds 64 – Mammals
	Westside Oak and Dry Douglas-fir Forest and Woodlands	31	<1	0	31	32 - Herpetofauna 115 – Birds 62 – Mammals
	Western Juniper and Mountain Mahogany Woodlands	0	3	0	3	19 - Herpetofauna 93 – Birds 35 – Mammals
	Subtotal	**658**	**259**	**354**	**1,271**	

TABLE 4.5.1.3-1 (continued)

Acres of Construction-Related Disturbance to Wildlife Habitat Types by the Pacific Connector Pipeline on Federal Land, and Wildlife Species Associated with Johnson and O'Neil (2001) Habitats

General Habitat Type	Mapped Habitat Type	Late Successional or Old-Growth Forest Crossed a/e/ (acres)	Mid-Seral Forest Crossed b/e/ (acres)	Clearcut/ Regenerating Forest Crossed c/e/ (acres)	Total Acres	Number of Species Associated d/
Grasslands Shrubland	Shrub-steppe	–	–	–	68	23 – Herpetofauna 76 – Birds 47 – Mammals
	Westside Grasslands	–	–	–	17	26 – Herpetofauna 82 – Birds 37 – Mammals
	Eastside Grasslands	–	–	–	2	20 – Herpetofauna 80 – Birds 46 - Mammals
	Subtotal	–	–	–	**87**	–
Wetland/ Riparian	Westside Riparian-Wetlands/Eastside Riparian-Wetlands	–	–	–	<1	38 – Herpetofauna 155 – Birds 77 – Mammals
	Herbaceous Wetlands	–	–	–	<1	18 – Herpetofauna 134 – Birds 44 – Mammals
	Subtotal	–	–	–	**<1**	
Agriculture	Agriculture, Pastures, and Mixed Environs	–	–	–	1	32 – Herpetofauna 181 – Birds 77 – Mammals
	Subtotal	–	–	–	**1**	
Developed/ Altered	Urban and Mixed Environs	–	–	–	28	37 – Herpetofauna 133 – Birds 64 – Mammals
	Roads	–	–	–	93	N/A
	Subtotal	–	–	–	**121**	
Barren	Coastal Dunes and Beaches	–	–	–	2	6 – Herpetofauna 100 – Birds 26 – Mammals
	Subtotal	–	–	–	**2**	
Open Water	Open Water - Lakes, Rivers, and Streams	–	–	–	1	17 – Herpetofauna 95 – Birds 20 – Mammals
	Subtotal	–	–	–	**1**	
	Project Total	**658**	**259**	**354**	**1,484**	

Note: Rows and columns may not sum correctly due to rounding. Acreages rounded to nearest whole acre; values less than 1 acre shown as "<1".

a/ Late Successional (80 to 175 years) and Old-Growth Forest (175 + years).

b/ Mid-Seral Forest (40 to 80 years).

c/ Clearcut (0 to 5 years) and Regenerating Forest (5 to 40 years).

d/ Numbers of species associated with each habitat type crossed by the Pacific Connector pipeline were summarized from Pacific Connector's Environmental Resource Report 3, Appendix 3D, Table 3D-1.

e/ Cells with no data result from the fact that non-forested habitat types did not identify seral stage, thus acres are identified only in the "total acres" column.

Effects on wildlife would be similar on federal lands to those discussed for all land ownerships above in section 4.5.1.2, including direct mortality to individuals unable to move away from construction equipment, noise and visual disturbance during construction, and habitat loss and modification. Less mobile wildlife species that are not able to move away from construction activities during clearing and site preparation could experience direct mortality. More mobile species would likely be displaced from the site during active construction. Wildlife in the vicinity of the pipeline would also be disturbed by construction activities and noise, and may move away from the construction site. However, the primary effect on wildlife from construction and operation of the pipeline would be habitat loss.

The discussion of effects on big game in section 4.5.1.2 under Game Animals includes effects on big game on federal lands. Table 4.5.1.2-4 lists the miles of designated big game winter range crossed by the pipeline within and outside federal lands, and table 4.5.1.2-10 lists the acres of habitat types in big game winter ranges affected by pipeline construction and operation within and outside federal lands.

Seasonal road closures on public lands have been applied to big-game winter range on BLM and NFS lands to minimize the effect of winter stress on deer and elk. Additionally, the BLM, Forest Service, and ODFW recommend the application of seasonal construction restrictions on big-game winter range. The following are recommended seasonal closures for big game winter range: November 1 to April 15 (BLM), December 1 to April 30 (Forest Service), and December 1 to March 31 (private and state). Pacific Connector notes that the numerous seasonal restrictions to protect applicable species pursuant to the ESA and the MBTA would require timber-clearing activities to be conducted outside nesting seasons during the spring and summer months. Therefore, Pacific Connector would be required to complete timber-clearing and other construction activities during recommended seasonal closures for big game winter range and appropriate waivers for recommended seasonal big game closures would be necessary.

Effects on wildlife associated with late-successional and riparian habitat on federal land would be generally similar to those described above wherein direct effects would occur during clearing and pipeline construction if individuals are killed, injured, and/or displaced to other locations where possible mortality increases and/or fecundity decreases. The goal for the LSR and Riparian Reserve Forest Service and BLM land allocations is to encourage healthy late-successional and riparian forests; see appendix F. Direct effects on late-successional and riparian habitat (removal and/or conversion to different vegetation) may indirectly affect wildlife by decreasing the amount of habitat locally available and decreasing the effectiveness of adjacent habitats in providing life-requisite functions for wildlife. That effect would not be able to be mitigated on-site and is assumed to persist through the long term. Effects on species inhabiting other, non-forested habitats in the affected areas in late-successional and riparian habitat on federal land (including LSRs, Riparian Reserves and the Matrix/Harvest Land Base) would be similarly affected, although the amount of time required to restore affected non-forested habitats would be shorter (see section 4.4.2.4). Effects on LSRs and Riparian Reserves on federal lands from construction and operation of the Pacific Connector pipeline are addressed in section 4.7.3 and appendix F.

Loss of snags is expected to be a long-term effect. Estimates of snag density (numbers per acre) that would be affected in the construction right-of-way and TEWAs were made on each of the three National Forests during timber reconnaissance conducted in 2006 and 2007, and verified in 2015 (Chapman 2017). Estimates of snag density by size class (inches dbh) and decay class (hard or soft) are provided in table 4.5.1.3-2. In the areas affected by construction, conifer snags less than 13 inches dbh are generally most dense on each forest, although there are numerous hardwood snags in that size category on the Rogue River National Forest. Most of the smaller snags (less than 13 inches dbh) were observed as hard wood, rather than softened due to decay.

TABLE 4.5.1.3-2

Snag Density Estimates on NFS Lands

National Forest	Tree Type	Decay Class	Estimates of Snag Density a/ (Number per Acre) by Size Category (inches dbh) <13	13-24	25-36	>36
Umpqua	conifer	Hard	5.7	0.7	1.0	0
		Soft	0.1	1.0	1.0	0.5
Rogue River	conifer	Hard	1.7	0.2	0.1	0
		Soft	0	0.5	0.2	0.1
	hardwood	Hard	1.7	0	0	0
		Soft	0	0.1	0	0
Winema	conifer	Hard	3.3	0.2	0.1	0
		Soft	0	0.4	0.1	0

a/ Snag density was verified in 2015 but was prior to Stout's Creek fire that affected acreage in Umpqua National Forest.
Source: Chapman 2017

Although no other portions of the pipeline route have been similarly examined, available data for the BLM districts crossed by the proposed pipeline generally show that snag density is higher on the BLM districts (BLM 2008). It is also assumed that snag densities on the Umpqua National Forest have increased following the 2015 Stout's Creek fire. Nevertheless, loss of snags regardless of decay class is expected to be a long-term effect because recruitment of new snags in the affected areas would take much longer than three years.

The Forest Service will require mitigation to meet their respective land use plans; those mitigation actions are described in table 2.1.5-1. Road decommissioning, fuel breaks, and forest thinning mitigation actions will assist in the recovery of late-seral habitat, reduce habitat fragmentation and edge effects, and enhance resilience of mature forest stands. Proposed snag creation and placement of LWD will mitigate the effect of loss of snag habitat and reduction in the contribution of large down wood due to clearing of forested habitat. Reallocation of matrix lands to LSR will meet the neutral to beneficial standard for new developments that affect LSRs and habitat improvement of meadow habitat within LSRs will mitigate effects on unique habitat. Livestock fencing will be used to protect revegetation efforts associated with construction disturbances.

4.5.1.4 Conclusion

Constructing and operating the Project would have both short- and long-term adverse effects on wildlife habitat and terrestrial wildlife species. We expect that some wildlife individuals would experience displacement or mortality during construction and operation, and some wildlife habitat would be removed or modified temporarily or permanently. However, based on the characteristics of the terrestrial wildlife species and habitat, the applicant's proposed construction and operations procedures and methods, and their implementation of impact minimization and mitigation measures, we conclude that the Project would not significantly affect terrestrial wildlife.

4.5.2 Aquatic Resources

4.5.2.1 Waterway for LNG Carrier Traffic

The waterway for LNG carrier traffic to Jordan Cove's terminal contains a diverse collection of anadromous, estuarine, and marine organisms and associated habitats (figure 4.5-1). The marine environment along the transit route outside of Coos Bay consists of varied habitats used by aquatic organisms including commercial and recreational fish and shellfish and marine mammals. This habitat includes gently sloping nearshore intertidal and subtidal sand area near the Coos Bay mouth and rocky shoreline to the south. Habitats near the mouth of the bay range from sand beaches to rocky shorelines. Offshore, deeper soft bottom habitats extend over 100 feet deep with main pelagic surface water along the ship transit route.

The Coos Bay estuary is described in section 4.3.2.1. Several freshwater streams and sloughs enter the bay, so that its habitats range from marine to estuarine. The bay contains shellfish resources, as well as marine fish. It is a migration corridor for salmon (*Oncorhynchus* spp.) and steelhead (*O. mykiss*) that spawn and rear in the streams that drain into Coos Bay. The bay along the transit route for LNG carrier marine traffic contains mostly sloping beaches with algae and eelgrass beds that supply important habitat for the estuarine organisms. A total of over 14,000 acres of habitat is present in Coos Bay, including some 1,400 acres of eelgrass beds.

Many fish, shellfish, and marine mammal species are common in the waterway leading to the Jordan Cove LNG terminal (see appendix I, table I-1). Most of these aquatic species are mentioned below.

The status and potential project effects of federally listed fish, marine mammals, and turtle species are presented in our pending BA. EFH fish species that are managed under the MSA will be presented in our EFH Assessment that will be attached to our BA. The federally listed species information is summarized in section 4.6, and the EFH assessment is summarized in appendix I.

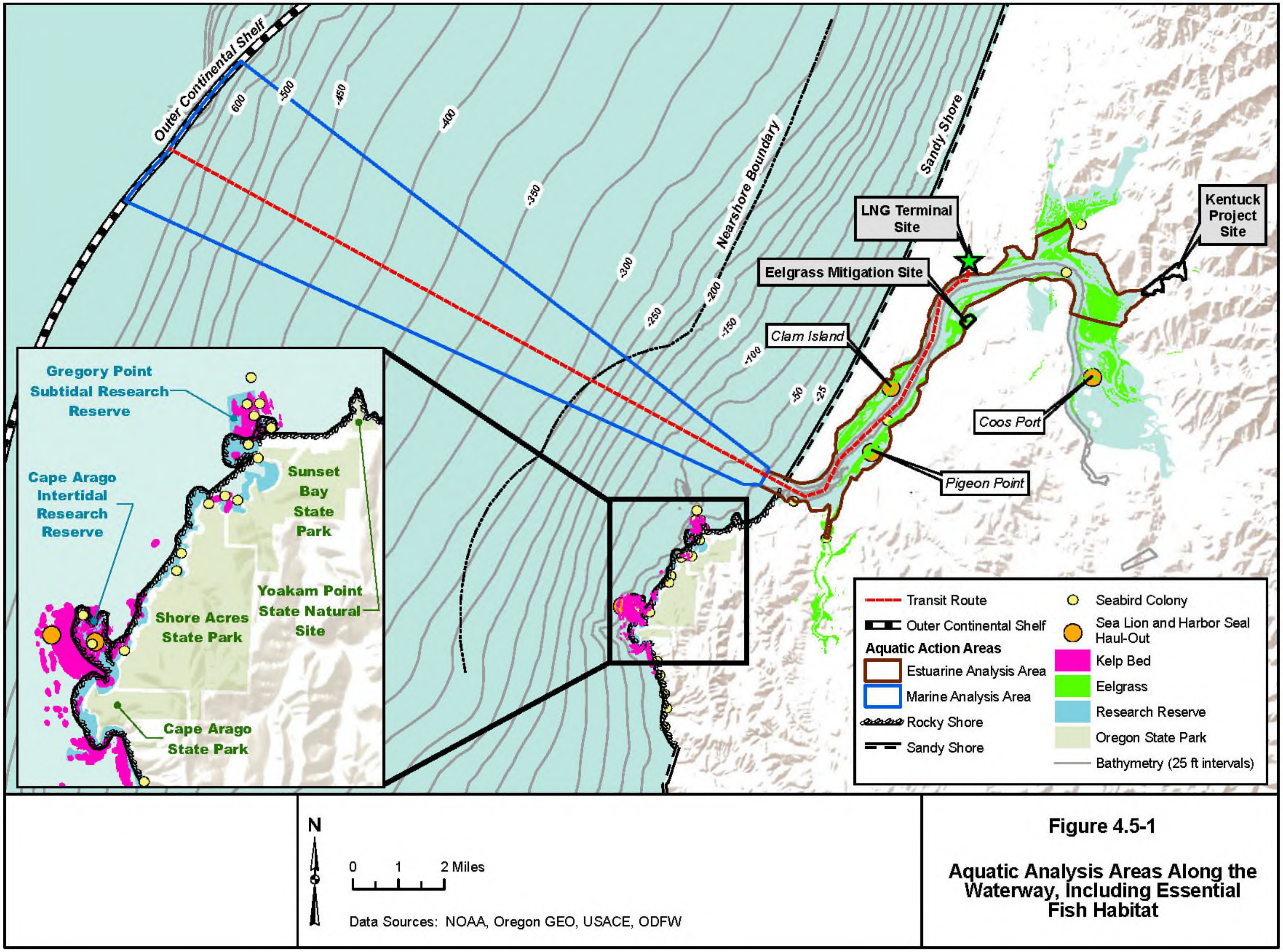


Figure 4.5-1

Aquatic Analysis Areas Along the Waterway, Including Essential Fish Habitat

Marine Fish

Species of groundfish, pelagic, anadromous, and marine species would be present in the waterway for LNG carrier traffic to the terminal, in the nearshore and marine waters outside of the Coos Bay estuary. This includes a variety of rockfish, flatfish, shark, skates, sturgeon, sablefish, cod, and migratory fish such as anchovy and sardine and in the outer regions may rarely include some highly migratory species such as thresher shark (*Alopias* spp.) and tuna.

Marine fish communities in Coos Bay consist of species found in estuarine and marine waters. Their distribution and abundance vary with physical factors such as bottom conditions, slope, current, salinity, and temperature, as well as season, which can affect migration and spawning timing. Some of the more commonly abundant fish include Pacific herring (*Clupea pallasii*), and the non-native American shad (*Alosa sapidissima*). Most fish species are migratory or seasonal, spending only part of their life in these waters. Other common seasonal marine fish species include surfperch (family *Embiotocidae*), lingcod (*Ophiodon elongatus*), rock greenling (*Hexagrammos lagocephalus*), sculpin, surf smelt (*Hypomesus pretiosus*), Pacific herring (*Clupea pallasii*), English sole (*Parophrys vetulus*), black rockfish (*Sebastes melanops*), northern anchovy (*Engraulis mordax*), eulachon (*Thaleichthys pacificus*), longfin smelt (*Spirinchus thaleichthys*), Pacific tomcod (*Microgadus proximus*), sandsole (*Psettichthys melanostictus*), and topsmelt (*Atherinops affinis*). California halibut (*Paralichthys californicus*) is also present in the bay near Jordan Cove. A few common species like kelp greenling (*Hexagrammos decagrammus*) and starry flounder (*Platichthys stellatus*) reside in the bay year-round. The bay from just beyond the LNG terminal site to its mouth is a prime feeding area for many local and seasonal fish species.

Fish abundance varies with salinity. Near NCM 1.5, the sloughs are mostly of high salinity, while farther up the bay, near NCM 15.5, sloughs are generally brackish, of lower salinity. Toward the mouth of the bay, the salinity is higher, especially in the summer, which is when the number of fish increase.

Anadromous Fish

A common group of anadromous fish species found in the waterway for LNG carrier traffic to the terminal includes Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), steelhead, coastal cutthroat trout (*O. clarkii clarkii*), Pacific lamprey (*Lampetra tridentata*), river lamprey (*L. ayersi*) , white sturgeon (*Acipenser transmontanus*), green sturgeon (*A. medirostris*), striped bass (*Morone saxatilis*), and American shad (*Alosa sapidissima*). Anadromous is a term describing fish that return from the ocean to the rivers where they were born to spawn. Adult anadromous fish spend a portion of their adult life in the ocean; the amount of time varies among the species. Sexually mature adults migrate or "run" from the ocean and estuaries upstream to fresh water streams to spawn for most salmonid anadromous fish in shallow gravel stretches. Other anadromous stocks noted above have varied spawning habitat uses. After a period, which varies with the species, juveniles migrate downstream to estuaries typically in late winter to summer. Salmon and steelhead undergo smolting (physiological maturation to adjust from fresh to salt water) before entering marine waters as juveniles. Salmon and steelhead and cutthroat typically rear in the ocean for one to five years before returning as adults to their natal streams to spawn, while other anadromous fish (striped bass, American shad, sturgeon, and lamprey) have a range of ocean-rearing periods ranging over multiple years, with striped bass largely confined to the estuary. Salmon typically return to streams in late summer through fall.

Steelhead and sea-run cutthroat trout may return to streams in the summer, fall, winter, or spring depending. Lamprey return from spring to fall to fresh water; striped bass are not native but spawn in the spring over a brief period in Coos River. Salmon species die after spawning but some steelhead and anadromous coastal cutthroat survive to return to the ocean and can spawn again. Steelhead typically remain in freshwater streams after emergence for two to three years before migrating to the ocean, with adults returning to spawn in their fourth or fifth year. Sea-run cutthroat usually remain in fresh water for two to four years before smolting and migrating to saltwater, usually staying in the estuaries or near shore (Behnke 1992).

There are eight native species of coldwater anadromous fisheries in the area affected by the Jordan Cove LNG Project: Chinook salmon, coho salmon, chum salmon, steelhead, coastal cutthroat trout, Pacific lamprey, river lamprey, and green sturgeon. The Oregon Coastal Coho Salmon Evolutionarily Significant Unit (ESU) is present and is listed under the ESA. The North American Green Sturgeon – Southern Distinct Population Segment (DPS), and Southern DPS Pacific eulachon, which are both listed as Threatened under the ESA, may be present or migrate through Coos Bay. The Project effects on these ESA listed fish and their critical habitat are presented in section 4.6 of this EIS.

Shellfish

A large and diverse population of benthic and epibenthic invertebrates is present beyond the entrance to Coos Bay. Clams, crabs, oysters, and shrimp make up important components of these invertebrates in the bay. Some of the most abundant and commercially important of these species include bentnose clams (*Macoma nasuta*), Pacific oyster (*Crassostrea gigas*), Dungeness crab (*Metacarcinus magister*), and ghost shrimp (*Neotrypaea californiensis*). Distribution varies along the route from the LNG terminal to the bay mouth. Principal subtidal clam beds are found in the lower bay and South Slough although the upper bay also has substantial clamming areas. Clam Island, located at the mouth of Coos Bay, has an abundance of recreationally important clams. Some of the highest recreational harvest of clams and crabs occurs at the mouth of Coos Bay with much of the crabbing occurring from the BLM boat ramp, west of the LNG terminal site to the mouth. Razor clams (*Siliqua patula*) are an important commercial and recreational species. In Jordan Cove, ghost shrimp, a commonly harvested bait shrimp, are found in the fine sediment and eel grass beds. Mud shrimp (*Upogebia pugettensis*) are also harvested in this region.

Coos Bay contains one of only three known native Oregon coastal populations of the Olympia oyster (*Ostrea lurida*). Within its native range, this species has significantly diminished from historical levels (National Fish and Wildlife Federation et al. 2010). Efforts have been taken in the bay to restore this species and improvements in bay water quality and sediment have resulted in self-sustaining populations over the last two decades (Groth and Rumrill 2009; Rumrill 2007). A pilot restoration project began in 2010 that resulted in stocking 4 million juvenile Olympic oysters in South Slough. Because of its low abundance and efforts to improve the quality of the Coos Bay environment and its survival, the Olympia oyster is not harvested.

Marine Mammals

Thirty species of marine mammals occur in Oregon, including seven species of baleen whales, nine species of toothed whales, eight species of dolphins and porpoises, five species of pinnipeds (seals and sea lions), and a single species of sea otter (NMFS 2017a).

Steller sea lions (*Eumetopias jubatus*), California sea lions (*Zalophus californianus*), northern elephant seals (*Mirounga angustirostris*), and Pacific harbor seals (*Phoca vitulina*) use haulout sites in the vicinity at Cape Arago, Three Arch Rocks, and Shell Island, along the southwest Oregon Coast. Eight species of whales are federally and state-listed. All marine mammals are protected under the MMPA.

Sea Turtles

Four species of sea turtles have been documented off the coast of Oregon: the green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), and loggerhead sea turtles (*Caretta caretta*).

Effects on Aquatic Habitat and Aquatic Species Along the Waterway for LNG Carrier Transit

The following section discusses transit-related effects of the LNG carriers. Although the regular transit of LNG carriers is a part of the operation of the Project, the carriers and their operation do not fall under the jurisdiction of the Commission; therefore, we can disclose but not require mitigation for these activities. Project-related effects from the LNG facility construction actions (including dredging of areas abutting the Federal Navigation Channel) are presented in section 4.5.2.2.

Vessel Strikes

Jordan Cove anticipates that as many as 120 LNG carriers each year would use the waterway to reach its terminal. In addition, in accordance with the WSR and LOR, there must be three tugboats and additional security ships that assist each LNG carrier in transit along the Coos Bay navigation channel. These vessels have the potential to strike aquatic species, including sea turtles and marine mammals, and seabirds and shorebirds during their transit to and from the Jordan Cove terminal.

In the open ocean prior to entering the Coos Bay Federal Navigation Channel, it is estimated that LNG carriers would travel at speeds of about 12 knots. Jordan Cove has proposed to provide measures supplied by NMFS to vessel operators in order to minimize potential ship strikes to cetaceans, and possibly other listed (sea turtles) and non-listed marine species by LNG carriers in a *Ship-Strike Reduction Plan*. Jordan Cove would provide operators of LNG carriers that would visit the terminal with copies of this plan for avoidance of marine mammals or sea turtles while in transit at sea. Some of the suggested measures would include the following:

- train LNG carrier crews to watch out for and avoid marine mammals and sea turtles;
- keep on board vessels copies of marine species reference guides, such as Marine Mammals of the Pacific Northwest, including Oregon, Washington, British Columbia and South Alaska by Pieter Folkens (2001);
- request LNG carriers to establish navigation policies when marine mammals or sea turtles are sighted, including:
  - maintain a distance of 90 meters or greater.
  - attempt to maintain a parallel course to the animal and avoid abrupt changes in direction until the animal has left the area.

  - reduce speed when pods or assemblages of marine mammals or sea turtles are observed nearby; and
- report sightings of any injured or dead marine mammal or sea turtles to the NMFS, regardless of whether the injury or death was caused by the LNG carrier. If the injury or death were caused by collision with an LNG carrier heading to or from the Jordan Cove terminal, the FERC should be notified within 24 hours of the incident. Information to be provided would include the date and location (latitude/longitude) of the strike, the ship name, and the species, if possible.

LNG carriers would enter the waterway at speeds between 8 and 10 knots, and slow between 4 to 6 knots as they proceed up the Coos Bay navigation channel to the Jordan Cove terminal. As required by the WSR, two tugs would escort each LNG carrier in the navigation channel, and another tug would assist in docking the vessel at the terminal. Use of tugs would allow the LNG carriers to maintain steerage even at these slow speeds.

Most sea turtles, marine mammals, and seabirds and shorebirds would be able to avoid LNG carriers traveling at slow speed through the waterway. Even with the additional LNG carriers in the waterway, the number of ships would still be below historic levels for deep-draft traffic to the Port. Effects on aquatic resources from LNG carriers would be not much greater than the effects of current deep-draft cargo ships visiting the Port. Based on the reduced speed of the LNG carriers and the efforts by Jordan Cove to increase the awareness of vessel operators, we conclude that the incidence of accidental strikes of aquatic species by LNG carriers in transit to and from the Jordan Cove terminal would be low.

Ship Grounding

During scoping some commenters raised the possibility that an LNG carrier waiting offshore to enter Coos Bay, either to avoid another ship coming out of the Port or seeking proper tidal conditions, could lose anchorage or steerage and run aground on the North Spit, like the *New Carrisa* incident of 1999. A ship grounding would have the potential to affect aquatic resources, as oil and fuel could leak from a grounded vessel. However, a Coast Guard investigation found that the *New Carrisa* grounding was caused by the captain's error in not having the ship well anchored.

All LNG carriers visiting the Jordan Cove terminal would have to adhere to Coast Guard regulations, including anchoring procedures offshore, in addition to the measures outlined in the WSA, WSR, and LOR. A pilot would board the LNG carrier to guide it through the Coos Bay navigation channel, and the vessel would be accompanied by tugs and security escort boats to keep it on course. In addition, the geometry of the navigation channel would keep the LNG carrier within its confines, away from the shore.

Shoreline Erosion from Waves and Propeller Wash

Propeller wash from LNG carriers and tugboats transiting the waterway to and from Jordan Cove's terminal could cause shoreline and bottom erosion and displace bottom organisms due to scour. Wakes and waves caused by vessels in the waterway could increase erosion along the shoreline and resuspend loose sediments in the bay. Increased erosion and suspended sediment levels can adversely affect fish eggs and fish survival, benthic community diversity and health, and spawning habitat. At high concentrations, suspended sediments can affect oxygen exchange over the gills, resulting in weakened individuals or mortality. Waves from vessels breaking on the shoreline can also cause fish stranding.

The possible magnitude and effects of the Jordan Cove Project on shoreline erosion were approximated by Jordan Cove through models that assessed effects of waves and propeller wash from LNG carriers in Coos Bay and at the LNG docking area (i.e., Moffat & Nichol 2008; CHE 2011; Moffatt & Nichol 2017f), and the details of the model results on physical conditions in the bay resulting from LNG carrier traffic and docking are presented in section 4.3.

Overall, the models estimated that additional waves generated by the new LNG carrier traffic could increase shoreline sediment transport at the modeled point by 5 to 8 percent over existing conditions (e.g., wind-generated waves plus existing large vessel–generated waves). While both models indicated some additional shore sediment movement could occur from the waves generated by the passage of LNG carriers through Coos Bay, the effects would be small because low magnitude and relative frequency of waves, contributing a small portion of total annual wave energy and sediment transport, and be within the normal magnitude of waves that naturally occur in the bay. Therefore, the total effect would likely be within the range of natural annual variability of wave conditions. Overall, increased sedimentation and disruption of aquatic nearshore habitat from additional tugboat and LNG carrier–generated waves would be unlikely because of the factors discussed in section 4.3.

The effects of propeller wash from LNG carriers and related tugboat vessels on bottom erosion and turbidity likewise would not reach levels to cause substantial disruption to benthic or pelagic resources other than in the immediate access channel and slip area (see section 4.3 for details of modeling results). The bottom velocity caused by the propeller would be similar to the maximum velocity of peak tidal exchange (about 4 fps) along most of the route. Because the disturbance would be relatively similar to what occurs during tidal exchange and confined to the relatively coarse sediment within an 80-foot-wide swath along the 9-mile-long Federal Navigation Channel, the bottom area disturbed would be slight along most of the route. Few organisms would be displaced by physical disturbance or affected by turbidity (see section 4.3 for details); however, as noted below, there are some areas near the entrance to the access channel that would experience bottom erosion and likely benthic disruption as the LNG carrier and tug boat leave after loading.

Mobile organisms would be able to return to the area affected, while some benthic organisms could be permanently displaced. Turbidity would likely be slight due to the coarse characteristics of the navigation channel sediment that is resistant to current induced suspension. The one area that would have marked local bottom scour and increased turbidity would be in the east side of the access channel and slip where bottom scour over about 12 acres may occur during each LNG carrier departure (Moffatt & Nichol 2017g). Overall, some loss of benthic organisms could occur from LNG carrier propeller wash during each transport trip near the slip approach, but the magnitude would be small and likely less than currently occurs under each existing large vessel trip. There would be some additional local bottom disturbance in the docking area. In most cases, this disturbance would likely be much less than estimated because of the conservative assumptions used for the model. While some sessile benthic organisms may be displaced during LNG carrier docking, the limited extent of bottom disturbance and sediment suspension would result in unsubstantial effects on organisms in the slip.

Fish Stranding

Fish stranding can occur when fish become caught in a vessel's wake and are deposited on shore by the wave generated by the vessel's passing. Stranding typically results in mortality unless another wave carries the fish back into the water. A study of strandings (Pearson et al. 2006) suggests that a series of interlinked factors act together to produce stranding during a ship passage. These factors include:

- Water-surface elevation—Low tides are generally more likely to result in strandings than high tides.
- Beach slope—Low-gradient beaches are generally more likely stranding locations than high-gradient ones.
- Wake characteristics—Ship wakes that result in both the greatest drawn-down and run-up on the beach are generally most likely to result in strandings. Wake characteristics are influenced by a number of dynamics including vessel size and hull form ("short and fat" vessels have a greater displacement effect and generate larger wakes than "long and thin" vessels); vessel draught (the smaller the under-keel clearance, the larger the wakes; thus, loaded vessels are more likely to result in strandings than unloaded vessels); vessel speed (fast moving vessels generate larger wakes than slow vessels); and the distance between the passing vessel and the beach (strandings are generally more likely at beaches close to the shipping channel than more distant beaches). Fish strandings were observed because of four types of vessel passages including oil tankers, container ships, car carriers, and bulk carriers (in order of the vessels observed to cause the highest to lowest stranding frequency).
- Various biological factors—For example, the larger the number of subyearling salmon that are present near the shoreline, the more fish that are likely to be stranded; salmon that are larger and relatively strong swimmers are generally less prone to stranding.
- Vessel speed—No stranding has been observed on the Columbia River at speeds less than 8 to 9 knots (about 10 miles per hour).

The factors discussed above can vary simultaneously, making it difficult to predict where and to what degree strandings may occur. A few areas may have the potential to strand fish in Coos Bay. One is the mud flats on the west side of the navigation channel along the Coos Bay and Empire Range that have beach morphology that has been shown to have potential for stranding, especially at low tide. Jordan Cove (Moffat & Nichol 2008) modeled the potential wave height and overall energy from 200 LNG carrier transits a year (combined inbound and outbound). As noted in section 4.3, the wave's height would not exceed that of normal conditions in Coos Bay and vessel-induced waves contribute a small portion of total waves in the bay. In addition, the LNG carriers would be arriving and leaving at high tide, which is a period when gently sloping beaches are mostly covered, and less likely to be dewatered from waves. The maximum vessel speed once inside the navigation channel, about 6 knots, is less than that observed to cause stranding in the Pearson et al. (2006) study. The one exception is near the Coos Bay entrance (first mile), when vessels may be traveling 8 to 10 knots. While waves generated in this portion of the waterway may be larger than farther in the bay, this is an area likely already receiving larger ocean-generated waves, so the vessel-generated waves would be little different than current conditions in this region. Additionally, the presence in Coos Bay of subyearling Chinook salmon, which are the outmigrating fish most likely to be stranded, is limited to the summer months, approximately mid-

June through the end of August. Considering the conditions, including LNG carriers entering and leaving at high slack tide, low velocity in most areas, wave height within normal range, and infrequent occurrence of susceptible fish, it appears unlikely that LNG carrier traffic in the waterway would substantially contribute to fish stranding.

LNG Spills

In a highly unlikely scenario, there could be an accidental spill of LNG from a carrier transiting in the waterway. As explained in section 4.13, in the entire history of LNG carrier transport worldwide, there has never been a major incident resulting in a large LNG spill or fire on water. An LNG spill has an extremely low probability of occurrence and, as described below, would likely affect a small area. As more fully discussed in section 4.13 of this EIS, spilled LNG would not mix in the water column, but would vaporize as warmed by ambient temperature and, if the LNG ignited, a fire could result. The greatest threat to aquatic organisms near an LNG spill would be from changes in water temperature. A spill of LNG would float on the water surface and not mix, but in the process of changing state from solid to liquid would rapidly cool off the upper water layers closest to the LNG spill. As the LNG would vaporize and turn to natural gas, it would be less dense than air and would rise above the water. Aquatic species in the waterway would not be directly affected unless individuals come in direct contact with the LNG. Should an aquatic species directly contact the LNG when it is first released, it could have its flesh frozen because the temperature is very low. The chance of this occurring would be remote because it would require the individual to be near the water surface at the direct point of the LNG spill, before it warms. If an LNG spill from a carrier in the waterway were to ignite, it would cause localized heating of the surface water. Neither the cooling nor heating would likely cause the overall water column to change temperature to the point of affecting aquatic organism beyond the surface layer at the time of initial spill or ignition. Aquatic species, other than possibly the smallest planktonic stages and shellfish, near this spill would be able to detect undesirable temperatures and avoid the LNG spill by swimming away.

The mitigation measures outlined in the WSA, WSR, and LOR would protect public safety and the environment, and ensure that aquatic resources would not be adversely affected by LNG carrier traffic in the waterway to the Jordan Cove terminal.

Fuel or Oil Spills

Fuel (e.g., diesel) used for LNG carrier propulsion could possibly leak or be spilled while en route in the waterway; likewise, oil could be spilled. Adverse effect could occur on marine fish and shellfish from oil spills ranging from direct morality, reduced growth and feeding, and reduced spawning success depending on location magnitude and type of spill. Effect can be compounded when spills intersect the shoreline habitats. These effects can be both short and long term. LNG carriers would have measures aboard to contain fuel or oil spills should they occur, as required under the Coast Guard required hazardous spill response plan for vessels in U.S. waters of 2013 (78 FR 60099). Additionally, LNG carriers are double hulled, which should prevent the escape of fuel or oil, other than spills from the deck. The chance of a spill is low, and any quantities leaked are likely to be small. As reported by Pacific States/British Columbia annual reports (http://oilspilltaskforce.org/documents/), the number of oil spills reported from fishing, recreational, and other harbor marine vessels in Oregon ranged from about 9 to 65 per year, which is infrequent considering that thousands of marine vessels, both recreational and commercial, use Oregon coastal marine waters. Spills or releases of fuel or other oils into surface waters from LNG carriers are more likely to occur during fueling at the dock when the materials are being transferred onto the carrier. As discussed in section 4.3, LNG carriers are required to develop and implement a Shipboard Oil Pollution Emergency Plan, which includes measures to be taken if an oil pollution incident has occurred, or a ship is at risk of one. With the implementation each LNG carrier's Shipboard Oil Pollution Emergency Plan, impacts resulting from the spill of fuel, oil, or other hazardous liquids would be minimized both in occurrence and quantity. We conclude that because fuel or oil leaks from LNG carriers transiting in the waterway to and from the Jordan Cove terminal are not reasonably certain to occur, adverse effects on aquatic resources are not anticipated.

<u>Introduction of Nuisance Species</u>

LNG carrier origin locations are unknown now; they could originate from ports across the Pacific. Operators of commercial vessels have a significant economic interest in maintaining underwater body hull platings in a clean condition. Fouling of bottom platings would result in increased fuel costs for voyages and could reduce the vessel's maximum transit speed. To prevent fouling and the associated economic costs, operators aggressively and conscientiously implement hull plating preservation and maintenance programs. Failure to preserve and maintain hull plating not only raises short-term operation costs but also sets the stage for increased long-term hull maintenance costs. There is a sensitivity to this engineering and economic reality regarding commercial vessels operating at the higher end of the sailing rates schedule, as is the case for LNG carriers.

In addition to the antifouling program measures, fluid dynamics plays a practical role as a barrier to the introduction of invasive species. The amount of water that passes over the hull and through the sea chest is a massively large volume. A sea chest is an opening with associated piping in the hull below the waterline to provide seawater to condensers, pumps, and other associated equipment. The velocity of the seawater, abrasive by nature, along the hull would be expected to "waterblast" off anything that is not affixed to the hull (e.g., a barnacle). The sea chest would have the equivalent of untold multiples of seawater exchange such that an organism would be flushed out with much more velocity and volume of water than the accepted international ballast exchange procedure.

Ballast water may be another source of non-native organisms. Water is held in the ballast tanks and cargo holds of LNG carriers to provide stability and maneuverability during a voyage when vessels are not carrying cargo. Normal ballast exchange requires only three changes of water through the ballast tanks to purge any loading port organisms before arrival at the unloading port. The effects of ballast water exchange, and the measures that would be implemented to minimize or avoid effects from this action, are addressed in section 4.3.

Conclusion

Based on measures and actions that will be in place to eliminate or mitigate potential adverse effects from actions during operation of LNG carrier transit, including waves size and propeller wash, LNG gas or hazardous substance spills or introduction of invasive species to marine resources, we conclude that the Project would not significantly affect marine resources.

4.5.2.2 Jordan Cove LNG Project

Coos Bay contains a variety of habitat for anadromous, marine, and estuarine fish species. A large diverse invertebrate population exists in Coos Bay. Shellfish (predominantly clams, crabs, and shrimp) are of significant economic importance to the Coos Bay area. Of marine mammals in Coos Bay, only the harbor seal, California sea lion, and killer whale have been observed during field surveys at the proposed location of the Jordan Cove access channel. No turtles have been observed or would be expected in the bay. Fish, shellfish, and marine mammals that may occupy Coos Bay are more fully discussed in the section 4.5.2.1.

Juvenile and larval life stages of vertebrate and invertebrate marine organisms are varied in the bay and near the terminal site. Over 35 species of ichthyoplankton have been documented in Coos Bay (Miller and Shanks 2005). There are some seasonal trends, with highest occurrence October through May, but fewer differences by month in the upper bay than near the ocean. Shanks et al. (2010, 2011) sampled zooplankton and ichthyoplankton in Coos Bay near the Jordan Cove terminal. A variety of zooplankton were found to be present in the bay (see table 4.5.2.2-1). Among the potential forage items, copepod adults, larvaceans, harpacticoid copepods, and Daphnia had the highest peak abundance. Overall, larval fish abundance was generally low, with those that spawn primarily in or near estuaries common (surf smelt, sand lance, and staghorn sculpins [*Leptocottus armatus*]). At times, other larval or juvenile fish were relatively abundant including English sole, buffalo sculpin (*Enophrys bison*), anchovy, and pipefish. A total of nine fish species were captured. Primary fish species spawn in winter and early spring, and larval fish were most abundant in winter samples (Shanks et al. 2011). Over 12 taxa of crab and shrimp larvae were also collected, including some recreational and commercially important crab and shrimp species, such as Dungeness crab and ghost shrimp larvae. Major known oyster and shrimp habitat and clamming and crabbing areas in the bay relative to Project activities are shown in figure 4.5-2. These habitat areas are mostly oriented along shoreline and shallow areas of the bay except for crabbing areas which extend into deeper water.

TABLE 4.5.2.2-1

Taxa Groups Collected in Coos Bay Near the Jordan Cove Terminal During 2009–2011

Categories	Specific Taxa
Fish larvae/juvenile	Surf smelt, sand lance, staghorn sculpin, buffalo sculpin, anchovy, pipefish, English sole, gunnel, pricklefish
Crab/Shrimp larvae	Porcelain crabs, pea crabs (*Pinnotheres pisum*), green crab (*Carcinus maenas*) (invasive), xanthid crabs, majid crabs, cancer crabs (e.g., Dungeness, rock crab), Lithodidae, Hippidae, Pagurid (hermit crabs), Callinassa (ghost shrimp), Sergestid shrimp, Pachygrapus crassipes (striped shore crab)
Gastropod and Bivalves larvae	Mytilus (mussels), Clinocardium (cockles), Bivalve juveniles, Gastropod juveniles
Larval Invertebrates	Barnacle nauplii and cyprids, Mytilus larvae, bivalve larvae
Cnidaria/ctenophore	Sea anemone, Hydroids, sea goose berry
Polychaete Worm Larvae	Marine worms
Salmonid Food Prey	Mysids, Amphipods, Isopods, Cumaceans, Copepod adults, Harpacticoid copepods, Calanoid copepods, Daphnia, Larvaceans, larval fish

Source: Shanks et al. (2010, 2011)

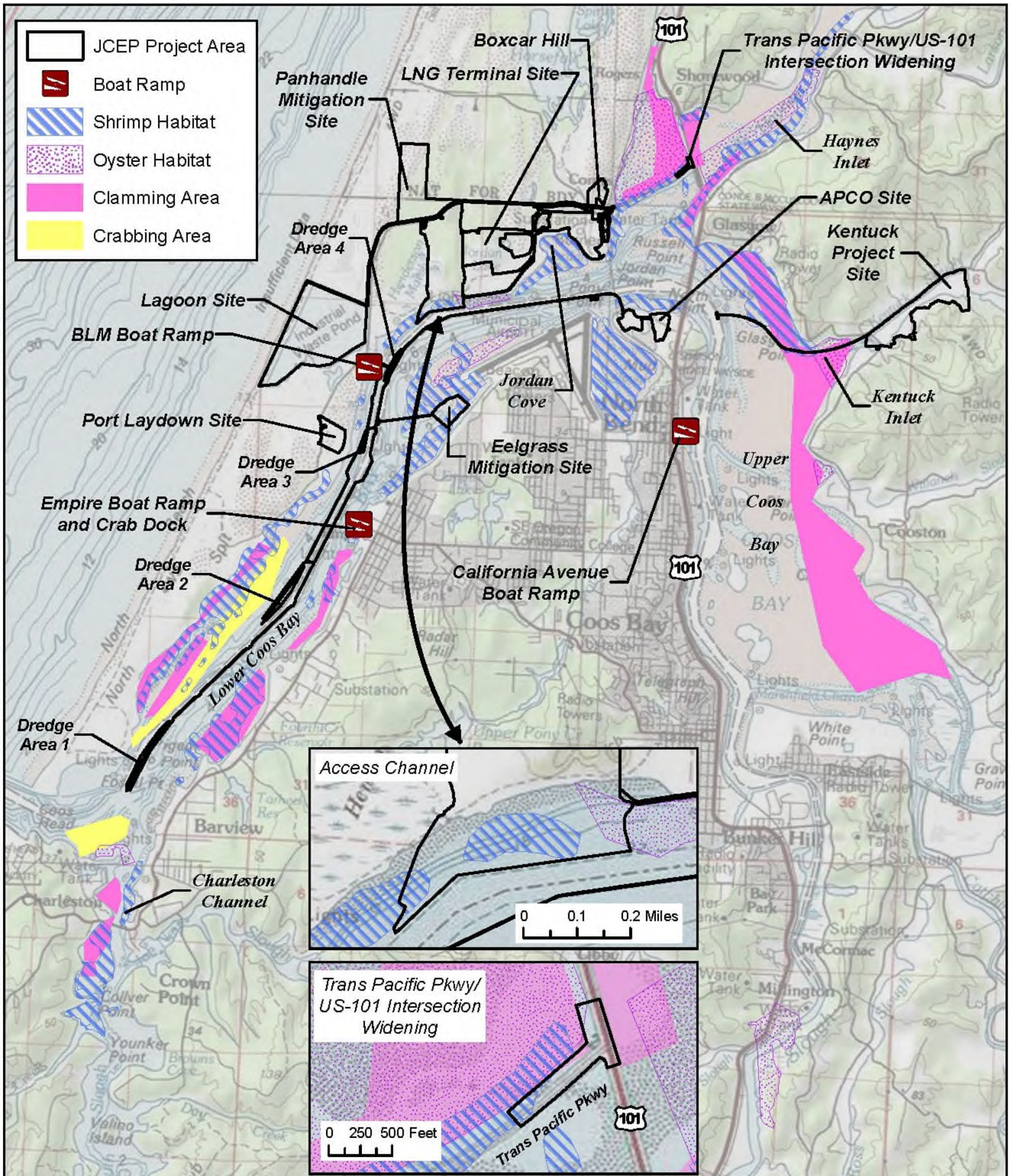


Figure 4.5-2

Shrimp and Oyster Distributions and Shellfish Areas in Coos Bay

The slip, access channel, MOF, and adjacent rock pile apron for Jordan Cove's terminal would cover about 37 acres below the mean higher high water line. This would include less than 1 acre of salt marsh, about 13 acres of intertidal area of unvegetated sand plus algae/mud/sand habitat, about 4 acres of shallow subtidal, about 18 acres of deep subtidal, and about 2 acres of eelgrass. This would include a pile dike rock apron area that would modify about 2 acres of habitat through intertidal and subtidal addition of small riprap. The habitat areas affected by the access channel are illustrated on figure 4.5-3 and listed in table 4.5.2.2-2. Nearly all this habitat change would be permanently converted to deepwater habitat. Other Project facilities would also temporarily disturb intertidal and subtidal habitat during construction (table 4.5.2.2-2). The largest other area disturbing estuarine habitat would be from marine waterway modifications (i.e., the proposed modifications in the navigation channel) totaling about 40 acres of mostly deep subtidal habitat including the 27 acres from dredging and 13 acres from the dredge lines used for this dredging. All other facilities would disturb less than about 5 acres in habitat which includes less than 1 acre of eelgrass habitat.

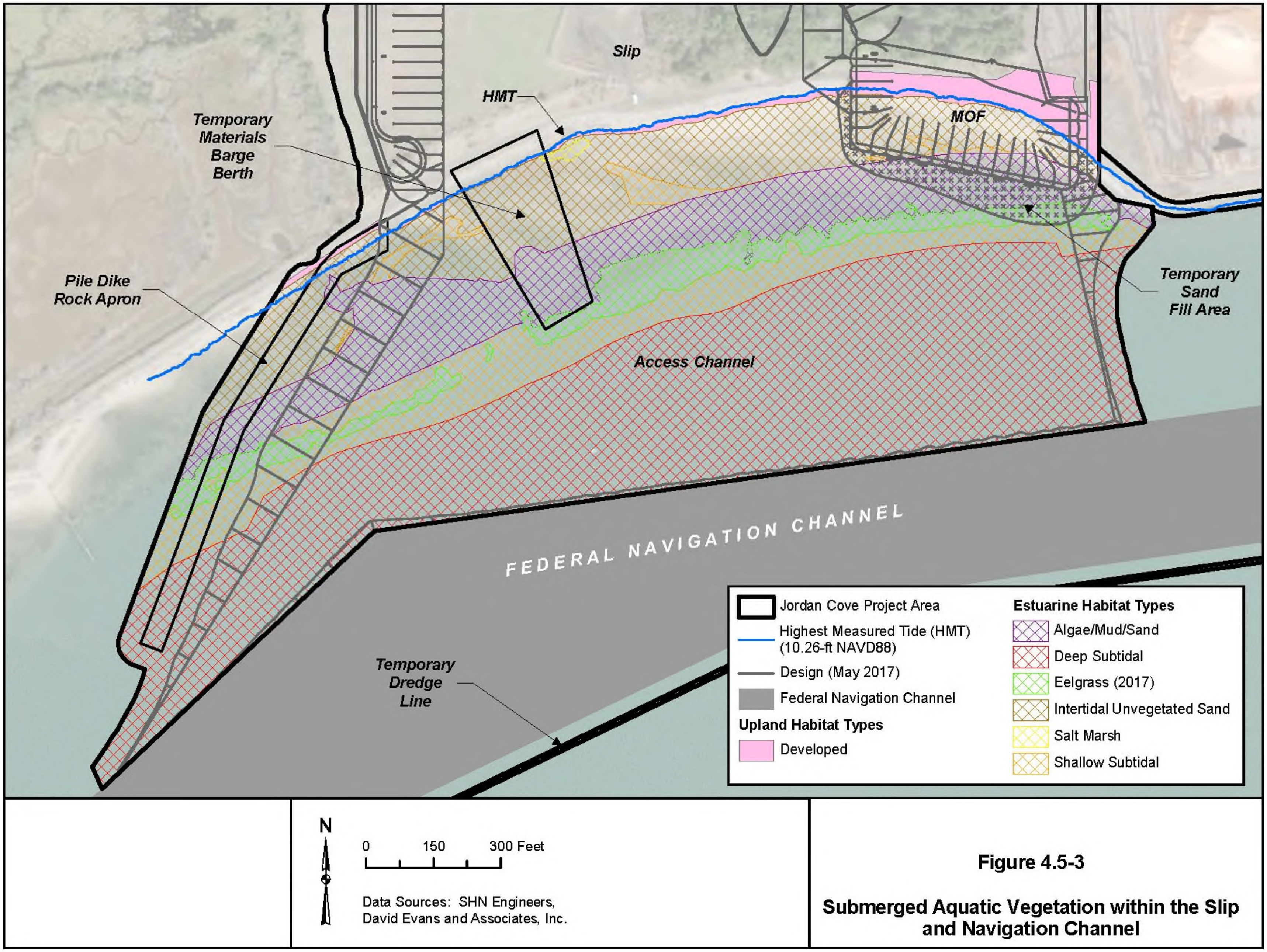
TABLE 4.5.2.2-2

Estuarine Habitat Affected by Construction of the Jordan Cove LNG Project Facilities and Marine Waterway Modifications in the Federal Navigation Channel

	Acres Affected							
Habitat Type	**Slip, Access Channel, TMBB MOF, and Rock Pile Apron**	**Marine Waterway Modifications - Dredge Areas**	**Marine Waterway Modifications - Dredge Lines**	**Kentuck Temp. Dredge Transfer line**	**Eelgrass Site Temp. Dredge line**	**APCO Temp. Dredge Transfer**	**Hydraulic Dredge Pipeline**	**Trans-Pacific Parkway/ Hwy 101 a/**
Eelgrass Habitat	2		<1	<1	<1	<1		
Shallow Subtidal	4		<1	1			<1	
Salt Marsh	<1							
Intertidal	13		<1	<1	<1		<1	1
Deep Subtidal	18	27	12	2	1	1		
Total	**37**	**27**	**13**	**2**	**1**	**1**	**<1**	**1**

Note: Columns/rows may not sum correctly due to rounding. Acres are rounded to nearest whole acre. Acreages less than 1 acre are shown as "<1".
MOF – Material Offloading Facility
TMBB – Temporary Material Barge Berth
a/ Riprap addition

Submerged grasses are one of the important major habitat components in Coos Bay. Recreationally and commercially harvested species such as clams and shrimps, Dungeness crab, English sole, and salmonids use the eelgrass beds extensively. Previous studies (Akins and Jefferson 1973) have reported that Coos Bay has 1,400 acres of lower intertidal and shallow subtidal flats covered by eelgrass meadows. ODFW (1979) conducted habitat mapping in Coos Bay and documented intertidal and subtidal aquatic beds. Submerged grass meadows provide cover and food for many organisms including burrowing, bottom-dwelling invertebrates; diatoms and algae; herring that deposit eggs clusters on leaves; tiny crustaceans and fish that hide and feed among the blades; and, larger fish, crabs and wading birds that forage in the meadows at various tides. Eelgrass provides shelter for a variety of fish and may lower predation, allowing more opportunity for foraging. The protective structure attribute of eelgrass is primarily for smaller organisms and juvenile life history stages of fishes.



Data Sources: SHN Engineers, David Evans and Associates, Inc.

Figure 4.5-3

Submerged Aquatic Vegetation within the Slip and Navigation Channel

Project activities associated with the LNG terminal that could potentially affect aquatic resources include in-water construction activities, habitat modification, water appropriations, artificial lighting, and accidental spills of hazardous materials. Measures that would be implemented by Jordan Cove to avoid or reduce effects on aquatic resources are discussed below.

Effects on Aquatic Habitat and Aquatic Species from Construction of the Jordan Cove LNG Facilities

The estuarine portion of the Jordan Cove LNG terminal would include a marine slip, access channel, and MOF. The entire access channel would be located within Coos Bay, while most of the marine slip would be excavated or dredged from existing upland on the North Spit. Many of the construction supplies for the facility would be provided through transport by marine barge and break-bulk ships. This would require the construction of a temporary barge berth. There would also be construction of the Kentuck project site and Eelgrass Mitigation site to mitigate for lost estuarine and wetland habitat (see chapter 2 and section 4.3.3 for further descriptions).

Construction of the LNG facilities and channel improvements would temporarily and permanently affect known oyster and shrimp habitat areas. There are currently about 753 acres of oyster habitat and 1,730 acres of shrimp habitat in Coos Bay. About 3 acres of oyster habitat and 10 acres of shrimp habitat would be permanently reduced primarily from construction and operation of the access channel. The largest temporary effect would be from the construction of the Eelgrass Mitigation site that would reduce shrimp habitat by about 4 acres. Overall, there would be temporary short-term disturbance of about 1 acre of oyster habitat and 6 acres of shrimp habitat primarily from the construction of the Kentuck project and Eelgrass Mitigation sites in addition to temporary effects from construction of the access channel. Less than about 1 acre of shrimp habitat would be disturbed by the construction of the 1,100-foot-long pile dike rock apron, which would include modification from soft bottom to riprap habitat that could affect future habitat suitability for these organisms.

<u>Dredging of the Slip Access Channel, Navigation Channel, and Other Facilities</u>

About 1.4 mcy would be removed by marine dredging during creation of the access channel in the bay. Effects of dredged material placement to terrestrial habitats is addressed in other portions of the EIS including sections 4.3.3 (Wetlands), 4.4 (Upland Vegetation). and 4.5.1 (Terrestrial Wildlife). The creation of the access channel would result in the modification of about 37 acres of present-day subtidal and intertidal habitat to deeper water habitat in the bay. The dredging operation to create the access channel would change physical conditions of the bay bottom in this area, locally altering the bathymetry and potentially altering the morphology and water currents. About 19 acres of intertidal to shallow subtidal habitat, including approximately 2 acres of eelgrass habitat and less than 1 acre of salt marsh, would be modified to primarily deep subtidal habitat during the dredging process of the deepened channel. Increasing depth and removal of vegetation would reduce the quality of habitat for juvenile salmonids and other juvenile marine species.

The construction of the access channel would affect local aquatic resources by removal or conversion of some habitats. This would include construction of the temporary barge landing facility on the southwest portion of the access channel, that would occur prior to the excavation and dredging required to complete the LNG carrier offloading facility. Additionally, the MOF would be constructed in the southeast portion of the entrance as a permanent facility to allow offloading of large equipment. There would also be short-term turbidity from dredging in the bay, and additional erosion of the shoreline during construction activities could result in sedimentation. To control upland soil erosion and potential sedimentation, Jordan Cove would follow the measures outlined in its ESCP; for marine waters, measures in their *Dredged Material Management Plan*[116] would be followed.

There is also the potential for an accidental oil or fuel leak from dredging equipment to affect aquatic resources in the bay. To avoid or reduce effects from oil or fuel leaks, Jordan Cove developed a preliminary SPCC Plan.[117]

About 37 acres of current upland habitat excavated and dredged to create the marine slip would be converted to open water, primarily deep subtidal habitat. While this area would have little intertidal habitat due to steep banks, it would supply some subtidal habitat that would not have been present without the Project. This habitat, however, would be highly disturbed due to large vessel arrivals and departures, and would generally be of low quality habitat for most species because of its armored banks, steel retaining walls, and lack of current in the slip.

To improve navigation reliability for LNG carriers, Jordan Cove proposes to excavate four submerged areas in Coos Bay along the vessel access route. This would include the dredging of some 27 acres of deep subtidal habitat at bend areas along the route and the dredge lines for this activity would include another 13 acres of mostly deep subtidal habitat modification. These dredging activities and follow-up maintenance dredging would disturb this habitat and, in the short term, reduce function of these areas primarily from disturbance to benthic and epibenthic organisms living in these areas and organism that feed in these areas.

The installation of the pile dike rock apron would change habitat from soft bottom to rock habitat over an area of about 2 acres. The construction would include short-term increase of local turbidity from bottom disturbance and initial loss of benthic organisms by burial. While the preferred placement of the riprap would be from a barge, some may occur in the intertidal area by land-based equipment, which may cause short-term effects on benthic organisms from transit of vehicles across the intertidal areas as part of rock placement. Construction would be limited to one in-water work window period when many important fish species, such as salmon, are of low abundances, reducing potential effect from local turbidity increases and loss of benthic and epibenthic resources from rock placement and shoreline vehicle transit used to place the rock. Increased rock areas may supply more habitat for rock-oriented species and cover for potential juvenile salmonid predators. Jordan Cove has identified two specific sites in Coos Bay that would be set aside and/or developed as compensatory wetland mitigation[118] for loss of intertidal and subtidal habitat from dredging. Their construction would also contribute to local turbidity.

The loss of 2 acres of eelgrass would be mitigated by off-site development and planting of a minimum of 6 acres of eelgrass habitat in the bay. The area proposed has been used successfully for eelgrass mitigation in the past. Donor stock eelgrass would be obtained from a combination of sites, including managed commercial oyster beds and existing high-density eelgrass areas, for use

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[116] The plan was attached as Appendix N.7 to Resource Report 2, as part of Jordan Cove's application to the FERC filed in September 2017.

[117] This plan was attached as Appendix F.2 to Resource Report 2 of Jordan Cove's application to the FERC filed in September 2017.

[118] Jordan Cove included a *Compensatory Wetland Mitigation Plan*, attached as Appendix O of their *Draft Applicant-Prepared Biological Assessment.*

in establishing new eelgrass beds at the mitigation site. There would be some short-term loss of eelgrass habitat from those areas dredged during construction and from the removal of donor stock areas when the Eelgrass Mitigation site is planted. The use of salvaged eelgrass from commercial oyster beds and taking donor stock only from high-density areas would reduce short-term effects caused by developing the Eelgrass Mitigation site. As noted above, the total area of eelgrass affected is small relative compared to that habitat in Coos Bay, but some local short-term reduction in productive estuarine habitat would result.

Disturbance to 17 acres of other estuarine habitats (non-eelgrass) would be mitigated with re-establishment of estuarine habitat on about 91 acres of unvegetated mudflats at the Kentuck project site. This mitigation site would reestablish 67 acres of tideland habitat and additional wetland acreage. It would be a combination of native estuarine habitats (saltmarsh, tidal sand/mudflats) and freshwater wetland habitat (forested, scrub/shrub and emergent) (see section 4.3.3). Kentuck Slough is located on the east shore adjacent to the main inner bay between the area affected by the Project and Coos River mouth. This area would be modified with the addition of some of the dredged tailings from the LNG slip excavation. Additionally, 2.7 acres of floodplain habitat would be re-established adjacent to Kentuck Creek and would include stream enhancements including realignment of Kentuck Creek through the site. This area is close to the main Coos Bay river channel, which would benefit early marine-rearing juvenile salmonids.

The details of the plan, measures of success, and contingencies are provided in the *Compensatory Wetland Mitigation Plan*; however, final acceptance of the adequacy of the plan by ODSL or other resource agencies is pending. Therefore, Jordan Cove must continue to consult with the COE, NMFS, ODSL, and ODFW and other appropriate resource agencies to develop a final wetland mitigation plan for permanent effects on eelgrass and other estuarine habitats (see section 4.3).

Considering the mitigation measures proposed, and the implementation of mitigation plans, dredging activities would have only short-term effects on subtidal and intertidal habitat in Coos Bay.

Increased turbidity and sediment from dredging for the slip construction and navigation channel expansion would also affect marine and estuarine organisms. There are other project actions that would also increase local turbidity such as eelgrass mitigation site dredging, pile dike rock apron construction, and others. These are discussed in section 4.3.2.2 of this EIS.

Jordan Cove has stated that their construction plans, including their ESCP, would prevent turbid water from on-land construction, dredge material placement, and slip formation to be discharged or allowed to flow into Coos Bay. All in-water work would be restricted to the in-water work window from October 1 to February 15, contributing to reducing effects on fish habitat and species.

A large quantity of suspended sediment can reduce light penetration, which in turn reduces primary production of both pelagic and benthic algae and grasses. Increased suspended sediment can affect feeding of benthic and pelagic filter feeding organisms (Brehmer 1965; Parr et al. 1998), and the settling of the suspended particles can cause local burial, affect egg attachment, and modify benthic substrate. High enough levels can have direct adverse effects on fish ranging from avoidance to direct mortality. Use of pumps to convey the material in a hydraulic dredging operation would serve to contain most of the siltation caused by the dredging. The siltation would be conveyed with the material removed to the disposal area where it would settle out before being discharged back to the waterbody. The suspended sediment and turbidity levels would decline to ambient levels following completion of dredging activities.

Because of the short duration and small areas of in-water work for project activities other than dredging, effects on aquatic organisms from elevated turbidity would be localized and short term, likely diminishing in a few hours. However, dredging of the access channel would require in-water work that would occur over a longer timeframe and larger area. Dredging of the access channel would result in temporary siltation and sedimentation effects similar to those that currently occur during COE maintenance dredging of the Coos Bay navigation channel. On average, the COE removes approximately 550,000 cy from the bar, 200,000 cy from NCM 2 to 12, and 150,000 cy from NCM 12 to 15 each year. In-water dredging of the slip and access channel would occur over four in-water work periods totaling about 4 to 6 months.

The ambient turbidity levels in the water (generated by flows, waves and ship traffic) create a background level of turbidity. Within Coos Bay, turbidity measurements observed as total suspended solids (TSS) at the Charleston Bridge over a two-year period show an average summer TSS level of 10 mg/l and an average winter level of 27.3 mg/l. Some individual events (e.g., winter storms) measured at the Charleston Bridge were recorded between 100 and 500 mg/l. Therefore, aquatic organisms in Coos Bay are adapted to and exposed to periods of high to moderate turbidity during the winter months. Dredge operations are expected to result in similar effects, with higher concentrations of TSS in the immediate area of dredging.

Jordan Cove conducted modeling to estimate turbidity and suspended sediment that would result from access channel construction (Moffatt & Nichol 2006a) and the construction and maintenance dredging for all proposed bay activities (Moffatt & Nichol 2017c). The details of the model results on quantity and distribution of these parameters are discussed in section 4.3.2.1. The maximum TSS at a specific dredge site using a clamshell dredge was estimated to be about 6,000 mg/l decreasing substantially away from the dredge location. Moffatt & Nichol (2006a) also estimated that average turbidity levels during dredging operations (covering changing tidal directions) would not exceed background levels (about 10 to 30 mg/l) for the mechanical dredge at the slip. These levels would be even less for the hydraulic dredge beyond the actual dredge location, while elevated levels would occur outside of the actual dredge area for periods not exceeding 2 hours in duration depending on tidal direction. At lower tidal velocities, values would not exceed 30 mg/l outside of 200 meters, and at high tidal velocity less than 50 mg/l in 200 meters.

The concentrations and distribution are partly dependent on the type of dredging method that would be used. Proposed methods for dredging include use of mechanical or hydraulic (suction) dredging equipment. While the hydraulic cutter suction dredge is preferred due to its lower turbidity generation, a type of mechanical dredge may be used, especially in portions of the nearshore area due to buried wood. Model results for the access channel and slip construction indicate that elevated TSS above background would extend about 0.2 to 0.3 mile beyond the dredge sites during a full tidal cycle with any method considered and would exceed about 500 mg/l for about 0.1 mile. Maximum concentrations outside of the specific dredge location would only occur for about 2 hours or less over the tidal cycle with the plume moving upstream or downstream of the dredge site on flood or ebb tide, respectively. TSS concentrations at the four navigation channel expansion sites (i.e., part of the marine waterway modifications) would reach background level (about 20 mg/l) over a distance of about 1.2 miles[119] with any of the dredging methods. However, hopper style suction dredging would have much higher concentrations during construction with TSS over 500 mg/l extending about 1.0 mile across the dredging site, while the hydraulic cutter suction dredge or mechanical clamshell dredge would produce TSS of 500 mg/l extending about 0.1 mile from the dredge site. The distribution of and concentrations of suspended sediment would be the same for construction or maintenance dredging. If a mechanical excavator would be used for the eelgrass site construction, a confined area of elevated TSS would extend less than 0.1 mile from point of dredging (Moffat & Nichol 2017c). The more limited effect of tidal flow over the area would help confine the distribution of the elevated sediment plume. These elevated levels would be short term and highly localized to the nearshore area of the eelgrass site.

During the dredging process, some small fish (such as sandlance), larvae, and fish eggs could be entrained. Larger fish would be able to avoid this process and would likely actively avoid the area during the dredging disturbance process. In a review of many maintenance dredge studies through 1998, Reine and Clarke (1998) concluded that "much of the available evidence suggests that entrainment is not a significant problem for many species of fish and shellfish in many bodies of water that require periodic dredging." However, Dungeness crab in some studies are highly susceptible to entrainment (Reine and Clarke 1998; Pearson et al. 2002, 2005). Based on this review, it appears that entrainment of marine fish and shellfish species would not be a substantial effect on the local marine resources, although some important fish and shellfish may be reduced in abundance locally. Effects would be minimized by the current in-water work windows (October 1 to February 15) and by maintaining the cutterhead near the bottom if a hydraulic dredge is used.

If salmonids are exposed to moderate to high levels of TSS for prolonged periods, many adverse effects could occur including behavioral changes, sub-lethal effects, and increased mortality from predators. Dredging is expected to create spikes of high to moderate turbidity in a localized area. Effects on estuarine organisms and their habitat are expected to be slight and not measurable due to the limited area affected and the short duration of dredging operations, and limitations on construction periods. Rearing and migrating salmonids including ESA listed salmon, which should be uncommon in Coos Bay during the in-water work window, would likely avoid active work areas.

In Coos Bay, suspended sediment from dredging activity could affect shellfish, including clams and oysters and other filter feeders in the immediate vicinity and downstream of the access channel dredging site. Depending on dredging-induced elevated suspended concentration and exposure duration, effects on individual species and life stage from elevated suspended sediment could include no, minor, or major behavioral effects, physiological stress, reduced growth, or reduced survival and reduced egg hatching success (Wenger et al. 2018). Entrainment of organisms, especially eggs and larvae, may also occur. Dredging of the access channel and marine waterway modifications would be in deep water areas away from major commercial oyster areas as well (figure 4.5-2) and would likely not results in substantial effects from elevated turbidity or entrainment of commercial shellfish.

Jordan Cove's dredging would also directly remove benthic organisms (e.g., worms, clams, benthic shrimp, starfish, and vegetation) from the bay bottom within the access channel and navigation channel modifications. Mobile organisms such as crabs, many shrimp, and fish could

[119] Plume distance noted includes total spread both upstream and downstream of dredge site.

move away from the region during the process, although some will be entrained during dredging so that direct mortally or injury could occur. Based on 1978 maps of shellfish (Gaumer et al. 1978), shrimp, soft shell calms, bentnose clams, and cockles are located within the intertidal areas near the slip and within dredge areas (west of the Roseburg Forest Products Company site). The four navigation channel modifications are not located in known clamming or crabbing areas, or shrimp or oyster habitat (figure 4.5-2). ODFW captured Dungeness crab and red rock crab in this area during 2005 seining efforts near the access channel location. Varied species could be injured or killed during dredging operations. Dredged areas typically have edge areas sloped to maintain their stability, reducing the potential for bank sloughing and restricting direct impacts on areas dredged. Dungeness crabs and sand shrimp (Crangon spp.) can be especially susceptible to entrainment, although many survive dredging (Reine et al. 1998). Dungeness crab entrainment has been reported as substantial in some areas depending on season, salinity, location, and type of dredge used (Pearson et al. 2005, 2002). Reine and Clark (1998) reviewed dredging studies and concluded that "much of the available evidence suggests that entrainment is not a significant problem for many species of fish and shellfish in many bodies of water that require periodic dredging." Dredge entrainment studies over a four-year period in the Columbia River found no juvenile or adult salmonids entrained during dredging, although some other pelagic fish including eulachon were entrained (Larson and Moehl 1990).

When benthic communities on mud substrates have been disturbed by dredging in Coos Bay, they typically recovered to pre-dredging conditions within 4 weeks (McCauley et al. 1977, as cited in Wilber and Clarke 2007). However, recovery in estuarine channel muds has been reported in a review paper of dredging to be typically six to eight months (Newell et al. 1998). In the lower Columbia River, McCabe et al. (1997, 1998) noted benthic organism recovery in three months. Studies of a dredged sandy substrate area in Yaquina Bay Oregon found recovery of benthos took one year (Swartz et al. 1980, as cited in Wilber and Clarke 2007). Because of the large quantity being dredged and type of substrate, it may take longer than a four-week period relative to typical dredging and thus the benthic communities in the areas to be dredged may take a more varied time period to recover. The similarity of sandy substrate, like that of Yaquina Bay, suggest it is likely that recovery would be closer to a year for benthic resources particularly in the navigation channel modifications.

We would also expect increased organic matter production to the Coos Bay system from Jordan Cove's proposed eelgrass and wetland mitigation sites. The Kentuck project would provide about 67 acres of shallow water habitat as mitigation for the loss of about 16 acres of shallow estuarine water habitat at the access channel and the Eelgrass Mitigation site would provide 6 additional acres of eelgrass habitat as mitigation for the loss of 2 acres of eelgrass habitat. The affected shallow water habitat is suitable habitat for oysters (about 3 acres) and shrimp (about 10 acres). The development of the Kentuck project would likely contribute to replacing this type of habitat loss since existing oyster and shrimp habitat is present near Kentuck Slough.

Additionally, although sediment samples to date have not indicated high organic content sediment, some high oxygen demand sediment could be encountered during dredging. This could remove oxygen from the local water areas, putting local organisms at risk from insufficient oxygen. This effect would be temporary, and tidal exchange would be expected to replenish oxygen. In most cases, where dredging and disposal occurs in open coastal waters, estuaries, and bays, localized removal of oxygen has little, if any, effect on aquatic organisms (Bray et al. 1997). Also, Nightingale and Simenstad (2001b) reviewed literature in a summary document on effects of dredging and could find no empirical data indicating reduction in oxygen was an issue of concern for estuarine and marine organisms for dredging actions.

Dredging may also resuspend nutrients to the water column and could affect primary production. At low levels, this could be of benefit, increasing phytoplankton production, which could benefit prey species eaten by fish. However, in estuaries, this production is limited by turbidity and flushing, so any effects would be slight and local.

The initial marine waterway modifications (i.e., widening) in four areas would have minor habitat changes in Coos Bay. Deepwater habitat area would be further deepened in the four areas totaling about 27 acres of benthic deepwater habitat disturbance, plus an additional 10 acres deepwater habitat for the slurry transport lines. Less than an additional acre of shallow water habitat would be disturbed from the dredge lines used. The deeper water habitat is generally less productive than the shallow water environments. As with all dredging, there would be an initial loss of benthic resources from the dredging of the navigation channel that would recover over time. Overall habitat structure of the bay would remain essentially unchanged from the widening of the channel in these areas. Some of this net loss would be offset by added annual benthic production from the newly formed 37-acre slip habitat, even though it would likely be of poor quality.

In conjunction with all dredging activities would be the placement of temporary pipelines (18 to 20 inches in diameter) possibly on the bottom of Coos Bay to the deposition areas of the dredged sediment. This would include a pipeline route up to about 7 miles from the navigation widening area 1 to 4 miles to APCO Sites 1 and 2, one from the Eelgrass Mitigation site to APCO Sites 1 and 2 (about 0.5 mile), and another line extending from the shipping channel near the APCO Site to the Kentuck project (about 1.5 miles). These would have some initial bottom disturbance from placement and would likely kill benthic organisms (e.g., clams, worms) that are under the pipe placements. Most of the line would be in deep water paralleling the navigation channel from the four navigation modifications, which is an area often currently disturbed by shipping and maintenance dredging. Overall, there would be some reduction in benthic organism abundance from this direct placement of the pipes. The effective periods of this activity would be brief each year, occurring only during the construction in-water work window taking about 5 months total over four in-water work windows.

Maintenance dredging would occur every three to five years, with dredging taking about a month for the slip and access channel and a week for the navigation channel modifications. This would keep the navigation channel depth as it is currently, and the LNG slip depth as originally developed. Thus, after the project-developed initial widening, the current habitat structure of the navigation channel would remain unchanged and slip area would be as originally developed following each maintenance dredging cycle.

Construction windows for in-water dredging, developed by the state, are intended to minimize effects on the overall aquatic environment. The in-water work window (October 1 through February 15) would minimize the exposure of juvenile salmonids to increased turbidity during outmigration but would occur during much of the adult salmonids' upstream migration. Resident estuarine species, however, would be present during the in-water work window.

New Deepwater Habitat

The construction of the slip and berth would add a new region of deeper water habitat in Coos Bay. The area would have steep riprap sides that would have little biological diversity in shoreline habitat. The deeper areas may have slightly different fish composition than the main bay but overall the change in depth would be slight relative to the main adjacent navigation channel. Based on COE surveys, the navigation channel adjacent to the proposed site is 44 feet deep, with proposed slip depth 45 feet similar to the local deep bay areas, although to the side of the channel. While future composition of the channel species cannot be predicted, it appears conditions would not be substantially different than the adjacent navigation channel area. This may, however, result in some species composition differences locally. It would remain a relatively disturbed area for organisms, with the frequency of LNG carrier traffic likely reducing its overall benefit to fish and invertebrate resources. However, the final use of this new environment and changes in use from the existing conditions cannot be completely estimated now and conditions may take time to fully develop. This also holds for the four navigation channel modifications; however, these areas are already deep (all greater than 26 feet and would be deepened to 37 to 41 feet) and would include gradually sloped banks to prevent slumping in these areas. Aquatic resources, such as fish, shellfish, and marine mammals that may use Coos Bay, are under the management of ODFW and NMFS. In its response to the FERC staff's pending BA and EFH Assessment (see section 4.6 of this EIS), the NMFS can impose conditions through its BO to protect aquatic resources in the new deepwater habitat created by the Jordan Cove terminal slip.

Pile Driving Acoustic Effects

There are three basic types of pilings proposed: steel sheet pile, steel post piles, and wood post piles. The methods of installation that can be used for installation is a vibratory hammer or impact hammer, with some piling installed using both methods. Generally, noise levels are less with the vibratory hammer. Most of the construction-related pilings would be installed well away from the water. However, some pilings would be installed directly in the water or near the water where sound waves may transmit substantially into the water. Jordan Cove would install pipe piles and sheet piles for the Project including the marine and upland piles (see chapter 2). About 600 of these pilings are associated with the marine facility. These steel piles would be for the LNG carrier berth and MOF on the southeast side of the marine slip. Most of these piles would be driven land-side adjacent to the berth and while the upland portions of the marine berth are still isolated from the bay by the berm. Additionally, about five metal piles would be installed in the shallow water in support of dredge tailings pipeline over eelgrass beds to the APCO Site. Some additional temporary pilings would be installed in the wet[120] for the MOF, temporary material barge berth (TMBB), temporary dredge off-loading areas, road widening area, and access bridge to the APCO site. A total of 119 in-water steel pipe piles would be driven for the Project considering all these facilities with a lesser number of sheet piles (most driven primarily by vibratory hammer and some limited impact hammer use). An additional 1,150 wood piles would be installed for the road widening at U.S. Highway 101.

Underwater noise that may result in harassment and/or take of marine mammals is regulated by the NMFS under the MMPA. Under the MMPA, Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine

[120] Installing a piling "in the wet" or "in water" means the piling is in direct contact with the water body when it is driven into the substrate with an impact or vibratory hammer

mammal stock in the wild; however, the actionable sound pressure level is not identified in the statute. Level B harassment is defined as any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

In July 2016, the NMFS finalized their *Technical Guidance for Assessing the Effect of Anthropogenic Sound on Marine Mammals* (NMFS 2016c). Under this new NMFS guidance, Level A harassment is said to occur as a result of exposure to high noise levels and the onset of permanent hearing sensitivity loss, known as a permanent threshold shift (PTS). This revision to earlier NMFS guidelines is based on findings published by the Noise Criteria Group (Southall et al. 2007), which concluded that for transient and continuous sounds, the potential for injury is not just related to the level of the underwater sound and the hearing bandwidth of the animal, but is also influenced by the duration of exposure. The evaluation of the onset of PTS provides additional species-specific insight on the potential for affect that is not captured by evaluations completed using the previous NMFS thresholds for Level A and Level B harassment alone.

Frequency weighting provides a sound level referenced to an animal's hearing ability either for individual species or classes of species, and therefore a measure of the potential of the sound to cause an effect. The measure that is obtained represents the perceived level of the sound for that animal. This is an important consideration because even apparently loud underwater sound may not affect an animal if it is at frequencies outside the animal's hearing range. In the NMFS (2016c) final Guidance document, there are five hearing groups: low-frequency (LF) cetaceans (baleen whales), mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales), high-frequency (HF) cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*), Phocid pinnipeds (true seals), and Otariid pinnipeds (sea lions and fur seals). All of the above-listed species except Otariid pinnipeds potentially occur in the aquatic analysis area.

There are specific hearing criteria thresholds provided by the NMFS for each functional hearing group. These criteria apply hearing adjustment curves for each animal group known as M-weighting (see table 4.5.2.2-3).

TABLE 4.5.2.2-3

M-Weighted PTS Criteria and Functional Hearing Range for Marine Mammals

Functional Hearing Group	PTS Onset Impulsive	PTS Onset Non-Impulsive	Functional Hearing Range
LF cetaceans (baleen whales)	219 dB_{peak} & 183 dB SEL_{cum}	199 dB SEL_{cum}	7 Hz to 35 kHz
MF cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	230 dB_{peak} & 185 dB SEL_{cum}	198 dB SEL_{cum}	150 Hz to 160 kHz
HF cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* and *L. australis*)	202 dB_{peak} & 155 dB SEL_{cum}	173 dB SEL_{cum}	275 Hz to 160 kHz
Phocid pinnipeds (underwater) (true seals)	218 dB_{peak} & 185 dB SEL_{cum}	201 dB SEL_{cum}	50 Hz to 86 kHz
Otariid pinnipeds (underwater) (sea lions and fur seals)	232 dB_{peak} & 203 dB SEL_{cum}	219 dB SEL_{cum}	60 Hz to 39 kHz

NMFS has defined the threshold level for Level B harassment at 120 decibels root mean squared (dB_{RMS}) for continuous noise and 160 rms_{90} sound pressure level (SPL) for impulse noise. Within this zone, the sound produced by the Project may approach or exceed ambient sound levels (i.e., threshold of perception or zone of audibility); however, actual perceptibility will be dependent on the hearing thresholds of the species under consideration and the inherent masking effects of ambient sound levels. The Level B harassment threshold was not updated with the July 2016 technical guidance.

Underwater noise from project construction activities could affect fish resources in Coos Bay. State agencies in Washington, Oregon, and California along with federal agencies including the FWS and NMFS have developed interim noise exposure threshold criteria for pile-driving effects on fish (WSDOT 2011; Fisheries Hydroacoustic Working Group 2008; Popper et al. 2006). These threshold criteria are considered levels below which injury effects would not occur to fish from in-water noise. These thresholds should be suitable for all forms of in-water noise. Interim noise exposure threshold criteria for pile driving effects on fish include: 1) a cumulative sound exposure level (SEL_{cum}) of 187 dB re 1 μPa^2 s for fishes more than two grams, 2) a SEL_{cum} of 183 dB relative to 1 square microPascal (re 1 μPa^2) for fishes less than two grams, and 3) a single-strike peak level (SPL_{peak}) of 206 dB re 1 μPa for all sizes of fishes (Fisheries Hydroacoustic Working Group 2008; WSDOT 2011). Generally, the high peak value is associated with potential mortal injury and forms of recoverable injury while the cumulative values are associated with forms of impairment that are likely recoverable forms of injury (Popper et al. 2014). While more recent studies based on additional information have recommended slightly different guidelines (Popper et al. 2014) these have not yet been implemented by the above agencies as new criteria. Piling location relative to water area, substrate piling is driven into, type of piling, and method of pile driving all influence the magnitude of in-water noise level and therefore the likelihood of noise levels injuring marine mammals and fish.

The potential noise levels relative to fish and mammal criteria of sheet pile and post pilings that would be installed at the LNG site out of the water were modeled (Deveau and MacGillvray 2017; O'Neill and MacGillivray 2017b; Wladichuk et al. 2017; Wladichuk et al. 2018). The sheet pile installation modeled were those that would be closest to the water. These sheet piles would be installed behind a 30-foot-wide berm separating the installation from the water. Wladichuk et al. (2018) modeled the installation of 36-inch steel post pilings by impact hammer located 100 feet back from sheet piles and adjacent to the water at the MOF.

The available information on decibel levels from these models were entered in the NMFS impact model for fish (NMFS 2009) for vibratory sheetpile installation to approximate the extent of potential noise effects from a general location in Coos Bay. Model results based on data from Deveau and MacGillvray (2017) indicate essentially no likely affect to fish from sheet piles installed away from the water. If any sheet piles were installed in or near the water edge, some adverse effects on fish that remain near the installation site (table 4.5.2.2-4).

Impact hammer use on steel post piles also was modeled for those near the MOF. Using the criteria noted above, estimated extent of potential injury to fish from these of pile installation are shown in table 4.5.2.2-4. While not directly modeled by Wladichuk et al. (2018), there will be unspecified locations in the bay that will have in-water pilings installed to anchor the navigation channel dredging pipes. Since most of these pilings would be installed with a vibratory hammer, effects on fish would limited in most areas. However, if an impact hammer were used, noise effects on fish in these areas would be limited because of the low number of impacts. Therefore, the extent of noise impact distribution is likely to be absent or limited in most other areas; however, where impact hammer is used, effects could be similar to those shown in table 4.5.2.2-4 if noise-dampening mitigation is not applied.

TABLE 4.5.2.2-4

Modeled Onset of Injury Distances of Unmitigated Metal Pile-Driving Sound Effects on Fish in Coos Bay during Construction

	Distance Threshold (ft) to Onset of Physical Injury to fish		
		Cumulative SEL dB by Fish Size	
Criteria and Hammer Type	**Peak dB**	**Fish ≥ 2 grams**	**Fish < 2 grams**
dB Criteria Threshold	206	187	183
Vibratory Hammer a/	0 ft	380 ft	380 ft
Vibratory Hammer b/	0 ft	<10 ft	< 10 ft
Impact Hammer MOF100-ft set back c/	120 ft	0.5 miles	0.5 miles
Impact Hammer MOF at shore c/	120 ft	1.1 miles	1.1 miles

a/ In water sheet pile noise level values averaged from data in Illinworth and Rodkin (2007). Model estimate from NMFS (2009); assumed 10,000 hammer impacts in 24 hours

b/ Sheet pile 30 feet back from water, peak value from Deveau and MacGillvray (2017). Model estimate from NMFS (2009); assumed 10,000 hammer impacts in 24 hours

c/ Assume 10,000 and 20,000 hammer impacts within 24 hours (Source: Wladichuk et al. 2018)

In addition, there would be 1,150 wood piles and sheet piles constructed at the Trans-Pacific Parkway/U.S. 101 intersection widening. These piles may be installed above or below water level depending on tide level. The methods for wood pile installation are unknown, but sheet piles would be installed by vibratory hammer with an impact hammer being used if necessary. One report measured peak values of 180 dB 10 meters from wood piling when using an impact hammer (Illinworth and Rodking 2007). Data are not available on noise levels from a vibratory hammer on wood, but vibratory hammer noise levels are generally much lower at peak noise production than those from an impact hammer. With the number of pilings to be installed, the frequency of piling contacts would be high. There is some risk of cumulative noise levels associated with wood pile-driving being an issue if peak noise values were near 180 dB. Jordan Cove has indicated that an impact hammer would not be used on sheet piles if they were inundated by high tides; implementation of this commitment would reduce the effects of cumulative and peak noise levels on fish.

Mitigative actions would be taken to reduce the potential effects of noise on fish. The estimates of noise levels that may cause injury to fish (table 4.5.2.2-4) assume that no mitigation (such as a bubble curtain) is in use, and that fish would remain in the area of adverse noise effects during the whole period of installation. Jordan Cove would implement sound attenuation measures in accordance with NMFS guidelines as needed, and fish are mobile and unlikely to remain in areas where cumulative noise levels would result in injury. All in-water pile driving would also occur only during the ODFW in-water approved construction window of October 1 to February 15, which would avoid noise injury to most salmonids.

General equipment used (e.g., trucks, compressors) and construction activity other than pile driving would all have noise levels below any that would affect marine mammals or fish (all less than 90 dB maximum). Noise in air produced by pile driving was modeled by Jordan Cove, and it was found that peak noise within 23 feet for all piles (18- to 72-inch diameter) being driven would be less than 117 dB and maximum of 101 dB at 50 feet, well below levels that would affect fish even if in the water. During pile driving, noise levels in air would decrease to below 90 dB_{RMS} (current in-air behavioral disruption threshold for harbor seals) at approximately 920 feet from the nearest piling rig. The current in-air behavioral disruption threshold for pinnipeds other than harbor seals (e.g., the California sea lion and Steller sea lion) is a less stringent 100 dB_{RMS} (NMFS 2018a). As a result, marine mammals within this distance could experience some behavioral disruption during pile driving.

Marine mammals inside Coos Bay may be affected by underwater noise from pile-driving during construction. The greatest distance at which PTS due to impulsive peak noise may possibly occur is around 250 feet for the harbor porpoise. Outside Coos Bay, the potential for effects on marine mammals from piling is limited to behavioral disturbance due to noise. Vibratory sheet pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 120 dB re 1 µPa at distances of up to 1.2 miles (Deveau and MacGillvray, 2017). Impact pipe pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 160 dB re 1 µPa at similar distances (O'Neill and MacGillvray 2017).

Jordan Cove would consult with the NMFS to design a monitoring and adaptive management plan including the development of a pinniped safety zone. If sound levels are determined to exceed NMFS Level A regulatory thresholds for marine mammals or guidelines for listed salmonids, sound attenuation measures would be used in accordance with NMFS guidelines. The NMFS has indicated that they may require additional monitoring as well as noise mitigation for the Project, including potentially the use of bubble curtains, sediment curtains, as well as various ongoing monitoring programs. These measures would be included, if required, in the NMFS BO.

Erosion and Runoff from Upland Facilities

Effects on marine resources could occur from the clearing of vegetation at the terminal, erosion and sediment runoff, and potential hazardous substance spills during construction. While no streams are present in the upland portion of the terminal, the removal of current vegetation could modify the character and amount of water runoff into the bay.

Nearshore vegetation clearing could indirectly affect aquatic resources in the bay; however, the amount of nearshore vegetation that would be removed for this Project is small. No planned nearshore disturbance would occur outside of the upland and shoreline that would be excavated and dredged to create the marine slip for the terminal. Jordan Cove would prevent uncontrolled releases of sediment runoff during construction by implementing erosion control and revegetation measures from its ESCP.

During construction of the LNG terminal facilities, stormwater runoff could erode disturbed soils, creating sediment in nearby surface waters, and affect local aquatic resources. Stormwater runoff from the disturbed portions of the site would be managed in accordance with Jordan Cove's ESCP and ODEQ-approved *Storm Water Management Plan* (see section 4.3.2.2). Following appropriate treatment, such as electro-coagulation, chemical flocculation, or filtration, if needed, all construction stormwater from the LNG terminal site would be directed toward Coos Bay.

Additionally, accidental spills of hazardous materials (e.g., equipment fuel, oils, and paints) during construction could have effects on aquatic resources in the bay. Jordan Cove prepared a preliminary SPCC Plan for construction to minimize the potential for accidental releases of hazardous materials.

Hydrostatic Testing

Water would be used for hydrostatic testing of the LNG storage tanks and piping prior to placing them in service (see chapter 2). The source of water would be local untreated potable supply from the CBNBWB. After completion of the test, the water would be discharged by filtration through the ODEQ-approved stormwater system or through the existing industrial wastewater pipeline. Permits would be obtained for all wastewater discharges as required by ODEQ. Water discharges would be treated, if necessary, to comply with discharge permits. If treatment were required, treatment procedures would be developed prior to discharge. The discharge through the existing industrial wastewater discharge pipeline, which connects to the previously existing ocean discharge diffuser location, would be at a rate of about 2.9 mg/d. Given that the water would be used inside the LNG storage tanks, chemicals would not be added, the water would be tested for quality and treated if necessary prior to discharge and would enter the ocean through a diffuser allowing rapid dissipation and mixing, the release of hydrostatic test water would not likely affect the ocean aquatic environment.

Construction Supply Vessel Transit

Much of the supplies needed for construction of the terminal and related facilities may be transported by break bulk ships and barges. These vessels would be similar to those used for typical transport of materials into Coos Bay. Approximately 60 deep-draft commercial cargo ships and 50 barges arrive in Coos Bay per year currently; while the frequency of vessel traffic would increase during the construction period, effects on marine resources would be similar to those that normally occur during commercial vessel traffic. The types of effects would be similar to those described for LNG carrier traffic but likely less due to a reduced number of trips and smaller vessel size. This would include effects of vessel strikes, ship grounding, shoreline erosion and fish stranding from vessel transit in the bay, fuel and oils spills and introduction of nuisance species. See section 4.5.2.1 for details of analysis of LNG transport effects addressing these parameters.

Effects on Aquatic Habitat and Aquatic Species from Operating the Jordan Cove LNG Project

Water Use by LNG Carriers at Berth

Jordan Cove estimates that about 110 to 120 LNG carriers would visit its terminal each year. While at the terminal dock for a period of about 17.5 to 24.5 hours, these LNG carriers would release ballast water while taking on LNG cargo. They also would take in water from the marine slip to cool their engines and would slightly affect the temperature of the water in the slip due to either the release of warm water after engine cooling or contact with the cool hull after taking on LNG cargo. These activities could have effects on aquatic resources in the slip.

Ballast Water

LNG carriers would discharge ballast water into the slip after arriving at the terminal berth and taking on cargo. As explained in section 4.3.2.2, Jordan Cove estimated that an LNG carrier taking on cargo at its berth would discharge about 9.2 million gallons of ballast water into the marine slip during the 17.5 hours it would be hoteled at the terminal. Ships may actually spend 24 hours at the berth so water use may be higher, as noted below. The potential of introduction of nuisance species from vessel transit including ballast water discharge was discussed earlier in section 4.5.2.1. Because the ballast water would have been taken on at sea, it might have slightly higher salinity than the water in Coos Bay that is fed from upstream fresh water sources. The tidal cycling of water in Coos Bay would reduce the effect of more saline seawater from ballast release in the slip on local aquatic resources. We estimate the total slip area to cover about 4.8 mcy (3.7 million m^3) of water. Therefore, the ballast water release would only amount to 1 percent of the entire size of the marine slip. By following Coast Guard and EPA procedures for ballast water, Jordan Cove and the LNG carriers visiting its terminal would probably not introduce exotic non-native organisms from a foreign port into Coos Bay.

Entrainment and Impingement from Vessel Cooling Water Intake

During operation of the terminal, LNG carriers at berth may entrain marine organisms through water taken from the slip to cool engines. Jordan Cove estimates that a 148,000 m^3 steam-powered LNG carrier would take in about 69.7 million gallons (264,000 m^3) of water from the slip for engine cooling while during their 24-hour loading period at the terminal dock. Dual-fuel diesel electric propulsion vessels (160,000 to 170,000 m^3) would take in 20.3 million gallons (76,800 m^3) less than steam-powered vessels over 24 hours.

Currently, no additional screening system other than that already employed on the LNG carriers, is proposed for water intakes. The current screen bar spacing on most LNG carriers is about 24 millimeters (mm; about 1 inch), bar width is 4.5 mm, and the total open area (considering screen open area is about 70 percent of total intake size) of the cooling water intake is about 3.5 to 4.2 m^2 or 36 to 45 square foot intake area. Additional finer mesh screens are located internally on the vessels to prevent larger items from entering the system. These screens would not meet NMFS (1997a) screening criteria for juvenile salmonids. The estimated velocity at the opening of the cooling water intake would range from 1.0 to 4.3 fps (0.30 to 1.32 meters/second), depending on the intake rate of cooling water used and intake area. The NMFS recommends an approach velocity of 0.33 fps for screening systems for salmonids of less than 60 mm, and 0.8 fps for larger juvenile salmonids. These guidelines also include other requirements such as sweeping velocity and type and size of openings that are not present on these screens. The result is likely to be that fish at fry and larger juvenile size salmonids near the intakes may be entrained or impinged during cooling water intake.

In addition, smaller marine and estuarine fish, juvenile stages of crab and shrimp, as well as other zooplankton and eggs and larvae fish could also be entrained. Some estuarine organisms potentially including juvenile salmonids would be removed from Coos Bay with this process during every loading cycle. It is expected that a high portion of juvenile larval stages of fish and invertebrates entrained or impinged would result in mortality. Nevertheless, natural mortality of these early life stages is extremely high. The result would be less than 1 percent of earliest life stages reaching adult size, with natural mortality over 20 to 30 percent per day during earliest growth periods (Comyns pers. comm. 2003). For example, data from an estuarine cooling water intake site determined that intake water larval stage entrainment, had very low natural survival (Marine Research Inc. 2004, as cited in FERC 2005). On a typical LNG carrier, the location of the water intake would be near the inner portion of the slip at depth of about 30 feet, which would likely reduce overall abundance of juvenile salmonids but not necessarily other organisms in the intake area. Salmonids migrating in Coos Bay would more likely be swimming in the main channel, away from the shoreline and the inset slip, reducing their chance of encountering the LNG carrier intakes. Other fish may have more varied distribution relative to the intake location. Therefore, the off-channel artificially created marine slip at the Jordan Cove LNG terminal would probably have a lower presence of juvenile salmonids but more varied overall fish abundance than the rest of Coos Bay.

To make a reasonable estimate of potential loss from cooling water intake, we compared the relative amount of water used by an LNG carrier while at dock at the terminal to the amount of water carried by the tide in Coos Bay past the Project vicinity. There are several assumptions with this method; the three major ones are: (1) organism distribution would be similar in water used to that in the bay as a whole, (2) all organisms entrained would be lost to the system, and (3) no avoidance to entrainment would occur. In addition, the estimate of entrainment loss was compared to what typical natural mortality loss would be for invertebrate and vertebrate life stages that are common in zooplankton as potential fish food sources. This information provides a perspective of how entrainment loss may influence food supply relative to natural conditions. This approach was developed in the Shanks et al. (2010, 2011) documents.

The period at the dock would span approximately two tidal cycles (each tidal cycle takes approximately 12 hours). We used data from Shanks et al. (2010, 2011) to make an average estimate that 106.1 million m3 of water would be passing through Coos Bay in the vicinity of the Jordan Cove terminal during one tidal cycle. This means that conservatively[121] from 0.07 to 0.25 percent of the water passing the marine slip would be taken in for engine cooling while an LNG carrier is at dock at the terminal, based on average tidal exchanges. Theoretically, organisms in this entrained water would be lost to the Coos Bay system and therefore not available as a food source. Based on the assumption that the concentration of various planktonic organisms is homogeneous in the resident water in Coos Bay, only about 0.07 to 0.25 percent of the planktonic population would be affected by each LNG carrier.

The loss of these organisms from entrainment can also be compared to loss from natural mortality in the bay environment by comparing estimated loss from entrainment to that occurring from natural mortality of typical pelagic organisms. This comparison was based on comparing instantaneous natural mortality rate (per day) loss, to loss from potential entrainment assuming all entrained organisms suffer 100 percent mortality. The natural mortality rate for various marine pelagic organisms was obtained from Rumrill (1990) and McGurk (1986). Using these rates, comparisons can be made to potential loss from entrainment to that that would naturally occur on a daily basis for a variety of typical marine organisms (table 4.5.2.2-5).

[121] Values is conservative (likely high) because total cooling water intake/discharge period is about 24 hours while we used the one tidal exchange period, about 12 hours for the estimate. Actual volume of water passing area would be about double, but some portion would be the “same” water.

TABLE 4.5.2.2-5

Comparison of Relative Loss of Larval Invertebrates and Larval Fish from Entrainment to Natural Mortality During Cooling Water Intake for One LNG Vessel Docked at the Jordan Cove Terminal

Mortality Category in Literature Source	Taxa Groups b/	Sample size	Natural Mortality Rate M (daily)(M=ln(S)/-t) c/	Estimated Percent Loss from Entrainment Relative to Daily Loss from Natural Mortality a/	
				Low Intake	High Intake
Lowest	Larval Invertebrate 1	14	0.0305	2.4%	8.2%
Lowest	Larval Invertebrate 2	28	0.0161	4.5%	15.5%
Lowest	Larval Fish	29	0.0200	3.6%	12.5%
Average	Larval Invertebrate 1	14	0.1450	0.5%	1.7%
Average	Larval Invertebrate 2	28	0.2470	0.3%	1.0%
Average	Larval Fish	29	0.1969	0.4%	1.3%

a/ Values based on average daily Coos Bay tidal water exchange rate of 106,000,000 m^3, and one LNG carrier water intake of 76,800 m^3 (low) and 264,000 m^3 (high) over 24 hours. Assumes 100% mortality of entrained organisms.
b/ Sources: Invertebrates from Rumrill (1990), and fish from McGurk (1986).
c/ S= Daily Survival, t=days, ln=natural log base e

Average and lowest mortality rates data for larval invertebrates and larval fish from these two sources were similar. Average loss of organisms from entrainment during one LNG carrier loading event would be low, ranging from 0.3 to 1.7 percent of what would occur from natural morality in one day. For the lowest literature mortality rate of larval taxa among those reported, daily entrainment loss would be much higher ranging from 2.4 to 15.5 percent depending on what water volume was used during one vessel loading cycle and which taxa group data are used. These values are conservative estimates when compared to natural mortality that would occur in the Coos Bay system overall because entrainment would not occur daily whereas natural mortality would, not all entrained organisms would suffer mortality, and, as noted, we assumed half the daily water volume passing the loading area.

Because about 110 to 120 LNG carrier trips a year would occur, LNG loading and water intake use would occur on average every 3 days. Therefore, relative fish food organism loss from entrainment annually would be considerably less than that estimated. Overall reduction in food sources for marine predators from entrainment of planktonic organisms appears to be slight, considering numerous factors. On average, water intake would be less than 0.3 percent of the water in Coos Bay passing by the terminal location on a daily tidal cycle, so relatively few organisms would be subject to entrainment assuming similar planktonic organism distribution at the intake. Typical “loss” on average would be about 1.7 percent or less of loss from natural mortality of invertebrate and fish larvae during the day of LNG cargo loading (table 4.5.2.2-5). Even though the number of fish individuals lost is not expected to be large, some mortality would occur. It is expected that the greatest portion of organism and fish that would be entrained would likely be early life stages, as these are unable to avoid entrainment. As noted above, natural mortality is high for these early stages.

We also considered what effect the direct loss of young stages may have on production of older individuals. EPA (2004) examined the effects of entrainment by California power plants on marine fish and shellfish. The document developed natural mortality information by life stage of common marine and estuarine species or groups of species present in the California coastal region. Many of the species groups are common to Coos Bay. This information supplies an additional indication that loss of early life stages because of high natural mortality would not markedly reduce later life stages. Table 4.5.2.2-6 shows the relative survival percent from one life stage to the next up to age 2, and overall percent survival from larval to age 1 and 2, based on the EPA (2004) document. For most taxa, less than 1 percent of larvae would be expected to survive to age 1, as the highest rate of mortality occurs in early life stages. Adult or harvestable populations of a fish species are also affected by many factors (e.g., currents, food, temperature, usable habitat) that are generally independent of numbers or survival of early life stages. Overall, the loss of marine fish and their prey resources from entrainment, relative to numbers in Coos Bay, would be small based on the information discussed.

TABLE 4.5.2.2-6

Selected Survival Values by Life Stage of Marine Species That May Be Entrained or Impinged

	Percent Survival by Life Stages a/				
Taxa Group/Species b/	**Larvae to Juvenile**	**Juvenile to Age 1**	**Age 1 to Age 2**	**Larvae to Age 1**	**Larvae to Age 2**
Anchovies	0.03%	12.00%	49.66%	<0.01%	<0.01%
Longfin Smelt	0.17%	40.01%	51.17%	0.07%	0.03%
Pacific Herring	0.90%	50.01%	62.31%	0.45%	0.28%
Other Forage Fish	0.05%	27.53%	19.79%	0.01%	0.00%
Flounder	0.19%	31.98%	69.56%	0.06%	0.04%
Rockfish	36.79%	36.79%	80.65%	13.53%	10.92%
Cabezon	1.87%	40.01%	26.18%	0.75%	0.20%
Sculpins	2.26%	40.01%	65.70%	0.90%	0.59%
Dungeness Crab	30.12%	30.12%	60.65%	9.07%	5.50%
Commercial Shrimp	4.98%	11.53%	11.53%	0.57%	0.07%
Forage Shrimp	0.31%	41.85%	33.29%	0.13%	0.04%
Average	**7.06%**	**32.90%**	**48.23%**	**2.32%**	**1.607%**
Median	**0.90%**	**36.79%**	**51.17%**	**0.45%**	**0.07%**

a/ Values based on natural mortality rates by life stage.
b/ Groups include multiple species defined in Appendix B1 of EPA (2004).

Loss of juvenile salmonids from entrainment or impingements could also reduce adult returns. Survival from smolt stage is highly variable among salmonid size, species, and year and easily can range from less than one to more than 10 percent. NMFS (2008b) in their assessment of effects of the Coos Bay airport expansions used a value of 4 percent survival for coho salmon smolts to returning adults. Even so, due to the extremely small portion of total water intake relative to the volume of Coos Bay, likely intake locations (30 feet deep, in the back of the isolated slip) likely away from concentrations of juvenile salmonids, the relative portion of juvenile salmonids that would be entrained and suffer direct mortality would be small.

Overall, the extremely small portion of total water intake relative to the volume of Coos Bay per LNG carrier (0.07 to 0.25 percent) suggests that the loss of zooplankton and ichthyoplankton, other marine invertebrates, eggs, larvae, shellfish, and fish including juvenile salmonids due to operation of the Jordan Cove Project would be low in comparison to total available entrainable size organisms in the bay and occurring from natural mortality. Therefore, we conclude that entrainment and impingement from LNG carrier water intakes at the terminal would not have substantial adverse effects on any marine phase of aquatic resources (e.g., the juvenile stage of salmonids) or their food sources.

Water Temperature in the Slip and Bay

LNG carriers at berth at Jordan Cove's terminal have the potential to both warm the temperature of the marine slip while discharging engine cooling water, and to cool the temperature of the marine slip while loading LNG cargo. Moderate to large temperature increases have the potential to reduce fish and invertebrate growth, reproductive success, and if high enough cause direct mortality. Fish of the north Pacific, including those found in Coos Bay, are adapted to cool water conditions and could be adversely affected by sharp increases in water temperature. Coos Bay temperatures historically remain less than 20°C (McAlister and Blanton 1963).

Moffat & Nichol (2018a) developed a temperature plume model for cooling water discharge from the LNG carriers during LNG gas loading. The model assumed that steam turbine vessel and dual-fuel diesel electric vessel would have a cooling water temperature of 2.0°C (3.6°F) and 2.8°C (5.0°F) above ambient at the point of discharge, respectively. Discharge rate would be 11,000 m^3/hour and 3,200 m^3/hour for about 24 hours of loading, for the former and latter vessels, respectively. Moffat & Nichol modeled the extent of the plume to where plume temperature would decrease to 0.3°C (0.6°F) over ambient water temperature. This model was run for varied bay water temperatures. The result was that the maximum distance from the port discharge point where the plume would reach this temperature was 80 feet for the steam turbine vessel and 37 feet for the dual fuel diesel electric vessel. The average water temperature increases for the total slip volume for one day when an LNG carrier is at dock for the vessel using the larger volume (steam turbine vessel) would range from 0.03 to 0.06°F (see section 4.3.2.2). We expect the actual average increase in water temperature in the slip would be less than the higher value estimated due to tidal exchange and the vessel uptake of heat from its surroundings due to the transfer of liquid gas into the vessel at -260°F (-162°C). While marine species would likely have a range of temperature tolerance, salmonids are known to be sensitive to elevated temperatures. The modified water temperature would be well below levels that would be considered lethal in the short term (a few days) for salmonids, which would be over about 24 to 26°C (WDOE 2002). Mortality of juveniles starts to occur at constant exposure to temperatures above 71.6°F (Hicks 2000), with an acute lethal temperature of 78.4°F (Beschta et al. 1987), while optimum temperatures are much lower for salmonids, with preferred ranges generally between 50ºF and 59ºF for rearing juvenile coho salmon (Brett 1952; Reiser and Bjornn 1979; Jobling 1981; Konecki et al. 1995; McCullough 1999; Sullivan et al. 2000; Carter 2008). Juvenile coho salmon are taxed in the temperature range of 60.1ºF to 68.5ºF but are still capable of growing at a reduced rate (Stenhouse et al. 2012). Short-term local temperature increases would remain well below short-term adverse levels for salmonids, and any small changes in temperature including to the area within 80 feet of the discharge port would be easily avoided by fish. Therefore, the cooling water discharge should result in no adverse effect on salmonid resources from temperature changes. Since salmonids are not tolerant of elevated temperatures, they are likely a reasonable indicator that other estuarine species (which may be less sensitive) would also not be adversely affected by small temperature changes. Considering the total volume of water in Coos Bay, in comparison to the small volume of heated water discharged, virtually no change in bay temperature would occur from operation of the LNG Project.

Water Runoff and Spills of Hazardous Materials

After construction of the terminal, about 100 acres would be covered by impervious surfaces (e.g., compacted gravel). There is the potential for stormwater to run off these hard surfaces into the marine slip or bay, carrying sediment or hazardous materials, which may harm aquatic resources. However, before stormwater is discharged, it would be directed to areas for treatment (see section 4.3.2.2). Low oil potential runoff would be treated primarily by filtration, although cartridge filtration may be implemented, as designated in Jordan Cove's *Stormwater Management Plan*. Examples where cartridge filter would be used are paved roads, parking lots, and dense-grated gravel process areas. As mentioned in section 2.1.1.5, Jordan Cove would design and construct a stormwater drainage and collection system for its terminal. Runoff, including potential hazardous materials from the site, would be designed to meet regulatory requirements from both NMFS and ODEQ, and would be managed by following the ODEQ-approved *Storm Water Management Plan*. Stormwater from areas that have no potential for contamination would be allowed to flow into the slip or bay through designed discharge ports. Stormwater collected in areas that are potentially contaminated with oil or grease would be directed to sumps and then processed through an oily water separator before discharge to the industrial wastewater pipeline. Industrial wastewater would be conveyed to the Port's existing ocean outfall, pursuant to the NPDES permit issued by the ODEQ. Stormwater collection and treatment facilities would be designed in consultation with NMFS and the ODEQ.

All areas where LNG may be present would be curbed and graded so that any spill would flow to containment trenches leading to impoundment basins. The two LNG storage tanks would be surrounded by a 65-foot-high barrier. Any spills of hazardous materials would be handled in accordance with Jordan Cove's SPCC Plan (see section 4.3.2.2).

Terminal Lighting

Localized changes in light regime have been shown to affect fish species behavior in a variety of ways (Simenstad et al. 1999; Valdimarsson et al. 1997; Tabor et al. 2004; Nightingale and Simenstad 2001a). Disorientation may cause delays in migration, while avoidance responses may cause diversion of migratory routes into deeper, less protected waters. In some cases, increased light may attract both predators and potential prey species (Simenstad et al. 1999; Valdimarsson et al. 1997; Tabor et al. 2004). Juvenile coho salmon show no response to moderately high light intensity but become inactive in very low light (Hoar et al. 1957). Other fish may respond differently; for example, schools of juvenile chum salmon show marked preference for light, while juvenile sockeye prefer the dark. Depending on their reaction, fish may have migration delayed, be moved into less protected deepwater habitat, or they may become more susceptible to predation, as light can attract predators and increase their ability to see fish. Some adverse modification in fish behavior could occur from the lighting present at the terminal, possibly delaying migration, moving fish to less desirable habitat conditions, or subjecting juvenile fish to greater nighttime predation.

Lighting at the LNG terminal would likely include a mixture of low-power fluorescent lighting and higher intensity security lighting that would primarily be located on shore, in and adjacent to the slip. Lighting used at the LNG terminal would be similar to that already in place at other Coos Bay facilities. The facility would have its highest intensity lighting on shore away from the water, although some lower level lighting would be present near the water. Lighting on the tug dock would be low intensity lighting adequate for safety. No high intensity lighting would be present near the water except possibly during vessel docking. When an LNG carrier is not in the berth, the lighting would be reduced to that required for security and would be focused upon the structures and not be in proximity to the water; therefore, the lighting would not serve as an attractant or deterrent to fish species. When an LNG carrier is at the berth, it would physically block the lighting on the berth from the slip waters and, due to its proximity to the slip wall, would block the fish from getting too close to the lighting on the berth. Lighting used would be similar to that already in place at other Coos Bay facilities.

The location of the facility, set back from the main channel of Coos Bay, would reduce fish encountering any shoreline lighting effects. The reduced lighting levels near the water should reduce any behavioral effects on fish near the terminal. As mentioned above, we have recommended that Jordan Cove develop the details of its final lighting plan in consultations with the FWS, NMFS, and ODFW to minimize potential effects on aquatic resources. The limited height intensity lighting and overall large habitat area available for fish avoidance of these regions, and plans to obtain an approved plan with managing agencies, are anticipated to reduce the potential for adverse effects on local and migratory fish resources.

Maintenance Dredging

Jordan Cove has estimated that maintenance dredging would occur every three to five years with varied amounts removed ranging from 115,000 cy to 160,000 cy each dredging cycle for slip and access channel (see section 4.3.2.2 for details). An additional 27,000 cy would be removed from the navigation channel about every three years. Jordan Cove proposes to place maintenance dredged material at land storage sites APCO Sites 1 and 2 (figure 4.5-2).

Modeling conducted by Jordan Cove and the Port (Moffat & Nichol 2006a) suggests a very narrow range of elevated suspended sediment (greater than 100 mg/l) during low tidal velocity extending out a few hundred feet from where the maintenance dredging area of the slip would occur in Coos Bay using a mechanical (clamshell) dredge. The highest concentration levels would occur at lowest tidal velocity when dispersion of suspended sediment would be the least. Peak value at the lowest modeled tidal velocity—the point of clamshell dredging—is estimated to be 830 mg/l, with decreasing values away from the actual dredging site to about 125 mg/l at 200 m (660 feet) from the site. During typical tidal cycles, turbidity would be up to 75 mg/l out about 0.2 to 0.4 mile from the dredging site. Moderately low values of 25 to 50 mg/l may extend out to about 3.5 miles depending on flow, sediment composition, and equipment used, for brief peak periods (about 2 hours daily). During high current velocity, peak values at the point of dredging would be about 90 mg/l, decreasing to 25 mg/l in 100 m (330 feet). Average daily (24-hour) values outside of the direct area being dredged would remain in the range of seasonal background levels of 25 to 50 mg/l during the ODFW-allowed dredging window. Maintenance dredging of the marine waterway modifications (i.e., the navigation reliably improvement areas) is expected to have similar turbidity effects but could be less if a hydraulic suction dredge is used. The number of days dredging would occur would depend on details of equipment used but would likely range from a few days to about a month of dredging to remove about 142,000 cy every three years (COE 2011). If dredging were to occur at the estimated removal rate of about 7,000 cy per day estimated for hydraulic dredging in Jordan Cove's *Dredged Material Management Plan*, active maintenance dredge would occur over 20 days.

Fish are likely to move from this narrow band of elevated suspended sediments during peak occurrences for short durations during dredging (likely several hours over the largest area affected). Additionally, some benthic organisms (e.g., clams, shrimp, and tubeworms) would be removed during this dredging. Maintenance dredging would occur from October 1 to February 15 during the Coos Bay in-water work window which would avoid major juvenile salmonid presence in the region.

Because all dredged material would be placed on land where runoff is controlled, there would be no effect on the estuary or marine environment from dredged material disposal. However, the final transport method of the dredged material to these sites has not been finalized and may include some bottom disturbance or effects from piping used to transport the discharge material. These are expected to be small areas of potential direct effects from pipeline impacting bottom areas and would not have substantial effects on benthic organisms.

Operational Acoustic Effects

LNG carrier and tugboat operations along the waterway, operational noise at the terminal, and maintenance dredging would generate underwater sounds pressure levels that could elicit responses in aquatic organisms. State agencies in Washington, Oregon, and California along with federal agencies (FWS and NMFS) have developed interim noise exposure threshold criteria for pile-driving effects on fish (WSDOT 2011; Fisheries Hydroacoustic Working Group 2008; Popper et al. 2006). These threshold criteria are described above for pile-driving acoustic effects during construction.

Underwater noise levels are expected to vary by ship type and by vessel length, gross tonnage, vessel speed, and, to some extent, vessel age as older vessels tend to be louder than newer vessels. Based on the general trend for higher underwater noise generated by larger vessels (McKenna et al. 2012), it is possible that some of the LNG carriers could generate more noise if they are larger than the LNG carrier built in 2003 with a 138,028 m^3 capacity reported by Hatch et al. (2008). The vessel in that study produced sound levels (with one standard error) of 182 ± 2 dB re: 1 µPa at 1 meter that attenuated to 160 dB at 35 ± 11 meters and to 120 dB at 16,185 ± 5,359 meters. These vessel noise levels are therefore generally less than threshold levels considered to cause direct harm to fish. Upland operational noise may also travel over water, but is not likely to affect fish, although there may be effects on marine mammals close to the terminal.

Generally, response to changes in noise levels would be behavioral and perceptual, and not physiological in nature, as fish and marine mammals would tend to avoid the area during periods of high noise output. We conclude that operational noise would not have significant adverse effects on aquatic resources.

4.5.2.3 Pacific Connector Pipeline Project

The Pacific Connector pipeline would cross or affect 352 waterbodies: 69 perennial streams, 270 intermittent streams (99 of these are considered ditches), 9 ponds (i.e., all ponds are adjacent to the line and would not be directly crossed), and 4 estuarine channels. Available data indicate that about 71 of these waterbodies are known or assumed to be inhabited by fish. Appendix I, table I-2, lists information on waterbodies crossed or potentially affected and known fish distribution and classification relative to the crossing.

Aquatic Habitat in the Coos Bay Estuary

The pipeline would cross under about 2.3 miles of Coos Bay in two separate crossings. Coos Bay consists of about 14,000 acres of varied intertidal and subtidal substrate habitat conditions including algae beds, eelgrass sites, marsh lands, and mostly unconsolidated substrate. The upper Coos Bay estuarine habitat contains important rearing habitat supplied by estuarine wetlands, algae, and eelgrass beds, which are important conditions for estuarine fish and migratory salmon, as well as commercial oyster beds. The estuarine habitat of the Coos Bay estuary along the pipeline route is in a mix of shallow regions of the Coos Bay near Kentuck Slough and deeper areas under the two navigation channels crossed (see figure 4.5-1). Most of the route and associated work areas are in nearly equal amounts of shallow intertidal and subtidal fine bottom and unconsolidated bottom habitat, with a few regions of mixed seabed of eelgrass, attached algae, tidal marsh and deep navigation channel. The fisheries in these habitats include a mix of anadromous and marine species, as well as shellfish, and are described above in section 4.5.2.1.

Aquatic Habitat in Inland Waterways

The freshwater streams crossed by pipeline route include six major subbasins of rivers in southern Oregon. The aquatic habitat crossed by the pipeline outside of Coos Bay is primarily coldwater streams, but with a few warmwater ponds adjacent to the pipeline. Most stream riparian areas crossed are heavily forested, and are therefore shaded by a mix of conifer and hardwood trees, providing typical salmon and/or trout habitat. Several waterbodies crossed are large (over 100 feet wide), but the majority are small waterbodies with generally no or low flow ,as about 75 percent are intermittent streams. Most of the major streams and many of the minor streams crossed contain salmon and steelhead, some of which are federally listed as threatened fish species.

Fishery Types and Fish Status

Fish species present in the pipeline area can be classified as warmwater, coolwater, coldwater resident, anadromous, and estuarine fish. Freshwater streams with habitat suitable for coldwater resident fish and anadromous fish are the most common along the pipeline route and associated facilities other than in the Coos Bay estuary, while warmwater fish species are typically associated with ponds in southeast Oregon. The status of federally listed fish species and other commercial fish species that are managed under the MSA will be presented in our pending BA and EFH Assessment that will be submitted to the FWS and NMFS. Endangered and threatened species and their respective critical habitat, and other special status species are addressed in section 4.6. The status of other state-listed fish species and fisheries of concern are also discussed in section 4.6. The EFH assessment summary relative to pipeline-related actions is included in appendix I.

<u>Warmwater, Coolwater, and Coldwater Fish</u>

Typical warmwater species in the pipeline area include black (*Pomoxis nigromaculatus*) and white crappie (*Pomoxis annularis*), and brown bullhead (*Ameiurus nebulosus*), which are not native to the region. Warmwater species are present in several lakes near the route and are present at pipeline crossing areas, and are likely in some Klamath Basin streams crossed by the pipeline.

Coolwater fish present in the area affected by the Project include both non-native and native species. Some important non-native species include smallmouth bass (*Micropterus dolomieu*) and yellow perch (*Perca flavescens*), as they are a common sport fish. These fish are often present in lakes, and smallmouth bass may be found in some larger rivers. Other native coolwater species of note include the ESA listed Lost River sucker (*Deltistes luxatus*), ESA listed shortnose (*Chasmistes brevirostris*) and Klamath largescale (*Catostomus snyderi*) suckers, and blue chub (*Gila coerulea*). These latter species occur primarily in the Klamath Basin, in Upper Klamath Lake and its tributaries. Umpqua chub (*Oregonichtyhys kalawatseti*) are a FWS species of concern, as this fish species has declined precipitously in the last decade. The pipeline would cross habitat occupied by Umpqua chub.

Resident coldwater fish species spend their entire lives in fresh water. Various waterbodies crossed by the Pacific Connector pipeline provide year-long habitat for several resident coldwater fish species. Resident cutthroat trout (*O. clarki*), rainbow trout (*O. mykiss*), and redband trout (*O.*

m. gibbsi) are the most common resident coldwater game species along the route. Non-game fish species, some of which migrate between freshwater and marine habitats (e.g., threespine stickleback [*Gasterosteus aculeatus*]), and others that are freshwater residents (e.g., speckled [*Rhinichthys osculus*] and longnose [*R. cataractae*] dace, sculpins, chiselmouth [*Acrocheilus alutaceus*], sucker) also may occur in waterbodies in the pipeline area.

Anadromous Fish

Anadromous fisheries in the pipeline area comprise eight species: Chinook salmon, coho salmon (including two ESA listed coho salmon ESUs), chum salmon, steelhead, coastal cutthroat trout, Pacific lamprey, river lamprey, Pacific eulachon, and green sturgeon (also ESA listed) (see section 4.5.2.1). Section 4.5.2.1 summarizes most of the major runs of anadromous salmon, steelhead, and trout species in the area affected by the Pacific Connector Project and their general timing of life phases.

Marine (Estuarine) Fish

The marine species that may be present along about 2.3 miles of the pipeline route where it would cross under Coos Bay at two locations between about MPs 0.3 and 1.0 and MPS 1.5 and 3.0 are the same as those discussed above for the Coos Bay portion of the waterway for LNG carrier marine traffic to and from the terminal (section 4.5.2.1).

Marine (Estuarine) Shellfish

Major invertebrate taxa present in Coos Bay are described in section 4.5.2.1. Invertebrate groups include pelagic (in the water column), epibenthic (residing on sediment surface), and benthic (residing in the sediment) organisms. Pelagic invertebrates include juvenile and larval stages of many species, such as crab, shrimp, clams, worms (polychaetes) as well as adult and juvenile crustacean zooplankton (e.g., copepods). Epibenthic organisms including harpacticoid copepods, snails, amphipods, mussels, oysters are all present to varying degrees. Benthic organisms include clams and the most abundant polychaetes and amphipods, the latter an important food for juvenile salmonids.

Estuarine Oysters

There are two different types of oysters identified along the pipeline route at the two Coos Bay crossings: 1) commercially grown non-native Pacific oysters; and 2) native Olympia oysters. Neither species can be legally harvested for recreational purposes. Native oyster populations are state-protected to encourage their recovery. Pacific oysters are the private property of their commercial growers.

Four companies lease state lands in Coos Bay to raise Pacific oysters commercially, two of which are near the pipeline crossing. They seed their beds with juvenile oysters (spat) and later harvest adults. These commercial beds are located on the north and east side of Coos Bay from Glasgow Point (north) to Crawford Point (south) in intertidal areas. Another commercial oyster operation is in South Slough. The pipeline route would go directly under one commercial oyster area owned by Clausen Oysters west of Kentuck Slough.

Olympia oysters can be found in the subtidal and intertidal zones of Coos Bay from Haynes Inlet south to Isthmus Slough. Pacific Connector surveyed nearly 7,000 feet of relatively shallow intertidal habitat for Olympia oysters along the previously proposed pipeline route in Haynes Inlet during late June 2011. Olympia oysters were found growing on riprap at the mouth of Haynes Inlet and on substrates within the pipeline right-of-way. Generally, Olympia oysters were found almost exclusively where hard surfaces (e.g., riprap, old oyster or clam shells) are present (Ellis Ecological Services 2011).

Marine Mammals

The marine mammals that may be present along the pipeline route in Haynes Inlet are the same as those discussed for the Coos Bay portion of the waterway for LNG carrier transit to and from the terminal (see section 4.5.2.1), except for large whale species that only inhabit the deep, open ocean. It is possible that killer whales, gray whales, and pinnipeds could be found in Coos Bay. The potentially present marine mammals are protected under the MMPA.

Freshwater Mussels

Limited native freshwater mussels may be present in some streams along the route. Only eight native mussels are present west of the Continental Divide, most of which belong to the genus *Anadonta* (Nedeau et al. 2009). This genus tends to occur more often in lakes and pond and quiet pools but may found in swifter waters in protected areas without current sheer. Another species, the Western pearlshell (*Margaritifer falcate*), while most common in large streams can be found in cold small streams only a few feet wide (Nedeau et al. 2009). The distribution relative to the project crossing for mussel species in not known; however, it is possible that some may be present near crossings, especially in larger, low-gradient streams. Two sensitive species (see appendix I) may be present in streams along the route: California floater mussel (*Anadonta californiensis*) and Western ridged mussel (*Gonidea angulata*). Both species are also addressed in the Forest Service's Biological Evaluation (BE; appendix F of this EIS).

Effects on Aquatic Habitat and Aquatic Species from Construction of the Pacific Connector Gas Pipeline Facilities

The pipeline route would cross under 2.3 miles of estuarine habitat in Coos Bay and cross or pass near an additional 349 waterbodies, of which about 71 are known or presumed to be inhabited by fish. In addition, 4 new stream crossings would occur along the 10 temporary or 15 permanent roads, 2 of which are known to have fish. Existing roads used by the pipeline project for construction would use existing stream crossings although final design may include new or modified structures at some locations (see below), with a total of 47 streams crossed, 5 of which are perennial streams with 1 known to have fish. One new permanent construction road would also cross a known fish-bearing stream (PAR 15.07 crossing an intermittent tributary to Stock Slough).

Pacific Connector proposes to cross under the two Coos Bay estuary crossing locations and three large river crossings (Coos, Rogue, and Klamath Rivers), using HDD methods. At two crossings of the South Umpqua River, Pacific Connector would use a diverted open-cut method at one and a DP method at the other. Pacific Connector proposes to cross Medford Aqueduct using a conventional bore. An additional 24 bore crossings would be used primarily at ditches and canals. All other stream crossings would employ a dry, open-cut method. General stream crossing methods for each of these are described in section 2.4.2.2, and specific crossing methods are listed in appendix I, table I-2. General Project activities potentially affecting aquatic resources include frac-out at estuarine and large river crossings, freshwater in-water construction activities, terrestrial/riparian habitat modification, accidental spills or leaks of hazardous materials, and periodic maintenance of the pipeline.

Right-of-way clearing would occur during the early spring through late fall unless site-specific deviations are proposed. The baring of soil upslope of streams has the potential to contribute sediment and elevated turbidity when near streams, especially if on steep slopes; however, the pipeline route has been selected to minimize steep slopes and unstable areas. Additionally, there is an ECRP which includes implementation of BMPs such as silt fences, water bars, slash filter windrows, and other general procedures. Additionally, an upland erosion control and revegetation plan is in place that identifies where specific actions would be needed to curtail substantial erosion and sediment runoff to streams. Therefore, upland erosion from right-of-way clearing would not contribute substantial new sediment to streams, thus avoiding adverse effects on aquatic systems.

Construction of the Pacific Connector pipeline in-water stream crossings would only occur during ODFW recommended in-water construction windows. This timing would minimize the coincidence of pipeline construction with upstream adult salmonid migration and spawning as well as juvenile outmigration. Resident salmonids, which would be primarily cutthroat and/or rainbow trout, and juvenile coho salmon would be present at pipeline crossings during construction. During construction in the Coos Bay estuary (October 1 through February 15), adult anadromous salmonids, green sturgeon, and possibly eulachon would be present (ODFW 2007b).

The extent of effects on aquatic resources from pipeline construction would depend on the waterbody crossing method, adjacent clearing methods, erosion control, the existing conditions at each crossing location, and the timing of construction. Potential short-term effects that degrade habitat could occur with trenching and laying of the pipe at waterbody crossing sites and sometimes adjacent slope runoff. The installation of the pipeline across a waterbody may result in temporary deposit of a limited amount of sediment in that stream, with associated short-term turbidity affecting aquatic species. Pacific Connector would install erosion control devices during construction to reduce sedimentation and in-stream turbidity at waterbody crossings. Right-of-way clearing would be 75 to 95 feet wide at stream crossings and a permanent 30-foot-wide access route maintained in herbaceous non-forest vegetation. We expect the pipeline right-of-way to be restored and revegetated immediately after pipeline installation. Except for forested areas, vegetation would be expected to re-establish in the area within three years (see section 4.4).

Long-term degradation of habitats can occur if flow or sediment regimes are modified in a manner that results in morphological changes to the bed and banks of the channel. Also, in forested areas, shade would be reduced at waterbody crossings for the time it would take trees to grow after restoration and revegetation. In streams that have very small flows, lack of shade may raise stream water temperatures and reduce LWD supply, which could in turn affect aquatic species. However, streams with low or intermittent flow generally support smaller fish populations and less diverse species composition.

Pacific Connector developed its project-specific ECRP which includes specifications for waterbody crossing techniques and associated sediment and erosion controls to be implemented during waterbody crossings. A detailed description of construction and mitigation measures that Pacific Connector would implement at waterbody crossings is included in section 4.3.

In addition to actual waterbody crossings by the pipeline, several of the project-related construction activities, such as improving existing access roads (EARs), PARs, TARs, and TEWAs within riparian areas, could indirectly affect aquatic resources by increasing erosion and runoff to nearby streams, losing future large wood input to streams, and increasing stream temperatures. The potential effects on fish or their habitat would be minimized by BMPs including the ECRP and procedures in place to eliminate or reduce potential effects on streams.

Fish passage is a potential issue relating to streams crossing by roads that would be used by the project. The final locations of all road-stream crossing and road use levels would not be determined until a construction contractor can assess what final road use would be needed and final designs are developed. However, Pacific Connector, in consultation with ODFW, has developed general plans and designs for methods to be use for road-stream crossings to ensure fish passage is maintained and other effects are minimized (Pacific Connector Gas Pipeline LP 2015). For temporary and permanent roads, designs may include use of existing instream structures, which could include the protection, repair or replacement of these stream-crossing structures. New culverts may be needed in some areas. Fish passage would be ensured for all life stages for any new structure. However, Pacific Connector would not modify the fish passability of existing structures if they use them without needing to replace them. Pacific Connector would submit a fish passage plan to ODFW, and the NMFS or FWS as applicable, and would not construct the crossing until approval is received.

Temporary bridges may be used before culverts are installed. These bridges would span above the ordinary water level and be maintained to stay above water levels during use. All new or temporary crossing structures would meet state fish passage requirements and NMFS fish passage criteria. Any culvert installation would occur during state designated in-water work windows unless otherwise approved by the ODFW, and the NMFS or FWS as applicable on streams with ESA listed fish, and fish passage would be maintained during construction if passage occurred at the crossing prior to construction. If temporary bridges are used, they may be installed outside of the in-water work window if the ODFW and NMFS approve. To provide equipment and material access up and down the construction right-of-way, temporary bridges would be installed outside of the ODFW in-water work window. For flowing waters, efforts would be made to span the water with a temporary bridge from the bank without entering the water. Where bridges cannot safely be installed this way, only equipment needed to install the bridge would be allowed in the stream, minimizing water disturbance. These bridges would have suitable clearance to allow higher flows to pass without inhibition, and any temporary bridges remaining in the fall would be removed before high flows. All installation structures would be approved by the COE, ODSL, ODEQ, ODFW, and, as appropriate, the Forest Service and BLM. Currently, there are no plans to have equipment cross flowing water streams for other purposes. In-water activities would meet state turbidity standards reducing turbidity effects. With procedures in place, disturbance to aquatic systems would be kept to a minimum during periods of greater sensitivity outside of the in-water work window. Riparian disturbance would be kept to that needed for construction. These actions would maintain adequate fish passage and minimize stream disturbance from the use and installation of road-stream crossing structures.

Construction in Estuarine Habitats

During in-water pipeline installation within Coos Bay, fish and other aquatic resources are unlikely to be affected unless a frac-out were to occur. Construction of the pipeline across the Coos Bay estuary would not directly disturb the substrate as crossings utilize HDD crossing methods. The current pipeline route in the bay would be two HDD spans of 0.7 and 1.6 miles with no planned subtidal or intertidal habitat disturbance. Generally, an HDD would avoid direct effects on the bay and associated estuarine resources. However, an HDD requires the use of drilling mud as a lubricant during the process. This fluid is under pressure and there is a possibility of an inadvertent release of drilling mud through a substrata fracture, allowing it to rise to the surface (also referred to as a frac-out).

Drilling mud primarily consists of water mixed with bentonite, which is a naturally occurring clay material. Bentonite by itself is essentially non-toxic (Breteler et al. 1985; Hartman and Martin 1984; Sprague and Logan 1979). However, bentonite can act like a fine particulate sediment in water, which could affect aquatic resources. The dispersal of drilling mud from a frac-out in the bay could interfere with oxygen exchange by clogging the gills of aquatic organisms (EPA 1986). The degree of interference generally increases with water temperature (Horkel and Pearson 1976). Sediments in high concentrations can clog gills, impair vision, make it difficult to feed, and increase the chance of predation. Drilling mud that accumulates on the bay bottom could cover over benthic organisms and estuarine food sources. Most highly mobile aquatic organisms, such as fish, crabs and shrimp, would be able to avoid or move away from the affected area. Local elevation of turbidity could affect fish, including salmonids if present, but with construction occurring during the in-water work window abundance in this area would be low further reducing the likely hood of adverse effects from elevated local turbidity. Other less mobile or immobile organisms, such as echinoderms, clams (i.e., *Macoma* sp.), Pacific oyster, Olympia oyster, and coral/anemone polyps (*Anthoszoa*) (Miller et al. 1990) and other macroinvertebrates, would incur short-term effects from direct mortality if smothered by the drilling mud. However, benthic communities on mud substrates in Coos Bay that were disturbed by more intensive effects from past dredging activities recovered to pre-dredging levels in four weeks (Newell et al. 1998). Some effects may be long term if important habitat elements are affected, such as the effects of turbidity on eelgrass growth (Martin and Tyrrel 2002).

The pipeline route does pass via HDD under commercial Pacific oyster designated areas and native oyster could also be present so there is some risk for oysters should frac-out occur directly in this area. While oyster surveys have not been conducted along the current proposed route, some oysters are likely to be present in the intertidal and shallow subtidal areas where hard surfaces (like Pacific oyster shells) are available. However, typical oyster habitat is not common in the bay because most bottom areas consist of sand and fines.

Attached algae and eelgrass could also be affected by direct burial. Effects would be localized and short term, limited to species in the immediate vicinity of the frac-out, and ameliorated by tidal exchange volume. While tidal exchange would keep much of the bentonite in suspension, because much of the area is shallow and intertidal, depending on timing, some would settle to the bottom, but may be resuspended during tidal change. In these mostly shallow bay areas, accumulation could be contained and removed. Because of the above, effects on benthic organisms from burial under a release of drilling mud are likely to be low.

To prevent a frac-out or address impacts should one occur, Pacific Connector developed its *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations*.[122] As discussed in chapter 2, the contingency plan would be implemented in the case of a frac-out into an estuarine or aquatic environment. These measures include, but are not limited to:

- temporarily halting the HDD, and sealing the source of the leak in the fractured zone;
- contacting agencies and developing a site-specific treatment plan;
- adding higher viscosity drilling fluid or lost circulation material to help seal leaks if required:
- deploying containment structures, if feasible;
- monitoring locations downstream of the HDD to identify areas of drilling mud accumulation;
- in estuary possibly remove muds during low tide if they are exposed; and
- in streams removing the drilling mud from substrate and streambanks, if possible.

The precise amount of drilling lubricant that would escape to water from a frac-out cannot be determined because of the many variables that affect quantity (proximity to water where frac-out occurs, length of time active drilling occurs after a frac-out begins, where in the process and flow rate where it occurs). However, with current designs and contingencies that would be in place at the site of any frac-out, the time period of drilling mud released into a waterbody would likely be short term if it were to occur. The *Drilling Fluid Contingency Plan* includes active monitoring of drilling activity that has procedures in place to detect potential drilling fluid spill such as monitoring sudden drops in drilling fluid pressure that would cause cessation of drilling. If monitoring detected a frac-out, the HDD activity would be immediately stopped. Detailed surveys and plans[123] have been made for each of the HDD crossing sites. Furthermore, the HDD locations are all under a large estuary or major rivers, with large volumes of water and swift flows, where the drilling mud would be diluted. Finally, frac-out most often occurs near the entry and exit locations, which are often landward of the stream channel. Displaced soil and a return flow of the bentonite slurry is another potential source of sediment from HDD crossings. As discussed in chapter 2, the drilling mud returns would be hauled offsite after completion of the HDD crossing and disposed of at an approved disposal facility in accordance with all applicable federal and state regulations. Therefore, we conclude that an inadvertent release of drilling mud from an HDD would have minor, short-term adverse effects on estuarine or aquatic resources.

There could also be oil or fuel leaks from construction equipment. Pacific Connector would implement the measures outlined in its SPCC Plan to avoid or reduce effects from an equipment oil or fuel leak.

Aquatic Nuisance Species in Coos Bay

Invasive species have the potential to modify the food base and induce other ecological modifications in the estuarine area of Coos Bay. Non-indigenous aquatic species (NAS) are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic

[122] This plan was attached as Appendix 2.H of Resource Report 2, in Pacific Connector's September 2017 application to the FERC.
[123] See Appendix G.2 of Resource Report 2, in Pacific Connector's September 2017 application to the FERC.

dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Within the Coos Bay estuary, over 67 NAS have been identified (Aquatic Nuisance Species Taskforce 2006). All the invertebrate NAS in the Coos Bay estuary have been introduced by ship fouling or discharge from ballast water of ocean-going vessels.

Pacific Connector identified two NAS that may occur in the Coos Bay estuary: New Zealand mud snails (*Potamopyrgus antipodarum)* and brackish water snail *(Assiminea parasitologica).* Pacific Connector would filter hydrostatic test water and discharge to upland areas through straw to reduce chance of transporting organisms between waterbodies and Pacific Connector proposes to use a treatment of 2 ppm or 2 mg/l of free chlorine residual with a detention time of 30 minutes to treat all non-municipal surface waters that would be used as a water source for hydrostatic testing purposes, and follow ODEQ criteria for this action. Additionally, the applicant did state it would not obtain hydrostatic test water from either Coos Bay or the Coos River, to prevent the spread of NAS from the estuary to inland watersheds.

Construction Across Stream Habitats

Construction of the pipeline would affect 69 perennial stream sites, 270 intermittent stream sites, 9 ponds, and 4 estuary channels (table 4.5.2.3-1; including Coos Bay crossings discussed above). A total of 285 locations would be direct channel crossings, while 67 would be locations where the waterbody is in the right-of-way clearing area. Direct effects on four perennial streams (and Coos River estuarine channel) would be avoided by placing the pipeline beneath them by HDD, DP, or conventional boring. Another 26 intermittent streams would be bored or employ DP technology under the channel.

At one crossing of the South Umpqua River, Pacific Connector would use a diverted open cut. All other waterbody crossings that have flow at the time of construction would be crossed using dry open cut, which is designed to minimize activities directly in flowing water. Of streams that would be crossed using the dry open-cut method, about 29 are known to support anadromous salmon and/or steelhead and another 13 streams are assumed to also have anadromous species. Thirty-four streams crossed are known to support primarily coldwater resident fish, estuarine fish, or important endemic species in the Klamath River Basin. Eighteen additional streams that would be crossed with dry open cut are assumed to support important resident fish. Resident trout are mostly cutthroat trout. In all, about 71 of the waterbodies that would be crossed by, or adjacent to, the pipeline are known or assumed to have fish. Pipeline construction could adversely affect EFH species in up to 55 streams, as well as streams with numerous special status fish species crossings (see section 4.6 for ESA listed species). Our pending EFH assessment and BA will describe effects on those species occupying inland streams, and measures Pacific Connector would implement to avoid, minimize, or mitigate the effects.

In-stream construction could interfere with essential life processes of aquatic species. Most of the waterbodies identified as known, presumed, or classified as being fish bearing would be crossed using isolated or "dry" crossing construction techniques including the flume or dam-and-pump method if water is flowing in the waterbody at the time of construction. At one site on South Umpqua, the diverted open cut method used would require diversion of the flow to one side of the channel at a time. Potential effects of trapping fish from these methods are discussed under Entrainment and Entrapment subsection below.

TABLE 4.5.2.3-1

Number of Waterbodies Crossed or Adjacent to the Pacific Connector Pipeline, by Fish Status Category and Fifth-Field Watershed

Fifth-Field Watershed (Fifth-Field HUC)	Estuarine	Ponds a/	Perennial Streams	Intermittent Streams	Fish-bearing Streams/channel with: Anadromous Species (assumed) b/	Fish-bearing Streams/channel with: Resident Species (assumed) b/, c/	EFH Species and Habitat Present (assumed) b/	ESA Species or Habitat Present (assumed) b/
Coos County								
Coos Bay Frontal (1710030403)	4	0	5	10	13(1)	4(11)	13(1)	13(1)
North Fork Coquille River (1710030504)	0	0	4	4	3	2(3)	3	3
East Fork Coquille River (1710030503)	0	0	9	5	2(6)	4(3)	2(6)	2(6)
Middle Fork Coquille River (1710030501)	0	0	3	6	1	0(2)	0(1)	0(1)
Douglas County								
Middle Fork Coquille River (1710030501)	0	0	4	6	0	3	0	0
Olalla Creek-Lookingglass Cr (1710030212)	0	0	4	15	2(2)	2(2)	2(3)	2(3)
Myrtle Creek (1710030210)	0	0	7	7	2(1)	2(1)	3(2)	3(2)
Clark Branch-South Umpqua River (1710030211)	0	0	7	15	4	4	4	4
Days Cr. South Umpqua River (1710030205)	0	3	6	10	4	6	4	4
Upper Cow Creek (1710030206)	0	0	4	6	0	0	0	0
Jackson County								
Upper Cow Creek (1710030206	0	0	0	1	0	0	0	0
Trail Creek (1710030706)	0	1	2	5	3	2	3	3
Rogue River-Shady Cove (1710030707)	0	0	4	14	1(1)	2	1(1)	1(1)
Big Butte Creek (1710030704)	0	0	3	7	2	2	2	2
Little Butte Creek (1710030708)	0	1	5	48	3(1)	6	2(2)	2(2)
Klamath County								
Spencer Creek (1801020601)	0	0	0	7	0	2	0	0
Klamath R-John C Boyle (1801020602)	0	0	0	3	0	0	0	0
Lake Ewauna-Upper Klamath (1801020412)	0	1	1	39	1	1	0	1
Mills Creek-Lost River (1801020409)	0	3	1	62	0	1	0	1
TOTAL	4	**9**	**69**	**270**	**41(11)**	**43(23)**	**36(16)**	**41(16)**

a/ None directly crossed but in ROW adjacent to direct pipeline locations.
b/ Known and assumed, possible or likely (value in parentheses) crossings or pipeline proximity with indicated fish category designation.
c/ Includes primarily coldwater trout, but also estuarine species in Coos Bay and lower Coos system, and endemic species in the Klamath Basin.

Timing of Construction

The degree of effects on aquatic resources associated with construction activities would depend on the timing of in-water construction. Construction during periods of sensitive fish activity (i.e., spawning, juvenile and adult rearing, and migration) can have a greater effect on fish than construction during other periods. Pacific Connector would cross fish-bearing waterways during the in-water work windows specified by the ODFW in consultation with the NMFS within the range of anadromous fish, and with the FWS as appropriate.

The timing restrictions would prevent construction during periods of sensitive fish use and would typically allow construction only in periods of lower flow rates in streams. In general, construction of the pipeline would be timed to miss periods of major juvenile or adult anadromous salmonid migrations in freshwater based on allowed fishery construction windows, typically July 1 to mid-September for most streams, and some other dates for specific waterbodies. These are tentative dates and timing restrictions would be subject to change by the ODFW. Any modifications to the allowable construction windows would be dictated by stream and fish migration conditions in the year of construction, and would be stated as conditions of state water crossing permits.

Sedimentation and Turbidity Resulting from Pipeline Installation Across Freshwater Streams and Effects on Aquatic Resources

Pipeline crossings of surface waterbodies would cause some downstream turbidity and sedimentation. The type of crossing and stream sediment characteristics can affect turbidity and suspended sediment in streams. Nearly all streams (88 percent) would be crossed using the dry open-cut method (flume and dam-and-pump) (table 4.5.2.3-2). Both "dry" techniques produce much less sediment in the water than alternative "wet" open cut methods (Reid and Anderson 1999; Reid et al. 2002; Reid et al. 2004). While several factors affect the effectiveness of dry construction methods, dry open-cut construction across waterbodies, if properly installed and maintained during construction and restoration, would produce minor levels of sediment and turbidity. Pacific Connector would minimize effects on surface waters and aquatic resources by implementing the waterbody crossing and erosion and sediment control measures as described in its project-specific ECRP, which would reduce the risk of sediment releases during construction.

TABLE 4.5.2.3-2

Proposed Waterbody Crossing Methods for All Waterbody Crossings, by Subbasins and Fifth-Field Watersheds

Subbasins and Fifth-Field Watersheds	Number of Waterbodies Crossed, by Construction Method						
	HDD or Direct Pipe	Bore	Diverted Open-Cut	Dry Open-Cut	Dry Open Cut (Bedrock) b/	Total Crossed	Adjacent Not Crossed a/
Coos Subbasin							
Coos Bay-Frontal Pacific Ocean	3			10		13	6
Coquille Subbasin							
North Fork Coquille River				7		7	1
East Fork Coquille River				9	4	13	1
Middle Fork Coquille River				15	1	16	3
South Umpqua Subbasin							
Olalla Creek-Lookingglass Creek				13	5	18	1
Clark Branch-South Umpqua River	2			8	3	13	9
Myrtle Creek				11	3	14	
Days Creek-South Umpqua River			1	9	5	15	4
Upper Cow Creek				7	1	8	3
Upper Rogue Subbasin							
Trail Creek				4	2	6	2
Shady Cove-Rogue River	1			8	2	11	7
Big Butte Creek		1		2	5	8	2
Little Butte Creek				44	5	49	5
Upper Klamath Subbasin							
Spencer Creek				6		6	1
J.C. Boyle Reservoir-Klamath River				3		3	
Lost Subbasin							
Lake Ewauna-Klamath River	1	6		18		25	16
Mills Creek-Lost River		20		39	1	60	6
TOTAL	**7**	**27**	**1**	**213**	**37**	**285**	**67**

a/ Waterbodies within the construction right-of-way that would not be crossed.
b/ Dry open-cut streams with bedrock streambeds which may require special construction techniques to ensure pipeline design depth including rock hammering, drilling and hammering, or blasting. The need for blasting would be determined by the contractor and would only be initiated after ODFW blasting permits are obtained. These streams are in addition to regular dry open-cut streams.

Duration of crossing can ultimately influence periods of downstream turbidity and suspended sediment elevation to aquatic resources. If channels are dry during construction, small streams (channel width less than 10 feet) are projected to be crossed in less than 24 hours, and intermediate streams (channel width 10 to 100 feet) usually in less than 48 hours. Reid et al. (2004) examined stream crossing data from 46 crossings (23 dam and pump, 12 flumed, and 11 open cut) over a range of stream types across Canada and the U.S. from streams that were mostly less than 10 meters wide. Reid et al. (2004) noted that, in flowing streams they monitored, instream work averaged 38 and 64 hours for dam-and-pump and flumed crossings, respectively. However, the times noted for crossings include all activities that occur, which influence when active suspended sediment may occur, but do not indicate the actual periods when increased suspended sediment development would occur, which is mostly influenced by periods of active instream installation or removal of flow diversions for dry open-cut methods. Additionally, failure of flow sealing and other instream structures at upstream diversions structures can occur from a variety of malfunctions such as pump failure, dam and flume failure, poor dam seal and others. Reid et al. (2004) noted seal failures of monitored diverted open cut crossing in 1 of 23 dam-and-pump projects and 5 of 12 flumed projects. Should these occur, suspended sediment would be relatively elevated over those without failure, but immediate repair work could reduce magnitude and duration of elevated suspended sediment.

Increased sediment loads associated with high turbidity can have effects on fish behavior and physiological processes (e.g., blood chemistry, gill trauma, immune system resistance), and can result in mortality. Salmonids (e.g., trout and salmon) are the most common, abundant, and important species in Project streams and often the most sensitive of common freshwater fish species to elevated suspended sediment. Approximately 27 percent all streams crossed contain salmonids that could be affected if TSS levels are elevated. Salmonids exposed to moderate to high levels of suspended sediment for extended periods could be adversely affected. At high levels, turbidity and suspended sediment directly affects survival and growth of salmonids and other species and interferes with gill function (reviewed and compiled by Bash et al. 2001). Turbidity can also reduce aquatic plant cover (over the long term) by limiting photosynthesis (Goldsborough and Kemp 1988), as well as adversely affecting fish vision, which is a requisite for social interactions (Berg and Northcote 1985), feeding (Vogel and Beauchamp 1999; Gregory and Northcote 1993), and predator avoidance (Meager et al. 2006; Miner and Stein 1996).

Sediment stirred into the water column can be redeposited on downstream substrates, which could bury aquatic macroinvertebrates (an important food source for salmonids, and other fish in estuarine areas). Additionally, downstream fine particle sedimentation could affect spawning substrate habitat, spawning activities, eggs, larvae, and juvenile fish survival, as well as benthic community diversity and health (reviewed and compiled by Bash et al. 2001).

Some studies related specifically to pipeline stream crossing have found varied effects from sediment. For example, rapid recolonization of benthic organisms has been documented on 30 pipeline projects post-construction (Gartman 1984). One long-term study (construction through three years post-construction) of multiple pipeline crossings of a coldwater streams found no measurable effect on fish or benthic resources or their habitat within two months to three years after construction (Blais and Simpson 1997). Reid et al. (2008) found similar conditions for benthic resources ranging from no effect on reductions in abundance or diversity for periods of less than a year, all for wet open-cut crossings, which is not likely representative of most dry crossings.

Dry open-cut construction methods may have the potential to alter fish abundance over the short term. Reid et al. (2002) found that fish abundance downstream of dam-and-pump or flumed crossings reduced immediately after construction in two of four sampled sites, but concluded these reductions were likely not the result of sediment. Additionally, one year after construction, Reid et al. (2002) found no difference in fish abundance below these two sites from preconstruction levels.

Newcombe and Jensen (1996) compiled research from many sources that demonstrates effects on anadromous and resident salmonids by various levels of suspended sediment concentration and exposure duration. They used this information to develop models that estimated the severity of these effects based on sediment concentration and exposure duration.

Output from the model provides severity-of-ill-effects (SEV) scores that are summarized below. Values range from 0 to 14, where an SEV of 0 indicates no effects, an SEV between 1 and 3 indicates behavioral effects, an SEV from 4 to 8 indicates sublethal effects, and an SEV from 9 through 14 indicates lethal and paralethal effects (see Table 1 in Newcombe and Jensen 1996).

1) Behavioral Effects SEV scores
    - 1 = Alarm reaction
    - 2 = Abandonment of cover
    - 3 = Avoidance response

2) Sublethal Effects SEV scores
    - 4 = Short-term reduction in feeding rates and/or feeding success
    - 5 = Minor physiological stress (increase coughing rate and/or increased respiration rate)
    - 6 = Moderate physiological stress
    - 7 = Moderate habitat degradation; impaired homing
    - 8 = Major physiological stress; long term reduction in feeding rate- feeding success; poor condition

3) Lethal and Paralethal Effects SEV scores
    - 9 = Reduced growth rate and/or delayed hatching and/or reduced fish density
    - 10 = 0 to 20 percent mortality and/or increased predation and/or moderate to severe habitat degradation
    - 11= >20 to 40 percent mortality (SEV scores exceeding 11 predict increased mortality rates)

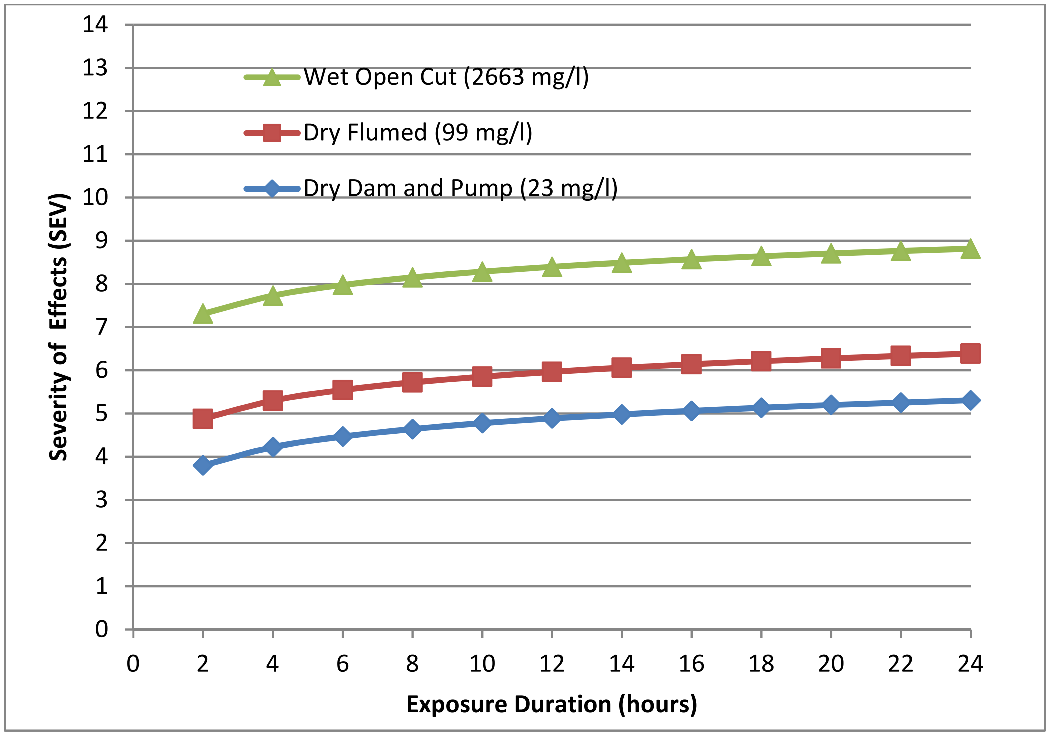
Newcombe and Jensen (1996) developed varied models for this assessment method. The one most relevant for this study is Model 1, which is used to estimate effects on both juvenile and adult salmonids and is based on 171 different study results.

Because of the uncertainty of both available site-specific information and the accuracy of models when applied to varied locations, two approaches were taken to estimate the concentration of suspended sediment and its effect on aquatic resources. One method used literature values from other stream pipeline studies concerning concentrations and durations of the activity to estimate reasonable approximations of likely sediment concentrations and effects on fish. The other was a detailed approach using models to predict sediment concentrations at Project stream pipeline-crossing sites based on known and assumed values, as presented in Pacific Connector's Resource Report 3.

Literature-Based Assessment of Sediment Effects

Application of the Newcombe and Jensen (1996) model to a collection of stream pipeline crossing locations supplies an approximation of what the likely range of effects may be to fish resources (primarily salmonid). The Reid et al. (2004) data are the most complete set of literature information available on likely ranges of suspended sediment that may occur from various crossing methods and likely in-stream construction duration. Reid et al. (2004) measured suspended sediment downstream from 12 flumed pipeline crossings and 23 dam-and-pump crossings (dry open-cut or isolated pipeline construction crossings) and 11 wet open-cut construction crossings. He noted that average suspended sediment concentrations near these 11 "wet cut" crossing sites were 2,663 mg/l, whereas values were much lower at "dry crossing" sites, which averaged 99 mg/l (12 sites) and 23 mg/l (23 sites) for flumed and dam-and-pump sites, respectively. Using the mean sediment concentration values from Reid et al. (2004) and the Newcombe and Jensen (1996) sensitivity Model 1, the effects on salmonid resources can be approximated (see figure 4.5-4).

While crossing times for construction may be in the range of less than one day to four days for dry crossings, actual periods of elevated sediment would occur primarily during periods of installation and removal of isolation structures. Therefore, time of elevated sediment for any one crossing would only be a few hours, which is why the range of duration in the figure 4.5-4 is limited to 24 hours which would more than cover the period of likely elevated sediment resulting from crossing under normal crossing conditions.



Note: Based on the Newcombe and Jensen (1996) effects model based on typical suspended sediment concentrations levels (data from Reid et al. 2004) by crossing type.

Figure 4.5-4. Effects of Pipeline Stream Crossing Suspended Sediment Concentrations on Salmonids

Based on the estimate of likely average conditions of construction at a crossing assuming the average of the Reid et al. (2004) suspended sediment values, SEVs for dam-and-pump crossings would be most likely in the range of 4 to 5, which could include short-term reduced feeding rate or minor physiological stress. Flumed crossing sites would on average have slightly greater effects, with SEVs mostly in the range of 5 to 6, which could result in minor to moderate physiological stress. If some failure occurred in crossing methods, short-term concentrations and duration would be greater with SEV values similar to those of wet open-cuts, likely in the range of SEV 8, implying adverse factors such as long-term reduction in feeding success and major physiological stress, with wet open cut crossing time closer to 14 hours (Reid et al. 2004). All levels of effects would remain sublethal even with some short-term failure in crossing methods, based on the literature concentration and duration values.

Active monitoring of pipeline crossing construction of mostly coldwater fish streams in New Hampshire found similar SEV level results to those shown above. Trettel et al. (2002) monitored suspended sediment levels within 50 to 150 meters (160 to 500 feet) downstream of the active pipeline crossing constructions sites and used information from 75 perennial streams consisting 71 dry dam-and-pump or flumed crossings and 4 open-cut wet sites to estimate SEV levels. They found that the average SEV of the dry crossings was 6.5 with no measurable difference between types of dry crossing, while the four wet crossings averaged an SEV of 7.4. The SEV level of 6 corresponds to moderate stress while SEV 7 suggests the lowest level where some habitat effects would occur. They found that about one-third of the dry crossings equaled or exceeded this SEV level (7) of potential adverse habitat effects. Additionally, 99 percent of all crossings were less than the designated paralethal or lethal range (SEV of 9 or above). The biggest factor affecting elevated SEV levels was the portion of fines in the sediment at the crossing. These results suggest a very low probability of any direct fish mortality from construction, with local crossing area effects consisting of mostly sublethal effects (e.g., physiological stress, short-term reduction of feeding), and limited habitat degradation.

The distance downstream effects could occur is dependent on many factors (e.g., substrate composition, velocity, flow, channel width). Ritter (1984) estimated that for a minor perennial stream (likely average only half a foot deep, and less than 20 feet wide), suspended sediment concentrations may be near background levels in the range of 60 meters (200 feet) to 150 meters (500 feet) downstream during open-cut crossings. These stream sizes would be most typical of crossings along the pipeline route. Reid et al. (2002) found that below four separate dam-and-pump crossings, mean suspended sediment was less than 20 mg/l within 30 meters (100 feet) downstream. However, at another crossing where some high suspended sediment concentrations occurred from leakage, values 340 meters (1,100 feet) downstream were reduced to 20 percent of those at 45 meters (150 feet) downstream. Low concentrations during construction of crossings appear to be more common when BMPs are closely followed. For example, according to Pacific Connector, a Williams Northwest pipeline completed in Washington State had only one state turbidity standard exceeded out of 67 waterbodies crossings. Pacific Connector estimated the changes of suspended sediment concentrations based on the Ritter (1984) model downstream of 13 Project subwatersheds using estimates of substrate sediment composition and other physical conditions at the crossing sites (e.g., width, depth, and flow).

Based on the Reid et al. (2004) average values, effects on salmonids would be low, other than when sealing failure events occur at the planned dry crossings; the effects would likely range from short-term behavioral to short-term sublethal effects, likely lasting a few hours or days depending on severity. Trettel et al. (2002) monitoring suggests adverse effects may be somewhat greater but still sublethal, with occasional local habitat degradation.

Model Estimates of Effects of Suspended Sediment

Pacific Connector incorporated site data, regional data, and available literature-based models to provide an estimate of both suspended sediment level and extent of effects on aquatic resources from pipeline stream crossing construction based on their estimates of sediment concentration and exposure duration. The parameters used in this model assessment are variable and are based on a combination of data. Thus, the results may be considered an approximation, rather than the exact suspended sediment levels that would be observed.

The method for approximating the concentration of suspended sediment at the specific crossing sites and the distance downstream that various concentrations travel relies on the use of two separate models and empirical suspended sediment value comparisons from typical crossing sites for each crossing method. The first is a regression model that estimates the concentration at or near the representative installation area (Reid et al. 2004) (see above) based on selected physical stream conditions. The second model estimates the distance various concentrations of suspended sediment travel downstream (Ritter 1984) based on selected physical site data.

The Reid et al. (2004) model uses site-specific physical parameters at representative crossing to predict sediment concentrations from a wet open-cut crossing at each stream reach in each watershed crossed by the Project. The basic stream reach data were obtained from the ODFW Aquatic Inventories Project. These data were not specifically from a proposed crossing site in a watershed but were considered to be representative of physical conditions of streams crossed in each watershed. Since all crossings would be dry cut, these model estimates were adjusted downward to equal predicted dry cut crossing values based on the average relationship between wet cut and dry cut methods in the Reid et al. (2004) article. Mean suspended sediment concentrations generated during dry open-cut construction for dry fluming construction were 3.7 percent of the wet open-cut concentrations and 0.85 percent of the wet open-cut concentrations for dam-and-pump construction. Pacific Connector assumed in their model that if sealing of the site from stream flow failed during construction, the average suspended sediments levels at the crossing would be equal to wet cut crossing values.

All parameters used in this model (flow, stream width, velocity, percent silt and clay), except for median sediment size (this had a regressed value based on percent fines for each stream reach), were taken from subbasin stream measurements report in ODFW's Aquatic Inventory database from fifth-field watersheds. This information was used to estimate what sediment concentrations would be for a wet open cut at the stream specific set of data.

The model by Ritter (1984) for small stream crossings was used to predict change in concentrations downstream of crossings based on stream characteristics (e.g., flow, depth, roughness). The details of how this model operates are provided in a revision to Pacific Connector's Resource Report 3.[124]

Estimates were made for 9 to 99 stream crossings per fifth-field watershed (average 51 per fifth-field watershed) for which sufficient data were available to conduct the analysis. These crossings were representative of the Project regions and ranges of stream width/gradient that would have normal dry open-cut crossings. Streams not modeled included the Upper Klamath River (except Spence Creek) and Lost River subbasins crossings, other HDD or boring sites, and bedrock stream crossings that would have low sediment during crossings. Due to the dynamic nature of sediment movement in streams, however, some bedrock crossings may have other substrate at the time of crossing.

The resulting estimates of potential suspended sediment concentrations (without major crossing area sealing failures) indicate that suspended sediment concentrations would remain low in most project regions (table 4.5.2.3-3) (See appendix I, tables I-10, I-11, and I-12 for details by watershed). These estimates are based on the average range of suspended sediment concentrations by watershed during low flows, the period when in-stream construction would occur. Estimates of suspended sediment concentrations produced during pipeline construction under summer low-flow conditions may be highest for the waterbodies crossed in the Coos Bay-Frontal Pacific Ocean fifth-field watershed, followed by crossings in the North Fork Coquille River and Myrtle Creek fifth-field watershed,

[124] Attachment FERC-PCGP-RR3-10 submitted to the FERC in a supplemental filing on May 4, 2018.

which is the result of assumed high fines concentrations at the crossings. For flumed crossings, suspended average watershed values ranged from 27 to 153 mg/l, with values even lower for dam and pump crossings, ranging from 7 to 35 mg/l among the 14 watersheds. Exposures to suspended sediment concentrations from any crossing method would decrease to background levels from about 0.6 to 19 kilometers downstream, among the 14 watersheds (table 4.5.2.3-3).

TABLE 4.5.2.3-3

Estimates of Total Suspended Sediment Concentrations (TSS) Generated during In-stream Construction and Estimated Downstream Distance to Attenuate to Ambient TSS in Fish-bearing Watersheds that Would Be Crossed by the Pipeline

	Average Estimates for Streams Sampled in Watershed a/			
Subbasin and Fifth-Field Watersheds	**Wet Open–Cut TSS (mg/l) at 50 m**	**Fluming TSS (mg/l) at 50 m**	**Dam & Pump TSS (mg/l) at 50 m**	**Distance (m) for TSS (Clay Fraction) to Equal Ambient(TSS = 2 mg/l)**
Coos				
Coos Bay-Frontal Pacific Ocean	4,102	153	35	595
Coquille				
North Fork Coquille River	2,923	109	25	1,840
East Fork Coquille River	2,783	104	24	1,744
Middle Fork Coquille River	2,576	96	22	2,072
South Umpqua				
Olalla Creek-Lookingglass Creek	2,425	90	21	1,780
Clark Branch-South Umpqua River	1,951	73	17	2,407
Myrtle Creek	3,436	128	29	1,708
Days Creek-South Umpqua River	727	27	6	633
Upper Cow Creek	1,996	74	17	7,315
Upper Rogue Subbasin				
Trail Creek	804	30	7	18,591
Shady Cove-Rogue River	712	27	6	16,534
Big Butte Creek	1,112	41	9	10,563
Little Butte Creek	1,198	45	10	11,439
Upper Rogue Subbasin				
Spencer Creek	850	32	7	15,577

a/ Stream-specific values are provided in Appendix X of the APDBA. Nearly all watersheds with at least 12 streams each, usually with multiple reaches per stream.

m – meter; mg/l – milligram per liter; TSS – total suspended solids (sediment)

If there is a failure of isolation structures during either type of dry open-cut construction, it is assumed that the suspended sediment generated during the failure would be similar to suspended sediment generated during wet open-cut construction. Suspended sediment concentrations assumed to occur during failure of isolation structures could be substantial. For the watersheds with highest concentrations, waterbodies in the Coos Bay-Frontal Pacific Ocean, Myrtle Creek, and North Fork Coquille River fifth-field watersheds, modeled suspended sediment assuming average wet open-cut values might be as high as 4,102 mg/l (Coos Bay -Frontal). Other watersheds could be as low as 712 mg/l (Shady Cove-Rogue River) 50 meters (164 feet) downstream from construction (table 4.5.2.3-3). However, each of these watershed values is based on the average of single point estimates from multiple streams but without consideration of how precise the model value is or how the variability of input parameters may affect the model output.

As noted above, Newcombe and Jensen (1996) developed models that estimate severity of effects on fish (primarily salmonids) based on the suspended sediment concentration and the amount of exposure time (i.e., assumed in-water peak disturbance period length) for various fish life stages. Model 1 (effects on juvenile and adult salmonids) was used for the analysis because those are the primary life stages and species of concern that may be present at locations and time of construction. The model requires estimates of both suspended sediment and the duration that values would occur in the stream.

While the actual full process of flumed or dam and pump crossing construction may last more than a day, elevated concentrations would likely peak over a two- to six-hour period, depending on stream width and construction methods with smaller streams taking less time. The number of dry open-cut crossings by stream size category for all watersheds assessed (two Lost River subbasins watersheds not included) is shown in table 4.5.2.3-4 (the number by watershed is given in appendix I, table I-10). Most crossings were of very small (less than 10-foot-wide) streams. Duration time ranged from two hours to six hours. To assess the potential sediment effects if major problems occurred with sealing during installation, a period of six hours duration was applied to sediment concentration estimates developed for wet open-cut crossing values. These times were used to estimate the duration of elevated sediment levels and used in the Model 1 of effects discussed above.

TABLE 4.5.2.3-4

Number of Streams Within Four Width Classed that Would be Crossed by Dry-Open Cuts and Estimated Duration (a/) of In-Stream Generating Actions

	Number by Width Class and Duration b/				
Category	**≤ 10 ft 2 hours**	**>10 ft to ≤25 ft 4 hours**	**> 25 to ≤50ft 5 hours**	**> 50 ft 6 hours**	**Total**
Number	121	47	17	4	189
Percent	64%	25%	9%	2%	100%

a/ Worst-case estimate as many of the smaller streams would be dry during construction.
b/ Total Dam and Pump and Flumed crossing for all watersheds except those in the Lost River subbasin.

Where flumed crossings are used, the magnitude of maximum average watershed severity of sediment effects for juvenile and adult salmonids for most stream crossing (i.e., smallest stream, less than 10 feet wide crossed) would be at most SEV 5 (minor physiological effect) in some of the 14 watersheds. This effect level would occur within 30 meters of stream crossings in six of the watersheds and not in the others. The lowest level of sublethal effect (SEV=4) (short-term reduction of feeding success) would occur in all watersheds to a distance average of about 800 meters below crossing (see appendix I, table I-11). With the longer duration of elevated sediment, severity of effects would be slightly greater for small stream crossings (i.e., 10-25 feet wide), with SEV 5 (minor physiological stress) occurring in about half of the watersheds at an average distance of about 100 meters below the crossings, while lowest sublethal effects (SEV 4) would occur in all watersheds and extend an averaged about 1,800 meters downstream. Except for two watersheds, effect levels on larger streams would be SEV 5 or less. This level would extend on average 180 meters for streams 25 to 50 feet wide (medium), and 280 meters for greater than 50-foot-wide (large) streams. SEV 4 would extend on average about 2,120 and 2,380 meters in the watersheds for the medium and large stream crossings, respectively. While the model results suggest some potential behavioral effect (SEV 1-3) may occur farther downstream in any stream crossing, the sediment concentration that could generate these effects is near background suspended sediment levels (e.g., 2 mg/l), so these effects would be similar to existing stream conditions.

Dam and pump crossings typically have lower suspended sediment generation so almost none of the crossings on the smallest streams (a majority of streams less than 10 feet wide in table 4.5.2.3-4)[125] would have suspended sediment levels reaching any sublethal SEV levels for any watershed, and the few that do would extend less than 50 meters. For the small stream crossing (10-25 feet wide), about half (8 of 14) the watersheds would have some areas reaching the lowest sublethal level (SEV 4), with most of these having sediment effects reduced to potentially only behavioral effects in less than 100 meters from the crossing. For the limited number (up to 21 crossings) of remaining medium and large stream crossings (table 4.5.2.3-4), if dam-and-pump crossings were used, a few watersheds would have no modeled sublethal effects, while the remaining 8 watersheds and up to 13 crossing would be at the lowest sublethal level (SEV 4) (appendix I, table I-11). In these crossings, severity levels would decrease to less than sublethal levels typically in less than about 200 meters of the pipeline crossings.

If the selected dry open-cut method has a failure in sealing, the in-stream construction area sediment levels would be higher than estimated for the crossing type. As noted earlier, if that occurred, then potential wet open-cut suspended sediment concentrations would be assumed. The severity effects model estimate of this assumed elevated sediment level would occur for about six hours (see above). Based on model results, the highest sublethal model effect of SEV 8 (major physiological stress, long-term reduction in feeding rate) would occur within at most 50 meters downstream of the crossing in any watershed, with about half (8 of 14) the watersheds having lesser sublethal effects (i.e., SEV 7 or lower). For most watersheds, if this crossing type occurs, severity levels of SEV 7 (moderate habitat degradation, homing effects) would extend downstream below the crossing between 500 and 2,000 meters (average about 1,000 meters; see appendix I, table I-11). Levels of SEV 6 or less would diminish in distance downstream of these areas as sediment settles. The minimal sublethal effects SEV 4 would still occur mostly from about 5 to 9 kilometers (average about 6.5 kilometers) downstream among the watersheds, over a 6-hour period. No watershed is modeled to have levels reaching the lethal or paralethal range (SEV $\geq$9) at any distance below crossings. In the unlikely event that dry crossing methods fail completely and wet open-cut methods must be implemented to complete the crossing, if suspended sediment conditions are high, the longer duration of elevated levels could result in the potential for severity levels to be higher (e.g., SEV 9, reduced fish density) over a limited stream area.

Overall, these effects would be short term, all less than a day as modeled. Some lower levels of effect would occur due to lower suspended sediment concentrations sporadically occurring during the actual crossing activity, and some resuspension of settled sediment with most lasting less than two or three days (Reid et al. 2004). As noted above for value estimates of suspended sediment, the SEV estimates should be considered approximate because the range of accuracy and variability of the input parameters is not directly included in the model estimates. However, the results are reasonable considering that typical dry crossing methods have relatively low concentrations of

[125] Number of streams that would definitely be crossed by dam-and-pump or flumed crossings will be determined during construction, but dam and pump is more often used on smaller streams.

suspended sediment (Reid et al. 2004) of short duration, likely less than 24 hours (Harper and Trettel 2002).

Sediment may also be contributed to fish streams from pipeline crossings of upstream feeder tributary streams. There were some 22 stream crossings of intermittent stream channels that could result in unlikely (due to lack of flow during crossing) sublethal effects (all SEV 4) to the downstream fish stream, and another seven tributary crossing of perennial streams that could result in sublethal effects (SEV 4 or 5) extending into downstream fish streams from these crossings (appendix I, table I-12).

The South Umpqua River diverted open-cut crossing would also result in some increase in suspended sediment. While not directly modeled, the coarse sediment at this crossing area would limit fine sediment distribution downstream of this crossing, likely less than 150 feet, based on model estimates of sediment transport distance, and would likely be less than levels that cause minor physiological stress (SEV 5). Elevated sediment and effects would be mostly reduced within a day of crossing activity termination.

No open-cut or dry-cut crossings would occur when any known adult salmonid resource, including spring Chinook salmon, would be spawning near a crossing during the designated approved construction window. Therefore, direct effects on spawning would be unlikely. Overall, the potential effect of suspended sediment on spawning activities of spring Chinook salmon would be restricted to the South Umpqua River diverted open-cut crossing, which would be limited in its downstream distribution as noted above.

Summary of Suspended Sediment Effects

While the modeled results supply a reasonable estimate of likely level of effects on primarily salmonid fish resources, the models rely on multiple input parameters (e.g., substrate composition and size distribution of fines, median substrate size (d_{50}), and water velocity at each stream) that are specific to fish streams in the watershed but not to specific crossing locations. Therefore, overall summary assessment of effects considered both literature results from other pipeline crossings and the modeled results of Project streams. For both modeled and literature-based assessments, effects would be mostly short term (less than 1 to 4 days) and remain at a near to moderate distance from the crossing location (downstream distance a few hundred feet based on literature, and a few hundred to a few thousand feet based on models).

Overall model results are based on regional watershed averages, but site-specific conditions may vary from these averages. However, the literature-based values of typical project-wide effects provide comparable results, suggesting more specific model estimated effects are reasonable. The results for either method is that crossings would cause at least some short-term adverse effects, primarily avoidance, short-term feeding reduction, and likely minor to moderate stress, but unlikely any direct effects on growth, fish density, or survival. No long-term adverse effects are expected unless some major failure occurred during construction. However, if failure occurred under certain conditions, some marked effects could be expected such as reduced fish density of salmonids in a limited stream area.

Sediment releases would affect primarily short-term stream habitat conditions. Sediment from stream crossings could affect spawning habitat below crossings as Project-generated sediment could increase gravel embeddedness downstream, although elevated fall and winter flows following crossing would likely flush fines from any local spawning sites. Habitat quality, including fish food sources, would be temporarily decreased downstream (e.g., visibility, flushed and covered benthic organisms, reduced fish movement) with overall habitat suitability (Anderson et al. 1996) temporarily decreasing, though not necessarily to levels that would cause moderate habitat degradation (SEV 7).

The Project could result in short-term adverse effects on estuarine and freshwater critical habitat for the Oregon Coast ESU of coho salmon. Short-term effects on critical habitat within the estuarine analysis area would include effects on food and rearing habitat as a result of dredging the access channel, marine waterway modifications, and the slip. Dredging in proximity to the Coos Bay shipping channel would decrease water quality and affect cover (e.g., aquatic vegetation and eelgrass).

Because of the linear nature of the Pacific Connector Project, the number of stream crossings and ultimately total area of stream habitat and individual streams that would be affected in any watershed would be extremely small. There would be 249 actual dry open cut stream channel crossings (table 4.5.2.3-2) in 231 miles of pipeline route over 17 fifth-field watersheds (watersheds with no crossing not included). Since almost no individual stream would have more than one crossing, effects on each stream would be limited to the crossing location. As an example of the relative portion of streams that may be affected in the short term by stream crossings, we examined the potential stream area affected in the four fifth-field watersheds of the Coquille subbasin, a route area with a high number of stream crossings. Those four watersheds have 3,093 miles of stream (Ecotrust 2015). The Project would cross 37 stream channels by dry open cut crossings in that length. Assuming the area affected from sediment to be 1,000 feet per stream crossing, about 0.2 percent of all stream length in this subbasin would have some short-term effect from sediment during construction. Overall cumulative effects would be unsubstantial based on the dispersed distribution of crossings and magnitude of effects at each and lengths of stream channel potentially affected.

<u>Inadvertent Release of Drilling Mud from HDDs and DPs</u>

Pacific Connector proposes to use the HDD method to cross under the Coos, Rogue, and Klamath Rivers. Generally, an HDD would avoid direct effects on a river and its associated aquatic resources. However, as discussed above for the Coos Bay crossing, an HDD requires the use of drilling mud (bentonite) as a lubricant which may leak (also referred to as a frac-out). This fluid is under pressure and there is a possibility of an inadvertent release of drilling mud through a substrata fracture, allowing it to rise to the surface.

As noted above, this release of drilling muds could interfere with various life activities for fish and benthic organisms. Drilling mud that accumulates on the stream bottom could cover over food sources and fish eggs. The majority of highly mobile aquatic organisms, such as fish, would be able to avoid or move away from the affected area while less mobile organisms could incur direct mortality if smothered by the drilling mud. These effects would be localized and short term, limited to species in the immediate vicinity of the frac-out, and ameliorated by river volume.

The effects of an in-stream frac-out on spawning habitat, eggs, and juvenile survival depend on the timing of the release. If spawning habitat is nearby, redds could be affected near a frac-out (Reid and Anderson 1999). During establishment of the spawning bed, the female as part of the normal preparation behavior would likely clean out a minor addition of sediment. However, a heavy sediment load dispersing downstream could settle into spawning beds and clog interstitial spaces, reducing the amount of available spawning habitat, which could be a limiting factor in areas of already reduced habitat. When redds are active, eggs could be buried, disrupting the normal exchange of gases and metabolic wastes between the egg and water (Anderson 1996). The effects of sediment intrusion into the redd on larval survival are more severe during the earlier embryonic stages than following development of the circulatory system of larvae, possible because of a higher efficiency in oxygen uptake by the older fish (Shaw and Maga 1943; Wicket 1954). Clogging of interstitial spaces also reduces cover and food availability for juvenile salmonids (Cordone and Kelley 1961). Benthic organisms could also be affected by burial. However, bentonite is more likely to stay in suspension and less likely to immediately settle than common bottom sediment so, in flowing water effects on benthic organisms from burial under a release of drilling mud are likely to be low and unsubstantial. As discussed earlier, Pacific Connector developed a Contingency Plan that includes measures to reduce effects should frac-outs occur.

DP technology would be used to cross the South Umpqua River at MP 71.3. Like HDD, DP crossings use a bentonite lubricant that theoretically could have an inadvertent return to the surface where it could enter the water contributing to suspended sediment levels. Because the excavated hole is continuously supported and the risk of hydraulic fracture is low, the DP alignment can be designed much shallower than is typical for HDD. Because of the limited amount of lubricant used and relatively low pressure of this construction, the chance of any inadvertent return occurring is remote. Therefore, the chance of accidental contribution of increased suspended sediment to this crossing is unlikely and adverse effects on fish and aquatic organisms at this crossing are likely to be unsubstantial.

Overall drilling mud releases to any waterbody would be short term and diluted from large river water volumes and swift flows. Additionally, frac-out most often occurs near entry and exit points, which may be out of the stream channel. Also, as noted for the HDD crossing in Coos Bay, Pacific Connector has conducted detailed crossing plans for each site and has contingency plans in place should it occur.

Streambank Erosion and Stream Bed Stability

The clearing and grading of vegetation during construction could increase erosion along streambanks, resulting in sedimentation and higher turbidity levels in the waterbodies crossed. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. Erosion, sedimentation, and higher turbidity levels related to the Project could affect aquatic resources, as discussed above. Effects on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size.

The rootwad network of trees adjacent to stream supplies bank stability. Those within 25 feet of the stream are considered most important at providing the root source aiding in bank stability (WDNR 1997). To aid in maintaining this bank stability, Pacific Connector would cut most trees near the bank (right-of-way width of 75 to 95 feet at the crossing), except those in the trench line, at ground level leaving the root systems in place helping to maintain short-term bank stability. Roots would be removed over the trench line or from any steam banks that would need to be cut down or graded to accomplish the pipeline crossing. To minimize these effects, Pacific Connector would use temporary equipment bridges, mats, and pads to support equipment that must cross the waterbody (perennial, intermittent, and ephemeral if water is present) or work in saturated soils adjacent to the waterbody. Pacific Connector would also install sediment barriers, such as silt fence and straw/hay bales, across the right-of-way at the edge of waterbodies throughout construction except for short periods when the removal of these sediment barriers is necessary to dig the trench, install the pipe, and restore the right-of way.

Pacific Connector proposes several measures to reduce the risk of erosion, bank failure, bed scour, and channel migration both from initial field evaluations and planned future actions. These are discussed in detail in section 4.3. The ECRP would be followed to help mitigate potential for bank and bed erosion, which would include not using riprap to stabilize streambanks. Immediately after installation of a waterbody crossing, the contours of the streambed, shoreline, and streambanks would be restored to preconstruction configurations (i.e., contour/elevations) to restore the physical integrity/condition of these features and to minimize the loss of stream complexity. Additional erosion control measures would include the installation of erosion control fabric (such as jute or excelsior) on streambanks at the time of recontouring. Stream banks would be restored to original contours, and selected site-appropriate riparian vegetation plantings would occur.

Pacific Connector has conducted a scour and channel migration analysis that identified channels with high risk of potential scour or migration, and pipe exposure. The channel migration and scour analysis rated crossings as to their risk of pipe exposure. Based on this analysis, Pacific Connector proposes to implement site-specific crossing methods at 11 waterbody crossings to reduce the risk of pipe exposure and reduce changes in stream channel habitat at potential areas of risk. Additionally, Pacific Connector has conducted an initial assessment of crossing conditions of all streams suitable for analysis based on the FWS risk matrix (GeoEngineers 2017d, 2018a, and 2018b). This assessment was intended to determine where stream crossings may pose significant risk to increase streambank erosion and streambed instability. GeoEngineers, using a combination of field and GIS data, rated the 173 pipeline stream crossings based on the matrix. Streams were lumped into categories based on their relative risk of project actions at that site affecting the stream and the sensitivity of the stream crossing to be affected crossing actions. The ratings help determine what kinds of BMPs would be most appropriate for each stream category depending on how the stream crossing were ultimately rated for project actions and stream conditions at that site based on the risk category the crossing fell into. Stream crossings that are unstable can ultimately adversely affect aquatic resources from such factors as loss of local habitat and addition of sediment to downstream habitat; these effects would last as long as it takes the crossings to stabilize.

Relatively few of the streams were considered to have marked potential for bank instability. Most streams were determined to be adequately protected with standard BMPs. Some streams would require additional specific BMPs to protect the stream channel and bank conditions (GeoEngineers 2017d, 2018b, and 2018c). Seven stream crossings were considered to need site-specific crossing measures to reduce the risk. Additionally, the BLM and Forest Service made recommendations for crossing designs on eight perennial stream crossing on their lands (see section 4.3). Most of these were the same crossing that Pacific Connector had concluded needed site-specific crossing BMPs. These recommended crossing plans were adopted by Pacific Connector for these crossings.

Proper substrate restoration would also be used maintain stream geomorphic and habitat conditions. Substrate characteristics and physical habitat features would be determined through pre-construction surveys, and the upper 1 foot of existing substrate would be replaced with clean cobble or gravel (not derived from crushed gravel), or a combination of both, or in some cases matching existing substrate during reconstruction after pipe installation. Many of these actions would be determined prior to construction based on results of the pre-construction survey (see below) and determined by a qualified EI specifically trained to determine proper restoration actions to implement based on river channel processes or a suitably trained professional. On non-federal lands, this person would have the authority to select appropriate additional BMP construction methods, bank stability actions, and revegetation types and methods to help reduce the risk of instability of the crossing and potential for future erosion (GeoEngineers 2017d and 2018a). Additional oversight would occur on federal land.

A pre-construction survey would be conducted by a technically qualified team of Pacific Connector on all stream crossings to confirm and clarify conditions developed in the aforementioned matrix analysis. This would include surveys of sites currently not accessible due to property ownership issues. Following these surveys, if significant changes were to occur to parameters of the risk matrix for a crossing, changes would be made to risk level and appropriate final methods of crossing and BMPs made at each stream crossing. Following the final surveys, special additional BMPs, as described in GeoEngineers (2017d and 2018a), would be implemented depending on individual site conditions and may include such actions as changes in bank material and bank angle modifications, specific substrate composition used, plants used on the bank, artificial stabilizing bank material, rootwad enhancement, type of bed and bank restoration structure and various other actions. As described in section 4.3, additional specific post-construction monitoring at various intervals over a 10-year period would occur and corrective actions taken if bank or bed issues are encountered. Additionally, as discussed below, Pacific Connector would supplement lost existing LWD and sources of local LWD in nearly all streams to various degrees, which should help stabilize bed, bank and habitat conditions. These actions are expected to reduce the chance of modification of stream habitat from erosion to occur from the result of the crossing actions to be unsubstantial in most areas.

<u>Construction of New TARs, New PARs, EARs, and TEWAs</u>

Construction of all of these facilities has the potential to contribute sediment to streams occupied by fish and influence benthic food organisms as discussed above concerning the effect of added sediment to streams. Section 4.3 addresses the sediment runoff that would occur from numerous TARs, PARs, EARs, and TEWAs that would be constructed or rebuilt along the route.

Within the range of coho salmon along the route, two new road crossings (PARs) would be built, and seven existing road crossing on EARs would also be improved. Road crossings are areas of potentially the highest relative contribution of sediment to streams. An additional five new roads (PARs and TARs) and an additional 15 EAR segments have the potential to contribute sediment to streams because they are within 200 feet of streams in this area. Sediment contribution to streams is affected by many factors (cover, slope, substrate) but typically decreases exponentially in distance from the road to the stream. Most potential sediment runoff to a stream channel from roads would occur within 100 feet of a stream, but some sediment, about 10 percent, can be contributed from roads between 100 and 200 feet, with contribution beyond 200 feet considered to be non-existent (Dube et al. 2004). Most road segments outside of this distance would have minimal potential for sediment delivery to streams. TEWAs near streams are common along the route. While some additional roads would be built or modified in other Project areas, these areas have limited fish streams along the route, and some additional sediment from these roads would have limited potential to affect fish or their habitat.

As discussed in section 4.3, multiple actions would be implemented to reduce potential sediment quantity entering fish streams. These would include such actions as graveling new road surfaces, restoring all TARs to preconstruction conditions, following land-managing agencies' engineering design and road management standards, and installing BMPs according to the ECRP for all related construction actions, which may include silt fence/straw bales, sediment barriers, temporary slope breakers, or prefabricated construction mats to prevent rutting/compaction.

While some additional sediment to streams may occur, implementation of the *Transportation Management Plan*, ECRP, BMPs, and maintenance procedures would minimize the amount of sediment entering streams, especially fish-bearing streams, reducing the potential for adverse effects on fish and their habitat from sediment runoff.

Crossing Unstable Slopes

Slope failure near the waterbody during pipeline operation could result in soil and sedimentation falling into the waterbody. Pacific Connector evaluated all likely unstable areas during selection of the proposed pipeline route and moved the route as necessary to areas considered to have low risk. Field reconnaissance to assess potential risk based on initial assessment of moderate or high risk was done along the proposed pipeline route, and the final assessment determined only two crossings, located near Steinnon Creek between MPs 24BR and 25BR, were considered to have moderate risk along the pipeline crossing area. The risks to the pipeline at these sites were not considered hazardous enough to require additional rerouting or mitigation. The final assessment considered protective measures that would be adequate to reduce this risk. The known landslide risk areas have thus been all but eliminated from the route (see section 4.1).

Resuspension of Potentially Contaminated Sediments

Elevated heavy metals in water and sediment can have adverse effects on aquatic organisms. Fish and other aquatic organisms are sensitive to mercury levels even at very low concentrations. Because of concerns about hazardous waste from historic mining activities near the crossing of the East Fork Cow Creek (approximately MPs 109 to 110), Pacific Connector evaluated the currently proposed route in the area for mercury-contaminated soils and stream sediment. Examination of the underlying rock type (volcanic) of the proposed route indicates it is unlikely to contain elevated mercury in the bedrock (GeoEngineers 2009a). Broeker (2010) examined this route and sampled soil and stream samples near the proposed stream crossings. Of the three crossing measurements, one value (0.29 milligram per kilogram [mg/kg]) exceeded the ODEQ Level II screening value for freshwater (0.2 mg/kg). The other two were less than the freshwater value but two of the three were equal to or exceeded the bioaccumulation value of 0.07 mg/kg. The six soils samples were considered low in mercury, although they were slightly higher than the ambient background levels. Two intermittent stream channels occur up slope in this region that theoretically could carry sediment and related mercury downslope. However, Broeker (2010) concluded that these intermittent streams would stop on upslope benches and not reach the stream. He concluded upslope delivery to streams was not likely unless erosion was not controlled. Special erosion control provisions, in addition to what usually are implemented, were agreed to by Pacific Connector for this region to reduce possibly elevated mercury levels reaching the stream (Pacific Connector 2013).

Additionally, while levels of mercury in the East Fork Cow Creek are sometimes over ODEQ Level II screening levels, little sediment would be disturbed or suspended from the crossing activity since the crossing would be done in the dry. The pipeline route had been moved about 2,500 feet to avoid areas where elevated mercury levels were measured, so soil is unlikely to have concentrations of naturally occurring mercury exceeding those measured. With adjacent upland disturbance following the standard ECRP and supplemental erosion control actions, additional site-specific ground cover actions would be taken at this crossing, and upslope potential sediment entry into the stream would be controlled and minimized. Overall, adverse effects on fish from mercury would not occur from Pacific Connector Pipeline Project actions.

Vegetation and Habitat Removal and Modification

Sections 4.4 and 4.5.1 list the acres of riparian habitat that would be directly affected by all construction-related activities. Much of this habitat is in forested areas, where stream shading and organic input are most prominent. The analyses conducted for considering effects on riparian vegetation present within a one site-potential tree height buffer on either side of a waterbody on both federal and non-federal lands. This area is within one site potential tree height of the stream, the area near streams with the greatest potential effects on stream. Federal lands have additional areas called Riparian Reserves, which are different than the riparian areas shown here. The analyses here do not consider effects on Riparian Reserves because those effects would be limited to certain federal lands; the analyses provided below consider effects on all lands, hence the analysis of effects on Riparian Zones rather than to Riparian Reserves. Table 4.5.2.3-5 lists riparian areas disturbed by construction and the 30-foot-wide maintenance corridor adjacent to perennial and intermittent waterbodies crossed by the pipeline. Tables listing these cleared areas by watershed are presented in appendix I, tables I-8 and I-9. Removal or alterations in other habitats (e.g., clearcut/regenerating forest, shrub and grasslands, and wetlands) would also contribute to effects on aquatic resources, but to a lesser degree because riparian influence (e.g., shade, organic input, sediment and nutrient filtration) on stream conditions would be less.

TABLE 4.5.2.3-5

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction and within the 30-Foot-Wide Maintained Operation Corridor Riparian Zones (One Site-Potential Tree Height Wide) Adjacent to Perennial and Intermittent Waterbodies Crossed/Near the Pacific Connector Pipeline Project

	Forest Habitat b/					Other Habitat b/						
Landowner	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Forest Regenerating**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Nonforested Habitat Unaltered**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Area Affected (acres)**
Construction												
BLM-Coos Bay District	7	4	10	0	21	0	<1	0	0	4	4	25
BLM-Roseburg District	1	2	<1	<1	4	0	<1	0	0	<1	<1	4
BLM-Medford District	12	1	0	0	13	0	0	6	0	<1	6	19
BLM-Lakeview District	1	0	0	0	1	0	0	<1	0	0	<1	1
Forest Service-Umpqua National Forest	2	4	2	0	8	0	<1	0	0	3	3	12
Forest Service-Rogue River-Siskiyou National Forest	1	0	1	0	2	0	0	<1	0	0	<1	2
Forest Service-Fremont-Winema National Forest	2	0	2	0	4	0	<1	<1	0	<1	<1	4
Federal Subtotal	**25**	**12**	**16**	**<1**	**53**	**0**	**<1**	**6**	**0**	**7**	**14**	**67**
Non-Federal Subtotal	**15**	**57**	**32**	**8**	**112**	**<1**	**38**	**78**	**14**	**13**	**144**	**257**
Overall Total	**40**	**69**	**48**	**8**	**165**	**<1**	**39**	**84**	**14**	**20**	**158**	**323**
30-foot wide corridor												
BLM-Coos Bay District	2	1	2	0	5	0	<1	0	0	1	1	6
BLM-Roseburg District	0	1	<1	<1	1	0	0	0	0	<1	<1	1
BLM-Medford District	3	<1	0	0	3	0	0	2	0	<1	2	5
BLM-Lakeview District	0	0	0	0	0	0	0	0	0	0	0	<1
Forest Service-Umpqua National Forest	1	1	1	0	2	0	<1	0	0	<1	<1	2
Forest Service-Rogue River-Siskiyou National Forest	0	<1	<1	0	1	0	0	<1	0	0	<1	1
Forest Service-Fremont-Winema National Forest	1	<1	<1	0	1	0	<1	0	0	<1	<1	1
Federal Subtotal	**7**	**3**	**4**	**<1**	**13**	**0**	**<1**	**2**	**0**	**1**	**3**	**17**
Non-Federal Subtotal	**4**	**14**	**8**	**2**	**28**	**0**	**7**	**16**	**3**	**2**	**28**	**56**
Overall Total	**11**	**17**	**12**	**2**	**41**	**0**	**7**	**18**	**3**	**3**	**31**	**73**

Note: Rows/columns may not sum correctly due to rounding.

a/ Project components considered in calculation of habitat "Removed:" Pipeline project construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

Effects on waterbodies and resident and anadromous fish due to removal of riparian vegetation and maintenance within the construction and operation corridor adjacent to but not crossed by the pipeline Project would be similar to effects on riparian vegetation for streams crossed by the pipeline:

- loss of riparian vegetation along the banks, reducing shade and potentially increasing water temperatures;
- decreased LWD recruitment in streams and on adjacent uplands, although current conditions of LWD in fifth-field watersheds crossed by the pipeline project are generally undesirable;
- removal of an important source of terrestrial food for aquatic organisms; and
- potentially increase in mass slope failures and/or erosion due to surface runoff adjacent to waterbodies that could increase sediment in the waterbody.

Pacific Connector would minimize effects on riparian vegetation by narrowing the width of its standard construction right-of-way at waterbody crossings, and by maintaining a setback between waterbody banks and TEWAs in forested areas. A riparian strip at least 25 feet wide on private lands, including widths ranging from 50 to 100 feet on fish-bearing streams as designated for Oregon State Riparian Management Areas, and 100 feet wide on federally managed lands, as measured from the edge of the waterbody, would be permanently revegetated. Pacific Connector would plant native tree and shrub species along all fish-bearing streams. Within a 30-foot-wide corridor centered on the pipeline, plants would be kept less than 15 feet high. Overall, about 84 acres (23 percent) of former riparian habitat cleared by pipeline construction would be maintained long term in an herbaceous state. The management of vegetation including the riparian areas is presented in detail in section 4.4. Restricting the low-growth vegetation area to a small portion of the total right-of-way clearing would allow much of the ecological function of the riparian conditions relative to fish needs (e.g., shade, future LW, and organic input) to more quickly return. This would limit the overall long-term effects of loss of riparian habitat to a small portion of each stream crossed, reducing future negative effects on fish resources. This would limit the overall long-term impacts of loss of riparian habitat, primarily as a result of LWD reduction, to a small portion of each stream crossed, reducing future negative effects on aquatic resources.

Water Temperature

The effects of water temperature on salmonid life stages have been extensively reviewed by McCullough (1999) and others. Maximum water temperatures ranging from 71.6 to 75.2°F (22 to 24°C) limit distribution of many salmonid species. For spring Chinook salmon, for example, the optimum temperature for growth is 60.1°F (15.6°C) and higher temperatures during summer could reduce growth and lead to increased mortality rates (McCullough 1999). Vegetative cover that provides shade, especially during summer, is one factor that regulates water temperature (WDNR 1997). If sufficient loss of shade occurs, temperatures in streams are known to increase. Increasing stream temperatures can result in reduced fish production and spawning success, and, if high enough, reduced fish survival also, especially for important northwest salmon and trout species found in many Project streams. The current Oregon state water quality temperature standards, which are addressed in section 4.3 of this EIS, include provisions to limit anthropogenic increases in stream temperature especially in salmon- and trout-bearing streams. Construction of the pipeline across waterbodies would necessitate removal of trees and riparian shrubs at the crossing locations that, if extensive enough along any single waterbody, may influence these stream temperatures. Pacific Connector has proposed to mitigate potential temperature increases on waterbodies through riparian plantings. This would include, as mitigation for loss of riparian shade vegetation, replanting the equivalent of 1:1 ratio for construction or 2:1 for permanent riparian vegetation loss with the goal to restore shade along the affected or nearby stream channels in the same watershed (GeoEngineers 2017f). Plantings would incorporate recommendations by the Forest Service and BLM for their lands in Riparian Reserve areas. The lengths of planting areas on streambanks would be determined prior to construction. Plantings are preferred to be continuous and not small parcels. Final plant species and spacing would follow those in the ECRP, which includes specific recommendations by the Forest Service and BLM, unless differently recommended by the landowner.

Temperature modeling was done by the BLM and Forest Service for some of the streams that would be crossed (NSR 2015a, 2015b, 2015c). During the low-flow conditions of 2013, modeled 7-day maximum stream temperatures just below in the three East Fork Cow Creek crossings showed potential increases of 1.0°F to 5.1°F (NSR 2015b). Wetted width on these channels was less than 5 feet, with the smallest channel and lowest flow having the highest temperature increase. The model also tended to overestimate the known temperature, so the results may be elevated, and the 2015 analysis of this creek showed larger temperature increases than those reported in NSR (2009) of similar locations primarily due to much lower flows during 2013. Again, these were very small streams (0.02 to 0.12 cubic foot per second) that also had a natural downstream decrease in temperature below the modeled areas likely from natural groundwater inflow. Steinnon Creek, a small 6-foot-wide stream, was also modeled to have a 7-day maximum stream temperature increase of 0.4°F assuming right-of-way clearing results in zero percent shade, also under the low flow conditions (0.22 cubic foot per second) of summer 2015 (NSR 2015c). Two other modeled creeks (Middle Creek and Big Creek tributary) had estimated increases of 0.1 and 1.1°F in 7-day maximum stream temperature (NSR 2015b). As with other streams, size affected relative change with Middle Creek having a flow of 1.62 cubic feet per second (12 feet wide) and Big Creek tributary 0.08 cubic feet per second (5 feet wide).

The results of the stream temperature model discussed above are likely conservative estimates based on other literature studies and modeling estimates. For example, Pacific Connector modeled 15 streams along the route (GeoEngineers 2017f), where the average temperature increase was modeled at 0.03°F, and the maximum increase among the streams was 0.3°F, with the highest value occurring at one of the smallest streams (table 4.3.2.2-9).

Other studies have noted lower temperature results in similar conditions as well. Two eastern U.S. studies looking at effects of right-of-way clearing in forested areas on stream temperature found no noticeable changes (Brown et al. 2002; Blais and Simpson 1997). More locally (i.e., in the north Oregon Cascades) a study of existing transmission line clearing found no significant downstream temperature changes from the clearings (Tetra Tech 2013). Modeled worst-case temperature conditions changes for this study estimated about 1.1°F (median of about 0.4°F) in the modeled maximum and maximum daily mean temperature across the assumed future clearing of the modeled 22 streams, for an estimated 150-foot-wide clearing (Tetra Tech 2013). The right-of-way width for these studies' crossings was much larger than what is proposed for the Pacific Connector Pipeline Project (i.e., 150 feet wide). Based on the literature studies noted above and project-specific models, estimated stream temperature changes that would result from right-of-way clearing are expected to be minor (see sections of 4.3.2.2 and 4.3.4.2).

These results demonstrate the effects that low-flow conditions, most common in very small channels, have on changes in water temperatures; as noted by Brown and Kygier (1970), given the same solar input, stream temperature is inversely proportional to flow. Observations of these streams also suggest that LWD and low-growing willows, huckleberries, and other brush species can provide effective shade for small, narrow channels. Blann et al. (2002) noted that riparian grasses and forbs supply as much shade as wooded buffers for streams less than 8 feet (2.5 meters) wide. In many cases after completion of pipeline crossing construction, low-growing grasses and brush within and outside of the immediate crossing construction area could minimize shade loss, resulting in lower temperature increases than modeled under zero percent shade.

Models addressing the temperature effect of adding shade from riparian revegetation plantings and other actions is that water temperature would be comparable to the existing condition and remain below ODEQ thresholds on the East Fork Cow Creek. Additionally, any temperature increases in small streams would likely be masked by the assimilative capacity of larger streams at the stream network scale (NSR 2009, 2014) (see section 4.3.2.2).

Over the whole pipeline project region, plantings and regrowth in riparian areas, as suggested by these modeling results, would help moderate potential temperature increases in the short term (a few years). Much of the riparian area would be allowed to regrow from plantings with herbaceous plants (only 10 feet wide would be maintained without some growth) and conifer and other trees (all but 30-foot width). On small streams and, to a lesser extent on larger streams, even 10- to 15-foot-high trees would supply substantial shade, reducing solar heating effects on streams. Additionally, many small streams have intermittent flow (about 80 percent of stream crossings are intermittent) and most would not have flow during periods of greatest temperature, with few of these having fish populations. Thus, the slight effects of solar heating from clearing would gradually be reduced or eliminated over time, based on the model, most between 5 and 10 years, with most areas of potentially higher increases absent flow or fish populations.

As discussed in section 4.3.2.2, potential cumulative watershed temperature increases from Project riparian clearing would be unlikely. GeoEngineers (2017f) provided an estimate the likely relative change in cumulative watershed heat input to streams from Project clearing at stream crossings. While actual total watershed stream temperature changes were not predicted, a relative measure can be approximated through an estimate of increased heat budget from clearing. In the example they provided for the South Umpqua subbasin, the thermal load from the Project due to initial construction clearing in these watersheds was about 16.5 million kcal/day, or about 0.032 percent. The relative unmitigated (i.e., no supplemental riparian plantings) change in heat load to these watershed streams relative to existing uncleared conditions would be an increase of only 0.004 percent once vegetation grows back outside of the 30-foot permanently maintained right-of-way clearing. The regrowth to achieve these levels would be expected to occur within 10 years in the Coos and Coquille subbasins and 20 years in others along the route. Considering the very small portion of total watershed riparian stream cover removed and low estimates of thermal increase, streamside clearing would not result in any measurable cumulative watershed-level changes in water temperature.

Based on available information, we conclude that any changes in water temperature, related to 75- to 95-foot-wide right-of-way vegetation clearing at waterbody crossings, are likely to be very small and undetectable through measurements, except for possibly the very smallest perennial streams and occasional intermittent flowing streams that may have flow during a hot period. Small streams with the greatest potential for measurable temperature increase also often contain limited numbers of fish because small headwater streams are often not fish-bearing or, if fish are present, their small size and often high gradient limit the stream's suitability as fish habitat. Any temperature changes that may occur would gradually be reduced or eliminated over time as most riparian vegetation, from plantings, natural vegetation growth, and size increases would increase stream shading.

Large Woody Debris

One effect on fisheries that would result from forest clearing at pipeline crossings and construction of the pipeline right-of-way within the riparian zone adjacent to but not crossing streams, TEWAS, and PARs, and TARs is the reduction of LWD in streams and on adjacent uplands (Harmon et al. 1986; Sedell et al. 1988). Large logs provide in-stream channel structures (i.e., pools and riffles), which are critical to salmon spawning and rearing. As the size of individual logs or accumulations of logs increases, the size and stability of pools that are created also increase (Beschta 1983). Riparian forests that undergo harvesting of large trees take on secondary-growth characteristics and contribute lower quantities of large wood than unmanaged, old-growth forests (Bisson et al. 1987). However, sufficiently wide, carefully managed riparian buffers that retain a full complement of ages, sizes, and species of native trees and vegetation can ensure adequate recruitment of LWD to streams (Bisson et al. 1987; Murphy and Koski 1989; Morman 1993).

Pacific Connector has proposed to mitigate for effects on waterbodies by installing LWD at agency- and landowner-approved and appropriate areas within the construction right-of-way across certain waterbodies. The use of LWD as a mitigation measure for effects associated with in-stream construction has been documented as an effective means of creating in-stream habitat heterogeneity, reducing streambank erosion, reducing sediment mobilization (Bethel and Neal 2003), and enhancing local fish abundance (Scarborough and Robertson 2002). Placement of LWD on the streambanks and in the streams, can provide slight shade and increase bank stability, while vegetation is maturing following construction. Additionally, placement of LWD in streams or keyed into streambanks can provide habitat for benthic invertebrates and important food source for salmonids, and increase habitat for forage species with the creation of pools and enhancement of the salmonid rearing potential of an area (Cederholm et al. 1997; Slaney et al. 1997).

To mitigate for short-term losses of LWD from riparian clearing and in-stream removal of wood during construction, Pacific Connector has developed a *Large Woody Debris Plan* which includes a proposal to install 733 pieces of LWD over several fifth-field watersheds along the pipeline route where the two ESA-listed coho salmon ESUs are present. Sizes would be based on those recommended by the current ODF and ODFW (1995) protocol for piece size by streambank full width category. The plan includes placing from one to four pieces of LWD per stream crossed in the stream or on the bank, depending on forest conditions, stream flow, and landowner approval. This number of pieces, if no other LWD were present in the stream reach affected by clearing, would be near the range of what is considered "desirable" by ODFW (Foster et al. 2001) for forested streams. Foster et al. (2001) noted that more than 20 LWD pieces/100 meters of stream length (i.e., 4.6 pieces/75 feet of right-of-way clearing) with more than 3 "key" pieces/100 meters (i.e., 0.7 "key" pieces/75 feet right-of-way clearing) is considered "desirable" in forested streams in Oregon. Bilby and Ward (1991) found LWD density in old-growth forest streams in southeast Washington to have a similar range. Based on their LWD regression model estimates using channel width,[126] LWD values in old-growth forest would be expected to range from about 1 to 7 pieces per 75 feet of stream channel length for streams ranging from about 50 to 10 feet wide. The sizes of LWD pieces to be installed are based on ODF and ODFW (1995) guidelines for sizes of LWD pieces to be present in streams to meet habitat needs for specific stream sizes and number of streams crossed. These final numbers would be developed as part of Pacific Connector's Mitigation Plan, which may have some modification prior to construction. Some long-term loss of local stream habitat would remain even with the LWD mitigation due to reduced future sources of LWD from the right-of-way.

Specific streams for LWD installation have been identified by Pacific Connector; however, the specific locations within the streams would be determined through discussion with ODFW, NMFS, and other agencies as appropriate, and in consideration of the BMPs outlined in the *Stream Crossing Risk Analysis Addendum* (GeoEngineers 2018a). The size of LWD installed would follow ODF and ODFW (1995) suggested guidelines for size of LWD based on stream size. Depending on private landholder approval, some pieces may be installed at various times and locations, but in general, LWD would be placed at waterbody crossings during the last phases of pipeline construction and right-of-way restoration. Pacific Connector has proposed that, if for some reason not all pieces proposed are installed, they would be donated to local water conservation groups for installation locally.

Long-term losses of LWD input would largely be mitigated through riparian replanting of conifers in the right-of-way, although some limited long-term reduction would remain from the absence of trees in the 30-foot-wide maintenance corridor and relatively smaller sizes of regrown trees in the remaining 45 to 65 feet of the right-of-way.

The NMFS, upon review of this proposed LWD plan, determined that the applicant's proposed number of LWD pieces, location, and methods of their proposed installation is not adequate to meet the loss of supply of LWD from riparian forest habitat related to right-of-way riparian clearing. However, we conclude that the proposed plan is consistent with ODF and ODFW protocols. Further, we note that the contribution of LWD to a stream from the 75- to 100-foot area cleared on both sides of a stream for construction represents an insignificant source for any stream other than extremely short headwater reaches.

<u>Fish Passage</u>

Waterbody crossings using the dry crossing methods, either flume or dam–and-pump, may result in some fish being trapped in streams. Flumes and dams would be completely installed and functioning before any in-stream trenching disturbance occurs. Up to about 250 stream crossings would be dry open cut, although most of these would be dry during crossing as they are intermittent streams (tables 4.5.2.3-1 and 4.5.2.3-2). Construction across a waterbody would take up to 4 days using dry open-cut methods, but less for small and intermediate streams. At one crossing of the South Umpqua River, a diverted open-cut crossing (only crossing of this type) would be used. This is similar to a dry open cut in that all in channel construction would be done in the "dry" but would require diversion of the flow to one side of the channel at a time. This method could take

[126] Model: Log10 frequency of LWD = -1.12 log10 of Channel Width (m) +0.46

about 14 days to complete. Because one channel would be open during the entire crossing, no passage of fish would be impeded, and no fish removal would be required.

For typical crossings, once streamflow is diverted through the flume pipe, but before pipeline trenching begins, fish trapped in any water remaining in the work area between the dams would be removed and released using the methods in Pacific Connector's *Fish Salvage Plan*.[127] Pacific Connector would use seining[128] as the primary method to salvage fish but would also use electrofishing if all fish cannot be removed by seining. All methods of capture and holding have risks of stress, injury, or mortality of fish and fish inadvertently left in the construction crossing area may die.

Tribal governments have expressed concern that the currently proposed fish salvage methods would not adequately capture and protect lamprey, which is an important resource to tribal communities (see section 4.11). Adult Pacific lamprey are expected to be captured during the proposed salvaging; however, the currently proposed salvage methods (which were developed primarily for salmonids) may not be effective for salvaging lamprey ammocete larvae, which may remain in dewatered sediments. Electrofishing procedures to sample Pacific lamprey larvae have been recommended by the FWS (see Appendix A in FWS 2010a) and the Coquille Tribe has indicated that they can provide Pacific Connector with additional measures that would be effective at salvaging lamprey. Pacific Connector has indicated that it would contract with either the ODFW or a qualified consultant to salvage fish; however, because the salvage methods currently proposed may not be effective at collecting all lamprey life stages, **we recommend that:**

- **<u>Prior to construction</u>, Pacific Connector should file with the Secretary, for review and written approval by the Director of OEP, its final *Fish Salvage Plan*, that addresses methods suitable to collect and salvage all lamprey life stages, to the extent practical, together with documentation that the final *Fish Salvage Plan* was developed in consultations with interested Tribes, ODFW, FWS and NMFS. The revised *Fish Salvage Plan* should also incorporate the applicable measures of the Handling Guidelines for Klamath Basin Suckers.**

Because the flume would maintain streamflow, some fish may move upstream through the flume. With the dam-and-pump method, the fish would not be able to move upstream or downstream through the work area until the dams have been removed. Flumes and dams would be removed as soon as possible following backfilling of the trench. Based on information from average stream crossing times (Reid et al. 2004) estimated durations when complete or partial blockage may occur for fluming would range from 36 to 92 hours, and for dam-and-pump, the range is from 20 to 56 hours.

<u>Aquatic Nuisance Species</u>

Currently, there are 180 reported NAS in Oregon, of which 134 are documented in the USGS hydrologic basins crossed by the Pacific Connector pipeline (USGS 2005). Some of the major potential aquatic invasive species are mussels, including the zebra and quagga mussels (*Dreissena polymorpha*, and *Dreissena rostriformis bugenisis*), and New Zealand mud snail (*Potamopyrgus antipodarumis*) as well as Cyanobacteria (blue-green algae), and freshwater mold (Saprolegnia). Invasive species can have multiple adverse effects when introduced to their non-native

[127] See Appendix F.3 of RR3 , which was included in Pacific Connector's application to the FERC.
[128] A fine meshed net pulled through the water to capture fish.

environment. The most common effect is competition with native species for habitat and resources, often with the reduction or elimination of the native species. They also may cause effects on human uses of the water. For example, zebra mussels have been found to multiply to such vast numbers that they effectively block water intakes, such as drinking water supplies. Additionally, invasive species may crossbreed with native stocks of organisms indirectly causing the reduction of viable native pure species. Some invasives may directly kill other native species that have no natural defenses against them. Pacific Connector's *Hydrostatic Test Plan*[129] includes measures that would prevent the spread of invasive species from one water basin to another. These plans would also be used for equipment used between waterbodies.

The procedures are outlined in Attachment C to the *Hydrostatic Test Plan*. Additional supplemental invasive species protective actions for cleaning of equipment used among water bodies was developed by ODFW specifically for this project and have been incorporated by Pacific Connector in their *Hydrostatic Test Plan*. Some items in the *Hydrostatic Test Plan* that would aid in ensuring invasive aquatic species are not transported between streams, including preventing the spread of quagga and zebra mussels, New Zealand mudsnail, and aquatic plant invasion, are:

- Clean all aquatic plants, animals, and mud from vehicles, boats, motors or trailers and discarding the debris in the trash. Rinsing, scrubbing, or pressure washing should occur away from storm drains, ditches, or waterways.
- Drain live wells, bilge, and all internal compartments.
- Dry equipment including boats between uses, if possible (leaving compartments open and sponging out standing water).
- Scrub or pressure wash life jackets, waders, boats, landing nets, and other gear that comes in contact with the water.
- Clean and sanitize as needed which may include heated power wash before moving establishing sanitizing areas away from areas where it may enter surface water including use of bleach solution and run through portable pumps for 10 minutes
- Inspect everything for signs of aquatic invasive species before launching and before leaving.

Blasting

Blasting in stream channels can have adverse effects on fish, especially for fish with swim bladders. Explosives detonated near water produces shock waves that can be lethal to fish, eggs, and larvae by rupturing swim bladders and addling egg sacs (British Columbia Ministry of Transportation 2000). Explosives detonated underground produce two modes of seismic wave (Alaska Department of Fish and Game 1991). Shock waves propagated from ground to water are less lethal to fish than those in-water explosions since some energy is reflected or lost at the ground-water interface (Alaska Department of Fish and Game 1991). Peak overpressures as low as 7.2 pounds per square inch (psi) produced by blasting on a gravel/boulder beach caused 40 percent mortality in coho smolts and other studies revealed 50 percent mortality in smolts with peak overpressures ranging from 19.3 to 21.0 psi (Alaska Department of Fish and Game 1991).

The best way to reduce or eliminate effects on fish is to keep fish out of regions where pressure waves are harmful. The Alaska Department of Fish and Game (1991) reported that a pressure change

[129] See Appendix V.2 of Resource Report 3, which was included in Pacific Connector's application to the FERC.

of 2.7 psi is the level for which no fish mortality occurs and is from 1.7 to 4.5 psi below any level where mortality would be expected. Based on normal charges used in trenching (about 1 to 2 pounds at 8-millisecond delay) the zone of the above pressure wave would extend 34 to 49 feet, depending on substrate near the charge (Alaska Department of Fish and Game 1991). Typically, the dry area (where fish could not be) would be at least 25 feet wide during construction. If blasting were to occur with only a 25-foot-wide dry working space buffer between the blast and the stream, the potentially hazardous pressure wave (i.e., greater than 2.7 psi) would extend no more than an additional 25 feet. Likely, the effects would be felt over a much smaller distance as this distance estimate is based on a very conductive energy transfer substrate, which is unlikely to occur at most crossings. Pacific Connector developed a *Blasting Plan* that outlined measures to reduce effects on resources. Prior to any blasting, proper permits would be obtained and agencies notified as required by permits. Blasting may occur in uplands adjacent to streams or in dry streambeds, and Pacific Connector does not anticipate conducting any in-water blasting. Pacific Connector would attempt to minimize shock waves from blasting that may affect aquatic resources by the types of explosives selected, the size of charges, and the sequences of firing. Currently, about 37 crossings have known bedrock, some of which may require blasting (table 4.5.2.3-2). Fish would be removed from the crossing area, in accordance with Pacific Connector's *Fish Salvage Plan*. Where blasting would occur near a crossing, fish would be excluded an additional 25 feet upstream and downstream from the crossing area by use of barrier nets. In addition, bubble/air curtains may be used to disrupt shock waves, depending on input from state agencies during the state permitting process.

Hydrostatic Testing

After the pipeline is installed, Pacific Connector would fill it with water under pressure to test it (see section 2.4.2.1). Total water used for hydrostatic testing would be about 64 million gallons. Pacific Connector would obtain its hydrostatic test water from commercial or municipal sources or surface water rights owners to lakes, impoundments, and streams from possibly 17 different locations. About half of the water would be from impoundments or lakes, and the rest may come from up to nine streams, including Coos River, East and Middle Fork Coquille Rivers, Olalla Creek, South Umpqua River, Rogue River, Lost River, and Klamath River. Pacific Connector estimates it would withdraw just over 39 million gallons from 12 source locations within six construction spreads along the length of the pipeline route. Pacific Connector would obtain all necessary appropriations and withdrawal permits, including from the OWRD, prior to use. All the streams identified as potential test water sources include anadromous salmonids or resident trout. About 3,084 potential discharge locations for the test water have been identified. During the test, it may be necessary to discharge water at each of the sites; however, discharges would be minimized and water would be conserved as much as practical by cascading water between test sections when feasible (pumping from one segment to the next).

Potential effects on aquatic resources associated with hydrostatic testing include entrainment of organisms including fish, reduced downstream flows, erosion and scouring at release points, and the transfer of aquatic nuisance species through the test water from one water basin to another. Estimates of potential water intake amounts from streams indicate flows below intake would be reduced by less than 10 percent of instantaneous flow based on typical monthly flows (cfs) during the month of withdrawal for all but one potential locations, where it would about 35 percent during withdrawal (duration about 6 to 11 days at each potential location) (Ambrose 2018; table 4.5.2.3-6). Final selection of intake rates and sites would be reviewed by ODFW and OWRD prior to testing, so that potential effects on fish habitat from flow reductions would be unlikely. Pacific Connector has developed a *Hydrostatic Test Plan* to minimize effects from hydrostatic testing on resources. This plan is discussed in more detail in section 4.3.2.2 of this EIS.

TABLE 4.5.2.3-6

Hydrostatic Testing Water Requirements and Flow Impacts on Water Sources

Alignment Location	**Pump Rate (gpm)**	**Pump Rate (cfs)**	**Total Estimated Volume Needs (gallons)**	**Water Source Name**	**Water Source MP Inter-section (MP)**	**Water Source Basin Area (sq miles)**	**Reference Gage**	**Reference Gage Basin Area (sq. miles)**	**Estimated Time of Use (month)**	**50% Exceedance Flow for Reference Gage (cfs)**	**50% Exceedance Flow for Water Source (cfs)**	**Adjusted Flow Based on Hydrostatic Test Water Use (cfs)**	**Estimated Flow Reduction Duration (days)**	**% Flow Reduction**
Spread 1	300	0.67	2,800,000	Coos River a/	11.08	400	StreamStats	n/a	October	n/a	131	130.3	6.5	0.51%
Spread 1	300	0.67	2,800,000	EF Coquille River	29.64	101	StreamStats	n/a	October	n/a	27.4	26.7	6.5	2.44%
Spread 2	300	0.67	2,500,000	EF Coquille River a/	29.64	101	StreamStats	n/a	October	n/a	27.4	26.7	5.8	2.44%
Spread 2	300	0.67	2,500,000	MF Coquille River	50.28	17.5	StreamStats	n/a	October	n/a	1.91	1.2	5.8	35.06%
Spread 3	300	0.67	4,000,000	Olalla Creek	58.79	68	StreamStats	n/a	June/July	n/a	9.25	8.6	9.3	7.24%
Spread 3	300	0.67	4,000,000	S. Umpqua River	71.25	1410	StreamStats	n/a	June/July	n/a	642	641.3	9.3	0.10%
Spread 4	300	0.67	2,800,000	S. Umpqua River a/	71.25	1410	StreamStats	n/a	July/Aug	n/a	268	267.3	6.5	0.25%
Spread 4	300	0.67	2,800,000	S. Umpqua River	94.70	571	StreamStats	n/a	July/Aug	n/a	137	136.3	6.5	0.49%
Spread 5a	300	0.67	2,500,000	S. Umpqua River a/	94.70	571	StreamStats	n/a	Sept	n/a	87	86.3	5.8	0.77%
Spread 5b	300	0.67	2,800,000	Rogue River a/	122.80	1090	StreamStats	n/a	Sept	n/a	1330	1329.3	6.5	0.05%
Spread 7	300	0.67	4,800,000	Klamath River a/	199.20		USGS 11509500	3920	February	1175	1175	1174.3	11.1	0.06%
Spread 7	300	0.67	4,800,000	Lost River	212.00	1350	StreamStats	n/a	February	n/a	88	87.3	11.1	0.76%

a/ Primary Water Source; all others are a Secondary Water Source.

*Klamath River Flow Estimate Based on Mean of February Monthly Means (2000-2017) at USGS Gage 11509500

Source: Table 1 in Attachment F, Hydrostatic Test Water Withdrawal Hydrologic Assessment, to Pacific Connector's updated *Hydrostatic Test Plan* submitted to the FERC November 8, 2018.

To prevent the entrainment of most aquatic species, the pumps and intake hoses for hydrostatic test water removal would be screened, in accordance with NMFS screening criteria. To ensure water withdrawal does not cause downstream water level issues (ramping rate), Pacific Connector would submit their withdrawal plans to ODFW for review prior hydrostatic testing. To prevent the transfer of organisms from one water basin to another, Pacific Connector would try to return hydrostatic test water to its basin of origin. However, given the linear nature of the pipeline and the need to cascade test water from one section to another, such a return may not always be possible. Therefore, Pacific Connector would treat the test water after withdrawal (most likely with chlorine) to prevent the spread of invasive species and pathogens. To prevent erosion or scour at discharge locations, the hydrostatic test water would be discharged at low head into energy dissipating devices and dewatering structures in uplands at least 150 feet from streams. Volume and flow rates would be controlled to prevent overland flows directly to waterbodies. Specific hydrostatic discharge sites have been reviewed and approved by BLM and Forest Service on their lands to minimize runoff and avoid effects on beneficial uses.

The hydrostatic testing would remove water from several different waterbodies along the pipeline route. The NMFS has indicated that to insure fish and aquatic habitats are adequately protected during these withdrawals that no more than 10 percent of existing flow at the time of withdrawal be removed during hydrostatic testing. Therefore, **we recommend that**:

- **<u>Prior to construction</u>, Pacific Connector should file with the Secretary, for review and written approval by the Director of OEP, a revised *Hydrostatic Test Plan* that requires that any water withdrawal from a flowing stream does not exceed an instantaneous flow reduction of more than 10 percent of stream flow.**

<u>Hyporheic Exchange</u>

Mixing of shallow groundwater and surface water in streams is a form of hyporheic exchange and can affect important physical factors such as temperature, dissolved oxygen, and chemical composition of streams that may influence aquatic habitat. As discussed in section 4.3, an assessment was made of likely crossing areas that may affect this exchange rate (GeoEngineers 2017g) and actions taken to reduce potential effects of these crossings. Fifteen stream crossings were categorized as having a "high" sensitivity, which would suggest a high likelihood of a functioning hyporheic zone, mostly associated with larger waterbodies with greater floodplain widths and instream morphologic features. As discussed in section 4.3, however, there are several site-specific crossing construction plans and BMPs in place to help reduce the chance of there being functional effects on this exchange, such as returning natural material to trenched areas and installing trench plugs adjacent to wetlands and waterbodies, all of which would help return natural hyporheic exchange rates after construction is complete. It is anticipated that substantial alterations in these water exchanges would not occur and not affect aquatic habitat in streams crossed.

<u>Fuel and Chemical Spills</u>

For any large construction project, there is the potential for spills of fuel or other hazardous liquids from storage containers, equipment working in or near streams, and fuel transfers. Any spill of fuel or other hazardous liquid that reaches a waterbody would be detrimental to water quality. The chemicals released during spills could have acute, direct effects on fish, or could have indirect effects such as altered behavior, changes in physiological processes, or changes in food sources. Fish could also be killed if a large volume of hazardous liquid is spilled into a waterbody. Ingestion of large numbers of contaminated fish could affect primary and secondary fish predators in the food chain.

To minimize the potential for spills, Pacific Connector has developed an SPCC Plan. Pacific Connector's implementation of this SPCC Plan would minimize the potential for and the effect of any spill near surface waters. The SPCC Plan would be updated with site-specific information prior to construction. Specific measures in this plan include prohibiting liquid transfer, vehicle and equipment washing, and refueling within 100 feet of waterbodies and specific steps to be followed to control, contain, and clean up any spill that occurs. The SPCC Plan is further described in section 4.3.2.2. Pacific Connector's implementation of this SPCC Plan would minimize the potential for and the effect of any spill near surface water on aquatic resources.

Benthic and Sessile Organisms

Benthic and sessile organisms including benthic invertebrates and freshwater mussels would be affected by most of the same factors noted primarily for fish discussed above. This would include effects from elevated turbidity and suspended sediments, release of drilling muds, herbicide application, blasting, fuel and chemical spills, and habitat modification. Mayflies, caddisflies, and stoneflies prefer large substrate particles in riffles and are adversely affected by fine sediment deposited in interparticle spaces (Cordone and Kelley 1961; Waters 1995; Harrison et al. 2007). Fish and benthic macroinvertebrate abundance downstream of pipeline construction sites have been reported short-term reductions following construction-generated suspended sediment (Reid and Anderson 1999). Reid et al. (2008) summarized the results of nine wet open-cut pipeline stream crossing studies and noted all measured effects on downstream stream invertebrate population abundance or diversity (six of nine studies) were less than a year in duration with three studies having no measured effects on invertebrate abundance. Since the proposed action does not include wet open cuts, effects on benthic invertebrates would be limited. Risk of adverse effect on relatively sessile species, such as mollusks, could extend downstream from construction sites if degradation of water quality affects downstream habitats. However, because they are relatively immobile, the trenched crossing would have the greatest effect and would directly kill many at the trenching site because most would be unable to actively move from the area. In the case of many aquatic invertebrates, including insect larvae, these areas would be rapidly (weeks/months) recolonized from upstream drift and new egg deposition from adults. In some cases, for longer-lived organism, such as mussels, recolonization would take longer as they are immobile and most take years to grow to full size. The largest effect on most benthic and sessile organisms would be directly at the crossing location and the effect would be short term. In the case of mussels, local affects may be long term. However, the overall area affected for any given stream would be small so adverse effects on local populations would be slight.

Effects on Aquatic Habitat and Aquatic Species from Operation of the Pacific Connector Gas Pipeline Project

Once installed, maintenance of the pipeline would include activities such as aerial inspections, gas flow monitoring, and visual inspection of surrounding vegetation for signs of leaks, and integrity management, which includes smart pigging[130] to investigate the interior surface of the pipe for any signs of stress cracking, pitting, and other anomalies. All the maintenance activities would be outlined in the *Operations and Maintenance Plan* that would be prepared according to operating

[130] A pig is a remotely operated pipe inspection and cleaning tool.

regulations in USDOT 49 CFR Subpart L, Part 192 and would be completed prior to going in-service. The *Stream Crossing Risk Analysis Addendum* (GeoEngineers 2018a) outlines the measures that will be contained in the final stream crossing monitoring plan. These general maintenance activities would require only surface activities and usage of the existing right-of-way, such as insertion of the pig at one of the pig launching facilities.

Potential estuarine or stream channel disturbance would occur if an integrity issue with the pipeline occurred. If this happened, the pipeline would likely be unearthed (except non-trenched crossings like HDD, which may be rebored) within the right-of-way and repair work done in-water. Within stream sites, repair work could require isolated flow from the section of pipe that is to be exposed. Typically, repairs would be made to the pipe within the right-of-way (within the trench) or, depending on the site-specific conditions and nature of the repair needed, a reroute around the affected section may be considered. Effects would be similar to those discussed above for initial installation except on a much smaller scale, because they would only involve one crossing compared to many streams and, in the case of the estuary, likely just a portion of whole route would be disturbed not the whole 0.7- or 1.6-mile HDD sections, or possibly just rebored without having to disturb the estuary bottom. However, should repairs be needed out of the standard stream crossing window (i.e., during periods of fish spawning or egg incubation) there would be additional adverse effects on key fish resources at the specific site. The actions would include similar BMPs and mitigation. Any future repairs would require additional permit approval from appropriate state and federal agencies, which would determine the acceptable parameters of these actions. Such pipeline integrity-based in-water projects are very infrequent.

Vegetation maintenance would be limited adjacent to waterbodies to allow a riparian strip to permanently revegetate with native plant species across the entire right-of-way. To facilitate periodic pipeline corrosion/leak surveys, a corridor centered on the pipeline and up to 10 feet wide would be maintained in an herbaceous state. In addition, trees that are within 15 feet of the pipeline and have roots that could compromise the integrity of the pipeline coating would be selectively cut and removed from the permanent right-of-way.

Herbicide Application

Pacific Connector would not use herbicides for routine vegetation maintenance; however, Pacific Connector would implement an *Integrated Pest Management Plan*[131] that addresses control of noxious weeds. The plan was developed in consultation with the ODA, BLM, and the Forest Service. The plan would include the selective use of herbicides where necessary to control noxious weeds by limited application from the ground, where allowed by landowners. Pacific Connector would only use agency-approved herbicides authorized in current planning documents to control noxious weeds where infestations occur in the right-of-way after construction and during operation. Herbicides would not be applied by aerial or broadcast spraying. Noxious weeds would be removed only by manual methods in the riparian zones, which is defined as one site potential tree height, and within federal lands Riparian Reserves that are defined as being greater than 150 feet in most areas along the route, and greater than 100 feet in other areas.

Herbicides can have toxic or other adverse effects on fish and other aquatic organisms. In general, most effects on aquatic systems occur from direct spray of herbicides, and possibly drift when herbicides are sprayed, and leaching through soils and groundwater (Tu et al. 2001). Pacific

[131] Appendix N of Pacific Connector's POD.

Connector would not directly spray, or otherwise apply, herbicides in waterbodies or in riparian zones. The risk of drift would be avoided by selectively applying herbicides from the ground. The five types of potential herbicides that could be used have various levels of toxicity to aquatic organisms. However, the restriction to selective applications outside of riparian zones would greatly reduce the potential of adverse effects on fish by keeping herbicides outside of riparian zones and preventing herbicides from reaching streams.

4.5.2.4 Environmental Consequences on Federal Lands

The Pacific Connector Pipeline Project would have some effect on 41 waterbodies and associated riparian areas in the approximately 77 miles of federal lands that would be crossed by the pipeline. The effects on federal lands in designated land use categories (e.g., Riparian Reserve, ACS, Key Watersheds) from the proposed action are addressed fully in section 4.7 and appendix F, and effects on special status species are discussed in section 4.6 and the BE (appendix F). Watersheds crossed on federal lands and characteristics of those watersheds are discussed in section 4.7 and appendix F. Aquatic species present on federal lands would be similar to those discussed in section 4.5.2.3, except no marine and estuarine fish and shellfish are present in the waterbodies crossed on federal lands. Aquatic species found on federal lands would be mostly the same as those on non-federal lands with freshwater habitat. Commercial and recreational fisheries of importance in waterbodies crossed include primarily anadromous salmon and steelhead and resident trout. Specials status species present in some stream segments crossed include federally listed Oregon coastal coho salmon and Southern Oregon/Northern California coastal coho salmon ESU. EFH habitat is also present along the route for coho and Chinook salmon stocks. Other state and federal fish species of special status are discussed in section 4.6. Aquatic habitats that would be affected by the pipeline on federal lands are primarily coldwater and anadromous streams, with a few warmwater ponds adjacent to the construction areas. Much of the stream riparian areas crossed on BLM and NFS lands is heavily forested and shaded by coniferous trees in the Coast Range and mixed conifer-hardwood forest in the Klamath Mountains.

TABLE 4.5.2.4-1

Number of Streams Crossed by the Pacific Connector Pipeline Route on Federal Lands by Fish Status Category within Each Fifth-Field Watershed Coinciding with the Pacific Connector Project

Fifth Field Watershed (Fifth Field HUC)	Federal Land Agency	Perennial Streams	Intermittent Streams	Fish-bearing Streams with (a/): Anadromous Species (assumed) b/	Fish-bearing Streams with (a/): Resident Species (assumed) a/, b/	EFH Species and Habitat Present (assumed) a/	ESA Species or Habitat Present (assumed) a/
Coos County							
Coos Bay Frontal-Pacific Ocean	BLM Coos Bay Dist.	0	0	0	0	0	0
North Fork Coquille River (1710030504)	BLM Coos Bay Dist.	3	1	2	1(1)	2	2
East Fork Coquille River (1710030503)	BLM Coos Bay Dist.	0	2	0	0	0	0
Middle Fork Coquille River (1710030501)	BLM Coos Bay Dist.	1	6	(1)	(2)	(1)	(1)

TABLE 4.5.2.4-1 (continued)

Number of Streams Crossed by the Pacific Connector Pipeline Route on Federal Lands by Fish Status Category within Each Fifth-Field Watershed Coinciding with the Pacific Connector Project

Fifth Field Watershed (Fifth Field HUC)	Federal Land Agency	Perennial Streams	Intermittent Streams	Fish-bearing Streams with (a/): Anadromous Species (assumed) b/	Fish-bearing Streams with (a/): Resident Species (assumed) a/, b/	EFH Species and Habitat Present (assumed) a/	ESA Species or Habitat Present (assumed) a/
Middle Fork Coquille River (1710030501)	BLM Roseburg District	0	0	0	0	0	0
Douglas County							
Middle Fork Coquille River (1710030501)	BLM Roseburg Dist.	1	0	0	(1)	0	0
Days Creek-South Umpqua (1710030205)	BLM Coos Bay Dist.	0	0	0	0	0	0
Upper Cow Creek (1710030206)	Forest Service Umpqua NF	3	4	0	(3)	0	0
Jackson County							
Upper Cow Creek (1710030206)	Forest Service Umpqua NF	0	1	0	0	0	0
Trail Creek (1710030501)	Forest Service Umpqua NF	0	0	0	0	0	0
Trail Creek (1710030501)	BLM Medford Dist.	1	0	1	1	1	1
Shady Cove-Rogue River (1710030707)	BLM Medford Dist.	0	3	0	0	0	0
Big Butte Creek (1710030704)	BLM Medford Dist.	2	0	0	0	0	0
Little Butte Creek (1710030708)	BLM Medford Dist.	0	6	0	1	0	0
Little Butte Creek (1710030708)	Forest Service Rogue River NF	1	1	0	2	0	0
Klamath County							
Spencer Creek (1801020601)	Forest Service Winema NF	1	2	0	1	0	0
Spencer Creek (1801020601)	BLM Lakeview NF	0	2	0	(2)	0	0
TOTAL		**13**	**28**	**3(1)**	**6(9)**	**3(1)**	**3(1)**

a/ Known and assumed (value in parentheses) crossings by the pipeline with indicated fish category designation
b/ Trout
Note: Based on Pacific Connector's analysis, numbers may differ from federal agency analysis of streams, in some watersheds.

The general effects on aquatic resources, and mitigation for those effects, would be similar on federal lands to those discussed above in section 4.5.2.3 for the entire pipeline. Crossing techniques for most waterbodies would include dry-open cut methods. Thirteen perennial and 28 intermittent streams would be directly crossed by the pipeline construction on federal lands (table 4.5.2.4-1). Of these streams, 4 are known or assumed to contain anadromous fish, and 15 known or assumed to contain resident fish species. ESA species and EFH habitat for salmon may be present in up to 4 stream disturbance areas (table 4.5.2.4-1).

Riparian Reserve Areas

Riparian Reserve is a land use allocation specific to BLM and NFS lands. BLM and Forest Service management objectives include protection of aquatic resources and ESA-listed fish species in streams on both BLM RMP and Forest Service-managed lands. One difference between BLM and Forest Service management of these areas is the width of streamside riparian buffer. The details of these two plans are described in section 4.7 and appendix F. This allocation was developed in conjunction with the ACS (NFS) and Riparian Reserve that are incorporated into each of the BLM and Forest Service LMPs for management of areas associated with streams, lakes, and potentially unstable areas. The ACS was developed as part of the NWFP *Standards and Guidelines* to restore and maintain the ecological health of watersheds and aquatic ecosystems contained within NFS lands (Forest Service and BLM 1994b) for a variety of species. In 2016, the BLM signed a ROD that approved the Northwestern and Coastal Oregon RMP and the Southwestern Oregon RMP and adopted a similar strategy for riparian areas. The Forest Service system for managing primarily stream riparian areas includes components of the ACS are Riparian Reserves and Key Watersheds (see section 4.7 and appendix F). Riparian Reserves are intended to serve as corridors in the matrix and enable the Forest Service to manage these land allocations to maintain and restore riparian structures and functions of these unique and important features. The BLM also has Riparian Reserve under its current management plan. As described in section 4.7 and appendix F, Riparian Reserve has unique sets of guidance that are applicable wherever these occur, although these differ now between the two agency plans. The Forest Service ACS places an emphasis on efforts to maintain and restore aquatic and riparian habitat that is necessary to support anadromous salmonids. The nine objectives listed for the ACS include maintaining and restoring aquatic systems, floodplains, wetlands, upslope habitats, and riparian zones in general to support invertebrate and vertebrate species dependent on those habitats. The description of these nine objectives and how they would be maintained under the proposed actions is presented fully in section 4.7 and appendix F. The BLM's Riparian Reserve land use allocation has associated Management Direction and Management Objectives but does not include Key Watersheds.

The Pacific Connector pipeline would cross Riparian Reserve areas of both NFS and BLM lands along the route. Project effects on Riparian Reserve resulting from all construction activities (e.g., pipeline right-of-way, TEWAs, permanent and temporary access roads) are discussed in section 4.7 and appendix F.

Key Watersheds on NFS Lands

Key watersheds on NFS land, as designated by the NWFP (Forest Service and BLM 1994a), provide high water quality and are crucial to at-risk fish species and stocks. They are the highest priority for watershed restoration. Tier 1 Key Watersheds consist primarily of watersheds directly contributing to anadromous salmonid, bull trout, and resident fish species conservation. Tier 2 watersheds do not necessarily contain at-risk fish stocks but are important sources of high quality water (Forest Service and BLM 1994a). The Key Watersheds include three Tier 1 (Days Creek – South Umpqua River [formerly named South Umpqua River], North and South Forks Little Butte, Spencer Creek) and one Tier 2 (Clover Creek) watershed. Potential effects on these Key Watersheds and actions that would be taken by the Project to ensure Key Watershed functions are maintained are discussed in section 4.7 and appendix F.

Measures That Would Mitigate Effects on Aquatic Resources on Federal Lands

Pacific Connector would develop project design, construction, and operation measures to avoid or minimize effects on aquatic resources to the extent practicable. To compensate for unavoidable effects along streams from loss of upslope and riparian vegetation and LWD input that do not meet the objectives of the ACS, Pacific Connector has developed a *Large Woody Debris Plan* and supplemental riparian plantings efforts to help maintain the functions of the system after construction. Actions that would be taken on NFS lands to help meet ACS objectives on those lands are included in chapter 2. No similar actions have been developed in BLM plans. These additional actions and mitigation measures agreed to for NFS lands are summarized in table 2.1.5-1. The effects of implementation of these measures on meeting the ACS and Riparian Reserve management objectives and management direction are discussed in section 4.7 and appendix F.

To ensure that the Pacific Connector Pipeline Project is consistent with the objectives of the ACS on NFS lands, which would in turn aid fish populations on federal land, Pacific Connector would develop a variety of enhancements (at the direction of the Forest Service): (1) donate LWD to agencies/conservation groups to perform in-stream restoration projects; and/or (2) relocate large boulders greater than 24 inches in diameter for use as fish habitat structures. As part of Project development, the BLM and Forest Service have also developed site-specific stream crossing plans for perennial streams on their lands that include specific riparian plantings and other actions to aid at maintaining stream and riparian functions. To mitigate for Project actions that, even with site-specific actions, may impede maintaining ACS and Riparian Reserve management objectives and direction on each watershed (e.g., pipeline crossing LWD placement and riparian vegetation plantings), Pacific Connector would fund the following types of projects that would be implemented on Forest Service areas not directly affected by Project activity:

- add LWD to several miles of streams outside of the area that would be affected by the Project;
- restore degraded riparian habitats through off-site revegetation projects;
- conduct off-site fish passage projects at road crossings;
- improve stream road crossings and replace or stabilize culverts that may contribute sediment from fill failure to streams;
- conduct pre-commercial thinning projects where feasible to improve riparian habitats;
- install fences in allotments to improve riparian habitats;
- decommission roads and waterbody features (e.g., culverts, crossings, bridges) identified by the Forest Service that are no longer needed for resource management to provide numerous benefits including lower road density, minimization of channel extensions, minimization of sedimentation, improvement of fish passage through culvert removal, and reduction of riparian habitat fragmentation;
- close roads that are not in use, which would reduce sediment runoff to streams; and
- stormproof roads (such as adding water bars, ditch cleaning, culvert bypass) to also reduce fine sediment to streams and reduce the risk of road blow out, which could contribute heavy sediment loads to streams.

The list of mitigation measures noted above is not all that would be in place on NFS lands (see table 2.1.5-1) but identifies some of the major efforts that would be undertaken to reduce and mitigate impacts from the proposed action on aquatic resources. Following Project construction, habitat and ecosystem function would be restored in place as much as possible. However, although mitigation actions would restore habitat and have long-term benefits to wetlands, estuarine ecosystems, and habitat for salmonids in general, there would be effects on some non-target species. The goal of additional mitigation would be to restore habitat with similar ecological function for the remaining effects on aquatic resources to ensure project actions meet the ACS and RMS objectives and direction at multiple scales. These actions would reduce effects on fish resources on Forest Service federal lands by reducing factors known to be harmful or limiting to fish species including elevated suspended sediment and sediment in the stream channel, which affects fish production and survival; loss of LWD in streams, which reduces habitat quality; loss of future riparian LWD and other vegetation supplying input of organic matter; and loss or restriction of fish movement (passage) in streams. Specific sites and actions for the mitigation measures were identified through meetings with the Forest Service. These are provided in the *Mitigation Plan for Federal Lands* included in appendix F of this EIS. The details of these mitigation actions and how they relate to ensuring the ACS and RMS is being met is discussed in section 4.7 and appendix F.

4.5.2.5 Conclusion

Constructing and operating the Project would have both short-term effects on fish and invertebrate individuals as well as short- and long-term effects on aquatic habitat. Individual fish and shellfish as well as their food sources would be directly lost as a result of Project construction, the initial and maintenance dredging, decreased water quality, and entrainment from vessel water intake. Habitat modifications would also reduce local important habitat areas including rearing, spawning, and cover areas (e.g., aquatic vegetation, eelgrass). Short-term effects from the pipeline would also include direct local reduction in food sources primarily from bottom disturbance resulting from stream crossings and short-term elevated turbidity; elevated turbidity would also cause short-term sublethal stress to fish and invertebrate stream organisms and movement blockages over limited specific stream locations and time, while limited reduction of riparian vegetation and trees would have limited short- and long-term reduction in stream habitat components. However, the distribution of adverse effects would be limited to areas near the Project (e.g., at the LNG facilities and near and downstream of pipeline stream crossings), and BMPs and impact avoidance measures implemented during construction as well as mitigative actions implemented following construction would limit long-term adverse effects. As a result, we conclude that the Project would not significantly affect fish and aquatic invertebrates.

4.6 THREATENED, ENDANGERED, AND OTHER SPECIAL STATUS SPECIES

This section analyzes the effects of the Project on special status species. In addition to species listed as threatened or endangered under the federal ESA[133] and Oregon ESA[134], agencies and organizations such as the FWS, BLM, Forest Service, ODA, and ODFW maintain lists of species that are considered special concern, sensitive, rare, or are otherwise offered protections under agency planning documents. These species are broadly defined in this assessment as "special status species."[135] Although the term "special status species" is used differently by various agencies, for the purposes of this assessment, the term "special status species" includes:

- species that are listed or proposed for listing by the federal government as endangered or threatened, or are candidates for listing;
- species that are identified by the BLM or Forest Service as "sensitive species" or "strategic species";
- species listed by the State of Oregon as endangered, threatened, or are candidates for listing; and
- species identified by federal or state agencies as rare or protected by federal or state planning documents (e.g., Standards and Guidelines in resource management plans such as "Survey and Manage" species identified in the NWFP).

Using data from the Oregon Biodiversity Information Center (ORBIC),[136] FWS, NMFS, discussions with Forest Service and BLM specialists, and information reviews of published and unpublished information, the applicants prepared lists of threatened, endangered, proposed,

[133] Federal agencies are required by Section 7 of the ESA (Title 19 U.S.C. Part 1536[c]), as amended (1978, 1979, and 1982), to ensure that any actions authorized, funded, or carried out by the agency do not jeopardize the continued existence of a federally listed endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat of a federally listed species. The action agency (e.g., the FERC) is required to consult with the FWS and/or the NMFS to determine whether federally listed endangered or threatened species or designated critical habitat are found in the vicinity of the Project, and to determine the proposed action's potential effects on those species or critical habitats. For actions involving major construction activities with the potential to affect listed species or designated critical habitat, the federal agency must submit its BA to the FWS and/or NMFS and, if it is determined that the action may adversely affect a listed species, the federal agency must submit a request for formal consultation to comply with Section 7 of the ESA. In response, the FWS and/or NMFS would issue a BO as to whether or not the federal action would likely jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Jordan Cove and Pacific Connector filed an applicant-prepared draft BA (APDBA) in December 2017, and a revised APDBA in September 2018. We are reviewing the revised APDBA and will prepare a BA and EFH Assessment, which will be submitted to the FWS and NMFS.

[134] Oregon has its own ESA that requires state agencies to protect and promote the recovery of state-listed threatened and endangered species. At the state level, consultation is conducted with the ODA for state listed plant species and the ODFW for fish and wildlife species. However, state regulations pertaining to the protection of botanical resources are limited to ORS 564 and OAR Chapter 603, Division 73. Oregon regulations regarding state endangered and threatened plants only apply on non-federal public lands (e.g., state, county, city, etc. lands).

[135] The term "special status species" is also used by the BLM, but in a narrower agency-specific definition than in this assessment. BLM "special status species" include species listed as threatened or endangered under the ESA, species that are proposed for listing under the ESA, species that are candidates for listing under the ESA, and species designated by the BLM as "sensitive" under criteria in BLM Manual 6840. The Forest Service uses similar designations. For the Forest Service, "Survey and Manage" are managed under specific criteria provided in the Northwest Forest Plan rather than the agency "special status species" programs. Several species are designated as both "special status species" for the Forest Service and "Survey and Manage species." Those species are noted in the assessment and are analyzed here under criteria for both programs.

[136] Formerly known as the Oregon Natural Heritage Information Center (ORNHIC).

candidate, and special status species that potentially occur near the proposed Project, as described in the following sections. Species that were initially considered but were dropped from further consideration due to a lack of habitat or because they were not detected during targeted field surveys are listed in tables I-3, I-4, and I-5 in appendix I.

4.6.1 Federally Listed Threatened and Endangered Species

Table 4.6.1-1 lists the federally endangered, threatened, and proposed species that potentially occur in the Project area and are discussed below. Additional species (beyond those listed in table 4.6.1-1) are federally listed in Oregon (i.e., the Canada lynx, bull trout Klamath River DPS, yellow-billed cuckoo Western DPS, streaked horned lark, and slender Orcutt grass); however, these species are not known or expected to occur within the Project area and are not discussed further in this document (Canada lynx: Verts and Carraway 1998, McKelvey et al. 2000, ORBIC 2006b; bull trout Klamath River DPS: FWS 1998a, 2002a, ORBIC 2006b; yellow-billed cuckoo: FWS 2013b; streaked horned lark: FWS 2017b; SBS 2008a, 2012, 2013, 2014, 2017a; and slender Orcutt grass: ORBIC 2017b, FWS 2006b). In addition, the North American wolverine occurs in Oregon and has been proposed for listing as threatened under ESA; wolverines have been occasionally documented in Oregon, most recently in the Wallowa-Whitman National Forest in Northeast Oregon during 2011-2012 (Magoun et al. 2013), but no evidence for a reproducing, self-sustaining population has been found in the state. There appears to be an extremely remote chance of a wolverine dispersing into southwest Oregon, but that is not foreseeable during the construction of the proposed action, and as a result, the North American wolverine is not discussed further in this document. The Eastern DPS of the Steller sea lion, which occurs on the west coast of the U.S. and within the Project area, was delisted on December 4, 2013 (78 FR 66139), and thus is not discussed in this section.

Table 4.6.1-1 lists all potentially affected federally listed and proposed species, indicates the portion of the Project area where they may occur, and provides our preliminary determination of effect.

TABLE 4.6.1-1

Federally Listed and Proposed Species Potentially Occurring in the Project Area

Species	Federal Status	State Status	Portion of the Project Area Where Species May Occur	Effect of Proposed Project on Species, Critical Habitat a/
Mammals				
gray wolf *Canis lupus*	Endangered	Delisted	Pacific Connector pipeline	NLAA
Pacific fisbher (West Coast DPS b/) *Pekania pennanti*	Proposed Threatened	Sensitive	Pacific Connector pipeline	NJ/LAA c/
Pacific marten (Coastal DPS b/) *Martes caurina*	Proposed Threatened	Sensitive	Jordan Cove terminal, navigation reliability improvements dredge area	NJ/NLAA c/
lue whale *Balaenoptera musculus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
fin whale *Balaenoptera physalus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
killer whale –Eastern North Pacific Southern Resident stock *Orcinus orca*	Endangered – Critical Habitat	No listing	LNG carrier transit in the waterway	NLAA, NE
humpback whale *Megaptera novaeangliae*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
Sei whale *Balaenoptera borealis*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA

TABLE 4.6.1-1 (continued)

Federally Listed and Proposed Species Potentially Occurring in the Project Area

Species	Federal Status	State Status	Portion of the Project Area Where Species May Occur	Effect of Proposed Project on Species, Critical Habitat a/
sperm whale *Physeter macrocephalus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
North Pacific right whale *Eubalaena glacialis*	Endangered – Critical Habitat	Endangered	LNG carrier transit in the waterway	NLAA, NE
gray whale (Western North Pacific Stock) *Eschrichtius robustus*	Endangered	No listing	LNG carrier transit in the waterway, navigation reliability improvements dredge area	NLAA
Birds				
short-tailed albatross *Phoebastria albatraus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
Western snowy plover *Charadrius alexandrinus nivosus*	Threatened – Critical Habitat	Threatened	Jordan Cove terminal, navigation reliability improvements dredge area	NLAA, NLAA
marbled murrelet *Brachyrampus marmoratus*	Threatened – Critical Habitat	Threatened	LNG carrier transit in the waterway Jordan Cove terminal, navigation reliability improvements dredge area Pacific Connector pipeline	LAA, LAA
Northern spotted owl *Strix occidentalis caurina*	Threatened – Critical Habitat	Threatened	Jordan Cove terminal Pacific Connector pipeline	LAA, LAA
Fishes				
North American green sturgeon (Southern DPS) *Acipenser medirostris*	Threatened – Critical Habitat	Sensitive Critical	LNG carrier transit in the waterway Jordan Cove terminal	LAA, LAA
Coho salmon (South OR/North CA Coast ESU) *Oncorhynchus kisutch*	Threatened – Critical Habitat	Sensitive	LNG carrier transit in the waterway Pacific Connector pipeline	LAA, LAA
Eulachon (Southern DPS) *Thaleichthys pacificus*	Threatened– Critical Habitat	No listing	LNG carrier transit in the waterway Jordan Cove terminal Pacific Connector pipeline	LAA, NE
Coho salmon (Oregon Coast ESU) *Oncorhynchus kisutch*	Threatened – Critical Habitat	Sensitive	LNG carrier transit in the waterway Jordan Cove terminal Pacific Connector pipeline	LAA, LAA
Lost River sucker *Deltistes luxatus*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	LAA, NLAA
shortnose sucker *Chasmistes brevirostris*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	LAA, NLAA
Amphibians and Reptiles				
green turtle *Chelonia mydas*	Threatened – Critical Habitat	Endangered	LNG carrier transit in the waterway	NLAA, NE
leatherback turtle *Dermochelys coriacea*	Endangered – Critical Habitat	Endangered	LNG carrier transit in the waterway	NLAA, NLAA
Olive Ridley turtle *Lepidochelys olivacea*	Threatened	Threatened	LNG carrier transit in the waterway	NLAA
loggerhead turtle *Caretta caretta*	Endangered	Threatened	LNG carrier transit in the waterway	NLAA
Oregon spotted frog *Rana pretiosa*	Threatened –Critical Habitat	Sensitive Critical	Pacific Connector pipeline	NLAA, NLAA
Invertebrates				
vernal pool fairy shrimp *Branchinecta lynchi*	Threatened – Critical Habitat	No listing	Pacific Connector pipeline	LAA, NLAA

TABLE 4.6.1-1 (continued)

Federally Listed and Proposed Species Potentially Occurring in the Project Area

Species	Federal Status	State Status	Portion of the Project Area Where Species May Occur	Effect of Proposed Project on Species, Critical Habitat a/
Plants				
Applegate's milk-vetch *Astragalus applegatei*	Endangered	Endangered	Pacific Connector pipeline	LAA
Gentner's fritillary *Fritillaria gentneri*	Endangered	Endangered	Pacific Connector pipeline	LAA
Western lily *Lillium occidentale*	Endangered	Endangered	Jordan Cove terminal Pacific Connector pipeline	NLAA
large-flowered woolly meadowfoam *Limnanthes pumila* ssp. *grandiflora*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	NLAA, NLAA
Cook's lomatium *Lomatium cookii*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	NLAA, NE
Kincaid's lupine *Lupinus suphureus* var. *kincaidii*	Threatened –Critical Habitat	Threatened	Pacific Connector pipeline	LAA, NE
rough popcornflower *Plagiobothrys hirtus*	Endangered	Endangered	Pacific Connector pipeline	NLAA

a/ Effects Key:
NLAA = Not likely to adversely affect, LAA = Likely to adversely affect, NE = No effect, NJ = not likely to jeopardize the continued existence for proposed species
b/ DPS=Distinct Population Segment
c/ This represents a provisional effect determination for this ESA proposed species. This provisional effect determination would apply if the species becomes listed prior to the completion of consultaion on the Project.

4.6.1.1 Mammals

Gray Wolf (Federal Endangered Species, State Delisted)

The federal ESA in Oregon protects gray wolves west of highways 395-78-95 (ODFW 2017e). Gray wolves were delisted from the Oregon ESA in 2015 (ODFW 2017f). Wolves are habitat generalists that only require the presence of ungulate prey and absence of excessive human-caused mortality (FWS 2013c). Wolf pack territory size is a function of prey density and can range from 25 to 1,500 square miles (FWS 2013c). Both male and female wolves disperse, sometimes greater than 600 miles (FWS 2013c).

A radio-collared male (i.e., OR7) dispersing from a pack in northeastern Oregon has been documented in southwestern Oregon and northern California since 2011, including near the Project in Jackson, Douglas, and Klamath Counties (ODFW 2013b). In 2014, a female joined the male, and they produced their first litter that year consisting of three pups (ODFW 2014e). This was the first evidence of wolves breeding in the Oregon Cascades since the early twentieth century (ODFW 2014d). The den was located within the Rogue River National Forest, between Crater Lake and Mount McLoughlin (Young 2014), approximately 6 miles from the pipeline route. Additional pups were born in 2015, 2016, and 2017 (ODFW 2018b). The Area of Known Wolf Activity (AKWA) initially mapped by ODFW for OR7 in 2014 (ODFW 2014c) is crossed by the pipeline route. The AKWA for OR7 and the Rogue Pack has shifted in size and shape since 2014. As currently mapped, it is less than 5 miles from the pipeline route in Jackson and Klamath Counties.

A second AKWA (Keno) was established in southwest Oregon in 2014 with limited evidence that three wolves inhabited an area approximately 280 square miles. ODFW recently removed the AKWA designation for the Keno wolves and is designating it as no longer active, but possibly used as a corridor for wolves moving between Oregon and California (ODFW 2018b). Approximately 2.48 miles of the pipeline route would pass through this area.

Three other radio-collared wolves dispersed from northeastern Oregon to southwest Oregon. One single male wolf (OR25) dispersed in 2015 and established an AKWA spanning northern Klamath County with portions in adjacent Jackson County and Lake County. A radio-collared female wolf (OR28) dispersed in late 2015 and was joined by a collared male (OR3) to establish the Silver Lake AKWA which coincides with the Silver Lake Wildlife Management Unit in western Lake County. The pair produced one pup in 2016 but the male was killed in 2016 (ODFW 2017g).

Given the occurrence of gray wolves in the areas affected by the Project, potential direct and indirect effects from construction and operation of the pipeline include the following:

- Construction-related noise. Construction would produce noise. Wolves appear most vulnerable to human disturbance in and around denning and rendezvous sites. No active denning sites are known within 1 mile of the pipeline.
- Locally concentrated human activities. Available evidence has shown that wolves subjected to increased vehicular traffic will avoid roads and will move pups if disturbed during denning. Wolves disturbed during winter indicated a physiological stress response to snowmobile stimuli.
- Increased risk of collision with construction vehicles along Project area roadways. Vehicles have killed a small number of wolves; overall, 80 percent of all wolf mortalities in the Northern Rocky Mountain population (which includes wolves in the Project area) are caused by humans but only 3 percent are due to accidental human interactions including vehicle collisions and capture mortality (FWS 2012a).
- Wildland fire as an indirect effect associated with increased human presence. The possibility of ignition in conifer and sagebrush/grass fuel types could range from low to extreme depending on weather conditions and patterns, current fire risk rating, moisture conditions, and fuel loadings. There is some possibility of human-caused fire, whether related to pipeline activities or to Project-induced increase of human presence in the area.
- Habitat alteration. Construction would remove forested habitat that might be used by some species that are preyed upon by wolves. However, corridors created within forested habitats are used for movement and foraging by big game species, which are prey for wolves.

Below is a determination of effects summary for this species and critical habitat. More details will be provided in the pending BA.

The Project **may affect** the gray wolf because:

- dispersing and resident wolves have been documented recently near the Project area;
- the OR7 wolf family den was near the pipeline route in 2014;
- construction noise could disturb wolves if present near the pipeline; and
- increased human presence associated with construction activities could affect wolf behavior and movements, including the chance of collisions with vehicles.

However, the Project is **not likely to adversely affect** the gray wolf because:

- the OR-7 den within the Rogue River National Forest is at least 6 miles from the pipeline;
- Project-related noises are not likely to be substantially different from noises produced by existing recreation and logging activities that wolves have been shown to tolerate;
- during pipeline construction, trash would be removed daily, and roadside carrion is expected to be present as an existing condition, and not substantially increased by the Project; and
- following construction, the restored and revegetated pipeline corridor is likely to increase habitat diversity and forage used by ungulates such as deer (Brusnyk and Westworth 1985; Forman 1995), which are prey for gray wolves.

No critical habitat has been designated or proposed for the gray wolf.

Pacific Marten-Coastal DPS (Federal Proposed Threatened Species, State Sensitive Species)

On October 9, 2018, the FWS proposed to list the coastal DPS of Pacific marten *(Martes caurina)* as a threatened species under the ESA (83 FR 150576). Should the rule for this species be finalized as proposed, it would be protected under ESA. The most current information for this species is provided in an updated species status assessment report, and provides a comprehensive account of the species, its life history needs, and stressors to the overall viability and extinction risk for the coastal marten (FWS 2018a). The coastal marten is a mammal in the weasel family and is native to forests of coastal Oregon and coastal California. They occur primarily in older forests, although there is one remnant population occupying the coastal dune forest of central Oregon. Coastal marten historically ranged throughout coastal Oregon and coastal northern California but have not recently been detected throughout much of the historical range, despite extensive surveys. The species exists in four small populations and is absent from the northern and southern ends of its historical range. In Oregon, there are two identified isolated small extent population areas: Central Coastal and Southern Coastal. The Jordan Cove LNG Project falls within the southern portion of the Central Coastal population area and the Pacific Connector pipeline crosses its historical range.

The Central Coastal Oregon population centers on the coastal forest of the Oregon Dunes National Recreation Area (ODNRA) and is managed by the Siuslaw National Forest. Most of this area comprises coastal forest that is less than 70 years old, and consists of shore pine and transitional shore pine/Douglas–fir–hemlock forests within the ODNRA. These forests grow on nutrient-poor sandy soils, dominated by young stands of shore pine and Sitka spruce. The dense understory is dominated by willow (*Salix hookeri*), Pacific waxmyrtle (*Myrica californica*), and berry-producing ericaceous shrubs such as evergreen huckleberry (*Vaccinium ovatum*) and salal (G*aultheria shallon*). These shore pine forests have a variable tree overstory; however, the common denominator with this habitat and older forest habitats is the presence of dense, spatially extensive ericaceous shrub understories and diverse and abundant prey. Coastal martens have a generalist diet that changes seasonally with prey availability. Overall, their diet is dominated by mammals (primarily voles in Central Coastal population area), but birds, insects, and fruits are seasonally important.

Reports by Zielinski et al. (2001) and Moriarty et al. (2016) noted a relatively high incidence of road kills in the last 30 years (i.e., 17) and it was assumed that animals were abundant. Linnell et al. (2018) used recent surveys to refine the extent of the Central Coastal population size of fewer than 87 adults divided into two subpopulations; however, there is no information at this time on long–term trends in population size. The 2018 species status assessment further divides this population into two subpopulations of approximately 30 adults each, separated by the Umpqua River, a relatively large barrier to movement and dispersal. Martens in this population occur in the highest densities reported for any North American marten subspecies (1.13 per square kilometer; Linnell et al. 2018). The Southern Coastal population area in Oregon is located over 40 miles to the south and would not be affected by the Project.

The 2018 species status assessment identifies various factors (stressors) that are directly and indirectly affecting what the coastal marten needs for long-term viability. These include loss of habitat due to wildfire, timber harvest, and vegetation management. Trapping, collisions with vehicles, and rodenticides are all impacting marten individuals, and the threat of disease carries the risk of further reducing populations. Changes in vegetation composition and distribution have also made coastal martens more susceptible to predation from larger carnivores. These threats are expected to be exacerbated by the species' small and isolated populations. Linnell et al. (2018) suggest that small population size, consistent annual human-caused mortality (primarily trapping and road kills), and isolation indicate this coastal marten population is likely to remain vulnerable to extirpation.

Section 4.4 describes five forested and two woodland vegetation types that may be suitable habitat for marten and would be affected by the construction and operation of the Jordan Cove LNG Project. The vegetation types are shown on figures 4.4-1a and 4.4-1b. Table 4.4.1.5-1 estimates that approximately 76 acres and 62 acres of forested and woodland vegetation would be cleared for the LNG facilities and temporary construction areas, respectively.

Given that the Project falls within the southern portion of the Central Coastal population area and the occurrence of marten habitat within the area of the proposed Project footprint, potential direct and indirect effects from construction and operation of the Project include the following:

- <u>Construction-related noise.</u> Construction would produce noise; and martens appear most vulnerable to human disturbance in and around denning and resting habitat. No active denning sites are currently known in the vicinity of the Project site.
- <u>Locally concentrated human activities.</u> Available evidence has shown that martens are subject to road kills and increased vehicular traffic has the potential to increased vehicle collision mortality.
- <u>Habitat alteration</u>. Construction would remove forested habitat that might be used by martens or species that are preyed upon by martens, or otherwise increase fragmentation within suitable habitat. However, much of the forested portions within the Jordan Cove Project boundaries are already in a disturbed state.
- <u>Wildland fire as an indirect effect associated with increased human presence</u>. The possibility of ignition in conifer and sagebrush/grass fuel types could range from low to extreme depending on weather conditions and patterns, current fire risk rating, moisture conditions, and fuel loadings. There is some possibility of human-caused fire, whether related to construction activities or to Project-induced increase of human presence in the area.

Below is a determination of effects summary for Pacific marten- coastal DPS. At this time, no critical habitat has been proposed or designated for this species. More details will be provided should this species become listed as threatened under ESA, including potential exceptions and/or any designation of critical habitat.

The Project **will not jeopardize the continued existence** of the Pacific marten- coastal DPS; however, in the event that Pacific marten- coastal DPS becomes listed prior to completion of the Project, a provisional effect determination is provided.

The Project **may affect** the Pacific marten- coastal DPS because:

- marten historically used the entire Oregon coastal region;
- the southern portion of the Central Coast population area overlaps with the Jordan Cove LNG Project;
- the Project would remove suitable habitat for the coastal DPS population; and
- increased human presence associated with construction activities could affect marten behavior and movements, including the chance of collisions with vehicles.

However, the Project is **not likely to adversely affect** Pacific marten-coastal DPS because:

- there is a relatively low potential for the coastal DPS individuals to occur based on historical accounts and the current low estimated number of individuals south of the Umpqua River;
- project-related noises are not likely to be substantially different from noises produced by existing recreation and logging activities that martens have been shown to tolerate;
- during Project construction, trash would be removed daily to reduce the potential for predator species; and
- construction-related vehicles and equipment would operate at slower speeds, and therefore not substantially increase the potential for vehicle collisions.

Pacific Fisher-West Coast DPS (Federal Proposed Threatened Species, State Sensitive-Critical Species)

The FWS proposed to list the West Coast DPS of the Pacific fisher as threatened under the ESA on October 7, 2014 (79 FR 60419). In April 2016, the FWS determined that the fisher does not warrant listing under the ESA (81 FR 22710). However, on September 21, 2018, the decision to deny the fisher protected status was rescinded and the comment period for the proposed rule to list the West Coast DPS of the fisher was reopened (84 FR 644). The FWS is scheduled to issue a new finding by March 22, 2019.

Fishers occur in the northern coniferous and mixed forests of Canada and the northern United States (69 FR 18770). The West Coast DPS includes fishers in Washington, Oregon, and California. In Oregon, this species is currently known to occur in Curry, Douglas, Jackson, Josephine, and Klamath Counties (Aubry and Lewis 2003; Aubry pers. comm. 2007 as cited in FWS 2014b). Currently, there are two documented populations of fisher in southern Oregon, one in the northern Siskiyou Mountains and one in the southern Cascade Range, that were believed to be genetically isolated from each other (FWS 2014b). However, recent research shows that the two populations are not genetically isolated (Barry et al. 2018).

Fisher habitat consists of mature, closed canopy coniferous and mixed conifer and hardwood forests at low to middle elevations, including riparian corridors with continuous canopies, and large stands with low levels of fragmentation and a high percentage of dead and downed timber (ODFW 2019; FWS 2016a). Fishers prefer large tracts of contiguous interior forest and typically avoid thinned or open forests, including areas where there is substancial human disturbance. A variety of large conifer tree species are used for denning and resting, including Douglas-fir, white fir, incense cedar, red fir, sugar pine, western white pine, ponderosa pine and lodgepole pine (Aubry and Raley 2006; Cummins et al. 2018). In the southern Oregon Cascades, average home range sizes for females were approximately 9.7 square miles and between 24 square miles for males during the non-breeding season and 57 square miles for males during the breeding season, based on locations of radio telemetered study animals (Aubry and Raley 2006).

Loss and fragmentation of habitat due to timber harvest and thinning, roads, urban development, recreation, and wildfire are the main reasons for the decline of the fisher in the west (FWS 2018b). Habitat loss, modification, and fragmentation continue to occur as a result of forest management practices and stand replacing wildfire, and appear to pose a substantial threat to fishers (FWS 2012b). In addition to removing forage, rest, and den sites, fragmentation can increase predation risk, impede movements, and affect prey species composition, abundance, and availability (FWS 2012b). Fragmentation can also increase energetic costs to fishers, which may result in nutritional stress that can reduce animal condition, ultimately affecting survival, reproduction, and recruitment (Lofroth et al. 2010). Additionally, linear infrastructure such as roads, power lines, and pipelines can also affect fisher populations and their habitat (FWS 2016a). As well as being sources of mortality from vehicle collision, these linear infrastructure features can result in permanent removal or alteration of potential fisher habitat and can disrupt movement patterns (FWS 2016a). However, linear infrastructure is considered to be a low-level impact to fishers currently and in the future (FWS 2016a).

Recent telemetry studies in the southern Oregon Cascades identified fisher home ranges that overlap with the Project on the Winema National Forest (Cummins 2018). Location databases show one observation within 1 mile and one observation within 1 to 3 miles of the Project on the Winema National Forest. These observations, together with the availability of suitable habitat within the pipeline ROW, indicate that there is potential for fishers to be present within the analysis area.

Section 4.5 discusses the various wildlife habitat types (from Johnson and O'Neil 2001) crossed by the Project. Late successional and old-growth forest within five forest and woodland habitat types crossed by the pipeline may provide habitat for the fisher. These habitat types include Westside Lowland Conifer-Hardwood Forest, Montane Mixed Conifer Forest, Southwest Oregon Mixed Conifer-Hardwood Forest, Westside Riparian-Wetlands, and Eastside Riparian-Wetlands. Table 4.5.1.2-5 estimates that approximately 657.9 acres of these habitat types would be cleared for the construction of the pipeline.

Given the potential for occurrence of fishers in the areas affected by the Project, potential direct and indirect effects from construction and operation of the pipeline include the following:

- Construction-related noise. Construction would produce noise. Fishers are vulnerable to human disturbance and fishers have been documented within 1 mile of the pipeline.

- Locally concentrated human activities. Construction activities could affect fishers by disturbing animals. Fishers are sensitive to disturbance and avoid areas used by humans (CBD 2000).
- Increased risk of collision with construction vehicles along Project area roadways. Human-caused mortality from vehicle collisions are listed as one of the threats to fisher populations (FWS 2018b).
- Habitat alteration and fragmentation. Construction would remove forested habitat and would modify habitat, particularly by removing large trees, snags, and large woody debris that are used for fisher den and rest sites. The cleared ROW could also fragment habitat, which is detrimental to fishers because they prefer large areas of contiguous, unfragmented forest (CBD 2000).
- Wildland fire as an indirect effect associated with increased human presence. The possibility of ignition in conifer, hardwood, and sagebrush/grass fuel types could range from low to extreme depending on weather conditions and patterns, current fire risk rating, moisture conditions, and fuel loadings. There is some possibility of human-caused fire, whether related to pipeline activities or to Project-induced increase of human presence in the area.

Below is a determination of effects summary for Pacific fisher-West Coast DPS. At this time, no critical habitat has been proposed or designated for this species. More details will be provided should this species become listed as threatened under the ESA, including potential exceptions and/or any designation of critical habitat.

The Project **will not jeopardize the continued existence** of the Pacific fisher-West Coast DPS; however, in the event that Pacific fisher-West Coast DPS becomes listed prior to completion of the Project, a provisional effect determination is provided.

The Project **may affect** the fisher because:

- fishers have the potential to occur in the fisher analysis area;
- suitable habitat is available within the fisher analysis area and would be impacted by the pipeline;
- construction noise could disturb fishers if present near the pipeline; and
- increased human presence associated with construction activities could affect fisher behavior and movements, including the chance of collisions with vehicles.

The following determination is warranted to receive a conference opinion of **may affect, likely to adversely affect** because:

- Recent telemetry studies in the southern Oregon Cascades identified fisher home ranges that overlap with the Project;
- 657.9 acres of suitable LSOG habitat, including snags, would be removed due to pipeline construction.
- Snags and large trees that could serve as fisher dens would be removed during pipeline construction.

Whales

Eight species of federally listed whales potentially occur off the coast of Oregon, including the blue, fin, southern resident killer, humpback, sei, north Pacific right, gray (Western North Pacific Stock) and sperm whales. All these whale species are federally protected under the MMPA. These species tend to feed during the summer in the northern latitudes and migrate to the tropical southern latitudes in the winter for breeding. However, whales could be encountered off the coast of Oregon throughout the year. Two killer whales were documented near the Project area in May 2017 during marine mammal surveys for the Project, although these were likely transient killer whales not belonging to the southern resident DPS (AECOM 2017). Gray whales have been reported in Coos Bay only on an occasional basis. Project effects on whales would be associated with LNG and construction supply vessel transits in the waterway inbound and outbound from the Jordan Cove terminal, as well as construction activities such as dredging and pile driving. Potential direct effects of the Project could include injury and/or mortality due to ship-strikes, injury or behavioral disturbance due to noise from vessels and construction activities, and potential adverse effects from a ship fuel spill. Spills could indirectly affect whales by harming or contaminating forage species. Additional details on whale densities and potential for ship strikes will be provided in the pending BA.

Below is a determination of effects summary for whales and critical habitat. More details will be provided in the pending BA.

The Project **may affect** federally listed whales because:

- federally listed whales may occur within the aquatic analysis areas (Figure 4.5-1 in section 4.5; includes the Coos Bay estuary and marine environment out approximately 12 nautical miles to the outer continental shelf) during construction and operation of the proposed action;
- vibratory sheet pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 120 decibel (dB) re 1 microPascal (μPa) at distances of up to 1.2 miles (Deveau and MacGillvray 2017) and impact pipe pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 160 dB re 1 μPa at 1.1 miles (O'Neill and MacGillvray 2017); and
- the proposed action would increase shipping traffic (LNG carriers) within the aquatic analysis areas.

However, the Project is **not likely to adversely affect** federally listed whales for the following reasons:

- ship strikes on whales off the Oregon coast are thought to be infrequent based on the Rockwood et al. (2018) assessment of potential whale/vessel collision mortalities for blue, humpback, and fin whales of less than 1 percent, and therefore thought to be discountable;
- 120 LNG carrier trips per year to the LNG terminal are expected to increase the potential in ship strikes to whales over known frequencies of incidents; however, Jordan Cove would provide a ship strike avoidance measures package to LNG carrier operators transporting cargo from the LNG terminal that would consist of multiple measures to avoid striking marine mammals;

- FERC does not have authority over the LNG carrier; however, the independent carrier operators would be required to follow all Coast Guard requirements regarding the operation of LNG carriers, including vessel speeds;
- noise from LNG carriers, dredgers, tugs, and other support vessels could result in behavioral disturbance to listed whales and effects of ship noise on whales could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise (NMFS 2016c, 2017b, 2018c), but LNG carrier noise would not exceed existing background ship noise levels and would not cause injury;
- whales inside Coos Bay in the vicinity of the Jordan Cove LNG Project may be affected by noise from piling during construction, and the use of an impact hammer has impulsive peak source levels that are high enough to cause permantent threshold shift (PTS) (an indicator of hearing damage) in these species; however, listed whales are unlikely to occur within Coos Bay during pile driving (October 1 to February 15), and Jordan Cove has indicated that these activities would be monitored and halted if a whale was detected in the area around the sound source;
- given vessel design, on-board spill kits, safety records, and implementation of Coast Guard recommendations, it is not likely that there would be a major ship spill of hazardous materials that may adversely affect water quality or aquatic species; and
- the relative population density of whales within the marine analysis area[137] would be low enough so that Project-related effects of LNG carrier transit in the waterway would be discountable.

No critical habitat has been designated or proposed for blue, fin, humpback, sei, or sperm whales.

The Project would have **no effect** on designated critical habitat units (CHUs) for the Eastern Northern Pacific Southern Resident stock of killer whales because:

- none of the designated CHUs occur within the marine analysis area off the Oregon coast.

The Project would have **no effect** on designated critical habitat for the North Pacific right whale because:

- none of the designated critical habitat occurs within the marine analysis area off the Oregon coast.

As described above, listed whales inside Coos Bay near the Jordan Cove LNG Project may be affected by noise from pile driving during construction, and the use of an impact hammer has impulsive peak source levels that are high enough to cause PTS (an indicator of hearing damage) in these species. Therefore, **we recommend that:**

- **<u>Prior to construction,</u> Jordan Cove should file with the Secretary, for review and written approval by the Director of OEP, a *Marine Mammal Monitoring Plan* that identifies how the presence of listed whales will be determined during construction,**

[137] Whale density estimates were based on habitat specific densities for blue whales, fin whales, and humpback whales (Becker et al. 2012; Calambokidis et al. 2015). Quantified comparable estimates for other species were not available, but the existing data were examined to qualitatively determine the level of risk to these species. These data sources and analyses are further described in the Applicant Prepared Draft Biological Assessment, filed with the FERC September 14, 2018.

and measures Jordan Cove will take to minimize potential noise effects on whales and other marine mammals, and ensure compliance with NMFS underwater noise criteria for the protection of listed whales.

4.6.1.2 Birds

Short-tailed Albatross (Federal Endangered Species, No State Status)

The short-tailed albatross was listed as endangered throughout its range in the United States on July 31, 2000 (FWS 2000a). In the North Pacific, the coastal habitat for the short-tailed albatross is in high-productivity areas with expansive deep water beyond the continental shelf. Short-tailed albatross rarely occur closer to the coast, but have been documented to occur off the Oregon coast near Coos Bay (in 1961, 2000, and 2001; National Audubon Society 2013). Because the closest breeding population of short-tailed albatross is within the Hawaiian Islands, the Project should not affect recovery criteria for the species. The short-tailed albatross could potentially be encountered within the LNG carrier transit route; however, short-tailed albatross are expected to avoid LNG marine traffic. Below is a determination of effects summary for the short-tailed albatross and critical habitat. More details will be provided in our pending BA.

The Project **may affect** short-tailed albatross because:

- short-tailed albatross may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area.

However, the Project is **not likely to adversely affect** short-tailed albatross for the following reasons:

- other species of albatross have infrequently collided with airplanes in flight but collisions of any albatross species with ships are unknown and are expected to be highly unlikely;
- 120 LNG carrier trips per year to the LNG terminal are expected to cause unmeasurable increase in potential ship strikes on short-tailed albatrosses;
- LNG carriers approaching Coos Bay would be traveling slowly and escorted by tractor tugs from 5 nautical miles offshore; and
- given vessel design, on-board spill kits, safety records, and implementation of Coast Guard recommendations, it is not likely that there would be a major ship spill of hazardous materials that may adversely affect water quality or aquatic species. Any oil released at sea would be in small enough quantities that potential effects on short-tailed albatrosses would be discountable.

No critical habitat has been designated or proposed for the short-tailed albatross.

Western Snowy Plover (coastal) (Federal Threatened Species with Critical Habitat, State Threatened Species)

The Pacific Coast population of western snowy plover has been listed as a threatened species under the ESA since March 5, 1993 (FWS 1993a). The Pacific coast population includes birds that nest adjacent to tidal waters, including all nesting birds on the mainland coast, peninsulas, offshore islands, adjacent bays, estuaries, and coastal rivers (FWS 1993a). The western snowy plover is a year-round, uncommon resident of the North Spit (BLM 2005); the spit supports the most productive snowy plover population segment on the Oregon coast (BLM 2008). Western snowy plovers may be encountered along the LNG carrier transit route from nearshore coastal waters to the LNG terminal. Potential effects include increased noise associated with construction of the Jordan Cove LNG Project, operation activities associated with shipping, increased recreation, increased habitat conversion, habitat degradation by human encroachment, and increased illegal harvest (Comer 1982). Conservation measures proposed to reduce effects include implementation of BMPs, education and outreach, and monitoring. CHUs OR-10 and OR-9 are located 2.6 and 6.9 miles from the LNG terminal, respectively; both units were occupied by western snowy plovers at the time of listing (1993) and in 2012. Below is a determination of effects summary for the western snowy plover and critical habitat. More details will be provided in our pending BA.

The Project **may affect** western snowy plovers because:

- the closest western snowy plover nesting habitat to the Project is on the North Spit approximately 1 mile from LNG terminal site, and contained active nests during 2016 surveys;
- temporary construction activities would occur at the Port Laydown site, which is less than 1 mile from known nesting sites;
- the meteorological station is located east of the foredune, approximately 100 feet from the northern extent of known nesting sites;
- impact hammer noise associated with the Navigation Reliability Improvement temporary facilities is expected to be above ambient levels, and may disturb wintering western snowy plovers if present along the eastern edge of the primary nesting area on the North Spit, which is within 0.25-miles of Dredge Area 1; and
- Jordan Cove terminal construction and operations personnel would likely use the North Spit for recreational purposes and increased recreational use could result in increased plover disturbance including destruction of nests by dogs, off-road vehicle traffic, inadvertent trampling, or increased predation if scavengers and predators (corvids, coyotes, striped skunk, feral cats) are attracted to nesting areas due to the presence of trash and food remains.

However, the Project is **not likely to adversely affect** western snowy plover because:

- Jordan Cove LNG Project construction noise at active nest sites (approximately 1 mile) and critical habitat (approximately 2.6 miles) is not expected be above ambient levels.
- Dredging operations would take place within the ODFW in-water work window, which is outside of the nesting period for western snowy plovers and dredging noise level is unlikely to affect wintering plovers approximately 0.25 miles away. Access to dredging areas would be by marine transport with no land-based access near primary snowy plover habitat.
- The meteorological station would be constructed outside the nesting season (March 15 to September 15) to avoid disturbance to snowy plovers and would include spikes or other deterrent measures on any potential perching surface, bird deterrent measures if guy-lines are required, and shielded security lighting to minimize glare. Operational activities would be maintenance-related and would be scheduled outside of the nesting season.
- Jordan Cove would minimize disturbance by humans, pets, vehicles or human-attracted predators through implementation of (1) BMPs to minimize predator density related to

increased human presence and habitat removal, and (2) education and outreach programs intended to train all construction and operations staff on the need for snowy plover conservation; current snowy plover regulations and recreational use restrictions; and the importance of conservation measures, including: litter control, avoidance of nesting and foraging areas, keeping pets on-leash, and remaining on established roads and trails.

Even though the northern end of CHU OR-10 on the North Spit is located approximately 2.6 miles from the Jordan Cove LNG Project, the Project **may affect** designated critical habitat for the western snowy plover because:

- temporary construction activities would occur at the Port Laydown site, which is approximately 1 mile from critical habitat;
- the Navigation Reliability Improvements Dredge Area 1 is approximately 0.25 mile from critical habitat; and
- the Project would result in a large but temporary increase in people employed on the North Spit during construction, and a much smaller long-term increase of operations staff. The additional human presence is likely to increase use of the North Spit with concomitant potential increase of pets, vehicles, and/or human-attracted predators.

However, the Project is **not likely to adversely affect** designated critical habitat for the western snowy plover because:

- dredging noise level is unlikely to affect physical or biological features (PBF) at CHU OR-10 approximately 0.25 miles away; and
- Jordan Cove would minimize potential secondary effects on the critical habitat PBF that identifies disturbance by humans, pets, vehicles or human-attracted predators through implementation of (1) BMPs to minimize predator density related to increased human presence and habitat removal, and (2) education and outreach programs intended to train all construction and operations staff on the need for snowy plover conservation; current snowy plover regulations and recreational use restrictions; and the importance of conservation measures, including: litter control, avoidance of nesting and foraging areas, keeping pets on leash, and remaining on established roads and trails.

Marbled Murrelet (Federal Threatened Species with Critical Habitat, State Threatened Species)

MAMUs in Washington, Oregon, and California were listed as threatened under the ESA on October 1, 1992 (FWS 1992a). Critical habitat for the MAMU was first designated on May 24, 1996 (FWS 1996) and subsequently revised in 2011 (FWS 2011b, 2016b). Throughout the forested portion of their range, MAMU habitat use is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low amounts of edge and fragmentation, proximity to the marine environment, and increasing forest age and height, although the presence of platforms is the most important characteristic of nesting habitat (FWS 2006c).

Through a combination of GIS data provided by the BLM and private timber companies, and field surveys conducted between 2007 and 2018, Pacific Connector identified 175 occupied and presumed occupied MAMU stands within 0.25 mile of the proposed action, or within 0.5 mile of federally-designated critical habitat that would be affected by the proposed action.

Construction of the Project would remove a total of about 806 acres of MAMU habitat (suitable, recruitment, capable), including about 78 acres of suitable habitat removed from 37 stands (18 occupied MAMU stands and 19 presumed occupied stands). There is the potential that effects could extend over a total of about 7,145 acres of suitable nesting habitat in the terrestrial nesting analysis area (i.e., the extent of disturbance/disruption of MAMU during the breeding season; FWS 2014c), where Project-related noise, primarily use of access roads, may affect MAMU behavior, including breeding activities. HDD and DP activities are not anticipated to disturb nesting MAMU as noise associated with this work would attenuate to ambient levels before reaching MAMU stands. Ten occupied and 24 presumed occupied MAMU stands occur within CHU OR-06 (b, c, and d) within the proposed terrestrial nesting analysis area. Overall, construction of the Pacific Connector Pipeline Project would remove about 4 acres of suitable MAMU nesting habitat (PBF-1) and about 12 acres of recruitment habitat and 15 acres of capable habitat (both of which make up PBF-2) within CHU OR-06-d.

Pacific Connector would implement several measures to reduce effects on MAMU habitat, including using UCSAs, and replanting conifer trees outside of the 30-foot-wide maintenance corridor on certain federal lands and non-federal lands. However, replanted trees may be harvested from non-federal lands or federal lands slated for timber harvest (i.e., Matrix lands and Harvest Land Base), and if allowed to grow would provide minimal benefit to MAMUs because it would take decades at a minimum to restore replanted forests to recruitment or suitable habitat conditions. To ensure that trees with active murrelet nests and chicks are not felled, timber would be removed outside of the entire MAMU breeding season (after September 15 but before March 31) within 300 feet of MAMU stands to avoid this direct effect on MAMU. To minimize disturbance and disruption of MAMU during operations and maintenance, vegetation maintenance activities would occur between August 1 and April 15, and Pacific Connector would apply daily timing restrictions during activities to minimize effects on MAMU during the late breeding season (August 6 – September 15).

Below is a determination of effects summary for the MAMU and critical habitat. More details will be provided in the pending BA.

The Project **may affect** MAMUs because:

- suitable habitat is available within the terrestrial nesting analysis area;
- MAMUs have been located within the terrestrial nesting analysis area during survey efforts for the proposed action; and
- MAMUs are expected to forage offshore in the marine analysis area, and within Coos Bay in the estuarine analysis area.

The Project is **likely to adversely affect** MAMUs for the following reasons:

- Disturbance associated with Pacific Connector Pipeline Project activities and construction of the Kentuck project would occur within the critical breeding season and within 0.25 mile of known MAMU stands.
- Proposed actions that generate noise above local ambient levels levels in approximately 7,145 acres of suitable habitat might disturb or disrupt MAMUs and interfere with essential nesting behaviors:

  - 82 MAMU stands (25 occupied and 57 presumed occupied) are within 0.25 mile of the pipeline that could be constructed during the breeding season.
  - 168 MAMU stands (50 occupied and 118 presumed occupied) are within 0.25 mile of access roads that could be used during pipeline construction in the breeding season.
- Blasting for the pipeline trench may occur within 0.25 mile of 11 MAMU stands between April 1 and September 30.
- Helicopter use within 0.25 mile of eight occupied MAMU stands during the breeding period (between April 1 and September 15) could occur and disturb MAMU adults and nestlings, as well as potentially blow nestlings out of the nest tree within six occupied MAMU stands from rotor wash.
- The Pacific Connector Pipeline Project would remove approximately 78 acres of suitable nesting habitat within the range of the MAMU; or approximately 0.5 percent of the 14,310 acres of suitable habitat available in the terrestrial nesting analysis area.
- The Pacific Connector Pipeline Project would remove approximately 307 acres of recruitment habitat and 421 acres of capable habitat within the range of the MAMU. These habitats do not currently support the recovery of the species.
- The Pacific Connector Pipeline Project would modify (cause other indirect effects such as increases in edge habitat and loss of interior forest habitat, including increased predation) approximately 656 acres of suitable, 2,058 acres of recruitment, and 2,449 acres of capable habitat.
- Turbidity generated during HDD if a frac-out occurred could affect local major prey species for chicks such as anchovy, sand lance, and smelt.
- LNG carrier traffic in the estuarine analysis area to the Jordan Cove terminal could cause potential behavioral effects on foraging MAMU, and fuel and lubricant spills from LNG carriers could cause injury or mortality to foraging MAMUs.

The Project **may affect** MAMU critical habitat because:

- the Project occurs within designated MAMU critical habitat; and
- the Project would affect habitat within designated critical habitat areas.

The Project is **likely to adversely affect** MAMU critical habitat because:

- the proposed action could remove or degrade individual trees with potential nesting platforms or the nest platforms themselves, resulting in a decrease in or elimination of the value of the trees for future nesting use (PBF 1, or suitable or potentially suitable habitat); and
- the proposed action could remove or degrade trees adjacent to trees with potential nesting platforms that provide habitat elements essential to the suitability of the potential nest tree or platform, such as providing cover from weather or predators (PBF 2, or recruitment/capable habitat).

As described above, construction of the pipeline (including clearing of timber, access road use, helicopter use, and blasting), as well as pipeline operation and maintenance, would occur within the MAMU breeding season and within 0.25 mile of known MAMU stands. These activities could disturb or disrupt MAMUs and interfere with essential nesting behaviors during the breeding season. Therefore, to reduce these effects during the breeding season, **we recommend that:**

- **<u>Prior to construction</u>, Pacific Connector shall file with the Secretary its commitment to adhere to FWS-recommended timing restrictions within threshold distances of MAMU and NSO stands <u>during construction, operations, and maintenance</u> of the pipeline facilities.**

The FWS timing restrictions for MAMU and NSO, as referenced in the above recommendation, were outlined in FWS (2016c).

Given the anticipated avoidance of disturbance and disruption to MAMU during the breeding season per inclusion of the recommendation above into the proposed action (i.e., implementation of distance and timing restrictions, without exception), noise and visual effects on breeding MAMU as a result of construction would be minimized. However, there would be a loss of future breeding opportunities due to the removal of suitable, recruitment, and capable habitat during construction, as there would be less suitable habitat available for nesting. Additionally, the quality of the remaining habitat would be reduced due to habitat fragmentation and the addition of edge along the pipeline corridor. Removal of suitable nesting habitat by harvest of old-growth timber has been cited as the primary reason for the species' decline (FWS 1992a). Suitable MAMU nesting habitat takes a long time to develop (more than 250 years on average); therefore, any removal of suitable habitat may affect the recovery of the MAMU. Jordan Cove has indicated an interest in working with the FWS to discuss possible mitigation and conservation measures but has not proposed compensatory mitigation. In the absence of mitigation other than avoidance and minimization, the Project would result in long-term negative effects on this this threatened species.

Northern Spotted Owl (Federal Threatened Species with Critical Habitat, State Threatened Species)

In Oregon, the NSO is found in low- and mid-elevation coniferous forest in the Coast, Siskiyou, and Cascade Ranges (Forsman 2003). Suitable habitat for NSOs provides elements necessary for nesting, roosting and foraging. NSOs generally nest in forests with multilayered, multispecies canopies with large (20–30 inches dbh or greater) overstory trees, a high basal area (greater than 240 square feet/acre), and a high diversity of different diameters of trees. NSOs have large home ranges and utilize large tracts of land containing substancial acreage to meet their biological needs and a wide array of forest types and structures are necessary to support the various life histories (FWS 2011a). Typically, a larger area is required for NSOs in more fragmented habitats (Courtney et al. 2004). NSOs remain on their home range throughout the year. As a result, NSOs have large home ranges that provide all the habitat components and prey necessary for the survival and successful reproduction of a territorial pair.

Home ranges contain three distinct use areas: 1) the nest patch, which research has shown to be an important attribute for site selection by NSOs and includes approximately 70 acres of usually contiguous forest (300-meter radius around an activity center; FWS et al. 2008), 2) the core area, which is used most intensively by a nesting pair and varies considerably in size across the geographic range, but on average encompasses approximately 500 acres around the nest site (0.5-mile radius around the activity center), and is generally made up of mostly mature/old-growth forest (FWS 2007c; Courtney et al. 2004), and 3) the remainder of the home range which is used for foraging and roosting and is essential to the year-round survival of the resident pair (FWS 2007c). NSO home range size varies by physiographic province. In the Coast Range

Physiographic Province (MP 0.00 to MP 51.74), the home range is assumed to be circular with a radius of 1.5 miles. Within the Klamath Mountains Physiographic Province (MP 51.74 to MP 122.67), the home range radius is 1.3 miles, and in the West Cascades (MP 122.67 to MP 167.76) and East Cascade Physiographic Provinces (MP 167.76 to MP 190.64) the home range radius is 1.2 miles (FWS 1992b). Surveys conducted by Pacific Connector in 2007 identified 12 NSO pairs and a resident single but no nests. In 2008, surveys found NSO pairs at 20 locations, with two nests identified, and resident singles noted at six sites. Surveys in 2015 along the Blue Ridge route did not document any NSO. In addition to NSO sites identified by these surveys, Pacific Connector also considered home range information from the BLM and Forest Service, historic home ranges, best location home ranges (alternate sites closest to proposed action), and Pacific Connector-assumed home ranges (determined by Pacific Connector's assessment of habitat maps). Taking a conservative approach, all owl sites (known, best location, and Pacific Connector-assumed) were analyzed as if occupied and reproductive.

The Project would affect habitat within 97 NSO home ranges and 9 nest patches. About 37 miles of pipeline route would cross 7 designated critical habitat sub-units. Project construction would remove a total of about 517 acres of nesting, roosting, or foraging (NRF) habitat for NSO, of which 134 acres would be permanently lost within the 30-foot-wide corridor maintained in an herbaceous state. Additionally, 214 acres of NRF habitat for NSO would be modified and used as UCSAs. Approximately 1,158 acres of dispersal habitat (high NRF, NRF, and dispersal only habitat) would be removed by the Project. Approximately 919 acres of NSO capable habitat would be removed by construction of the proposed Project, of which 216 acres would remain in a permanent herbaceous/shrub state within the 30-foot operational ROW. Approximately 13,294 acres of NSO habitat (1,307 acres of high NRF/NRF habitat, 4,147 acres of dispersal only habitat, and 5,690 acres of capable habitat) occur within 100 meters (328 feet) of habitat removal, of which 4,326 acres (or 32.5 percent of NSO habitat within 100 meters of habitat removal) of interior NSO habitat would be indirectly affected (1,586 acres of high NRF/NRF habitat, 1,388 acres of dispersal only habitat, and 1,352 acres of capable habitat). The Pacific Connector Pipeline Project would remove 442 acres from LSRs , of which 379 acres is NSO habitat or capable of becoming NSO habitat (approximately 69 acres of high NRF, 93 acres of NRF [includes about 9 acres of "post-fire" NRF], 71 acres of dispersal only habitat, and 146 acres of capable habitat).

Potential direct effects on NSOs would include the following: (1) removal of a known nest tree during the entire breeding season (March 1 through September 30), and (2) human and noise disturbance due to ROW clearing and construction during the breeding period, including noise due to blasting and helicopter support during construction, and smoke from prescribed burnings. Potential indirect effects include the following: (1) removal or modification of suitable NRF habitat, dispersal habitat, and habitat that would be capable, over the life of the Project, to achieve dispersal or NRF habitat characteristics but for the Project's effects within LSR, Riparian Reserves, or NSO home ranges; (2) habitat fragmentation; and (3) other indirect effects that occur due to Project-related increases in edge habitat and loss of interior forest habitat, including increased predation, increased competition, and effects on prey utilized by NSOs. HDD and DP activities are not anticipated to disturb nesting NSO because noise associated with this work would attenuate to ambient levels before reaching NSO sites.

Pacific Connector would minimize effects on NSO habitat using the BMPs for crossing forested lands described in section 4.4 of this EIS. Pacific Connector would reduce effects on NSO habitat by replanting conifer trees outside of the 30-foot-wide maintenance corridor on certain federal lands and non-federal lands. However, replanted trees may be harvested from non-federal lands or federal lands slated for timber harvest (i.e., Matrix lands and Harvest Land Base), and if allowed to grow would provide minimal benefit to NSOs because it would take 80 years at a minimum to restore replanted forests to suitable habitat conditions. Timber removal would occur outside the entire NSO breeding season (March 1 through September 30) within 0.25 mile of NSO activity centers, and as a result, no nest trees within activity centers would be removed during the NSO nesting period, and disturbance or disruption would also be reduced. Additionally, Pacific Connector would install the pipeline within 0.25 mile of activity centers after the critical breeding period (after July 15). However, activities from pipeline construction during the late breeding period (July 16 through September 30) could disrupt or disturb NSO at 10 NSO activity centers within 0.25 mile of the pipeline ROW, and construction activities off the ROW would occur during the entire breeding season and could disturb NSO at two known activity centers located 0.25 mile of pipeline project components, if NSO are present.

For operations and maintenance activities, Pacific Connector would not conduct vegetation maintenance activities within 0.25 mile of NSO activity centers during the entire breeding season (March 1–September 30) to minimize disturbance and disruption to NSO. Other operations and maintenance activities may occur within the breeding season. Mitigation projects such as snag creation projects proposed by the Forest Service to meet LRMP objectives would benefit NSO.

Below is a determination of effects summary for the NSO and critical habitat. More details will be provided in the pending BA.

The Project **may affect** NSOs because:

- suitable habitat is available within the Provincial Analysis Area;[138] and
- NSO pairs and resident singles have been located within the Provincial Analysis Area during survey efforts.

The Project is **likely to adversely affect** NSOs for the following reasons:

- Noise from blasting during pipeline construction within 0.25 mile of NSO sites during the late breeding season would occur and could increase the risk of predation to fledglings that are generally not as able to escape as adults during the latter part of the breeding season.
- Construction of the Pacific Connector Pipeline Project would remove approximately 517 acres of high NRF and NRF habitat (including 26 acres of "post fire NRF" within the 2015 Stouts Creek fire area) within the provincial analysis area. This would result in effects on nest patches, core areas, and home ranges of known, best location, and Pacific Connector-assumed owls, some of which are currently below thresholds needed to sustain NSOs. Once suitable NRF habitat is reduced or modified in NSOs' home ranges, there is an increased likelihood that NSOs remaining in the Project area would be subject to:
  - displacement from nesting areas;
  - concentration into smaller, fragmented areas of suitable nesting habitat that may already be occupied;

[138] The Provincial Analysis Area includes the extent of the following potential Project effects: 1) habitat removal or modification, and 2) disturbance/disruption of NSO during the breeding season

  - increased interspecific (with barred owls) and intraspecific competition for suitable nest sites and forage;
  - decreased survival due to increased predation and/or limited resource (forage) availability; and
  - diminished reproductive success for nesting pairs.
- Construction of the Pacific Connector Pipeline Project would remove and modify high NRF, NRF, dispersal only, and capable habitat for NSOs throughout the Project area, including removal of habitat within the home range of 97 NSOs, 58 of which are currently below sustainable threshold levels of suitable habitat for continued persistence in their home range and/or core area.
- Construction of the Pacific Connector Pipeline Project would bring one NSO core area (best location activity center affected by 2015 Stouts Creek fire) below the 50 percent NRF threshold, and two NSO home range (known activity centers, one of which was affected by the 2015 Stouts Creek fire) below the 40 percent NRF threshold (best location activity center).

The Project **may affect** NSO critical habitat because:

- the Project would occur within designated NSO critical habitat; and
- the Project would affect habitat within designated critical habitat areas.

The Project is **likely to adversely affect** NSO critical habitat because:

- The proposed action would remove or potentially downgrade PBFs in critical habitat sub-units ORC-6, KLE-1, KLE-2, KLE-3, KLE-4, KLE-5, and ECS-1 as defined in the Final Rule designating critical habitat for the NSO (FWS 2012b).

As described above, construction of the pipeline (including access road use, helicopter use, and blasting), as well as pipeline operations and maintenance, would occur within the NSO breeding season and within 0.25 mile of NSO activity centers. These activities would disturb or disrupt NSOs and interfere with essential nesting behaviors during the entire breeding season. Therefore, to reduce these effects during the breeding season, we have recommended that Pacific Connector adhere to FWS-recommended timing restrictions within threshold distances of NSO activity centers (FWS 2016c; see recommendation above in the MAMU section).

Given the anticipated avoidance of disturbance and disruption to NSO during the breeding season per inclusion of the recommendation above into the proposed action (i.e., implementation of distance and timing restrictions, without exception), noise and visual effects on breeding NSO as a result of construction would be minimized. However, there would be a loss of future breeding opportunities due to the removal of suitable habitat during construction, as there would be less suitable habitat available for nesting. Additionally, the quality of the remaining habitat would be reduced due to habitat fragmentation and the addition of edge along the pipeline corridor. Habitat loss and modification, whether to nesting, roosting or foraging habitats, due to forest clear-cutting has been the primary factor causing declines of the NSO (FWS 1992c). Habitat losses and habitat fragmentation have indirect effects that can affect survival and reproduction of NSOs. Jordan Cove has indicated an interest in working with the FWS to discuss possible mitigation and conservation measures but has not proposed compensatory mitigation. In the absence of mitigation other than avoidance and minimization, the Project would result in long-term negative effects on this threatened species.

4.6.1.3 Fish

In this section, we summarize the listing status, life history, and presence and determination of Project action effects on the federally listed fish species and their critical habitat that could be affected by the Project. The species addressed include the Coho Salmon-Southern Oregon/Northern California Coast ESU, Coho Salmon-Oregon Coast ESU, North American Green Sturgeon–Southern DPS, Eulachon–Southern DPS, Lost River sucker, and shortnose sucker. Project effects on waterbodies are described in section 4.3 of this EIS. Minimization measures are currently proposed to reduce effects on threatened and endangered fish species. Overall, the types, methods, and magnitude of effects on listed fish species are represented by those presented for fish in general as presented earlier in section 4.5 of this EIS.

Coho Salmon-Southern Oregon/Northern California Coast ESU (Federal Threatened Species, State Sensitive Species)

The Southern Oregon/Northern California Coast (SONCC) ESU coho salmon was listed as a threatened species on June 28, 2005, between Punta Gorda, California, and Cape Blanco, Oregon (70 FR 37160). It includes all naturally spawning populations as well as three artificial propagation programs, of which one, the Cole Rivers Hatchery (ODFW stock #52) located on the Rogue River, is within the Project area.

Critical habitat for the SONCC ESU was designated in May 5, 1999 (74 FR 24249) and includes the accessible reaches of all rivers (including water, substrate, and adjacent riparian zone of estuarine and riverine reaches) between the Mattole River in California and the Elk River in Oregon. The Pacific Connector pipeline route would cross designated critical habitat within waterbodies of the Upper Rogue HUC (17100307) below Lost Creek, Willow Creek, and Fish Lake Dams.

Major rivers, estuaries, and bays known to support coho salmon within the range of the SONCC ESU include the Rogue River, Smith River, Klamath River, Mad River, Humboldt Bay, Eel River, and Mattole River (NMFS 1999), two of which (i.e., the Rogue and Klamath Rivers) are within the Project area although this ESU is currently prevented from accessing the potential Project-affected Klamath River areas due to dam passage barriers downstream.

Direct and indirect effects on SONCC Coho salmon are not expected within the marine analysis area. Coho salmon can avoid acoustic effects from LNG carriers during transit. Potential oil and gas spills from LNG carriers in the marine analysis area are highly unlikely to occur; even if LNG spilled or leaked, it would turn to vapor and would not mix with water, and vessel response plans required to address accidental spills of LNG and other petroleum products onboard would be implemented. Effects within the riverine analysis area are expected from in-water construction activities resulting in short-term increased sediment levels that would be stressful to fish, short-term benthic food source reduction, temporary migration impedance, short-term terrestrial/riparian habitat modifications, and limited long-term reduction in LWD sources. Limited fish mortality would also occur from fish salvage.

Below is the determination of effects summary for SONCC Coho Salmon ESU and critical habitat; see the details in our pending BA.

The Project **may affect** coho salmon in the SONCC ESU because:

- several stages and activities of coho salmon (upstream adult migration, juvenile rearing, and juvenile out-migration) are expected to occur at various locations in the riverine analysis area during construction and operation of the proposed action.

The Project is **likely to adversely affect** Coho salmon in the SONCC ESU for the following reasons:

- Juveniles would be exposed to elevated TSS concentrations during standard dry open-cut construction (fluming or dam-and-pump) for 2 to 5 hours. Such an exposure could cause injury, a short-term reduction in both feeding rate and feeding success, and minor physiological stress.
- A site crossing failure while dry open-cut construction is underway could result in elevated TSS concentrations for six hours while repair of failed isolation structures occurs, which could cause moderate habitat degradation injury, a short-term reduction in both feeding rate and feeding success, impaired fish homing, and possibly major physiological stress.
- Literature-based estimates of suspended sediment effects from pipeline construction on severity of ill effect (SEV) scores suggest typical dry crossing methods could result in SEVs of 4 and 6 for Coho salmon within a few hundred feet (e.g., 150 to 500 feet) below the crossing, which may include factors ranging from short-term reduction in feeding to moderate physiological stress. If failure of sealing occurs, SEV scores for coho salmon could be as high as 8, which may include habitat degradation, major physiological stress, and long-term reduction in feeding rate or success.
- Construction-induced blasting at 13 streams (4 at streams known to contain coho) could cause mortality to fish by rupturing swim bladders, but active fish removal from area prior to blasting would reduce risk of occurrence.
- Fish salvage would occur for some dry stream crossings as discussed in Pacific Connector's *Fish Salvage Plan*.[139] Capture and handling constitutes a taking under ESA and subjects coho salmon to injury and mortality.
- Lack of LWD is a limiting factor in most streams within range of SONCC coho salmon. Removal of mid-seral riparian forest (40 to 80 years old) would have long-term effects on recruitment of LWD, and removal of LSOG forest (80 years old or older) would have permanent effects on recruitment of LWD because planted conifers would not attain those age classes within the 50-year life of the Project, plus the ongoing loss of trees within the 30-foot-wide maintance corridor.

The Project **may affect** designated critical habitat for coho salmon in the SONCC ESU because:

- the Pacific Connector pipeline crosses designated critical habitat within waterbodies of the Upper Rogue HUC (17100307) below the Lost Creek, Willow Creek, and Fish Lake Dams.

[139] Appendix L of Pacific Connector's POD filed with the FERC in January 2018.

The Project is **likely to adversely affect** designated critical habitat for coho salmon in the SONCC ESU for the following reasons:

- a failure of dry open-cut crossing could cause moderate or more severe habitat degradations in some crossing areas;
- increases in turbidity are expected to temporarily affect the water quality downstream from stream crossing sites during construction;
- food resources would potentially be affected over the short term by dry open-cut and diverted open-cut construction methods that would remove substrate and benthos at crossing sites;
- freshwater migration corridors would potentially be affected over the short term by dry open-cut and diverted open-cut construction methods that would create temporary barriers to in-stream movements; and
- approximately 17 acres of native riparian vegetation (forest, wetlands, unaltered, and nonforested habitats) and altered habitat would be removed during construction within riparian zones associated with designated critical habitat. Adverse effects on riparian zones associated with critical habitat would be long term or permanent depending on whether mid-seral riparian forests (7 acres) or LSOG riparian forests (2 acres) are removed.

Coho Salmon-Oregon Coast ESU (Federal Threatened Species, State Sensitive Species)

This Coho salmon ESU was first proposed for listing on July 25, 1995 (60 FR 38011) and subsequently listed as threatened on June 20, 2011 (76 FR 35755). The Oregon Coast ESU includes all naturally spawned populations of coho in Oregon coastal streams south of the Columbia River and north of Cape Blanco, including the Cow Creek (ODFW stock #37) coho salmon hatchery program (NMFS 1995). Critical habitat for Oregon Coast coho salmon was designated on February 11, 2008 (73 FR 7816) and includes water, substrate, and adjacent riparian zones of estuaries and rivers within the range of the Oregon Coast ESU. There are three subbasins that coincide with the Project: South Umpqua Subbasin (HUC 17100302) and Coquille Subbasin (HUC 17100305), which are crossed by the Pacific Connector pipeline; and Coos Subbasin (HUC 17100304), which includes the Coos Bay estuary where the LNG terminal, slip, navigation channel improvements, and HDD portion of the Pacific Connector pipeline route would be located contain critical habitat watersheds. Within these subbasins are eight fifth-field watersheds crossed that contain designated critical habitat. Life stage requirements of coho salmon, within freshwater habitats in the Oregon Coast ESU, are expected to be similar to those described above for Coho salmon in the SONCC ESU.

Coho salmon would be expected to avoid acoustic effects from LNG carriers during transit of marine areas, and no substantial adverse oil and gas marine spills from LNG carriers are expected. Short-term adverse effects on coho salmon in the estuarine analysis area would result from locally increased turbidity from dredging activities and LNG carrier propeller wash and ship wake, causing avoidance and short-term reduction in food supply. Entrainment and impingement of coho salmon could occur in LNG carriers' cooling water intake port during LNG carrier loading and possibly dredging. Acoustic effects would likely cause at least avoidance during LNG terminal construction. Habitat modification would occur from all dredging activity and restoration activities at the Kentuck project site. Suspended sediment released accidentally during HDD construction across Coos Bay and the Coos River would also result in elevated sediment levels.

Effects within the riverine analysis area primarily from in-water construction activities would include short-term increased sediment levels causing fish stress, reduced short-term benthic food supplies, temporary migration impedance, terrestrial/riparian habitat modifications, and limited long-term reduction in LWD sources. Limited mortality from fish salvage would also occur.

Below is the determination of effects summary for Oregon Coast Coho Salmon ESU and critical habitat; see our pending BA for details.

The Project **may affect** coho salmon in the Oregon Coast ESU because:

- several stages and activities of coho salmon (upstream adult migration, juvenile rearing, and juvenile out-migration) are expected to occur at various locations in the riverine analysis area during construction and operation of the proposed action;
- several stages and activities of coho salmon (juveniles, adults) are expected to occur within the estuarine analysis area during construction and operation of the proposed action; and
- juvenile and adult coho salmon area expected to occur within the marine analysis area during operation of the proposed action.

The Project is **likely to adversely affect** coho salmon in the Oregon Coast ESU for the following reasons:

- Short-term increase in noise associated with in-water or nearwater pile driving at various temporary construction activities throughout the bay may cause disturbance and physical injury to Oregon Coast coho if they are in proximity to the noise during construction.
- Some juvenile coho may be subject to localized entrainment by dredging associated with the access channel and Navigation Reliability Improvements, as well as ongoing maintenance dredging.
- Local short-term increases in suspended sediment in Coos Bay from in-water construction, particularly during dredging of Jordan Cove terminal access channel and navigation channel widening, may result in behavioral effects on rearing coho salmon juveniles with physiological consequences that may affect growth and survival.
- Short-term effects on the benthic community and potential food resources for Oregon Coast coho would result from dredging the proposed marine waterway modifications in Coos Bay.
- Installation of the proposed pipeline beneath Coos Bay and the Coos River using HDD construction would avoid effects on coho unless an inadvertent return of drilling fluid occurred. An inadvertent return would temporarily increase sedimentation and turbidity and likely result in behavioral avoidance of the affected area.
- Individual Coho salmon may be directly affected by local restoration activities at the Kentuck project due to short-term construction-related increases in turbidity, in-water work, and isolation measures.
- Water intakes by LNG carriers at the Jordan Cove terminal berth during engine cooling operations could entrain or impinge juvenile salmon.
- Dredging of the Jordan Cove terminal access channel in Coos Bay in the short term could remove eelgrass and benthic community that provide potential food resources and rearing habitat for Oregon Coast Coho salmon;

- Removing eelgrass from donor stocks in the bay to develop the Eelgrass Mitigation site may reduce cover and food sources for rearing juvenile coho salmon in the short term:
- Exposure to TSS concentrations during dry open-cut construction (fluming or dam-and-pump) for 2 to 6 hours could potentially cause minor physiological stress (increased coughing rate and/or increased respiration rate) in juvenile coho salmon.
- A site crossing failure while dry open-cut construction is underway could result in elevated TSS concentrations for six hours while repair of failed isolation structures could cause moderate habitat degradation, impaired homing by fish, moderate to major physiological stress, and, in very limited areas, reduced growth and reduced fish density.
- Literature-based estimates of suspended sediment effects from pipeline construction on SEV scores suggest typical dry crossing methods could result in SEVs between 4 and 6 for coho salmon within a few hundred feet (e.g., 150 to 500 feet) below the crossing, which may include factors ranging from short-term reduction in feeding to moderate physiological stress. If failure of sealing occurs, SEV scores for coho salmon could be as high as 8, which may include habitat degradation, major physiological stress, and long-term reduction in feeding rate or success.
- Blasting at 22 streams (12 known or assumed to have Coho salmon at the crossing) could cause mortality to fish by rupturing swim bladders but active fish removal from the area prior to blasting would reduce risk of occurrence.
- Fish salvage would occur within isolated construction sites, possibly when adult and juvenile coho salmon are present. Coho salmon are considered vulnerable to electrofishing, subject to injury and mortality. Seining, electrofishing, and handling during salvage may adversely affect Oregon Coast coho salmon.
- Lack of LWD is a limiting factor in most streams within range of Oregon Coast coho salmon. Removal of mid-seral riparian forest (40 to 80 years old) would have long-term effects on recruitment of LWD, and removal of LSOG forest (80 years old or older) would have permanent effects on recruitment of LWD because planted conifers would not attain those age classes within the 50-year life of the Project, plus the ongoing loss of trees within the 30-foot-wide maintance corridor.

The Project **may affect** designated critical habitat for coho salmon in the marine analysis area, the estuarine analysis area, and the riverine analysis area for the Oregon Coast ESU because:

- construction and operation of the Project would occur in or cross designated critical habitat within waterbodies of the Coos, Coquille, and South Umpqua subbasins.

The Project is **likely to adversely affect** proposed critical habitat for coho salmon in the Oregon Coast ESU for the following reasons:

- dredging of the Jordan Cove terminal access channel in Coos Bay and marine waterway modifications could remove eelgrass and benthic community that are potential food resources and rearing habitat for Oregon Coast coho salmon;
- increases in turbidity are expected to temporarily affect the water quality downstream from stream crossing sites during construction;
- TSS concentrations generated during dry open-cut construction and potential failure of isolation structures would adversely affect freshwater habitats by changing coho habitat preferences (SEV = 3) or causing moderate habitat degradations (SEV = 7 or 8);

- a failure of dry open-cut crossing lasting up to 6 hours could cause moderate or more habitat degradations in some streams;
- food resources would potentially be affected over the short term by dry open-cut and diverted open-cut construction methods that would remove substrate and benthos at crossing sites;
- freshwater migration corridors would potentially be affected over the short-term by dry open-cut and diverted open-cut construction methods that would create temporary barriers to in-stream movements; and
- approximately 88 acres of native riparian vegetation (forest, wetlands, and nonforested habitats) and altered habitat would be removed during construction within riparian zones associated with designated critical habitat associated with waterbodies within range of Oregon Coast coho ESU. Adverse effects on riparian zones associated with critical habitat would be long term or permanent depending on whether mid-seral riparian forests (14 acres) or LSOG riparian forests (4 acres) are removed.

North American Green Sturgeon – Southern Distinct Population Segment (Federal Threatened Species, State Sensitive-Critical Species)

On January 23, 2003 (NMFS 2003), NMFS determined that the North American green sturgeon comprises two DPSs that qualify as species under the ESA: (1) a northern DPS consisting of populations in coastal watersheds northward of and including the Eel River in California; and (2) a southern DPS consisting of coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River. On April 7, 2006, NMFS listed the southern DPS as federally threatened under the ESA, including spawning populations of green sturgeon south of the Eel River, principally the Sacramento River spawning population (71 FR 17757). Designated critical habitat extends from U.S. marine waters to 110 meters depth (360 feet) or 60 fathoms from Monterey Bay, California, north to Cape Flattery, Washington, including the Strait of Juan de Fuca (74[195] FR 52300 [October 9, 2009]). Critical habitat includes three components that are occupied by and are essential to different life stages of green sturgeon: (1) freshwater riverine systems, (2) estuarine areas, and (3) nearshore marine waters. No rivers in Oregon were included in the listing. However, many estuaries were part of the critical habitat proposal in Washington, Oregon, and California. Estuaries in Oregon proposed for inclusion were the Columbia River estuary, Winchester Bay, Yaquina Bay, Nehalem Bay, and Coos Bay. Large numbers of this green sturgeon DPS are within Coos Bay. Subadults and adults may occupy Coos Bay for feeding, optimization of growth, and thermal refuge, and the Bay supplies oversummer habitat. Similarly, coastal marine waters 110 meters deep or less. The North American green sturgeon (both northern and southern DPSs) occurs within Coos Bay and its adjacent waterbodies (Israel and May 2007) and is considered abundant in the bay (73 [174] FR 52084 [September 8, 2008]). This fish may also occur in the lower portions of the Coos River.

Green sturgeons spawn every three to five years in deep pools in large, turbulent river mainstems, generally from March through July (Tracy 1990; Moyle et al. 1992). Little is known about sturgeon feeding, but some studies have found that adults and juveniles feed on benthic invertebrates including shrimp, mollusks, amphipods, and even small fish (Moyle et al. 1992; Radtke 1966). Natural reproduction in this estuary is considered low (Wagoner et al. 1990). The Coos River system is not considered to provide suitable spawning habitat for green sturgeon (Whisler et al. 1999). Green sturgeon, likely less than three years of age, may utilize both shallow and deep-water habitats within the estuarine area, though there is no information relating individual occurrence to DPS membership. Green sturgeon may also occur in bottom areas along the LNG carrier transit route, in waters mostly less than 110 meters deep, which would be primarily only during entry and exit of the vessels as they would travel in deeper water during transit between ports.

Direct and indirect effects on green sturgeon in the southern DPS are not expected within the marine analysis area. Green sturgeon might detect noise from LNG carriers but would be able to avoid adverse effects from noise. Potential oil and gas spills from LNG carriers in the marine analysis area are unlikely to affect aquatic resources because they are highly unlikely to occur; if LNG spilled or leaked, it would turn to vapor, would not mix with water, and would not contaminate surface water; and vessel response plans required to address accidental spills of LNG and other petroleum products onboard would be implemented. Effects on green sturgeon in the estuarine analysis area include acoustic effects such as avoidance during terminal construction, increased turbidity sedimention affecting benthic food sources from dredging activities, bed and bank erosion from LNG carrier propeller wash and ship wake, loss of forage from removal of eelgrass and shallow water habitat, and elevated suspended sediment released from an accidental drilling mud release during HDD construction across Coos Bay and the Coos River. Effects within the riverine analysis area include increased turbidity and sedimentation causing short-term avoidance and food source reduction from in-water construction activities on Stock Slough.

Below is the determination of effects summary for the Southern DPS of green sturgeon and critical habitat. Details will be provided in our pending BA.

The Project **may affect** green sturgeon (Southern DPS) because:

- adult and/or subadult green sturgeon may occur within the estuarine analysis area during construction and operation of the proposed action;
- adult and/or subadult green sturgeons may occur within the marine analysis area during operation of the proposed action; and
- the proposed action may affect potential food resources and water quality during the short-term construction period and maintenance dredging within the estuarine analysis area.

The Project is **likely to adversely affect** green sturgeon (Southern DPS) because:

- short-term increase in noise generated from in-water and nearshore pile driving at various temporary construction sites throughout the bay may cause disturbance and physical injury to green sturgeon if individuals are in proximity to the noise during construction;
- exposure to TSS concentrations during dry open-cut construction (fluming or dam-and-pump) could potentially cause minor physiological stress, a short-term reduction in feeding rate, and short-term reduction in feeding success in the Stock Slough estuarine stream/river channel crossed by the pipeline if present there at the time of construction;
- on a localized basis, the proposed action may affect migratory and feeding behavior, potential food resources, and water quality (TSS) during the short-term construction period and periodic maintenance dredging within the estuarine analysis area;
- bottom disturbance from Project construction, navigation channel widening, and maintenance dredging may reduce the abundance and diversity of benthic food supply within Coos Bay; and

- short-term increased turbidity could cause avoidance in Coos Bay or lower Coos River HDD if frac-out were to occur.

The Project **may affect** critical habitat for green sturgeon (Southern DPS) because:

- Project activities would occur within portions of the Coos Bay estuary, Stock Slough, and coastal marine waters, which have been designated as critical habitat;

The Project is **likely to adversely affect** critical habitat for the southern DPS of green sturgeon because:

- bottom disturbance from Project construction, navigation channel widening, and maintenance dredging may disrupt local food supply and habitat usability within Coos Bay; and
- suspended sediment produced during dry open-cut crossing Stock Slough could affect water quality in freshwater riverine critical habitat.

Eulachon – Southern Distinct Population Segment (Federal Threatened, No State Status)

On March 18, 2010, the NMFS published in the Federal Register the final rule to list the southern DPS of the Pacific eulachon as threatened under the ESA (75 FR 13012 [March 18, 2010]). The NMFS has identified the eulachon southern DPS as those populations which spawn in rivers south of the Nass River in British Columbia, Canada, to and including the Mad River in California (NMFS 2008c). The southern DPS has been further segregated into four subareas: Klamath River, Columbia River, Fraser River, and British Columbia coastal rivers south of the Nass River (NMFS 2008c). A total of 16 distinct regions in Washington, Oregon, and California have been designated as critical habitat for Pacific eulachon (76 FR 65323 [October 20, 2011]). No part of the Project or its effects would occur within waterbodies included in the eulachon critical habitat designation.

Adult Pacific eulachon usually spend three to five years in saltwater before returning to freshwater to spawn from late winter though early summer in rivers (74 FR 10857 [March 13, 2009]). Fertilized eggs adhere to river bottoms and shortly after hatching, the larvae are carried downstream and dispersed by estuarine and ocean currents (74 FR 10857 [2009]). No recent spawning runs have been documented for the Coos River, although some may have occurred historically and have recently been found in Winchester Creek, a major tributary to South Slough that enters Coos Bay near the ocean (Willson et al. 2006; Wagoner et al. 1990, NMFS 2018b).

Little is known about the use of marine waters by eulachon and, due to paucity of sampling, little specific information exists on eulachon distribution off the U.S West Coast, including Oregon (Gustafson et al. 2010). Larvae and young juveniles become widely distributed in coastal waters, with fish found mostly at depths up to 15 meters (171 feet) but sometimes as deep as 182 meters (597 feet; Hay and McCarter 2000). Larger rearing fish have been reported to be in the near benthic habitats in open marine waters of the continental shelf between 20 and 150 meters (66 to 492 feet) deep (Barraclough 1964 as cited in Gustafson et al. 2010).

Adults and juveniles commonly forage at moderate depths (15 to 182 meters [50 to 600 feet]) in inshore waters, feeding on zooplankton, primarily eating crustaceans (Hay and McCarter 2000). Adults are found rarely in Coos Bay (64 FR 66601 [1999]), but have been reported to utilize both shallow and deep habitats in the estuary (64 FR 66601 [1999]). A 1971 report (Cummings and Schwartz 1971) noted their distribution only in the outer 7 miles of Coos Bay. Detailed larvae and juvenile fish sampling in Coos Bay over a 3.5-year period (1998-2001) found no eulachon (Miller and Shanks 2005). More recently, pelagic Tucker trawl samples over a 17-month period found larvae and small juveniles of a close relative, surf smelt, but no eulachon near the proposed terminal in Coos Bay (Shanks et al. 2011). However, given the limited survey effort and highly variable presence of eggs and larvae, eulachon occurrence in Coos Bay could not be ruled out (Storch and Van Dyke 2014).

Direct and indirect effects on eulachon in the southern DPS are not expected within the marine analysis area. Eulachon might detect noise from LNG carriers, but would be able to avoid adverse effects from noise. Potential oil and gas spills from LNG carriers in the marine analysis area are unlikely to affect aquatic resources because they are highly unlikely to occur; if LNG spilled or leaked, it would turn to vapor, would not mix with water, and would not contaminate surface water; and vessel response plans required to address accidental spills of LNG and other petroleum products onboard would be implemented. Effects on eulachon in the estuarine analysis area include increased turbidity from dredging activities and LNG carrier propeller wash and ship wake causing avoidance and reduced food supply, increased suspended sediment should an HDD construction failure occur in Coos Bay or the Coos River, entrainment and impingement in LNG carriers' water intake ports, acoustic effects including avoidance during terminal construction, habitat modification from dredging, and restoration activities at the Kentuck project site.

Below is the determination of effects summary for Pacific eulachon (Southern DPS) and critical habitat. Details will be provided in our pending BA.

The Project **may affect** Pacific eulachon (Southern DPS) because:

- Pacific eulachon may be present within the estuarine analysis area during construction and operation of the Project;
- Pacific eulachon may occur within the marine analysis area during operation of the proposed action;

The Project is **likely to adversely affect** Pacific eulachon (Southern DPS) because:

- Bottom disturbance and suspended sediment from Project construction, navigation channel widening, and maintenance dredging may affect the abundance and diversity of potential benthic and pelagic food resources, water quality, and suspended sediment during the short-term duration of these actions within the estuarine analysis area.
- Short-term increase in noise generated from the MOF land-based pile driving and in-water pile driving in various Coos Bay estuarine analysis areas may cause physical injury to individual eulachon at a limited distance during construction.
- Although eulachon would be rare in Coos Bay, and their large size would allow most to be able to avoid the LNG carrier cooling water intake, some limited number could be entrained during dredging and vessel loading in the bay.

The Project would have **no effect** on critical habitat for the Pacific eulachon (Southern DPS) because no designated critical habitat is present within the areas affected by the Project.

Lost River Sucker (Federal Endangered Species, State Endangered Species)

The Lost River sucker was listed as a federally endangered species on July 18, 1988, because of a variety of factors including loss of habitat and access to historical range, overfishing, degraded water quality, lack of adaquate recruitment, inadequate regulatory mechanisms, and a variety of other reasons resulting in declining populations (FWS 1988). Lost River sucker critical habitat was originally proposed in 1994 (59 FR 61744) but that proposal was never finalized. In 2011, a revised critical habitat designation was proposed and ultimately finalized in December 11, 2012 (77 FR 73739). Designated critical habitat for the Lost River sucker includes two units: the Upper Klamath Lake Unit and Lost River Basin Unit

The present distribution of the Lost River sucker includes Upper Klamath Lake and its tributaries, Clear Lake Reservoir and its tributaries, Tule Lake and the Lost River, the Klamath River, and Copco, Iron Gate, and John C. Boyle Reservoirs with no substantial change since listing (Reclamation 2007, 2012; FWS 2007d). They have also been found in Tule Lake (Reclamation 2012; FWS 2007d, 2013d). Critical habitat that could potentially be affected by construction of the Pacific Connector pipeline includes the Klamath River.

In the Upper Klamath Lake watershed, the Lost River sucker spawning runs are primarily limited to Sucker Springs in Upper Klamath Lake, and the Sprague and Williamson Rivers. Spawning runs also occur in the Wood River and in Crooked Creek in this watershed. In the Project vicinity, Lost River suckers spawn in the Lost River and are present in John C. Boyle Reservoir, downstream from the pipeline crossing at river mile (RM) 225 (NRC 2004). In addition to collections of Lost River suckers in John C. Boyle Reservoir, ORBIC (2012) cites records of collections in Lake Ewauna and in the Lost River Diversion Channel connecting the Klamath River (at RM 249.8) to the Lost River at the Lost River Diversion Dam, approximately 10 river miles downstream from the Pacific Connector pipeline crossing of the Lost River at RM 9.5.

The Pacific Connector pipeline route would cross Lost River (MP 212.07) 7.6 miles upstream of the known spawning area downstream of Anderson–Rose Dam, using a dry, open-cut method during low flows that coincide with the ODFW instream construction window extending from July 1 through March 31.

Spawning occurs within limited areas of the Lost River (FWS 2013d; Reclamation 2012), and occasional individuals have been found in this stream (NMFS and FWS 2013), which suggests it is possible that Lost River sucker occurs at the Pacific Connector pipeline crossing of Lost River at MP 212.07 during the non-spawning period. An additional 31 dry open-cut small intermittent stream crossings could also contain Lost River suckers as surveys have not been conducted for their presence.

Potential effects on the Lost River sucker are associated with pipeline stream crossings. These effects include the release of drilling mud from Klamath River HDD potential frac-out as well as potential entrainment or entrapment of fish, and increased turbidity and suspended sediment in occupied stream affecting fish avoidance and benthic food supply. Pacific Connector would install a temporary flowing stream crossing by lifting or spanning a structure from a bank so that equipment does not enter flowing waters. However, if it is not possible to do this safely, only equipment necessary to install the bridge would cross the stream. This would cause some limited short-term bottom benthic disruption and possibly elevated suspended sediment. Adults and juveniles subject to fish salvage associated with the Lost River crossing could be injured or killed if electrofishing is used, and stressed if seining is used. Incidental take of a Lost River sucker is possible, but salvage operations would follow Pacific Connector's *Fish Salvage Plan* which describes netting methods (e.g., beach seining, dip netting) that would be used before using electrofishing. There are additional salvage methods that have been specifically developed for these listed suckers to further reduce the potential effects of salvage (see the Klamath Project Operations Biological Opinion [Reclamation 2008] consistent with Reclamation's *Handling Guidelines for Klamath Basin Suckers).*

Below is the determination of effects summary for Lost River sucker and critical habitat. Details will be provided in our pending BA.

The Project **may affect** Lost River suckers because:

- Lost River suckers occur within the Upper Klamath River subbasin and Lost River subbasin, which would be affected during construction of the proposed action.

The Project is **likely to adversely affect** Lost River suckers because:

- Lost River suckers could occur in 19 waterbodies crossed by dry open-cut construction in the Lake Ewauna-Klamath River watershed and in 13 waterbodies west of MP 214.38 (including the Lost River) crossed in the Mills Creek-Lost River watershed and be indirectly affected by elevated suspended sediment levels, streambank erosion and stability, and aquatic nuisance species introductions; and
- fish salvage during the crossing of 31 ditches crossed by dry-open cuts and the Lost River crossing could result in injuring or killing of Lost River suckers if electroshocking is used, and stressing fish if seining is used.

The Project **may affect** designated critical habitat for the Lost River sucker because:

- there is a low risk of HDD failure during crossing of the Klamath River, resulting in a frac-out that releases drilling mud into the river.

However, the Project is **not likely to adversely affect** designated critical habitat for the shortnose sucker because:

- HDD crossing methods would avoid critical habitat in the Klamath River;
- the potential for hydraulic fracture during HDD drilling is so unlikely as to be discountable; and
- in the event of released bentonite, corrective actions would contain and temporally limit drill mud volumes.

Shortnose Sucker (Federal Endangered Species, State Endangered Species)

The shortnose sucker was listed as a federally endangered species on July 18, 1988 (FWS 1988). The final rule to list the shortnose sucker as endangered suggested several reasons for their decline, including the construction of dams, water diversions, overfishing, competition and predation by exotic species, water quality problems associated with timber harvest, removal of riparian vegetation, livestock grazing, lack of adaquate recruitment, inadequate regulatory mechanisms and agricultural practices. Shortnose sucker critical habitat was originally proposed in 1994 (59 FR 61744) but that proposal was never finalized. In 2011, a revised critical habitat designation was proposed and ultimately finalized in December 11, 2012 (77 FR 73739). Designated critical habitat for the shortnose sucker includes two units: the Upper Klamath Lake Unit and Lost River Basin Unit. The Klamath River is the only critical habitat for the shortnose sucker crossed by the pipeline or potentially affected by any Project actions.

Currently, shortnose suckers are present in upper Klamath Lake and tributaries, Lost River, Clear Lake Reservoir, the Klamath River, and three large Klamath reservoirs (Keno, Copco, and possibly Iron Gate Reservoirs) with no substantial change since listing (Reclamation 2007, 2012). They have also recently been found in Tule Lake and Gerber Reservoir (Reclamation 2012; FWS 2007d, 2013e).

Shortnose suckers live in lakes and spawn in rivers, streams or springs associated with the lake habitats, generally from early February through mid-April. After hatching, larval suckers migrate out of spawning substrates, which are usually gravels or cobbles, and drift downstream into lake habitats from early May to mid-June (FWS 1988, 1993b). The shortnose sucker is known to migrate out of Tule Lake to spawn in the Lost River below Anderson–Rose Dam about 7.6 miles downstream from the Lost River crossing. Therefore, the Pacific Connector pipeline would cross the Lost River where shortnose suckers could be present.

Potential effects on the shortnose sucker are associated with pipeline stream crossings. These effects include the release of drilling mud from Klamath River HDD potential frac-out as well as potential entrainment or entrapment of fish, and increased turbidity and suspended sediment affecting fish avoidance and benthic food sources in occupied streams, and fish being injured or killed during fish salvage efforts. Pacific Connector would install temporary flowing stream crossing by lifting or spanning a structure from a bank so that equipment does enter flowing waters. However, if it is not possible to do this safely, only equipment necessary to install the bridge would cross the stream. This would cause some limited, short-term bottom benthic disruption and possibly elevated suspended sediment. Adults and juveniles subject to fish salvage within the isolated construction site at the Lost River could be injured or killed if electroshocking is used and stressed if seining is used. Pacific Connector has included guidelines noted above under the Lost River sucker section in their *Fish Salvage Plan* that would be used near listed suckers. However, despite these measures, it is still possible that shortnose suckers could be killed by salvage operations and modifications to these plans may be needed to reduce this risk (see the Lost River Sucker section above).

Spawning occurs within limited areas of the Lost River (FWS 2013d; Reclamation 2012), and occasional individuals have been found in this stream region (NMFS and FWS 2013), suggesting it is possible that shortnose sucker could occur at the Pacific Connector pipeline crossing of Lost River at MP 212.07 during the non-spawning period. An additional 31 dry open-cut small intermittent stream crossings cannot be ruled out completely from potentially having shortnose sucker present because surveys have not been conducted for their presence.

The Project **may affect** shortnose suckers because:

- shortnose suckers occur within the Upper Klamath River subbasin and Lost River subbasin, which would be affected during construction of the proposed action.

The Project is **likely to adversely affect** shortnose suckers because:

- there is a possibility that shortnose suckers could occur within the Lost River when it would be crossed by the Pacific Connector pipeline and may be affected by elevated suspended sediment;
- shortnose suckers could occur in 19 waterbodies crossed by dry open-cut construction in the Lake Ewauna-Klamath River watershed and in 13 waterbodies west of MP 214.38 (including the Lost River) crossed in the Mills Creek-Lost River watershed and be indirectly affected by elevated suspended sediment levels, streambank erosion and stability, and aquatic nuisance species introductions; and
- adults and juveniles subject to fish salvage within the isolated construction site at 31 ditches crossed by dry-open cuts and the Lost River could be affected if electroshocking is used and stressed if seining is used.

The Project **may affect** designated critical habitat for the shortnose sucker because:

- there is a low risk of HDD failure during crossing of the Klamath River, resulting in a frac-out that releases drilling mud into the river.

However, the Project is **not likely to adversely affect** designated critical habitat for the shortnose sucker because:

HDD crossing methods would avoid critical habitat in the Klamath River;

- the potential for hydraulic fracture is so unlikely as to be discountable; and
- in the event of released bentonite during an HDD crossing, corrective actions would contain and temporally limit drill mud volumes.

4.6.1.4 Amphibians and Reptiles

Oregon Spotted Frog (Federally Threatened Species, Critical Habitat, State Sensitive-Critical)

On August 29, 2014, FWS listed the Oregon spotted frog as threatened (79 FR 51657). Critical habitat for the Oregon spotted frog was finalized in May 2016 and includes critical habitat in Oregon (Units 7 through 14; 81 FR 29335). This species is almost always found in or near a perennial body of water that includes zones of shallow water and abundant emergent or floating aquatic plants, which the frogs use for basking and escape cover (Corkran and Thoms 1996; FWS 2013f). The closest designated critical habitat unit to the Project is CHU 14 – Upper Klamath, which consists of 262 acres of lakes and creeks in Klamath and Jackson Counties and is currently occupied by Oregon spotted frogs (1 FR 2933). The Buck Lake population within CHU 14 is the closest occurrence of Oregon spotted frogs to the Project. This site includes seasonally wetted areas adjacent to the western edge of Buck Lake encompassing Spencer Creek downstream due west of Forest Service Road 46, three unnamed springs, and Tunnel Creek (81 FR 29335).

Oregon spotted frogs at Buck Lake have been consistently monitored from 2012 to 2016, along with other populations in the Oregon Cascades (Adams et al. 2017). Observations of frogs at two sites in Buck Lake and one in Tunnel Creek (both in CHU 14) indicate some variability in counts for each of several life stages but adults and larva or juveniles were found each year. Spencer Creek upstream of Buck Lake is almost equally subdivided into Buck Marsh, closest to Clover

Creek Road, and Buck Meadow, closest to Buck Lake (Lerum 2012). Buck Marsh is fed by several springs with evidence of beaver activity, and Buck Meadow is a pasture that often floods in the spring but does not stay flooded long enough to provide Oregon spotted frog breeding habitat. Further, soils in Buck Marsh are dense, possibly compacted by past heavy livestock use, and provide little water infiltration. Neither Buck Marsh nor Buck Meadow currently provide habitat for Oregon spotted frogs (Lerum 2012). Riparian vegetation is sparse and is unlikely to support beaver occupancy that could help to create suitable habitat (Lerum 2012).

The Project would cross Spencer Creek on the north side of Clover Creek Road, approximately 6,400 feet upstream from the CHU 14 at Buck Lake and pass within 280 feet of critical habitat in Spencer Creek downstream of Buck Lake. Potential effects on Oregon spotted frogs include changes to habitat quality and acoustic. Conservation measures proposed by Pacific Connector to minimize construction and operation effects on waterbodies and riparian zones would apply to Oregon spotted frogs.

Spencer Creek upstream of Buck Lake is not currently suitable habitat for Oregon spotted frogs and is unlikely to become suitable habitat and support Oregon spotted frogs at the time of construction. Clover Creek road separates the ROW from Spencer Creek downstream of Buck Lake so sediment from the construction ROW is not expected to enter Spencer Creek.

The Project **may affect** Oregon spotted frogs because:

- the Pacific Connector pipeline route would cross Spencer Creek, which is hydrologically connected to Buck Lake which is occupied by the frog; and
- the Pacific Connector pipeline route is within 280 feet of Spencer Creek and would cross tributaries to Spencer Creek downstream of Buck Lake, which is occupied by the Oregon spotted frog.

However, the Project **is not likely to adversely affect** Oregon spotted frogs for the following reasons:

- Buck Lake is approximately 6,400 feet downstream from where the pipeline route would cross Spencer Creek. Suspended sediment generated by the proposed action is expected to remain in the water column for 1,450 feet downstream from the construction site.
- Suspended sediment resulting from the crossing of Spencer Creek would pass through Buck Marsh, which Oregon spotted frogs do not currently inhabit. If the Oregon spotted frog does occur in Buck Marsh at the time of pipeline construction, conservation measures would limit potential effects due to acoustic shock, introduction of non-native species and/or disease, fuel and chemical spills, and herbicides.
- Future presence of Oregon spotted frogs in the Spencer Creek upstream of Buck Lake at the time of construction is extremely unlikely and considered to be discountable.
- Although the ROW occurs as close as 280 feet from Spencer Creek downstream of Buck Lake, they are not hydrologically connected because Clover Creek road separates the ROW from Spencer Creek; BMPs and erosion control measures should prevent sediment from the construction ROW from entering Spencer Creek.

The Project **may affect** designated critical habitat for the Oregon spotted frog because:

- the Pacific Connector pipeline route would be within 280 feet of proposed critical habitat within Spencer Creek downstream of Buck Lake.

The Project **is not likely to adversely affect** designated critical habitat for the Oregon spotted frog because:

- the designated critical habitat within 280 feet of the pipeline is not hydrologically connected to the ROW because it is separated by Clover Creek Road; and
- test water from the proposed hydrostatic discharge site at MP 169.52 is not expected to reach the critical habitat in Spencer Creek or Buck Lake, so effects on PBFs from changes in hydrology or introduction of nonnative species from the Project are discountable.

Sea Turtles

Four federally listed sea turtles potentially occur near the Project: green sea turtles, leatherback sea turtle, olive ridley sea turtle, and loggerhead sea turtle. All four species are federally threatened and state endangered.

Green sea turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south (NMFS 2007a). Green turtles primarily use three types of habitat: oceanic beaches (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas (NMFS 2007a). Reports of stranding suggest that the green turtle is a frequent visitor to the coast of California. Based on this data, green turtles are likely infrequent, transient visitors to the Oregon Coast, but may occasionally be found in the marine analysis area.

The leatherback sea turtle is the most common sea turtle in United States waters north of Mexico (NMFS and FWS 1998), and numerous sightings have been documented off the Oregon Coast. Adult leatherback turtles are highly migratory and available information indicates that eastern Pacific migratory corridors exist along the west coast of the United States (NMFS and FWS 1998). The west coast of the United States may represent some of the most important foraging habitat in the world for the leatherback turtle (NMFS and FWS 1998). Despite occasional reports of leatherbacks sighted at sea, and a growing database documenting their incidental catch in coastal and pelagic fisheries, there are very few areas where the species is routinely encountered. Exceptions include Monterey Bay, California (NMFS and FWS 1998). These data suggest that leatherback sea turtles would be present in the marine analysis area in higher densities relative to other sea turtle species, but still in low densities overall.

At-sea occurrences of olive ridley sea turtles in waters under United States jurisdiction are limited to the west coast of the continental United States and Hawaii, where the species is rare, but possibly increasing. During feeding migrations, olive ridley turtles may disperse into waters off the Pacific west coast as far north as Oregon (FWS 2013g). Based on sightings off the Oregon coast, olive ridley turtles may occasionally occur in the marine analysis area.

Loggerhead sea turtles occupy three different ecosystems during their lives—the terrestrial zone, the oceanic zone, and the neritic zone (NMFS 2007b). In the United States, occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California (NMFS 2007b). The potential importance of Oregon waters and the marine analysis area to loggerhead turtles is unknown, although two loggerhead turtles have been reported stranded in Oregon and Washington since the beginning of 1997 through 2007 (NMFS 2008d).

Direct effects of the proposed action include injury and/or mortality due to ship-strikes, underwater ship noise, and potential adverse effects from a vessel spill or ship release of LNG and fire at sea. Spills and/or release could indirectly affect federally listed sea turtles by affecting forage species. Below is a determination of effects summary for the federally listed sea turtles and critical habitat. More details will be provided in the pending BA.

The Project **may affect** federally listed sea turtles because:

- these sea turtles may occur within the marine analysis area during operation of the proposed action;
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area; and
- the continental U.S. Pacific Coast provides important foraging habitat for leatherback turtles.

However, the Project is **not likely to adversely affect** federally listed sea turtles because:

- ship strike on sea turtles would be highly unlikely;
- Jordan Cove would provide a ship strike avoidance measures package to LNG carrier operators transporting cargo from the terminal that consists of multiple measures to avoid striking marine mammals, which should also benefit sea turtles;
- The FERC does not have authority over the LNG carrier; however, the independent carrier operators would be required to follow all Coast Guard requirements regarding the operation of LNG carriers including carrier speeds;
- noise produced by LNG carriers would contribute to overall noise levels within the marine analysis area en route to the Port of Coos Bay and effects of ship noise on sea turtles could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise (NMFS 2016c, NMFS 2017b, NMFS 2018c), but would not exceed existing background ship noise levels and would not cause injury; and
- given vessel design, on-board spill kits, safety records, and implementation of Coast Guard recommendations, it is not likely that there would be a major ship spill of hazardous materials that may adversely affect water quality or aquatic species. Fuel released at sea, if any, would be in small enough quantities that potential effects on listed sea turtles would be discountable, especially given the low density of sea turtles within the marine analysis area.

No critical habitat has been designated or proposed for the olive ridley or loggerhead sea turtles. Critical habitat was established for the green turtle on Culebra Island, Puerto Rico, on September 2, 1998 (NMFS 1998); however, no critical habitat for green sea turtles occurs on the U.S. Pacific Coast, and the Project would therefore have no effect on designated critical habitat for the green turtle.

The Project **may affect** designated critical habitat for the leatherback turtle because:

- Critical habitat coincides with nearshore waters in the marine analysis area through which LNG carriers would transit to Coos Bay and the LNG terminal.

However, the Project is **not likely to adversely affect** designated critical habitat for the leatherback turtle because:

- LNG carriers and the Jordan Cove LNG Project are not likely to contribute oil, fuel, lubricants, or other contaminants to critical habitat to the extent that would adversely affect the occurrence of prey species, primarily jellyfish, of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction and development (PBF 1); and
- disturbance of benthic habitats within Coos Bay due to dredging would be of sufficiently short duration and small scale relative to the area available for settlement of larvae of the scyphozoan prey species within Area 2 that effects on PBF 1 would be unmeasurable and would therefore be discountable.

4.6.1.5 Invertebrates

Vernal Pool Fairy Shrimp (Federally Threatened Species with Critical Habitat, No State Status)

Vernal pool fairy shrimp were listed as threatened under the ESA on September 19, 1994 (FWS 1994a). This crustacean inhabits vernal pools, or seasonal wetlands that fill with water during fall and winter rains, in California and southwestern Oregon. The vernal pool fairy shrimp was identified relatively recently (in 1990) and was not discovered in Jackson County, Oregon until 1998 (FWS 2005s). As a result, it is possible that additional locations for the species will be found in Oregon in the future (FWS 2005a). Suitable vernal pool habitat occurs within and adjacent to Project facilities, some of which has not been surveyed. Additionally, a proposed pipe storage yard is in the Burrill Lumber industrial yard adjacent to the vernal pool fairy shrimp critical habitat unit VERFS 3A. Potential effects on vernal pool fairy shrimp and critical habitat include possible disturbance to pools from driving or storing equipment or pipes near or on pools or wetlands, and alteration of hydrology. Although nine vernal pools within the ROW between MPs 145.3 and 145.4 are outside the known range for vernal pool fairy shrimp, the vernal pools may provide suitable habitat for the species because the pools occur within the appropriate soils type (Agate-Winlo) for vernal pool fairy shrimp, occur near (i.e., within 8.2 miles of) the known and relatively recently (1998) expanded range of the species, and the species' absence has not been confirmed. Based on the relatively recent expansion of the known range of this species and the presence of potentially suitable habitat (including soil type) that has not been surveyed, there is potential for this species to be present within the ROW and be affected by pipeline construction.

These effects would be minimized through avoidance and minimization measures. Specifically, Pacific Connector has indicated they would avoid using areas within yards that may contain vernal pool fairy shrimp and, if this species is noted during survey efforts, they would implement proper sedimentation control barriers to minimize potential effects on the species. Below is a determination of effects summary for the vernal pool fairy shrimp and critical habitat. More details will be provided in the pending BA.

The Project **may affect** vernal pool fairy shrimp for because:

- Potentially suitable habitat for vernal pool fairy shrimp has been identified near four proposed Jackson County pipe storage yards, as well as within and adjacent to the pipeline ROW between MPs 145.30 and 145.40.

The Project is **likely to adversely affect** vernal pool fairy shrimp because:

- Effects on vernal pool fairy shrimp are possible due to the Project's crossing of potentially suitable, unsurveyed habitat within the pipeline ROW between MPs 145.30 and 145.40 (within Agate-Winlo soils).

The Project **may affect** vernal pool fairy shrimp critical habitat because:

- the Project occurs adjacent to designated vernal pool fairy shrimp critical habitat; and
- the Project may affect suitable habitat within designated critical habitat adjacent to the Project.

However, the Project is **not likely to adversely affect** vernal pool fairy shrimp critical habitat because:

- Although the proposed Burrill Lumber pipe yard occurs within 250 feet of designated vernal pool fairy shrimp critical habitat unit (VERFS 3A), it is separated from the critical habitat unit by Agate Road, which is a two-lane paved road that acts as a barrier to hydrologic connectivity that is considered a definitive boundary to the area of effects.
- Burrill Lumber pipe yard has been previously disturbed, and additional surface disturbances and/or soil compaction by heavy machinery from use within Burrill Lumber pipe storage yard should be minimal. Also, Agate Road is located between Burrill Lumber pipe yard and critical habitat unit VERFS 3A, which is raised and paved, and would serve as an existing barrier between the pipe yard and critical habitat unit. Therefore, use of the Burrill Lumber pipe storage yard is not expected to adversely modify geographic, topographic, and edaphic features potentially within 250 feet of the yard that support systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within the matrix of surrounding uplands (PBF 2).
- Proposed conservation measures would reduce the potential for increased sediment mobilization, increased fugitive dust, and the potential spread of invasive species to suitable vernal pool habitats.

4.6.1.6 Plants

A botanical analysis area applies to the extent of Project-related effects on listed plant species. The botanical analysis area for this Project extends to 98 feet (30 meters) each side of the pipeline project (i.e., construction ROW, TEWAs, UCSAs, rock source and disposal sites, proposed storage yards, and aboveground facilities) as well as the footprint for the Jordan Cove LNG Project. The botanical analysis area, in general, includes the area surveyed for sensitive and listed plant species (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands) and distance that indirect effects on plants would be expected. Surveys are incomplete in areas of potential habitat along the pipeline route where landowner permission was denied. Pacific Connector would survey these areas after the Project is certificated, but before construction begins (i.e., if the Project is approved and Pacific Connector gains access using eminent domain proceedings under Section 7h of the NGA). Pacific Connector identified unsurveyed areas that may contain suitable habitat for listed species, as will be discussed in our pending BA.

Pacific Connector has developed a *Federally-listed Plant Conservation Plan* to address how avoidance, minimization, propagation, restoration, and other conservation measures would be applied to protect listed plant species, as well as how potential effects on unsurveyed lands would be addressed. For example, if populations of listed plant species are identified where surveys were previously denied, Pacific Connector would apply mitigation measures that have been developed for surveyed lands to minimize and avoid effects on these species including (1) minor alignment or route adjustments; (2) narrowing or necking-down the construction ROW; or (3) eliminating or removing a portion of a TEWA or UCSA (depending on where new populations of these species were identified). Additional construction measures that would be implemented in areas that contain listed plants to minimize and avoid effects on these species, if they occur, include the following measures listed below.

- The construction ROW and TEWAs would be surveyed and flagged to clearly mark the limits of construction disturbance (i.e., clearing/grading).
- Where feasible, the EI would monitor the survey and flagging efforts and would provide additional protective buffers or neckdowns to ensure protection of adjacent plant populations or provide additional avoidance. The EI would consult with Pacific Connector's Chief Inspector and the construction contractor during construction to determine where additional buffer protections or neckdowns could be accommodated without affecting construction safety.
- Known plant populations adjacent to the construction ROW or other plants populations identified during preconstruction surveys would be protected by a safety fence and silt fence to ensure these plants are not inadvertently affected by Project activities.
- BMPs outlined in Pacific Connector's *Air, Noise and Fugitive Dust Control Plan*[140] to minimize wind erosion and fugitive dust emissions during construction and restoration activities would be implemented. Water would be used to control fugitive dust along the construction ROW (no Dustlok® would be used within 150 feet of any listed plants). Only enough water would be sprayed to control the dust or to reach the optimum soil moisture content to create a surface crust; no runoff would be generated.
- Equipment would be inspected and cleaned of potential noxious weed seed or plant parts consistent with the requirements of Pacific Connector's *Integrated Pest Management Plan*.
- Topsoil salvaging would occur within affected populations after species-specific seed, bulb, or whole plant salvage has occurred. The salvaged topsoil would be returned to its original location during restoration.
- During restoration, all areas would be regraded as closely as possible to the original contours to ensure preconstruction drainage patterns are not affected.

[140] Appendix B in Pacific Connector's POD filed with the FERC in January 2018,

- The construction ROW would be restored to its original contours and reseeded with an appropriate seed mixture recommended by FWS prior to the following growing season.
- When feasible, Pacific Connector would collect and bag seeds and/or bulbs of affected listed plants and provide these seeds and/or bulbs to a suggested repository. Upon FWS approval, the collected seeds would be replanted within or adjacent to the construction ROW on suitable federal lands where future protection can be managed or on private lands where a conservation easement has been acquired.
- Construction activities would occur in the fall and winter outside the critical growing, flowering, and seeding periods.
- Wetland mats would be used in travel areas in saturated soil areas to minimize soil rutting and soil compaction and protect existing plants that may be present.

The *Federally-listed Plant Conservation Plan* includes specific mitigation plans for Applegate's milk-vetch, Gentner's fritillary, Kincaid's lupine, and Cox's mariposa-lily. In addition, the Forest Service has developed mitigation measures/requirements related to their ROW Grant that may also indirectly benefit listed plant species (see chapter 2 of this EIS and appendix F).

Below is a discussion of each federally-listed plant species that could be affected by the Project. The mitigation measures discussed above would apply to all federally-listed plants discussed in this section.

Applegate's Milk-vetch (Federally Endangered Species, State Endangered Species)

FWS listed Applegate's milk-vetch (*Astragalus applegatei*) as endangered on July 28, 1993 (FWS 1993c). This species has a narrow range, known only in the Lower Klamath Basin (the plain containing Lower Klamath Lake), near the city of Klamath Falls in southern Oregon. It was believed to be extinct until its rediscovery in 1983 and at the time of listing was only known from two extant sites. Applegate's milk-vetch grows in flat-lying, seasonally moist, alkaline soils with underlying clay hardpans. The species' habitat was historically characterized by sparse, native bunchgrasses and patches of bare soil, allowing for some seed dispersal by wind. Today, dense coverage of the habitat by introduced grasses and weeds means seed dispersal is highly localized, with most seedling establishment found adjacent to mature plants (FWS 1998b). Continued destruction, modification, and/or curtailment of its habitat or range due to urban and commercial development, and loss of habitat through competition with non-native weeds, are the principal threats to the survival of the species (FWS 2009a).

The Pacific Connector Project is located within known and historic Applegate's milk-vetch range between MPs 191.20 to 214.30. The "Collins Tract site," which is located within and adjacent to the botanical analysis area between approximately MP 195.3 and MP 196.7, contains 19 sub-populations of Applegate's milk-vetch, several of which were discovered by FWS and SBS during surveys conducted for Pacific Connector. This area was revisited in 2018 and no new sites were documented. Pacific Connector has revised its proposed route slightly in this area to avoid direct effects on the plants identified in 2008 within the Collins Tract site. Survey efforts of the pipeline route subsequent to these initial survey efforts in 2007 and 2008 have not identified any additional plants; however, Pacific Connector has not surveyed all potential habitat. Additionally, in 2009, the FWS and The Nature Conservancy documented 1,260 plants within and adjacent to the proposed Klamath Falls Memorial Drive 2 pipe storage yard, in an area that has not been surveyed for the Project (ORBIC 2017a).

The route has been relocated to avoid known populations of Applegate's milk-vetch as well as suitable habitat found during surveys conducted during summer 2008; therefore, no direct effects on known plants in those sites are expected. Additionally, Pacific Connector would resurvey the Klamath Falls Memorial Drive 2 pipe storage yard prior to construction and avoid the use of the proposed yard within 30 meters of known and documented Applegate's milk-vetch plants. Project surveys of all suitable habitat have not been completed for this species; therefore, additional plants could potentially be encountered and affected by the Project. Measures to reduce impacts on unidentified plants are included in the *Applegate's Milk-vetch Mitigation Plan*; however, the FWS has indicated it may require additional mitigation for these potential impacts as part of their BO (including additional survey, seed collection, and salvage requirements). Below is a determination of effects summary for Applegate's milk-vetch and critical habitat. More details will be provided in the pending BA.

The Project **may affect** Applegate's milk-vetch because:

- suitable habitat is available within the botanical analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Applegate's milk-vetch because:

- approximately 175.3 acres of potential suitable habitat that has not been surveyed occurs within the botanical analysis area along the pipeline route, which includes 77 acres within the pipeline ROW; therefore, it is possible that unidentified plants occur within the construction ROW and workspace;
- surface disturbance and excavation would occur within potentially suitable habitats and could impact unidentified plants (including in areas where surveys have not been completed); and
- indirect effects, including potential changes in hydrology and soil characteristics, introduction and spread of invasive plants and noxious weeds, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust, could impact documented or suspected plants and habitat outside the construction ROW, but within 30 meters of the Project pipeline.

Critical habitat has not been designated for Applegate's milk-vetch.

Gentner's Fritillary (Federally Endangered Species, State Endangered Species)

FWS listed Gentner's fritillary (*Fritillaria gentneri*) as endangered on December 10, 1999 (FWS 1999). Gentner's fritillary is found in small, scattered locations in the Rogue and Klamath River watersheds in Jackson and Josephine Counties in Oregon (FWS 2003c; 2016d). This species is highly localized, with populations occurring within a 30-mile radius of Jacksonville Cemetery in Jacksonville, Oregon (FWS 2003c). Since the 2003 publication of the recovery plan, nine new Gentner's fritillary populations (approximately 131 flowering plants within 1.6 acres) have been detected outside of the four recovery unit boundaries (FWS 2016d). It is difficult to census populations of Gentner's fritillary because this species does not flower every year and individuals can remain dormant for one or more years underground.

Gentner's fritillary is often found on the edge of dry woodland and forests where the overstory can be dominated by Oregon white oak, madrone, Douglas-fir, and ponderosa pine; it also occurs in open chaparral and grassland environments. It occurs at a wide range of elevations, from 1,000 to 5,100 feet, and is usually associated with shrubs that provide protection from the wind and sun (FWS 2003c).

The Pacific Connector Project crosses the plant's range between approximately MP 113 through MP 155. Surveys for Gentner's fritillary have occurred within suitable habitat near the pipeline from 2007 through 2018. Surveys are expected to continue to complete recommended second year survey efforts, where necessary. Additionally, surveys will be initated in other areas that receive survey permission. Since 2007, survey efforts have identified Gentner's fritillary individuals in five locales: (1) approximately 0.38 mile north of MP 128.0 near Indian Creek and 50 feet below a four-wheel drive road; (2) 21 feet from TEWA 128.01-W; (3) 100 feet from proposed access road EAR-128.05; (4) near MP 129.1 approximately 54 feet from TEWA 128.96-N; and (5) within 21 feet of TEWA 142.07-N near MP 142.1. Of these five sites, three are located within the analysis area. Direct impacts on known individuals of Gentner's fritillary would be avoided; however, unidentified *Fritillaria* plants near MP 142.1 that could be Gentner's fritillary occur within the pipeline ROW and would be impacted if a reroute of the pipeline alignment is not implemented (additional details to be provided in our pending BA). Additionally, unidentified *Fritillaria* plants near MP 129 that could be Gentner's fritillary occur within the analysis area and could be indirectly affected.

Additionally, Project surveys of all suitable habitat have not been completed for Gentner's fritillary; therefore, additional plants could potentially be encountered and affected by the Project. The FWS will require two-year protocol surveys in unsurveyed, potentially suitable habitat and in suitable habitat where surveys are older than 10 years. However, indirect impacts on known individuals could be eliminated with minor modifications to the construction ROW. Therefore, **we recommend that:**

- **Prior to end of the draft EIS comment period, Pacific Connector should file with the Secretary revised alignment sheets that eliminate or relocate TEWA 128.01-W, TEWA 128.96-N, TEWA 142.07-N. and EAR-128.05.**

Below is the determination of effects summary for Gentner's fritillary; more details will be provided in our pending BA.

The Project **may affect** Gentner's fritillary because:

- suitable habitat is available within the analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Gentner's fritillary because:

- approximately 240.9 acres of potential suitable habitat that has not been surveyed occurs within the botanical analysis area along the pipeline route, which includes 50.4 acres within the pipeline ROW; therefore, it is possible that unidentified plants occur within the construction ROW and workspace;

- *Fritillaria* spp. have been identified within and adjacent to areas that would be affected by the Project;
- Gentner's fritillary can remain dormant underground for one year or longer, does not flower every year, and has been documented to not flower for several years; therefore, it is possible that protocol surveys conducted for the Project did not locate this species; and
- indirect effects, including potential changes in hydrology and soil characteristics, introduction and spread of invasive plants and noxious weeds, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust, could impact documented or suspected plants and habitat outside the construction ROW, but within 30 meters of the Project pipeline.

Critical habitat has not been designated for Gentner's fritillary.

Western Lily (Federally Endangered Species, State Endangered Species)

FWS listed the western lily (*Lilium occidentale*) as endangered on August 17, 1994 (FWS 1994b). This lily is currently known from 23 small populations in freshwater marshes and swamps, early successional fens (bogs), coastal scrub and prairie, openings in coastal, Sitka spruce–dominated coniferous forests, as well as other poorly drained soils along the coast of southern Oregon and northern California (FWS 2009b). Western lilies have an extremely restricted distribution, and only occur along the coast within 4 miles of the Pacific Ocean. Occurrences within the Coos Bay area are reported to occur in Blacklock soils; however, it also grows in soils that are well drained that have a substancial layer of organic soil (SHN 2013c).

The closest known western lily occurrence in relation to the Project is approximately 1 mile south of the Myrtlewood Off-site Park & Ride at the Hauser Bog (ORBIC 2017b). However, the Myrtlewood Off-site Park & Ride is located completely in the paved parking lot and does not contain suitable habitat for the western lily. There are no other known occurrences within two miles of the Project (ORBIC 2017b). There are no records of western lily north of Hauser, and the FWS typically considers Hauser the northern extent for the species along the Oregon coast.

Surveys for western lily within potential habitat in the analysis area (i.e., poorly drained bogs with acidic organic soils and within six miles of the coast below 300 feet elevation) were conducted between 2006 and 2017 (SHN 2013c; SBS 2008a, 2012, 2013, 2014, 2017a). Jordan Cove conducted surveys at the LNG terminal site in 2006, 2012, and 2013 and surveys were conducted by SBS for Pacific Connector between 2007 and 2017. No occurrences of western lily were detected during these surveys, and only limited areas of potential suitable habitat were identified. More details will be provided in our pending BA.

Although no plants were identified in the area that would be affected by the Project and potential occurrence of this species in this area is low, surveys of all potential habitat in the area have not been completed for this species; therefore, western lily could potentially be encountered and affected by the Project. Additionally, this species is difficult to detect when not flowering, and surveys may overlook western lily juveniles or vegetative adults, especially non-flowering individuals growing within dense vegetation (FWS 2008b). Below is the determination of effects summary for western lily and critical habitat.

The Project **may affect** the western lily because:

- known populations occur within 1 mile of the botanical analysis area; and
- potential suitable habitat is available within the analysis area.

The Project is **not likely to adversely affect** the western lily because:

- surveys of potential western lily habitat at the Jordan Cove site and associated facilities and along the pipeline route did not document western lily and potential suitable habitat within the botanical analysis area is limited;
- surveys in potentially suitable habitat would occur prior to ground-disturbing activities; if plants are identified, conservation measures developed to avoid or minimize effects on any documented plants would be implemented; and
- consultations with the FWS would be reinitiated if this species is found to be present in the area and effects cannot be avoided.

Critical habitat has not been designated for the western lily.

Large-Flowered Meadowfoam (Federally Endangered Species, State Endangered Species)

The large-flowered meadowfoam (*Limnanthes pumila* ssp. *grandiflora*) was federally listed as endangered on November 7, 2002 (FWS 2002b). It is an endemic species restricted mostly to the Agate Desert area in the Rogue River Valley of southern Oregon. It grows on the wetter, inner edges of vernal pools at elevations between 1,220 and 1,540 feet. The plant is capable of self-fertilization and self-pollination. In the Rogue River Valley, large-flowered meadowfoam is often found in the same vernal pool habitats as Cook's lomatium (*Lomatium cookii*) and the vernal pool fairy shrimp.

In 2010, FWS designated eight CHUs (5,840 acres) for the large-flowered meadowfoam in the Agate Desert complex in Jackson County, Oregon. Two of the units designated are shared by the designated habitat for Cook's lomatium. All designated CHUs are currently occupied (or expected to be occupied; FWS 2010b). Within the vicinity of White City, Oregon, where multiple pipe storage yards would be located, CHUs RV6 (6A through 6H) and RV8 have been designated. Industrial parks surround all units. Unit RV6C is across an existing paved road from the Burrill Lumber pipe storage yard, and Unit RV6D is 590 feet northeast of this pipe storage yard. RV8 is over 1.8 miles west of the proposed Rogue Aggregates and the other three pipe storage yards.

Botanical surveys were conducted within identified suitable habitat for this species where access was permitted, during the flowering season in April 2007. In 2007, survey efforts documented approximately 36 large-flowered woolly meadowfoam plants approximately 850 to 1,165 feet east of the proposed Burrill Lumber pipe storage yard. Additionally, ORBIC (2017a) has reported several other subpopulations of large-flowered woolly meadowfoam (approximately 16,200 plants) near proposed pipe storage yards, including within the Ken Denman State Game Management Preserve across an existing paved road east of the Burrill Lumber pipe storage yard.

No surveys have been permitted within Avenue F & 11th Street and WC Short pipe storage yards; however, off-site observations identified approximately 0.48 acre of highly modified, low-quality vernal pool habitat within 250 feet of the Avenue F & 11th Street and WC Short pipe yards. This area is associated with active industrial sites or previously disturbed industrial areas and is not expected to provide high-quality vernal pool habitat or support individuals of large-flowered woolly meadowfoam. Additionally, no direct or indirect effects on potential vernal pool habitat are expected from use of the Avenue F & 11th Street and WC Short pipe storage yards.

The Project **may affect** large-flowered woolly meadowfoam because:

- the pipeline occurs near occupied, large-flowered woolly meadowfoam habitat.

The Project is **not likely to adversely affect** large-flowered woolly meadowfoam because:

- surveys of potentially suitable habitat at proposed pipe storage yards in Jackson County and along the Project did not document large-flowered woolly meadowfoam plants;
- the 0.48-acre of unsurveyed potential habitat within the Avenue F and 11th and WC Short pipe storage yards consists of low-quality vernal pool habitat within active industrial sites or previously disturbed industrial areas and is unlikely to contain large-flowered woolly meadowfoam;
- Pacific Connector would avoid using portions of the pipe storage yards within 250 feet (indirect effect) of this species or potentially suitable vernal pool habitat;
- effects on suitable habitat are likely to be discountable to the point where no meaningful measurement, detection, or evaluation of effects would be possible (i.e., effects would not reach a level where individual plants would be lost);
- sedimentation barriers would be used, as appropriate, to prevent run-off and changes in hydrology;
- conservation measures have been developed to avoid or minimize effects on any plants identified during surveys prior to construction; and
- construction of the pipeline is not expected to adversely modify hydrology in nearby suitable habitat areas within 250 feet of proposed pipe storage yards.

The Project **may affect** designated critical habitat for large-flowered woolly meadowfoam because:

- the Project occurs adjacent to large-flowered woolly meadowfoam critical habitat.

The Project is **not likely to adversely affect** large-flowered woolly meadowfoam critical habitat because:

- Construction of the pipeline is not expected to adversely modify designated critical habitat areas within 250 feet of pipeline components (i.e., subunit RV6C); existing features (i.e., paved Agate Road) and proposed conservation measures would provide sufficient protection from adjacent development and invasive plant and noxious weed sources; and

- The Burrill Lumber pipe yard is hydrologically disconnected from subunit RV6D due to topography (flow is away from RV6D) and distance (greater than 590 feet) and is hydrologically isolated from subunit RV6C by the raised Agate Road.

Cook's Lomatium (Federally Endangered Species, State Endangered Species)

Cook's lomatium was listed as federally endangered on November 7, 2002 (FWS 2002b). Its range is on seasonally wet soils limited to two areas: (1) along vernal pools in the Agate Desert area of the Rogue River Valley, Jackson County, and (2) in seasonally wet serpentine-derived grassland meadows, sloped mixed-conifer forest openings, and and along roadsides edges in shrub dominated plant communities or adjacent to meadows within the Illinois River Valley area near Cave Junction, Josephine County. The Jackson County populations occur along the margins and bottoms of vernal pool habitats within a 20,510-acre landform known as the Agate Desert. The plant flowers from late March to May and is pollinated entirely by insects. In the Rogue River Valley, Cook's lomatium is often found in the same vernal pool habitats as the large-flowered meadowfoam and the vernal pool fairy shrimp.

In 2010, the FWS designated 16 units (6,289 acres) of critical habitat for the Cook's lomatium, including three CHUs in Jackson County, totaling 2,282 acres. Two of the designated units in Jackson County are shared by the designated habitat for large-flowered woolly meadowfoam. All designated CHUs are currently occupied (FWS 2010b). CHUs RV6 (A, F, G, and H) and RV8 have been designated within the vicinity of White City, Oregon, where multiple pipe storage yards would be located. Industrial parks surround these units. CHUs RV6A and RV6H are located approximately 0.5 mile south and 0.8 mile southeast, respectively, of the Avenue F & 11th Street and WC Short pipe storage yards.

Four pipe storage yards, Burrill Lumber, WC Short, Avenue F & 11th Street, and Rogue Aggregates, occur within the Agate Desert near White City in proximity to known occupied vernal pools. No vernal pool habitat or individuals of Cook's lomatium were observed during surveys of the Burrill Lumber and Rogue Aggregates pipe storage yards, and no potential vernal pools were located within 250 feet of the Burrill Lumber pipe storage yard. Although the layout for the Rogue Aggregates pipe storage yard has been reconfigured since surveys in 2007, unsurveyed portions do not contain suitable soil types for Cook's lomatium. Several patches of Cook's lomatium have been documented in the Denman Wildlife Management Area and Agate Desert Preserve, 0.5 mile south of the Avenue F & 11th Street and WC Short pipe storage yards (Friedman 2006, ORBIC 2017a). Surveys have not been conducted within the Avenue F & 11th Street and WC Short pipe storage yards because access has not been granted; however, based on aerial photography and off-site observation in April 2018, Avenue F and 11th and WC Short pipe storage yards do not appear to contain suitable habitat for Cook's lomatium. A long drainage ditch running along the northern edge of the Avenue F and 11th pipe storage yard, which could provide low-quality habitat for Cook's lomatium, was observed during these off-site surveys.

Below is the determination of effects summary for Cook's lomatium and critical habitat; more details will be provided in our pending BA.

The Project **may affect** Cook's lomatium because:

- suitable, occupied habitat is available within the vicinity of the Project.

The Project is **not likely to adversely affect** Cook's lomatium because:

- surveys of suitable habitat at pipe storage yards in Jackson County and along the pipeline did not document Cook's lomatium;

- Pacific Connector would avoid using portions of pipe storage yards within 250 feet of high-quality vernal pool habitat, as well as areas with potential vernal pool habitat;
- effects on suitable habitat are likely to be discountable to the point where no meaningful measurement, detection, or evaluation of effect would be possible (i.e., effect would not reach a level where individual plants would be affected);
- sedimentation barriers would be used, as appropriate, to prevent run-off and changes in hydrology;
- conservation measures have been developed to avoid or minimize effects on any plants identified during surveys prior to pipeline construction;
- known sites within the vicinity of the Project are farther than 0.5 mile from pipe storage yards; and
- unsurveyed habitat is low-quality vernal pool habitat located over 0.25 mile from known sites with no apparent hydrologic connectivity.

The Project would have **no effect** on designated Cook's lomatium critical habitat because:

- the pipeline is over 0.5 mile from the nearest critical habitat subunit RV6A; and
- the proposed action is not expected to adversely modify habitat areas that provide buffer protection from adjacent development and weed sources, continuous nonfragmented habitat, and intact hydrology (PBFs 1 and 4).

Kincaid's Lupine (Federally Threatened Species, State Threatened Species)

Kincaid's lupine was listed as federally threatened on January 25, 2000 (FWS 2000b). It is a long-lived perennial herb inhabiting native prairies and foothills (FWS 2000b). In Douglas County, Oregon, it occupies sites that are more shaded, occurring in areas with tree (i.e., Douglas-fir, California black oak, Pacific madrone, ponderosa pine, incense cedar, hairy manzanita, and poison oak) and shrub canopy cover of 50 to 80 percent (FWS 2006f). About 600 acres have been designated as critical habitat for this species; however, all of these designated habitats are located outside of areas that would be disturbed by the Project.

The pipeline is located within known or historical Kincaid's lupine range between MPs 46.8 and 99.3. Multiple populations of lupine have been identified in the Project's botanical analysis area within Douglas County, including 11 sites within 2.5 miles of the pipeline (ORBIC 2017a). Surveys in 2007 identified three populations of Kincaid's lupine in the vicinity of the pipeline: 1) within and adjacent to the construction ROW on private land between approximately MPs 57.84 and 57.92; 2) on private land near MP 59.60 (approximately 300 feet north of MP 59.60; 67 and 222 feet to the north and west of TEWA 59.30-N; and approximately 40 and 85 feet to the south and west of EAR 59.62); and 3) and on private land within the construction ROW and along proposed access roads between MPs 96.48 to 96.90.

Pacific Connector has modified the pipeline route to avoid the population located within the construction ROW between MP 57.84 and MP 57.92. No direct impacts are anticipated to the population near MP 59.60, as plants are located at least 67 feet from pipeline facilities. The two sites, near MP 57.84-57.92 and 59.60, were revisited in 2017, and both populations appeared to be stable or slightly increasing (SBS 2017b).

Pacific Connector also modified the construction ROW between MP 96.48 and 96.90 to avoid direct impacts on the Kincaid's lupine individuals identified during surveys in 2007. Additionally, the population between MP 96.48 and 96.90 was burned during the 2015 Stouts Creek fire. This population was revisited in 2016 to determine the affect of the fire, associated fire-suppression activity, and subsequent logging activities. Kincaid's lupine was observed in only 2 of the original 28 subpopulations documented in the area during surveys in 2007, and no viable plants were observed in the pipeline ROW or within proposed access roads (SBS 2016). Although no plants were relocated along the construction ROW between MP 96.48 and 96.90 in 2016, it is possible that construction of the pipeline and use of access roads could affect this population if plants resprout in this area. Pacific Connector would conduct additional surveys within the Stouts Creek fire area (MP 96.48 to 96.9) prior to ground disturbance.

No additional plants have been documented in other areas of the pipeline route, where access was granted, during subsequent surveys. However, not all suitable habitats within the Project area have been surveyed to date, indicating that additional unknown populations may be present within areas that could be affected by the Project. If other Kincaid's lupine populations are identified during additional surveys, Pacific Connector would implement applicable mitigation measures, such as necking down the construction right-of way, excluding a portion of an identified TEWA or pipe storage yard, and erecting a protective fence or barrier, to avoid or minimize impacts on newly observed populations. Persisting subpopulations at MPs 96.48 to 96.9 would be flagged/fenced to minimize potential disturbance.

The Project could affect unknown populations of Kincaid's lupine within and adjacent to the pipeline ROW. The *Federally-listed Plant Conservation Plan* contains a Kincaid's Lupine Mitigation Plan that specifically addresses mitigation that would be implemented for Kincaid's lupine; however, the FWS may require additional mitigation for these potential impacts as part of their BO (including additional survey, seed collection, and salvage requirements). Below is the determination of effects summary for Kincaid's lupine and critical habitat.

The Project **may affect** Kincaid's lupine because:

- suitable habitat is present within the analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Kincaid's lupine because:

- approximately 991.6 acres of potential suitable habitat that has not been surveyed occurs within the botanical analysis area along the pipeline route, which includes 448.7 acres within the pipeline ROW; therefore, it is possible that unidentified plants occur within the construction ROW and workspace;
- surface disturbance and excavation would occur within potentially suitable habitats, and could impact unidentified plants (including in areas where surveys have not been completed);
- indirect effects, including potential changes in hydrology and soil characteristics, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust, could impact documented or suspected plants and habitat outside of the construction ROW, but within 30 meters of the Project pipeline and along access roads; and

- trenching activities associated with the pipeline could affect below-ground stems, and the expected effect to extant plants is unknown.

The Project would have **no effect** on Kincaid's lupine critical habitat because:

- the pipeline does not occur within designated Kincaid's lupine critical habitat.

Rough Popcornflower (Federally Endangered Species, State Endangered Species)

The rough popcornflower was federally listed as endangered on January 25, 2000 (FWS 2000c). It is found in seasonal wet meadows or wet prairies in poorly drained clay or silty clay loam soils at elevations ranging from 100 to 900 feet. This plant occurs mostly on private lands in the Umpqua River drainage near Sutherlin and Yoncalla in northern Douglas County (FWS 2003d). As of 2010, there were 14 extant populations of rough popcornflower distributed from Yoncalla Creek near Rice Hill, south to Sutherlin Creek near Wilbur, of which five populations have been introduced (FWS 2010c). Six populations are considered protected and have a documented occupancy of at least 5,000 plants (FWS 2010c).

The closest known occurrences of rough popcornflower to the Project include multiple subpopulations approximately 1.7 miles north of the Winchester pipe storage yard and 17.5 miles north of the pipeline ROW at MP 68 (ORBIC 2017a, 2017c). Surveys for rough popcornflower have been conducted in potential habitat between MPs 51.7 and 67.0. To date, no individuals of rough popcornflower have been documented during surveys. However, Pacific Connector has not been granted access to approximately 99.83 acres of potentially suitable rough popcornflower habitat within the analysis area, the majority of which is associated with the Winchester pipe storage yard.

Due to the potential for the plant to occur within areas of potential habitat that have not been surveyed by Pacific Connector and may be disturbed by construction activities, the Project may affect rough popcornflower. Below is the determination of effects summary for rough popcornflower and critical habitat.

The Project **may affect** rough popcornflower because:

- populations occur near a pipe storage yard; and
- potential suitable habitat might be present within the 98-foot (30-meter) botanical analysis area.

The Project is **not likely to adversely affect** rough popcornflower because:

- where access has been granted, surveys for the Project have not documented individuals of rough popcornflower; surveys in potentially suitable habitat identified within the Winchester pipe storage yard would occur prior to ground-disturbing activities; if plants are identified, Pacific Connector would not use either the pipe storage yard or portions of the yard where plants are documented;
- surveys within potential habitat along the pipeline ROW would occur prior to ground disturbing activities; if any plants are identified, conservation measures developed to avoid or minimize effects on documented plants would be implemented; and
- consultation with the FWS would be reinitiated if this species is found to be present in the area and effects cannot be avoided.

Critical habitat has not been designated for rough popcornflower.

4.6.1.7 Conclusions and Recommendations for Threatened and Endangered Species

Based on informal consultations with the FWS and NMFS, 34 federally listed and proposed species were identified as potentially occurring near the Project. The FERC would only authorize the Project to proceed if the FWS' and NMFS' BOs find the Project, as described, would not jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. Further, to ensure compliance with the ESA, **we recommend that:**

- **Jordan Cove and Pacific Connector <u>should not begin construction until</u>:**
  - **a. the Commission staff completes formal consultations with the NMFS and FWS; and**
  - **b. Jordan Cove and Pacific Connector have received written notification from the Director of OEP that construction and/or implementation of conservation measures may begin.**

4.6.2 State-Listed Threatened or Endangered Species

In addition to species that are federally threatened or endangered, there are 13 species designated as threatened or endangered by the State of Oregon that could potentially occur in the area affected by the Project (table 4.6.2-1).

TABLE 4.6.2-1

State-Listed Species Potentially Occurring in the Area Affected by the Proposed Project

Species	FWS Status	ODFW Status	Portion of the Project Area Where Species Potentially Occur
Mammals			
Kit fox *Vulpes macrotis*	None	Threatened	Pacific Connector Pipeline
Gray Whale *Eschrichtius robustus* (Eastern North Pacific stock)	Delisted	Endangered	LNG carrier transit in the waterway, Navigation Reliability Improvements Dredge Areas
Birds			
California brown pelican *Pelecanus occidentalis*	None	Endangered	Navigation Reliability Improvements Dredge Areas, Jordan Cove terminal
Plants			
Pink sand verbena *Abronia umbellata* ssp. *Breviflora*	Species of Concern	Endangered	Jordan Cove terminal
Point Reyes bird's-beak *Cordylanthus maritimum* ssp. palustre (*C. maritimus* ssp. *palustris*)	Species of Concern	Endangered	Jordan Cove terminal; Pacific Connector pipeline
Wayside aster *Eucephalis vialis* (*Aster vialis*)	Species of Concern	Threatened	Pacific Connector pipeline
Peck's milk-vetch *Astragalus peckii*	None	Threatened	Pacific Connector pipeline
Pumice grape-fern *Botrychium pumicola*	None	Threatened	Pacific Connector pipeline
Cox's mariposa-lily *Calochortus coxii*	Species of Concern	Endangered	Pacific Connector pipeline
Umpqua mariposa-lily *Calochortus umpquaensis*	Species of Concern	Endangered	Pacific Connector pipeline

TABLE 4.6.2-1

State-Listed Species Potentially Occurring in the Area Affected by the Proposed Project

Species	FWS Status	ODFW Status	Portion of the Project Area Where Species Potentially Occur
Dwarf woolly meadowfoam *Limnanthes pumila ssp. pumila*	Species of Concern	Threatened	Pacific Connector pipeline
Silvery phacelia *Phacelia argentea*	Species of Concern	Threatened	Jordan Cove terminal Pacific Connector pipeline
Wolf's evening primrose *Oenothera wolfii*	None	Threatened	Jordan Cove terminal

4.6.2.1 Mammals

Kit Fox (No ESA Status, State Threatened Species)

The kit fox reaches its northern limit in southern Oregon. In Oregon, it is found in arid desert valleys dominated by halophytic plants like greasewood and shadscale, intermingled with sagebrush. Although the Project may affect suitable kit fox habitat, the expected distribution of this species does not include the Project area. Because kit foxes have not been recently observed within the area affected by the Project (ORBIC 2017a), the Project is not expected to affect this species.

Gray Whale (Eastern North Pacific stock; Federal Delisted Species, State Endangered Species)

The gray whale is a large baleen whale that is distributed in the northern Pacific Ocean in western and eastern stocks. The eastern stock, found along the west coast of North America, was federally delisted on June 16, 1994 (59 FR 115), but remains state endangered in Oregon. The eastern Pacific stock feeds in the summer in the Chukchi Sea, the western Beaufort Sea, and the northern Bering Sea. They migrate south from November through early February to lagoons on the Pacific coast of central and southern Baja California. Northward migration occurs after the calving and breeding season, from early February to May. These whales have the longest known migration of any mammal. Gray whales feed on infaunal benthic species that are buried in sediments (Maser et al. 1981). Gray whales are federally protected under the MMPA.

Potential effects on gray whales include injury and/or mortality due to ship strikes, underwater ship noise, construction noise (including pile driving and dredging) and potential adverse effects from a ship fuel spill at sea. Spills could indirectly affect gray whales by impacting forage species. These potential effects would be similar to the effects on federally listed whales that are discussed above, except that gray whales migrate in coastal waters north and south parallel to the Pacific Coast, making them more susceptible to ship strikes in nearshore waters during migration.

According to the Oregon Parks and Recreation Department (OPRD 2007), gray whales are the most predominant whales seen along the Oregon coast. They migrate twice a year, in winter and spring, and about 200 of them feed along the coast during the summer months. Gray whales have on occasion entered Coos Bay beyond the Jordan Cove LNG Project site and have been seen in Coos Bay at about the same frequency as killer whales. Gray whales may be encountered along the LNG carrier transit route during their southern migration from November through early February or from early February to May during the northern migration. Based on data in Pacific waters between 1999 and 2003, gray whales are struck by ships at a rate of 1.2 whales annually (Angliss and Outlaw 2007). The increase in shipping traffic resulting from LNG carriers could cause an increase in the probability of whales being struck by ships, or of being disturbed during migration. Measures that Jordan Cove would implement to avoid or minimize effects on federally listed whales (see section 4.6.1.1) would serve to avoid or minimize effects on the gray whale.

4.6.2.2 Birds

California Brown Pelican (Federal Delisted Species, State Endangered Species)

The brown pelican was listed as a federally endangered species on June 2, 1970, within California, Oregon, Texas, and Washington states, as well as Central and South America (FWS 1970). It was delisted in December 2009 (FWS 2009c); however, Oregon still considers the brown pelican an endangered species under state law (ODFW 2017h).

The California brown pelican is a primarily coastal species, rarely seen inland or far out at sea (FWS 2005b). They feed mostly in shallow estuarine waters, normally staying within 20 miles of shore (FWS 2005b). Pelicans make extensive use of sand spits, offshore sand bars, and islets for nocturnal roosting and daily loafing, especially by non-breeders and during the non-nesting season (FWS 2005b).

Brown pelicans nest in colonies, mostly on small coastal islands in California (FWS 1985, 2007e). Brown pelicans generally breed between February and October and are most abundant in Oregon during post-breeding migration (FWS 2005b). In Oregon, numbers peak in late August through October and gradually decline from October through early November as birds move south (Gilligan et al. 1994). Since brown pelicans have wettable feathers, they return to land daily to roost and dry their feathers (FWS 2005b). Sand islands within three large estuaries in Oregon and Washington serve as primary night roosts (Jaques and O'Casey 2006 as cited in FWS 2007e). The total number of brown pelicans in Oregon in 2001 was estimated to be 6,095 (Marshall et al. 2003).

Brown pelicans are regularly seen in moderate numbers during the summer months in Coos Bay, and they also occur in small numbers in the winter (Contreras 1998). Coos Bay provides excellent habitat for this species. Brown pelicans were recorded foraging near the Project site more than 500 feet from the shore and loafing across the bay in moderate numbers daily during surveys in October 2012 (SHN 2012). The species was also observed during surveys conducted in 2005-2006 until early September (LBJ 2006). The Project site provides no nesting habitat for the brown pelican. Roosting and feeding sites have been documented within the Project area, although the last observation was in 1985. Roosting was reported on the north side of Coos Bay on a sunken jetty close to the Bay mouth and on a sand spit on the North Spit of Coos Bay, as well as on dredge spoil islands around MPs 3R through 4R (ORBIC 2017a).

In the past, California brown pelicans have been affected by human disturbances at nesting colonies and roosting habitats. Existing nesting and roosting habitats within the Coos Bay Estuary and Jordan Cove LNG Project area have not been documented. If they occur within the estuary during construction and operation of the proposed action, pelicans may be associated with on-shore fish-cleaning stations where they possibly feed on offal (Marshall et al. 2003). Existing fish-cleaning stations are present at the Empire Boat Ramp, Oceanside RV Park and Bastendorff Beach County Park, both in Charleston. Fish-cleaning could also occur at the Charleston Marina, California Street Boat Ramp, and BLM Boat Ramp, though they are not designated as such.

Noise and human activities associated with construction and operation of the Project are likely to be the only direct effect to brown pelicans if they occur within one or more of the Project's analysis areas. Jordan Cove is proposing construction of its access channel in Coos Bay during the ODFW recommended in-water work window between October 1 and February 15. This schedule would minimize effects on brown pelicans because there is a gradual decline in populations in Oregon as birds move south from October through early November (Gilligan et al. 1994). However, noise created by pile driving and construction in general is likely to affect brown pelicans if present and could disrupt brown pelican feeding behavior.

Brown pelicans that forage within the vicinity of the Jordan Cove LNG Project (i.e., the estuarine analysis area) could ingest low levels of contaminants through the food web that are re-suspended from dredging activities. However, sediments at the Jordan Cove LNG Project site and pipeline route within Coos Bay are not expected to contain levels of sediment contaminants that could adversely affect brown pelicans. Access channel dredging and maintenance dredging would not occur during the period of peak pelican abundance in the lower bay. Therefore, dredging activities would not substancially disrupt normal behavior patterns for brown pelicans.

Pacific Connector is proposing construction across Coos Bay using HDD construction in two segments (MP 0.12 to MP 1.11 and MP 1.40 to MP 3.09). It is possible that the brown pelican could be present within Coos Bay and its vicinity during the time of construction (see Contreras 1998). Therefore, noise and human activities associated with construction and operation of the pipeline are likely to affect brown pelicans as sources of disturbance and disruption if they are present and could disrupt brown pelican feeding behavior.

There is some evidence in the literature that high intensity continuous anti-collision lights on structures may result in an increased number of bird strikes, especially at night or during fog and overcast conditions. The number of strikes can apparently be reduced by strobe or blinking the anti-collision lights. The LNG storage tanks would not be illuminated with high intensity lighting. The intensity and number of lights would be limited to what is required for security and operations. With the low-intensity lighting to be used, the likelihood of adverse effects on brown pelicans from collisions with the LNG storage tanks is minimal.

Brown pelicans may be encountered during any portion of the LNG carrier transit route in the waterway. There is no evidence that pelicans are struck by current cargo ships using the Port.

During operation of the Pacific Connector pipeline, aerial inspection of the pipeline route would occur within the permanent ROW. Aerial inspections would generally occur during all times of year, although inspections would not affect nesting or breeding brown pelicans since they do not nest or breed within Coos Bay. Additionally, aerial inspection should not disturb migrating, roosting, or foraging brown pelicans since air traffic is a constant disturbance within Coos Bay from the existing North Bend airport.

The proposed action would create auditory and visual disturbances that are likely to cause foraging brown pelicans to temporarily avoid areas of high activity. The proposed action area does not contain existing nesting or roosting habitat and would not affect nesting or roosting individuals. As a result, the proposed action would temporarily affect foraging individuals but is not expected to affect nesting or roosting by brown pelicans

4.6.2.3 Plants

Pink Sand Verbena (Federal Species of Concern, State Endangered Species)

The historical range of pink sand verbena (*Abronia umbellata* ssp. *breviflora*) was from northern California to Vancouver British Columbia, Canada (ODA 2017c). Its present range is along coastal beach and foredune, predominantly from Cape Blanco (Curry County), southern Oregon to Point Reyes National Seashore in Marin County, California and sporadically along Oregon's northern and central coast. Pink sand verbena only inhabits the littoral sandy beach areas and unstabilized sand dunes of the coastal strip and usually occurs on beaches in fine sand between the high-tide line and the driftwood zone, and in areas of active sand movement below the foredune (ORBIC 2010). In the northern portion of its range, most populations of pink sand verbena occur on broad beaches and/or near the mouths of creeks and rivers.

Of the 12 reported occurrences in Oregon, only 2 have more than 50 plants; many of the populations consist of only one plant and will probably not persist. Two populations of pink sand verbena documented near the mouth of Coos Bay, contained approximately 300,000 plants when surveyd in 2012 (ORBIC 2017a). Approximately 15 miles north of the entrance to Coos Bay, 19 plants were documented in 1995 within a protected (public entry prohibited) snowy plover nesting area (ORBIC 2012). There are no known occurrences of pink sand verbena within two miles of the Jordan Cove Project area (ORBIC 2017a). No pink sand verbena plants have been reported within the Pacific Connector pipeline area (ORBIC 2006a) and the pipeline route would not affect coastal sand dune habitat; therefore, Pacific Connector has not conducted botanical surveys for this species and no incidental documentations of this species has occurred.

Jordan Cove identified suitable habitat for the plant along the eastern portion of the LNG terminal in areas of actively moving dunes and European beachgrass. However, surveys conducted at the Jordan Cove Project area in 2006, 2012, and 2013 did not locate any pink sand verbena plants (SHN 2006b, 2013c). As surveys conducted within the Jordan Cove Project area, as well as historic data, indicate that pink sand verbena is not present within the Project area, the Project is not expected to affect this species.

Point Reyes Bird's-beak (Federal Species of Concern, State Endangered Species)

Point Reyes bird's-beak (*Cordylanthus maritimum* ssp. *palustre* [*C. maritimus* ssp. *palustris*]) inhabits salt marshes along the coast, sometimes growing just above tidewater in wet areas. Its habitat requirements are specific: approximately 7.5 to 8.5 feet (2.28 to 2.59 meters) above mean lower low water, soil salinity of 34 to 55 parts per thousand, sandy substrate covered by 1 to 10 cm (0.39 to 3.93 inches) organic silt, and less than 30 percent bare soil in summer. Point Reyes bird's-beak occurs along the Pacific Coast from Tillamook County, Oregon, south to Santa Clara County, California. In Oregon, the species is restricted to Netarts Bay, Yaquina Bay, and Coos Bay, with most known occurrences located in Coos Bay. Within the counties crossed by the Project, Point Reyes bird's-beak is found in Coos County.

Several occurrences of Point Reyes bird's-beak are near both the Jordan Cove LNG Project and the Pacific Connector Pipeline Project. Populations with 1,000 to 10,000 plants are located along the margins of Coos Bay and on sand salt marshes near the edge of high water marks (ORBIC 2017a). Several occurrences of Point Reyes bird's-beak are near the Jordan Cove LNG Project, and this species is known to occur within the intertidal wetland between APCO Sites 1 and 2;

however, there is no suitable habitat on APCO Site 2 as this area is dominated by upland vegetation. This species also occurs outside the LNG terminal area along the west and southeast shoreline of the South Dunes site (ORBIC 2017a) and potential habitat for this species has also been observed along the shoreline south of the South Dunes site. Jordan Cove would conduct an additional survey in this area of potential habitat prior to construction.

The area affected by the Pacific Connector Pipeline Project is within the vicinity of documented populations of Point Reyes bird's-beak and the pipeline route would cross suitable habitat. Populations with 1,000 to 10,000 plants were located in 1982 and 1999 along the margins of Coos Bay approximately 260 feet south of TEWA 0.10 (HDD pull-back) and on sand salt marshes near the edge of high water marks on the west side of Haynes Inlet approximately 815 feet north of the Jordan Cove Meter Station near the proposed HDD across Coos Bay (ORBIC 2017a). These plants are farther than 100 feet from the pipeline route and should not be affected by construction. Surveys conducted for Pacific Connector in 2007 located one population of about 1,000 Point Reye's bird's-beak plants approximately 1.7 miles south of MP 1.7 (FERC 2009). Additional surveys occurred in 2017 along the pipeline route near MPs 0.3, 1.0, and 1.47 near the edge of high water marks where the pipeline HDD exits and enters land. Approximately 30 Point Reyes bird's beak plants were located at the margin of Coos Bay near MP 0.9, approximately 475 feet northwest of the construction right-of way and 700 feet west/northwest of TEWAs 1.09-N and 1.09-W. This portion of the pipeline would be constructed by HDD and should not affect plants observed at this location.

Point Reyes bird's-beak is found within and near the Jordan Cove and Pacific Connector Project areas; however, construction of the Project should not directly affect individual plants. Additionally, Pacific Connector has committed to protecting plants adjacent to the pipeline construction ROW through the appropriate installation of safety and silt fence as determined by Pacific Connector's EIs.

Wayside Aster (Federal Species of Concern, State Threatened Species)

The wayside aster's (*Eucephalis* [*Aster*] *vialis*) range is limited to central, southern, and western Oregon and the northern California state line (ORBIC 2010). About 100 populations are known, totaling fewer than 9,000 individuals. Most populations are centered in the southern Willamette Valley of Lane County or in southern Jackson and Josephine Counties, although a few populations exist in the adjacent counties of California (ORBIC 2010). None of the known populations are protected, and many populations are along roadsides and in areas of residential development. Wayside aster occurs in areas of natural and man-made disturbance, edges and openings in woodlands and forests, in second and old-growth, and in shaded roadsides.

Several populations of wayside aster plants have recently been documented within Douglas and Jackson Counties; however, except for one site discussed below, these records are more than 0.5 mile from the Pacific Connector Project area. Botanical surveys for this species in potential habitat have been conducted by Pacific Connector in Coos Bay, Roseburg, and Medford BLM Districts; Umpqua National Forest; and Jackson County. This species was documented in 2007 adjacent to a previously proposed existing access road that would require improvements; however, this road is no longer proposed for use as an access road. This site was revisited in 2009 and additional surveys were conducted within 0.25 mile of this site; however, no plants were located.

Although the species is documented near the Project, surveys conducted by Pacific Connector for the wayside aster did not detect this plant's presence. Construction of the pipeline, including the use of access roads, is not anticipated to affect this species.

Peck's Milk-vetch (Federal Species of Concern, State Threatened Species)

Peck's milk-vetch (*Astragalus peckii*) occurs east of the Cascades Mountain range. Most populations of Peck's milk-vetch are centered in three separate areas: one in north-central Deschutes County, another in north-central Klamath County, and the third in south-central Klamath County. These populations total about 300,000 individuals. The plant occurs in very dry sites, on loose, sandy soil or pumice, often in or along dry water courses, in sagebrush or rabbitbrush openings in ponderosa pine forests (in the south) or in western Juniper woodlands (in the north), and occasionally on barren flats.

Peck's milk-vetch has not been documented within the vicinity of the Project (ORBIC 2006a). No suitable habitat for Peck's milk-vetch occurs within the areas crossed by the pipeline route; therefore, Pacific Connector did not conduct botanical surveys for this species. As this species is not expected to occur along the pipeline route, it would probably not be affected by construction and operation of the Project.

Pumice Grape-Fern (No ESA Status, State Threatened Species)

This species is one of the rarest grape-ferns, and in Oregon is found only within the Crater Lake area and Paulina Mountains in Deschutes and Klamath Counties. Most known populations are found in fine pumice gravel at elevations above 7,800 feet (2,400 meters). It has also been located within frost pockets in lodgepole pine forests with bitterbrush, in areas with deep, sterile pumice. In Oregon, pumice grape-fern *(Botrychium pumicola*) is typically associated with Brewer's sedge and buckwheat (*Eriogonum* spp.) species (Eastman 1990; ORBIC 2010).

The Project is not located near known sites of this plant, and no suitable habitat for this plant occurs within the areas crossed by the pipeline route; therefore, Pacific Connector did not conduct botanical surveys for this species. As the pumice grape-fern is not expected to occur along the pipeline route, the Project would probably have no effect on this species.

Cox's Mariposa Lily (Federal Species of Concern, State Endangered Species)

The Cox's mariposa lily (*Calochortus coxii*) is endemic to serpentine and ultramafic soils and is limited to a small area (30 square meters) along a 10-mile serpentine ridge system in Douglas County, Oregon. All known populations are on serpentine soils, mostly on shady, north-facing, mesic sites near ridgelines, typically, growing in serpentine grasslands and forest margins. Population monitoring studies on BLM land from 2011 through 2015 demonstrated relatively high interannual variation in population estimates for Cox's mariposa lily. For example, 6,966 plants were observed in 2011, whereas 13,865 individuals were observed in 2012 (Gray and Bahm 2015). Populations are also known to occur on private lands; however, surveys haven't been conducted on private lands since the early 1990s (ORBIC 2017a; Aaron Roe, Botanist Roseburg BLM District, personal communication, February 1, 2019). Threats to this species include fire exclusion, encroachment by conifers, noxious weed invasion, logging, grazing, road construction, and off-highway vehicle recreational use (Gray and Bahm 2015; BLM and FWS 2004).

Based on existing data, the Pacific Connector pipeline route would cross one population between MP 74.1 and 75.0 on lands administered by the BLM Roseburg District (ORBIC 2017a). In 2012, surveys conducted by the BLM documented approximately 1,300 plants within and adjacent (within 100 meters) to the Project, with approximately 300 plants occurring in the construction ROW (BLM 2017c). However, modifications have been made to the pipeline route subsequent to these surveys. In 2018, surveys for Cox's mariposa lily were conducted during the flowering season on approximately 65 acres between MPs 74 and 75 of the revised pipeline route. The 2018 survey data are currently under review by the BLM. Additionally, there are approximately 45.3 acres of potential suitable Cox's mariposa lily habitat on private lands within the pipeline route that have not been surveyed.

Individuals of Cox's mariposa lily occur along the pipeline route; therefore, construction and operation of the Project would directly and indirectly affect this species and this species' habitat. In addition to the direct removal of individuals, construction of the pipeline would fragment approximately 0.9 mile of of suitable Cox's mariposa lily habitat. Potential indirect effects to documented or suspected plants and habitat include potential changes in hydrology and soil characteristics, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust.

Pacific Connector has developed a Cox's mariposa lily specific mitigation plan (included as an attachment to the *Federally-Listed Plant Conservation Plan*[141]) to avoid and minimize potential effects on this species. As described in the mitigation plan, Pacific Connector would determine if site-specific neck-downs can be incorporated into the construction ROW to minimize direct effects on the population of Cox's mariposa lily between MPs 74 and 75. The construction ROW in this area utilizes the typical 95-foot width with TEWAs because of the steep and narrow ridgeline alignment; thus, neck-downs would be dependent on site-specific conditions and would be based on species presence and the work area requirements to ensure safe pipeline installation. Appropriate barriers would be installed along areas that contain this species to ensure that the mariposa lily populations in the vicinity are not affected by sediments and debris from the ROW. In locations where individual plants cannot be avoided by construction activities, plants would be salvaged during the late summer or fall after the growing season of the year preceding actual pipeline construction. Additional mitigation techniques that would be employed to protect these populations of Cox's mariposa lily include seed collection and bulb salvage, and site restoration and monitoring. However, there has not been any research on the effectiveness of seed collection and bulb salvage as mitigation techniques for this species. Based on comments provided by the BLM, the BLM may require additional mitigation measures for the Cox's mariposa lily as part of their review of the ROW application.

Umpqua Mariposa Lily (Federal Species of Concern, State Endangered Species)

The Umpqua mariposa lily (*Calochortus umpquaensis*) is known to occur within 17 localities; none of which are protected. This plant grows in both forests and meadows on serpentine soils at elevations below 2,500 feet, but it is the most vigorous in margins between forests and meadows. In southwestern Oregon, it is associated with a diverse array of plants, and it is found in diverse soils, aspects, and slopes.

[141] Appendix J to Pacific Connector's POD filed with the FERC in January 2018.

Several large populations of this plant (5,000 to 60,000-plus) have previously been documented approximately 1.3 and 2.5 miles east of the pipeline alignment near MP 99.55, adjacent to the Green Butte (EAR 102.30) and Callahan Creek (EAR 104.24) access roads. Pacific Connector conducted botanical surveys for this species between 2007 and 2017 in potential habitat within the vicinity[142] of the pipeline in lands administered by the Roseburg BLM District and Umpqua National Forest. In 2016, seven plants were observed adjacent to EAR 102.3 and 25 feet east of the Hatchet Quarry MP 102.3 Rock Source/Disposal Site near a previously (1992) documented population. Additionally, potential suitable habitat would also be crossed by the pipeline near the site where Cox's mariposa-lily was documented (MPs 74.08 to 75.02), although no individuals of Umpqua mariposa lily were observed during surveys conducted for the pipeline in this location.

Although, Umpqua mariposa lily individuals have been documented adjacent to EARs 102.30 and 104.24, no road improvements are necessary. Additionally, plants are separated from the access roads by topography and/or Callahan Creek; therefore, it is not expected that use of the existing access roads would directly or indirectly affect these populations. The population along EAR 102.30 and 25 feet east of the Hatchet Quarry MP 102.3 Rock Source/Disposal Site may be indirectly affected by the Pacific Connector Project; however, construction of the Project should not directly affect individual plants. Additionally, Pacific Connector has committed to protecting plants adjacent to the pipeline construction ROW through the appropriate installation of safety and silt fence as determined by Pacific Connector's EIs.

Dwarf Woolly Meadowfoam (Federal Species of Concern, State Threatened Species)

Dwarf woolly meadowfoam's (*Limnanthes pumila* ssp. *pumila*) range is restricted to two small protected areas, totaling about 2 square miles with at least 10,000 individuals (ORBIC 2010). Dwarf woolly meadowfoam inhabits small depressions in thin clay soil overlying old basalt at the edges of deep vernal pools, which are dry by mid-summer and generally exposed to full sunlight. The only known occurrences are on Table Rock in Jackson County (on Lower and Upper Table Rocks); which is over 12 miles southwest of the Pacific Connector pipeline and 1.4 to 2.4 miles north of four proposed Jackson County pipe storage yards (ORBIC 2006a).

Because the dwarf woolly meadowfoam is endemic to vernal pools at Table Rocks, Pacific Connector did not conduct botanical surveys for this species. Additionally, this species was not documented incidentally during survey efforts for other vernal pool–associated species conducted for the Project. As this species is not expected to occur along the pipeline route, it would probably not be directly affected by construction and operation of the Project.

Silvery Phacelia (Federal Species of Concern, State Threatened Species)

The silvery phacelia (*Phacelia argentea*) is known from 24 occurrences, totaling 15,000 individuals, along the coastline of Coos and Curry Counties and in adjacent northern California, Del Norte County (ORBIC 2010). In March 2015, a petition was submitted to the FWS to list the silvery phacelia as a threatened or endangered species (FWS 2015a); however, the petition was denied in 2015 due to lack of substantial information that this species was a listable entity (FWS 2015b). Silvery phacelia is the only phacelia growing along the coastline in open sand or on dunes

[142] Provided in Pacific Connector's Initial Response to the FERC staff's Environmental Information Request dated January 3, 2018, filed with the FERC on January 23, 2018.

along the south coast of Oregon. It inhabits sandy beach dunes and bluffs near the coast, and some partially-stabilized or unstabilized dunes.

Silvery phacelia has not been documented in the vicinity of the Project and the closest known plants are located more than 10 miles south of the entrance to the Coos Bay Estuary (ORBIC 2017a); however, suitable habitat for this species does exist at the LNG terminal area, in regions of active and semi-active dunes where the European beachgrass and the red fescue-salt rush herbaceous vegetation associations occur (see section 4.4 of this EIS). There is marginal habitat at the APCO Site and the meteorological station, although the European beachgrass in these areas is generally too dense to support this species. Surveys conducted by Jordan Cove have not detected this species (SHN 2006b, 2012) and, due to the lack of suitable habitat, botanical surveys for this species were not conducted along the pipeline route. Based on the lack of occurrences (from both historical data as well as surveys), it is not expected that the Project would affect this species.

Wolf's Evening Primrose (No ESA Status, State Threatened Species)

Wolf's evening primrose (*Oenothera wolfii*) occurs in well-drained sandy soils with adequate moisture in coastal bluff scrub, coastal prairie, roadsides, and coastal dune habitats from Curry County in southern Oregon to the northern California coast (Tibor 2001). This species is associated with a high disturbance regime and several occurrences in California are located along roadsides with sandy soil (CNDDB 2005 as cited in FERC 2015). Wolf's evening primrose is typically associated with low elevation coastal habitats, but there have been reported occurrences in lower montane coniferous forest in California, at elevations greater than 2,500 feet (Tibor 2001).

The closest known occurrence of Wolf's evening primrose to the Project is in Port Orford, Oregon, approximately 60 miles to the south of the Jordan Cove LNG terminal site; however, suitable habitat for this species is present at the LNG terminal site. There is marginal habitat at the APCO Site and the meteorological station, although the European beachgrass in these areas is generally too dense to support this species. Surveys conducted at the LNG terminal site did not detect the Wolf's evening primrose (SHN 2006b, 2012). Considering the lack of occurrences (based on historic and recent survey data), it is not expected that the Project would affect this species.

4.6.3 Other Special Status Species

In addition to the federal and state threatened, endangered, and proposed species described above, there are species that have been given special status designations by federal or state agencies and Indian tribes that could potentially occur in the Project area (see tables I-3, I-4, and I-5 in appendix I). The FWS and NMFS maintain a list of federal species of concern, which are species whose conservation standing is of concern but for which status information is still needed. The ODFW also assigns special status to fish and wildlife species that are not listed. State special status designations include sensitive and sensitive-critical (ORBIC 2016). Sensitive refers to fish and wildlife that are facing one or more threats to their populations and/or habitats. Species or taxa with a sensitive-critical subdesignation are sensitive species of particular conservation concern. Sensitive-critical species have current or legacy threats that are impacting their abundance, distribution, diversity, and/or habitat. They may decline to the point of qualifying for threatened or endangered status if conservation actions are not taken.

In addition to the threatened and endangered plant species described above, ODA designates candidate species for listing. ODA candidate species include any plant species designated for study by the director of ODA whose numbers are believed low or declining, or whose habitat is sufficiently threatened and declining in quantity and quality, so as to potentially qualify for listing as a threatened or endangered species in the foreseeable future (ODA 2017d).

4.6.3.1 U.S. Fish and Wildlife Service and National Marine Fisheries Service

The FWS (2006d, 2006e, 2013h, 2017c) and NMFS (2006) list 69 fish and wildlife species of concern that potentially occur in counties coinciding with the Project. The list of federal species of concern includes 14 mammals, 20 birds, 3 reptiles, 10 amphibians, 10 fish, and 12 invertebrates. These species, and expected habitat for each species, are listed in tables I-3 and I-4 in appendix I of this EIS. The FWS has noted that the Umpqua chub may be present in the Umpqua River, and this species is of concern because it has rapidly decreased in abundance. This species is discussed in detail in the BE (see appendix F.7 of this EIS).

The FWS lists one plant species as a federal candidate for listing, and 52 federal plant species of concern that potentially occur in counties coinciding with the Project. These species are listed in table I-5 in appendix I of this EIS, along with expected habitat for each species.

4.6.3.2 Oregon Department of Fish and Wildlife

The ODFW (2016) identified 71 state sensitive species that potentially occur in counties coinciding with the Project area, some of which (i.e., 37) are also considered federal species of concern. This list includes 15 mammals, 28 birds, 13 fish, 2 reptiles, and 13 amphibians. The ODFW does not assign special status for invertebrates. Tables I-3 and I-4 in appendix I provide the following information for each state special status species: expected habitat and documentation within each county, BLM district, and National Forest crossed by the Pacific Connector pipeline and vicinity.

Although the state sensitive species listed in tables I-3 and I-4 may occur in counties noted by FWS (2006d, 2006e) and ODFW (ORBIC 2006a, 2012), distributions and/or habitat associations of some preclude their potential occurrence in the area that would be affected by the Project.

4.6.3.3 Oregon Department of Agriculture

The ODA identified 41 candidates for listing that potentially occur in counties coinciding with the Project area, 26 of which are also federal species of concern. Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species as a result of the Project are presented in table I-5 in appendix I.

4.6.3.4 Tribal Species of Concern

The CIT identified the following plant and animal species as species of concern. According to the CIT, this list is not comprehensive, but does represent the most significant and important traditional cultural plant and animal species that are found on the Coquille Forest and other Tribal lands. A more complete list and description of plant usage can be found in "Ethnobotany of the Coquille Indians". Significant and important plants include, but are not limited to:

- Trees (bark and wood): Port Orford cedar, western red cedar, Sitka spruce, big leaf maple, myrtle, red alder, madrone, Pacific yew.

- Shrubs (wood, nuts and berries): elderberry (*Sambucus* spp.), willows, hazel, vine maple, rhododendron, azalea (*Rhododendron* spp.), manzanita, ocean spray, Labrador tea (*Ledum* spp.), huckleberry, salal, thimbleberry, salmonberry, Oregon grape.
- Flowers and vines (roots and fiber): yarrow (*Achillea millefolium*), camas (*Camassia*), tiger lily (*Lilium columbianum*), columbine (*Aquilegia* spp.), various *Lomatium* and *Brodiaeas*, iris (*Iris* spp.), trailing blackberry (*Rubus ursinus*), yerba buena (*Clinopodium douglasii*), beargrass (*Xerophyllum tenax*).
- Wet Meadow/Riparian Plants: cattail, tule (*Schoenoplectus* spp.), various sedges and ferns, skunk cabbage, various mosses.
- Marine/Estuary: eelgrass, giant kelp (*Macrocystis* spp.), bull kelp (*Nereocystis luetkeana*), sea lettuce (*Ulva* spp.), surfgrass (*Phyllospadix* spp.).

Impacts on these species would be similar to the impacts on vegetation described in section 4.4. Project effects on the wetland and estuary species of traditional-cultural importance would be as described for wetlands and waters in section 4.3. Species that are protected by federal and/or state jurisdictions (e.g., various sedges) are also addressed elsewhere in this section and in appendix I.5.

The following list of mammals, bird, and fish is also not comprehensive, but does represent many of the CIT's species of concern:

- Terrestrial: deer, elk, coyote, cougar, bear, bobcat, raccoon, beaver, squirrel.
- Marine/ Estuary: lamprey, salmon (all available species), shellfish, crab, sea mammals, rockfish, lingcod, sculpin, halibut, flounder, perch, herring, greenling, candlefish (i.e., eulachon), snails, mussels, barnacles, chiton, sea urchin, abalone (*Haliotis spp*.), dentalium (*Dentalium spp*.) (other seasonally available estuary species).
- Streams: salmon (all available species), lamprey, sturgeon, trout, mussels.
- Birds: Eagles, hawks, owls, cormorant, kingfisher, herons, osprey, flicker (*Colaptes auratus*), woodpeckers (particularly pileated), grebe, crows and ravens, and colorful neo-tropicals.

Impacts on these species would be similar to the impacts on wildlife and aquatic resources described in section 4.5. Species that are protected by federal and/or state jurisdictions (e.g., owls) are also addressed elsewhere in this section and in appendix I.3.

4.6.3.5 Assessment of Other Special Status Species

Of the other special status species identified above as potentially occuring in counties coinciding with the Project, only a subset have the potential to be affected by the Project. Table 4.6.3.5-1 identifies the number of these other special status mammals, birds, fish, amphibians, reptiles, invertebrates, and vascular plants potentially affected by the Project. For species that are also BLM and Forest Service sensitive species or the Forest Service's Survey and Manage species, occurrence and potential effects on federal lands are also described below in section 4.6.4, Environmental Consequences on Federal Lands.

TABLE 4.6.3.5-1

Numbers of Other Special Status Species Potentially Affected by the Project a/

Taxonomic Group	Federal Status: FWS or NMFS Species of Concern	State Status: ODFW Sensitive or ODA Candidate	Total b/
Mammals	12	12	16
Birds	19	24	31
Non-anadromous Fish	4	4	5
Anadromous Fish	3	5	7
Amphibians and Reptiles	7	9	9
Aquatic Invertebrates	3	N/A	3
Terrestrial Invertebrates	1	N/A	1
Vascular Plants	2	2	2

Sources: FWS (2006d, 2006e, 2017c), NMFS (2006d), ORBIC (2006a, 2006b, 2017a), ODFW 2016b.

a/ Other Special Status Species include FWS and NMFS fish, wildlife, and plant species of concern and candidate species, ODFW Sensitive fish and wildlife species, and ODA candidate species for listing. Forest Service sensitive and Survey and Manage species and BLM sensitive species are only tallied here if they meet this criteria for Other Special Status Species. Species are not tallied here if they are also federal or state listed or proposed.

b/ Rows do not sum because a species is tallied in multiple columns where it is considered special status by multiple agencies.

Descriptions of expected habitat, documented or suspected occurrences, and potential Project effects on these other special status species within the Project area are presented in tables I-3, I-4, and I-5, respectively, in appendix I. Additionally, effects on these species and proposed measures to minimize effects would be similar to the those described for general fish and wildlife in section 4.5 of this EIS.

4.6.4 Environmental Consequences on Federal Lands

The BLM and Forest Service maintain lists of sensitive species to ensure that their actions do not contribute to or cause a trend toward listing under the ESA. Additionally, until 2016, the BLM and Forest Service maintained a list of Survey and Manage species, or species that are rare and uncommon or poorly understood that are closely associated with late successional or old-growth forests within the range of the NSO (Forest Service and BLM 2001a). In August 2016, the BLM issued two RODs for two new RMPs (BLM 2016a and 2016b). These two plans supersede the NWFP on BLM lands, and eliminated requirements to survey and manage for species included on the 2001 ROD Survey and Manage species list on BLM lands. Potential effects on Survey and Manage species on NFS lands are discussed here.

Species that are on both the sensitive list and the Survey and Manage list are discussed on NFS land under section 4.6.4.3, Survey and Manage Species. Additionally, although the Forest Service and BLM include federal and state threatened, endangered, proposed, and candidate species on their species lists, these species are not discussed in this section as they are presented above.

4.6.4.1 Description of BLM and Forest Service Sensitive Species

The BLM maintains a list of Special Status Species (including BLM sensitive species) as required by BLM 6840, Special Status Species Manual, to ensure that BLM actions do not contribute to a loss of viability or cause a trend toward listing under the ESA. Like the BLM, the Forest Service is required by Forest Service Manual (FSM) 2760 to maintain a list of sensitive species for each region, including species listed as federally threatened, endangered, or proposed under the ESA, as well as species that are threatened by human activities. Activities on NFS lands must be managed to ensure that current federally listed species do not become extirpated or that activities do not result in ESA listing for other sensitive species. As required in FSM 2760, the Forest Service is obligated to evaluate Project effects on sensitive species in a BE (see appendix F.7).

The Pacific Northwest Regional Office of the Forest Service and Oregon/Washington State Office of the BLM established an interagency program for the conservation and management of special status species. New criteria for BLM Special Status Species and Forest Service Sensitive Species were jointly approved in 2015 by the Region 6 Regional Forester and BLM Oregon/Washington State Director for determination of species included within the BLM and Forest Service Sensitive Species Program. The new criteria were designed to make the BLM and Forest Service more consistent in their approaches to the development of lists of species with conservation concerns. The BLM (2015) and Forest Service (Forest Service 2015) identify federally listed, federally proposed, and sensitive species required under their respective policies. Additionally, they have identified “strategic species” that are not considered sensitive under those policies. Strategic species include species with information gaps (e.g., distribution, habitat, threats, taxonomy) that are suspected to occur on NFS or BLM lands.

According to Instruction Memorandum No. OR-2015-028, sensitive species are those that are documented or suspected endangered or threatened at the federal or state level, federal de-listed species, are Oregon Heritage List 1 or List 2, and have been documented on at least one Oregon BLM district. These species should be managed to ensure that activities on BLM lands do not contribute to their listing.

Strategic species are not classified as Special Status for management purposes. The only requirement for this group of species is to record sites found during any survey efforts. Therefore, strategic species are not discussed in this section unless observed during surveys.

Table 4.6.4.1-1 lists the BLM and Forest Service sensitive species documented or suspected to occur within the districts and forests crossed by the Pacific Connector pipeline (BLM 2015; Forest Service 2015).

Not all species documented or suspected in BLM districts and national forests crossed by the Project occur within the area affected by the Project. Many were excluded from consideration after review of range and habitat information. Other species were excluded if they were not known to occur in the Project vicinity based on special status species locations within 3 miles of the Project obtained from the BLM Geographic Biotic Observations (GeoBOB) database and Forest Service Natural Resource Information System (NRIS) database (BLM 2006a, 2012, 2017a; Forest Service 2006, 2012, 2017c; NSR 2012), and through ORBIC data requests (ORBIC 2006a, 2012, 2017a).

TABLE 4.6.4.1-1

Numbers of BLM and Forest Service Sensitive Species within the Four BLM Districts and Three National Forests Crossed by the Proposed Pacific Connector Pipeline a/

	Number in BLM Districts				Number in National Forests		
Taxonomic Group	**Coos Bay**	**Roseburg**	**Medford**	**Lakeview**	**Umpqua**	**Rogue River-Siskiyou**	**Fremont-Winema**
Mammals	4	5	4	6	5	6	5
Birds	8	7	9	13	11	9	12
Reptiles	1	1	1	1	1	1	1
Amphibians	1	1	3	2	1	3	2
Non-anadromous Fish	1	1	2	10	2	0	10
Anadromous Fish	5	3	4	0	3	4	0
Invertebrates	14	10	16	7	14	21	21
Fungi	13	12	14	0	11	16	4
Non-vascular Plants	34	17	18	5	26	27	12
Vascular Plants	35	36	91	44	31	99	49

Note: A species is tallied in multiple columns where it occurs and is sensitive on multiple BLM Districts or National Forests.
a/ Source: BLM 2015; Forest Service 2015

Pacific Connector conducted surveys from 2007 through 2018 for special status species, including BLM and Forest Service sensitive species. Special status mollusks, fungi, and vascular and non-vascular plants not detected during these complete, targeted surveys were determined to not be present, and thus not affected by the Project. Forest Service and BLM sensitive species that are documented or suspected to occur on BLM districts and/or national forests crossed by the Project, but were dropped from further consideration due to a lack of habitat or because they were not detected during targeted field surveys are listed in tables I-3, I-4, and I-5 in appendix I. Information provided for each of these species in appendix I includes expected habitat, county, national forest, and BLM district distribution, known occurrences in relation to the Project, and effects determination and rationale for this determination.

BLM and Forest Service sensitive species that may be affected by the Project are listed below in table 4.6.4.1-2, excluding the state and federally listed, proposed, and candidate species discussed above, and the Survey and Manage species on NFS land discussed below. Where suitable habitat was documented for a species, but species-specific surveys were not conducted, presence was assumed, and potential effects on these species are discussed here.

TABLE 4.6.4.1-2

BLM and Forest Service Sensitive Species with the Potential to be Affected by the Project a/

Common Name	Scientific Name	Forest Service Sensitive	BLM Sensitive
Mammals			
Pallid bat	*Antrozous pallidus*	X	X
Townsend's big-eared bat	*Corynorhinus townsendii*	X	X
Fringed myotis	*Myotis thysanodes*	X	X
Pacific marten	*Martes caurina*	X	X
Pacific fisher	*Pekania pennanti*	X	X
Birds			
Grasshopper sparrow	*Ammodramus savannarum*	X	
Red-necked grebe	*Podiceps grisegena*	X	X
Horned grebe	*Podiceps auritus*	X	X
American white pelican	*Pelecanus erythrorhynchos*	X	X
Snowy egret	*Egretta thula*		X
Aleutian Canada goose	*Branta canadadnsis leucopareia*		X
Harlequin duck	*Histrionicus histrionicus*	X	X

TABLE 4.6.4.1-2 (continued)

BLM and Forest Service Sensitive Species with the Potential to be Affected by the Project a/

Common Name	Scientific Name	Forest Service Sensitive	BLM Sensitive
Bufflehead	*Bucephala albeola*	X	
Franklin's gull	*Larus pipixcan*		X
White-tailed kite	*Elanus leucurus*	X	X
Upland sandpiper	*Bartramia longicauda*	X	
Bald eagle	*Haliaeetus leucocephalus*	X	X
American peregrine falcon	*Falco peregrinus anatum*	X	X
Greater sage-grouse	*Centrocercus urophasianus*	X	X
White-headed woodpecker	*Picoides albolarvatus*	X	X
Lewis' woodpecker	*Melanerpes lewis*	X	X
Purple martin	*Progne subis*	X	X
Oregon vesper sparrow	*Pooecetes gramineus affinis*		X
Tricolored blackbird	*Agelaius tricolor*	X	X
Reptiles			
Western pond turtle (formerly Pacific pond turtle)	*Actinemys marmorata*	X	X
Amphibians			
Foothill yellow-legged frog	*Rana boylii*	X	X
Terrestrial Invertebrates			
Oregon shoulderband	*Helminthoglypta hertleini*	X (also Survey and Manage)	X
Traveling sideband	*Monadenia fidelis celeuthia*	X	X
Siskiyou hesperian	*Vespericola sierranas*	X	X
Franklin's bumblebee	*Bombus franklini*	X	X
Western bumblebee	*Bombus occidentalis*	X	X
Siskiyou short-horned grasshopper	*Chloealtis aspasma*	X	X
Gray-blue butterfly	*Plebejus podarce*	X	X
Johnson's hairstreak	*Callophrys johnsoni (Mitoura johnsoni)*	X	X
Insular blue butterfly	*Plebejus saepiolus littoralis*	X	X
Mardon skipper	*Polites mardon*	X	X
Coronis fritillary	*Speyeria coronis coronis*	X	X
Aquatic Invertebrates			
Western ridgemussel	*Gonidea angulata*	X	X
California floater	*Anodonta californiensis*	X	X
A caddisfly (no common name)	*Namamyia plutonis*	X	X
Montane Peaclam	*Pisidium ulttramontanum*	X	X
Pacific walker	*Pomatiopsis californica*	X	X
Archimedes springsnail	*Pyrgulopsis archimedis*	X	
A caddisfly (no common name)	*Rhyacophila chandleri*	X	X
Lined ramshorn	*Vorticifex effusa diagonalis*	X	X
caddisfly (no common name)	*Rhyacophila leechi*		X
Non-anadramous Fish			
Umpqua chub	*Oregonichthys kalawatseti*	X	X
Millicoma dace	*Rhinichthys catarctae* ssp.		X
Anadramous Fish			
Pacific lamprey	*Entosphenus tridentata*	X	X
Chinook Salmon Southern Oregon Coast/California Coast ESU, Fall-run, Spring-run	*Oncorhynchus tshawytscha*	X	X
Steelhead Klamath Mountains Province ESU Summer/winter run	*Oncorynchus mykiss*	X	X
Steelhead Oregon Coast ESU	*Oncorynchus mykiss*	X	X

TABLE 4.6.4.1-2 (continued)

BLM and Forest Service Sensitive Species with the Potential to be Affected by the Project a/

Common Name	Scientific Name	Forest Service Sensitive	BLM Sensitive
Vascular Plants			
Rogue Canyon rockcress	*Arabis modesta*	X	X
Bensonia	*Bensoniella oregana*	X	X
Bristly sedge	*Carex comosa*	X	X
Coastal lip-fern	*Cheilanthes intertexta*	X	X
Pine woods cryptantha	*Cryptantha simulans*	X	
California globe-mallow	*Iliamna latibracteata*	X	X
Bellinger's meadowfoam	*Limnanthes floccosa* ssp. *bellingeriana*	X	X
Lichens			
no common name	*Bryoria subcana*	X	X

a/ Excluding state and federally listed, and select proposed and candidate species and Survey and Manage species, which are discussed in other sections of this EIS.

Excluding federal and state threatened, endangered, and select proposedand candidate species (discussed above), and Survey and Manage species on NFS lands (discussed below), a total of 60 BLM and Forest Service sensitive species have the potential to be affected by the Project: 5 mammal, 19 bird, 1 reptile, 1 amphibians, 20 invertebrate, 6 fish, 7 vascular plant, and 1 lichen species(table 4.6.4.1-2). Tables I-3, I-4, and I-5 in appendix I provide habitat descriptions for these species. Forest Service sensitive species that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7), and Survey and Manage species that would potentially be affected by the proposed action on NFS lands are addressed in more detail in the Survey and Manage Report (appendix F.5 of this EIS).

4.6.4.2 Assessment of BLM and Forest Service Sensitive Species

BLM and Forest Service sensitive species that may be present and potentially affected by construction of the pipeline on federal lands are described here. If species were documented during targeted surveys, those locations and potential effects are also described.

Mammals

There are five BLM and Forest Service sensitive mammals that may be present and potentially affected by construction of the pipeline on federal land: the pallid bat (*Antrozous pallidus pacificus*), Townsend's big-eared bat (*Corynorhinus townsendii*), fringed myotis (*Myotis thysanodes*), marten (*Martes caurina*), and fisher (*Pekania pennanti*). Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species within the Project area are presented in table I-3 in appendix I. As all five of these species are Forest Service sensitive, they are additionally addressed in the BE if effects are anticipated on NFS lands (appendix F.7). Marten and fisher are also discussed above as federal proposed threatened species.

Birds

There are 19 BLM and/or Forest Service sensitive birds that may be present and potentially affected by construction, maintenance, and operation of the pipeline on federal land. Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species as a result of the Project are presented in table I-3 in appendix

I. Forest Service sensitive birds that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7).

Fish

There are six BLM and/or Forest Service sensitive fish species that may be present along the LNG carrier transit route, in the waters of Coos Bay potentially affected by construction of the pipeline, or in waters crossed by the pipeline. Of these species, four are anadromous and two are non-anadromous. Descriptions of life histories, expected habitat, and potential occurrences of these special status fish species within the Project area are presented in table I-4 in appendix I. Forest Service sensitive fish that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7).

Amphibians and Reptiles

There are two BLM and Forest Service sensitive amphibians and reptiles that may be present and potentially affected by construction of the pipeline on federal land: western pond turtle (*Actinemys marmorata*) and foothill yellow-legged frog (*Rana boylii*). Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species within the Project area are presented in table I-3 in appendix I. As both species are Forest Service sensitive, they are additionally addressed in the BE (appendix F.7).

Invertebrates

<u>Aquatic</u>

There are nine BLM and Forest Service sensitive aquatic invertebrates that may be present and potentially affected by construction of the pipeline on federal land. All these species are associated with freshwater environments. Table I-4 in appendix I summarizes the life history, habitat associations, and occurrence of these invertebrates. Eight of these species are Forest Service sensitive aquatic invertebrates, and thus are additionally addressed in the BE if effects are anticipated on NFS lands (appendix F.7).

<u>Terrestrial</u>

There are 11 BLM and Forest Service sensitive terrestrial invertebrates that may be present and potentially affected by the construction of the pipeline on federal land. Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species within the Project area are presented in table I-3 in appendix I. As all 11 species are Forest Service sensitive terrestrial invertebrates they are additionally addressed in the BE (appendix F.7).

Approximately 20 acres of the ROW near known populations of two Forest Service sensitive terrestrial invertebrates (Mardon skipper and short-horned grasshopper) on the Dead Indian Plateau would be restored with grasses (including *Festuca* sp.) preferred by these species in addition to the rehabilitation required under BMP guidelines. This mitigation on the Rogue River National Forest has the potential to increase the habitat and local range for these two species.

Three BLM and Forest Service sensitive mollusk species were located during surveys for the Project: Siskiyou hesperian, traveling sideband, and Oregon shoulderband. These three species are discussed in the following paragraphs; Siskiyou hesperian and traveling sideband are additionally addressed in the BE as they were observed on NFS lands during surveys (appendix F.7).

Field Survey Locations and Potential Effects

Traveling sideband is a BLM and Forest Service sensitive species (BLM 2015; Forest Service 2015) and an Oregon endemic terrestrial snail. During surveys in 2007 and 2010, this species was observed at nine locations on the Rogue River and Winema National Forests (between MP 154.9 and 175.4), and at six locations on BLM land in the Lakeview and Medford BLM Districts (MPs 116.3 to 176.9). Shells and live individuals were located within and outside the ROW, as well as within proposed TEWAs and UCSAs (SBS 2008a, 2011b). During surveys in 2012 and 2015, this species was observed at five locations on the Rogue River and Umpqua National Forests (between MP 104.9 and 162.5) and four locations on BLM land in the Roseburg and Medford BLM Districts (MPs 91.7 to 116.9), adjacent to the ROW and TEWAs.[143]. Direct mortality could occur to this species if they are within the ROW during Project clearing or construction due to their low mobility. Clearing of the ROW could affect habitat by removing forest overstory, potentially making the area unsuitable for this species. Indirect effects could result from the alteration of composition and structure of vegetation resulting in changes in microclimate. Realignments following the 2007 and 2010 surveys resulted in avoidance of some but not all the sites observed during Project surveys. As currently proposed, Pacific Connector would directly affect 5 of the 14 sites observed during Project surveys on NFS lands, and 4 of the 10 sites observed during Project surveys on BLM-managed lands. Indirect effects are expected to the traveling sideband sites observed even if direct effects on these sites are avoided because 5 and 4 of the sites are within approximately 100 feet of Project disturbance on NFS lands and BLM-managed lands, respectively, and thus would be affected by changes in microclimate conditions.

Siskiyou hesperian is a BLM and Forest Service Sensitive species (BLM 2015; Forest Service 2015) and a riparian associated terrestrial snail. During Project surveys in 2007, 2008, and 2010, this species was observed at 14 locations on the Rogue River and Umpqua National Forests (between MPs 110.2 and 164.7), and 10 locations in the Medford and Roseburg BLM Districts (MPs 79.8 to 151.5). In 2011, 2012, and 2014, this species was observed at nine locations within the Rogue River and Winema National Forests (between MPs 154.5 and 168.9), and two locations in the Medford BLM District (MP 148.7 and 153.5). Shells and live individuals were observed within and outside the ROW, as well as proposed TEWAs and UCSAs (SBS 2008, 2011b; April 27, 2015 response to FERC data request). During surveys in 2015, this species was observed at eight locations on the Rogue River National Forest (between MP 155.7 and 160.6) and one location on BLM land in the Medford BLM District (MP 128.8), within and adjacent to the ROW and TEWAs.[144] During surveys in 2017, active individuals were observed at one location on the Rogue River National Forest (MP 154.6; Tona 2018). Direct mortality to individuals could occur if they are located within the ROW during Project clearing or construction. Another potential direct effect is destruction or alteration of hydrology of riparian, wetland, or aquatic habitats used by this species. Indirect effects could result from the alteration of composition and structure of vegetation resulting in changes in microclimate. The increase in sun exposure could reduce moisture levels

[143] See Table D.3-10 in Pacific Connector's Resource Report 3, included as part of their September 2017 filing with the FERC.
[144] See Table D.3-10 in Pacific Connector's Resource Report 3, included as part of their September 2017 filing with the FERC.

and potential decrease dispersal between populations or suitable habitat. As currently proposed, Pacific Connector would directly affect 11 of the 31 sites observed during Project surveys on NFS lands, and 6 of the 13 sites observed during Project surveys on BLM-managed lands. Indirect effects are expected to the Siskiyou hesperian sites observed even if direct effects on these sites are avoided as 16 and 5 of the sites on NFS lands and BLM-managed lands, respectively, are within approximately 100 feet of Project disturbance, and thus would be affected by changes in microclimate conditions.

Oregon shoulderband is a BLM and Forest Service sensitive species (BLM 2015; Forest Service 2015) and a terrestrial snail endemic to northern California and southwest Oregon. This species is also managed as a Survey and Manage species on NFS lands; however, it was not observed on NFS lands during surveys for the Project. During Project surveys in 2007, this species was observed at five locations in the Roseburg BLM District (MPs 64.6 to 76.0). Shells and live individuals were observed within and outside the ROW (SBS 2008a). Direct mortality to individuals could occur if they are located within the ROW during Project clearing or construction. Clearing of the ROW could affect habitat by removing forest overstory, potentially making the area unsuitable for this species. Indirect effects could result from the alteration of composition and structure of vegetation resulting in changes in microclimate. The increase in sun exposure could reduce moisture levels and potential decrease dispersal between populations or suitable habitat. As currently proposed, Pacific Connector would directly affect two of the five sites observed during Project surveys on BLM-managed lands. Indirect effects are expected to the Oregon shoulderband sites observed even if direct effects on these sites are avoided as two of the sites on BLM-managed lands are within approximately 100 feet of Project disturbance, and thus would be affected by changes in microclimate conditions.

Plants and Fungi

A total of 270 BLM and/or Forest Service sensitive bryophyte, lichen, fungus, and vascular plant species were identified as potentially occurring within the Project area (see table I-5 in appendix I). Between 2007 and 2018, SBS surveyed for special status fungi and vascular and non-vascular plant species in suitable habitat, where access was granted, within 50 feet (non-federal lands) or 100 feet (federal lands) of the ROW, TEWAs, UCSAs, and access roads (note that surveys continued through 2018). Plant and fungus species documented on federal lands during surveys are described below. Descriptions of expected habitat, documented or suspected occurrences, and potential Project effects on all species within the area affected by the Project are presented in table I-5 in appendix I. Forest Service sensitive plants and fungi that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7).

Of the 41 BLM and/or Forest Service sensitive bryophytes identified as potentially occurring within the area affected by the Project, none were documented during surveys of the currently proposed route. Two strategic bryophyte species (*Andreaea nivalis* and *Orthotrichum euryphyllum*) were documented during surveys. See table I-5 in appendix I for a list of sensitive and strategic bryophyte species identified as potentially occurring within the area affected by the Project, descriptions of their expected habitat, and documented or suspected occurrences, including documented occurrences of the two strategic species observed during Project surveys.

Lichens

There are 16 BLM and/or Forest Service sensitive lichens identified as potentially occurring within the area affected by the Project. Potential Project effects on lichens include trampling or killing of individual plants. One BLM and Forest Service sensitive species, *Bryoria subcana*, was documented during surveys of the currently proposed route. This species is also an Survey and Manage species under the 2001 ROD list (Forest Service and BLM 2001a).

Bryoria subcana is a BLM and Forest Service Sensitive coastal lichen species and was observed during Project surveys in the BLM Coos Bay District, approximately 100 feet of the ROW near MP 21.88BR. The species was observed just east of the area affected by the Project and may be avoided by activities within the corridor; however, construction would disturb vegetation and soils within 200 feet of the site and could modify microclimate conditions around the observation. The removal of trees and woody debris could negatively affect *Bryoria subcana* in adjacent areas by removing its habitat and affecting its association with the trees, affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions within 200 feet of the observation as a result of the Project construction and operation would likely make habitat within the site no longer suitable for the species. Restored portions of the corridor and TEWAs would be dominated by early seral vegetation for approximately 30 years, which would result in long-term changes to habitat conditions. A portion of the corridor would be maintained in low-growing vegetation for pipeline maintenance and would not provide habitat for the species during the life of the Project. *Bryoria subcana* is not likely to persist at the site following Project implementation; however, remaining sites of this species would continue to provide a reasonable assurance of species persistence.

Five BLM and/or Forest Service strategic lichen species (*Collema curtisporum, Collema quadrifidum, Leptogium platynum, Peltula euploca,* and *Sclerophora amabilis*) were also observed during Project surveys. See table I-5 in appendix I for a list of sensitive and strategic lichen species identified as potentially occurring within the Project area, descriptions of their expected habitat, and documented or suspected occurrences, including documented occurrences of the one sensitive and five strategic lichen species observed during Project surveys.

Fungi

Of the 25 BLM and/or Forest Service sensitive fungi identified as potentially occurring within the Project area, none were documented during surveys. Thirteen Forest Service and BLM strategic fungi were observed during surveys. See table I-5 in appendix I for the locations of these observations in relation to the Project.

Vascular Plants

There are 188 BLM and/or Forest Service sensitive vascular plants identified as potentially occurring within the Project area, 10 of which were documented during Project surveys: Rogue Canyon rockcress (*Arabis modesta*), Bensonia (*Bensoniella oregana*), Cox's mariposa lily, Umpqua mariposa lily, bristly sedge (*Carex comosa*), coastal lip fern (*Cheilanthes intertexta*), pine woods cryptantha (*Cryptantha simulans*), clustered lady's slipper (*Cypripedium fasciculatum*), California globe-mallow (*Iliamna latibracteata*), and Bellinger's meadowfoam. Two of these species—Cox's mariposa lily and Umpqua mariposa lily—are also state-listed species and are discussed above in section 4.6.2.3. One of these species, clustered lady's slipper, is a Forest Service Survey and Manage species and is discussed below under section 4.6.4.3. Potential effects on Umpqua mariposa lily, pine woods cryptantha, California globe-mallow, and Bellinger's meadowfoam on NFS lands are additionally discussed in the BE (appendix F.7 of this EIS).

Field Survey Locations and Potential Effects

Rogue Canyon rockcress is a regional endemic found within chaparral and lower montane coniferous forests in northern California and southern Oregon (CNPS 2018). In Oregon, it is only known from Jackson and Josephine Counties (NRCS 2018). This species has been found on dry, serpentine soils on exposed slopes and rocky cliffs in the Rogue River canyon at elevations between 490 and 1,480 feet (NatureServe 2018). Two sites of Rogue Canyon rockcress were observed during Project surveys in 2017 on state forest lands 24 feet and 90 feet north/northwest of TEWA 124.30-N. This species was not observed on BLM or Forest Service land during Project surveys.

Bensonia is found mainly within the Siskiyou Mountains of southwestern Oregon in Curry and Josephine Counties, with a few small disjunct populations in adjacent Humboldt County, California (NatureServe 2018). The rhizomatous species grows in wet meadows and edges near bogs and springs. Populations seem to be associated with cloud or fog banks that blanket the mountain tops at certain times of year. Most plants are in meadows on gentle slopes, and they thrive on partial shade. The species has been found at elevations between 2,000 to 4,750 feet (Hoover and Holmes 1998). One bensonia site was noted near the Project in 2011 in the Roseburg BLM District, approximately 100 feet east of the existing Signal Tree Road Quarry at MP 47. Pacific Connector surveyed this area in 2013 and no special status species were observed, including bensonia. Due to the distance between this site and the Project, no effects are anticipated.

Bristly sedge is found from Quebec to Minnesota and south, as well as in the Pacific Northwest and Montana (NatureServe 2018). This species habitat includes marshes, lakeshores, and wet meadows. In Oregon, this species is known from Columbia, Klamath, and Multnomah Counties; although it is believed to be extirpated or possibly extirpated in Columbia and Multnomah Counties (NatureServe 2018). One population of bristly sedge was documented in 2012 on private land 66 feet south of TEWA 184.30. This species was not observed on BLM or Forest Service land during Project surveys.

Coastal lip fern grows in crevices and bases of rocks and is found mainly in California, although it also occurs in Oregon and Nevada (The Jepson Herbarium 2018). In Oregon, this species is known from Douglas and Jackson counties (NRCS 2018). Two observations of coastal lip fern site were noted near the Project in the Medford BLM District. One observation is located approximately 65 feet west of the pipeline ROW near MP 148.9 and the other observation is greater than 100 feet from the pipeline ROW near MP 149.9. Due to the distance between these sites and the Project, direct effects are not anticipated; however, the Project could potentially indirectly affect individuals and/or habitat of this species.

Pine woods cryptantha is found in dry gravelly sites, disturbed areas, and open conifer forests from elevations between 820 and 8,530 feet (The Jepson Herbarium 2018). This species' range includes California north to Washington and east to Idaho (NRCS 2018). Five observations of pine woods cryptantha were documented during Project surveys in 2017. One site was located in the Rogue River-Siskiyou National Forest approximately 96 feet northwest of MP 155.8. One site was located on the Fremont-Winema National Forest pm the edge of Clover Creek Road and 10 feet from the pipeline ROW near MP 175.3, and two sites were located in the Lakeview BLM District:

1) within the ROW near MP 176.96 and 2) on the edge of Clover Creek Road near MP 176.98. Because this species was observed within the pipeline ROW, the Project may directly and indirectly affect individuals and habitat of this species.

California globe mallow is found in southwestern Oregon, extending into Humboldt County in northern California (Malaby 2005). This species inhabits moist forests, streamsides, lower montane coniferous forests, and montane chaparral; often in recently burned areas (Malaby 2005; CNPS 2018). In Oregon, California globe mallow is found in coastal ranges in Coos and Douglas counties and is also known from Curry, Jackson, Josephine, and Linn Counties. Three observations of California globe mallow were observed during Project surveys in 2017: one in the Roseburg BLM District and two in the Umpqua National Forest. The observation in the Roseburg BLM District was located within the pipeline ROW near MP 99.9, within the are burned during the Stouts Creek fire in 2015. The sites in the Umpqua National Forest are in the pipeline ROW near MP 106.2 and MP 106.7; both sites were in recently burned areas. Because this species was observed within the pipeline ROW, the Project may directly and indirectly affect individuals and habitat of this species.

Bellinger's meadowfoam (*Limnanthes floccosa* ssp. *bellingeriana*) is associated with vernally wet meadows or vernal pools and is generally found on basalt scablands at elevations between 1,000 and 4,000 feet in Jackson and Klamath Counties, Oregon, and Shasta County, California. Six Bellinger's meadowfoam populations were located in the Project area. Two populations were in the Rogue River-Siskiyou National Forest: within the pipeline ROW near MP 154.1 and within the pipeline ROW between MP 154.71 to 154.82. The other four populations were in the Medford BLM District: near MPs 120.3, MP 128.8, and MP 129.0, and TEWA 128.79-N. All these observations are located greater than 100 feet from the pipeline route, except for the observation in TEWA 128-79. Six hundred plants were observed in and near TEWA 128.79-N during Project surveys in 2017.

In 2010, 30,000 plants within less than one acre were documented between MPs 154.8 and 154.7, near Heppsie Mountain (SBS 2011a), also within the Rogue River National Forest. Potential effects on this site include removal of individuals, temporary disturbance, and permanent loss or alteration of habitat including changes in hydrology. The site is in a vernally moist scabland meadow within the ROW and a TEWA and therefore would be disturbed by the Project (SBS 2011a; Rolle 2014). Measures to avoid this site considered but excluded to avoid a rare fungus, *Gymnomyces abietis*, which was also found at the same location on the north end of the meadow at MP 154.8. *Gymnomyces abietis* is a Forest Service Survey and Manage species, discussed below in section 4.6.4.3. Although Project activities would affect the local population at MP 154.7, the species would not likely be eliminated from the site as it is able to grow on disturbed soil (Rolle 2014). Conservation measures at this site include recontouring, reseeding, and controlling for noxious weeds. Additionally, although the site that would be affected is one of only a few Bellinger's meadowfoam sites on NFS land, a large number of sites are known from BLM and private land in eastern Jackson County. More undocumented sites are likely to occur on unsurveyed private lands (Rolle 2014). Consequently, the expected loss of individuals and habitat at this site is not expected to affect the viability of Bellinger's meadowfoam over the broader geographic area of the low mountains and foothills of eastern Jackson County (Rolle 2014).

4.6.4.3 Survey and Manage Species

The BLM and Forest Service first identified Survey and Manage species in 1994 as rare amphibians, mammals, bryophytes, mollusks, vascular plants, fungi, lichens, and arthropods that occupy LSOG forests in the range of the NSO (see Forest Service and BLM 1994a, the NWFP ROD). The agencies established standards and guidelines for management of these rare species in the *Standards and Guidelines for Management for Late-Successional and Old-Growth Related Species in the Range of the Northern Spotted Owl* (Forest Service and BLM 1994b). The NWFP ROD established overall objectives for managing Survey and Manage species populations that were referred to as “persistence objectives.” These objectives were based on the Forest Service viability provision in the 1982 National Forest System Land and Resource Management Planning Regulation for the National Forest Management Act of 1976.

In 2001, the Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines (2001 ROD; Forest Service and BLM 2001a) modified the management direction provided in the NWFP ROD for Survey and Manage species and amended BLM and Forest Service land management plans in the range of the NSO accordingly. The management direction for Survey and Manage species varies based on its assigned category, which establishes varying levels of surveys and management of known sites (refer to the 2001 ROD and appendix F.5 to this EIS for additional details on the categories). For the Survey and Manage Standards and Guidelines, the major elements were retained with some restructuring for clarity, and the 1994 list of Survey and Manage species was modified to remove 72 species in all or part of their range because new information indicated they were secure or otherwise did not meet the basic criteria for Survey and Manage. Based on the history of the Survey and Manage rule, it should be noted that by definition, there is a general concern for persistence for any of the species listed in the 2001 ROD. That concern is the basic reason species are listed in the Survey and Manage Standards and Guidelines.

In 2004 and again in 2007, the BLM and Forest Service issued a ROD to eliminate the Survey and Manage requirements of the 2001 ROD and to provide protection for species on the Survey and Manage lists by managing them under the agencies’ special-status species programs. In 2014, the Court issued a remedy order in the case of *Conservation Northwest et al. v. Bonnie et al.*, No 08-1067-JCC (W.D. Wash.)/No. 11-35729 (9th Circ.). As the latest step in the ongoing litigation challenging the 2007 ROD, this remedy order vacated the 2007 ROD to remove or modify the Survey and Manage mitigation measure standards and guidelines, which returned the agencies to the status quo in existence prior to the 2007 ROD. Thus, the 2001 ROD was reinstated, including any amendments or modifications to the 2001 ROD that were in effect as of March 21, 2004, returning the species to the category assigned in the 2001 ROD.

In accordance with the 2014 Court decision, this assessment was completed using the 2001 ROD Survey and Manage Standards and Guidelines, with the 2003 Annual Species Review (ASR) modifications for the species list and category assignments (excepting the 2003 ASR red tree vole removal).

In 2016, the BLM approved two new RMPs, including the Northwestern and Coastal Oregon RMP and the Southwestern Oregon RMP (BLM 2016a, 2016b). All lands managed by the BLM that occur in the Pacific Connector Project are within the revised RMPs’ management areas. The past RMPs were developed consistent with the 1994 NWFP and thereby included Survey and Manage species measures. The 2016 RMPs revises the past RMPs in their entirety and removes all measures for Survey and Manage species, although Forest Service Survey and Manage species identified as BLM sensitive species would continue to receive protections consistent with BLM's sensitive species management program.

Although some species covered by the Survey and Manage Standards and Guidelines also occur on private land, land managed by the BLM, and areas outside the NSO range, the requirements of the 1994 NWFP and 2001 ROD apply only to lands managed by the Forest Service within the range of the NSO.

The NWFP ROD and the 2001 ROD do not prescribe a well-defined process for evaluating effects on species persistence or viability from a proposed activity. The 2001 ROD states "instead, common sense and agency expertise must be used in making determinations of compliance with the viability provision" (Standards and Guidelines). The Forest Service has embraced this approach for evaluating effects of the Project on the persistence of affected Survey and Manage species in the NSO range. The Standards and Guidelines and 2001 ROD are intended to "provide a reasonable assurance of species persistence" for all the Survey and Manage species. If the Project is constructed, it would affect numerous known sites of Survey and Manage species. This assessment seeks to determine, should the Project be constructed, whether there would be a reasonable assurance of species persistence for those Survey and Manage species affected by the Project in the NSO range. The evaluation of species persistence is presented in appendix F.5 to this EIS, and this section summarizes the results of the evaluation. Attachment A to appendix F.5 lists the Survey and Manage species considered in the persistence evaluation.

This section is organized by taxonomic group and includes a brief overview of the species considered in the persistence evaluation; a summary of the distribution of sites of the species in the NSO range; an analysis of the effects of the Project on the sites; and breakdowns of the number of sites of each species in the NSO range, the number of affected sites of each species across the analysis area, and the number of affected sites on the Umpqua, Rogue River-Siskiyou, and Fremont-Winema National Forests. Details on the methodology used for the persistence evaluation (e.g., establishment of sites for each species, mapping of general habitat and site distribution, analysis of effects on sites) and a glossary of key terms used in the evaluation available in appendix F.5. The factors used to evaluate the Project effects are outlined in appendix F.5 and were derived from the 2001 ROD criteria for species persistence and relative rarity. This persistence evaluation is not intended to serve as an annual species review or an evaluation of the relative rarity of the species. This analysis is focused only on the effects on the species that could result from implementation of the Project and is intended to provide sufficient information to support subsequent findings by the Forest Service.

This assessment provides a conservative site-specific analysis of effects on sites, which consist of the recorded observations of Survey and Manage species from agency geodatabases and a surrounding protection buffer, and generally assumes that site persistence would not be maintained following Project implementation if a site falls within the analysis area. This conservative approach was considered sufficient if Project-related effects on the sites would not substantially alter the distribution of the species across the NSO range (e.g., the species would still be well distributed or locally abundant near the Project area). However, if the initial analysis revealed that remaining sites (i.e., those not affected by the Project) may not provide a reasonable assurance of species persistence, a closer evaluation of the effects on each site was conducted to further assess effects of the Project and determine if site persistence would be maintained at any of the sites following Project implementation, or if measures would be needed to protect or avoid the site(s). Additional details on the methodology used to evaluate effects are presented in appendix F.5.

Incomplete or Unavailable Information

CEQ regulations 40 CFR 1502.22 require a discussion of incomplete or unavailable information. Information is incomplete or unavailable for:

- **Total populations of Survey and Manage species beyond those represented in the geodatabases of the agencies used in this report.** Although a statistically reliable region-wide survey has been completed for most of the Survey and Manage species (Forest Service and BLM 2007: 142), the results of those surveys have not been biologically interpreted, and the final results have not yet been published. In absence of a published interpretation of the results of those regional surveys, this assessment relies on the known sites of affected species that have been inventoried and recorded in the known site geodatabases of the BLM and Forest Service. These data constitute "best available information" for populations of Survey and Manage species and provide sufficient information to make a reasoned choice between the alternatives and to make an informed decision related to the persistence standards of the 2001 Survey and Manage ROD. A total population estimate is not necessary to make a reasoned choice between the alternatives.
- **Total acres of the specialized microsites and habitats used by certain Survey and Manage species.** This analysis was completed using geodatabase records of observations (i.e., "known sites"), regionally available vegetation inventory data, and evaluation criteria developed from the 2001 ROD. In many cases, Survey and Manage species rely on specialized habitats that may not be catalogued in agency geodatabase records or vegetation inventories. This is one of the reasons why pre-Project surveys are required for Survey and Manage species. Habitat requirements for each of the species considered are discussed in detail in appendix F.5. In this assessment, estimates are provided of the general areas where specialized habitats may be found, but these should not be interpreted as the actual acres of available specialized habitats; the actual acres of available specialized habitats are typically a fraction of the general habitat description. For example, some mollusks rely on moist microsites found in late-successional coniferous forests. A regional inventory of late-successional coniferous forests is available, but a regional inventory of moist microsites is not; there are many, many more acres of late-successional forests than there are acres of moist microsites within those forests. This assessment identifies known sites and broad habitat classifications such as "late-successional coniferous forests below 6,000 feet" where specialized habitats and the species in question may be found, but makes no estimates of, nor does the analysis rely on, estimates of specialized habitats that may exist within those broad vegetation categories. The cost of acquiring such an inventory of microsite environments over the entire area of the NWFP would be exorbitant and is not essential to making a reasoned choice between the alternatives. As noted in the Final Supplemental EIS for Survey and Manage Species, "the likelihood that an activity modifying late-successional forest will occur within the range of a truly rare or localized species population must be viewed in light of the relatively conservative degree of modification of late-successional forest projected to occur within the NWFP area. For example, management activities (timber harvest and prescribed fire) are projected to

modify approximately 3 percent of the late-successional forest within the area over the next decade" (Forest Service and BLM 2000: 180). Pre-Project survey data and existing known sites of Survey and Manage species within the area of the NWFP provide sufficient information to determine whether there is a "reasonable assurance of species persistence," which is the standard of the 2001 Survey and Manage ROD.

- **Recovery of occupied sites after disturbance.** Survey and Manage species are associated with LSOG forests on NFS lands. The construction corridor and TEWAs will be reforested and replanted with native vegetation similar to what occupied the Project area prior to disturbance. It will be at least 80 years before those areas provide late-successional habitat. A 30-foot-wide maintenance corridor centered along the pipeline route would be maintained in low growing brush and grass vegetation (no trees) for the life of the Project. When the Project is decommissioned, it would be at least an additional 80 years before this strip provides late-successional stand characteristics. Information is not generally available as to how effectively the affected Survey and Manage species will reoccupy these areas. This analysis presumes that if the "site" is within the construction clearing or TEWAs, the Project would result in a long-term loss of that site. This analysis does not speculate on when or if the affected species may reoccupy the site. Since sites are presumed lost if affected, and that provides the basis for the assessment, data related to recovery or reoccupation of sites are not essential to the decision to be made or the choice between alternatives.

Survey and Manage Species Surveys and Evaluations

Surveys conducted for the Project in and near the Project area through 2016 resulted in numerous observations of Survey and Manage species. These survey results in combination with results from prior surveys conducted near the Project area were used to identify the Survey and Manage species that could be affected by the Project. Observation data stored in agency geodatabases were converted to "sites" or "known sites" using a standardized mapping protocol based on buffer distances described in the 2001 ROD. Species evaluated include those that have sites on NFS lands in or near the Project area. The species considered include 31 fungi, 2 lichens, 1 vascular plant, 2 mollusks, 1 mammal, and 1 bird.

Fungi

The diverse fungi of the Pacific Northwest include several hundred saprobic (decomposers), parasitic, and symbiotic (mutualistic) macro- and micro-fungi species. The 2003 list includes 194 species of fungi under the Survey and Manage Standards and Guidelines. Of these species, 31 are considered in this evaluation of the Project because they have been documented on NFS lands in or near the Project area. Appendix F.5 of this EIS presents additional details on each species, while the key information used to evaluate Project-related effects is summarized in this section.

The fungi considered in this analysis consist primarily of mycorrhizal or symbiotic species, which include truffles, false truffles, chanterelles, boletes, coral fungi, and gilled mushrooms. Some of the species are saprobic gilled mushrooms or parasitic fungi. The mycorrhizal fungi form symbiotic relationships with vascular plants to exchange nutrients and water for photosynthate. The saprobic species are found on dead or decaying wood, including snags. The fungi fruit at different times of year, and many do not fruit annually, although they may still be present in the soil. Although surveys have been conducted across the Project area and in other parts of the NSO range, the difficulty in detecting fungi when fruiting bodies are not present has limited the ability to fully describe the range and distribution of many species within the NSO range. The fungi species considered in this analysis are listed in table 4.6.4.3-1 with the currently known number of sites in the NSO range. Many of these species are likely more abundant than currently documented, and more survey effort would be expected to locate additional sites of the species.

TABLE 4.6.4.3-1

Regional Site Count of Fungi Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Albatrellus ellisii	112	72	33 (46%)
Arcangeliella crassa	26	21	2 (10%)
Boletus pulcherrimus	60	34	21 (62%)
Choiromyces alveolatus	21	17	11 (65%)
Clavariadelphus occidentalis	177	63	21 (33%)
Clavariadelphus sachalinensis	273	35	20 (57%)
Clavariadelphus truncatus	332	127	56 (44%)
Collybia bakerensis	149	145	64 (44%)
Collybia racemosa	71	24	13 (54%)
Cortinarius magnivelatus	47	28	8 (29%)
Cortinarius olympianus	73	44	27 (61%)
Cortinarius verrucisporus	52	32	5 (16%)
CCudonia monticola	82	35	9 (26%)
Galerina atkinsoniana	96	68	55 (81%)
Gastroboletus subalpinus	91	81	36 (44%)
Gomphus clavatus	189	102	53 (52%)
Gomphus kauffmanii	159	99	53 (54%)
Gymnomyces abietis	21	18	10 (55%)
Hygrophorus caeruleus	56	47	14 (30%)
Mycena overholtsii	205	201	94 (47%)
Polyozellus multiplex	87	83	40 (38%)
Ramaria araiospora	152	69	26 (38%)
Ramaria coulterae	67	19	26 (32%)
Ramaria rubrievanescens	143	105	53 (50%)
Ramaria rubripermanens	231	103	35 (34%)
Rhizopogon truncatus	210	70	26 (34%)
Sarcodon fuscoindicus	74	38	18 (46%)
Sedecula pulvinata	3	3	2 (67%)
Sparassis crispa	106	51	9 (18%)
Spathularia flavida	194	81	52 (64%)
Tremiscus helvelloides	318	62	34 (55%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent "Riparian Reserves" across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in NFS reserves to total sites on NFS lands.

Habitat for these species varies and has generally been classified as coniferous, mixed hardwood-coniferous, and/or hardwood forests, including the LSOG component of these forests. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The data are the best available data on forest types across the NSO range but likely overestimate the amount of potential habitat available in the region for many of the species considered in this analysis, particularly those with microsite conditions that have not been mapped at a regional scale. The extent of potential habitat for each species varies based on its distribution across the NSO range and its habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of 31 Survey and Manage fungi at one or more sites in or near the Project area. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soil within sites and could result in the removal of populations or individuals of fungi. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase, although not all species are affected by open corridors or change in forest age (e.g., *P. fallax*, *P. piceae*, *P. sipei*, and *P. spadicea*). The removal of coniferous, mixed hardwood-coniferous, and hardwood forests, including the LSOG component of these forests, and disturbance to soil, understory substrate (e.g., rocks, downed logs), and roots of trees could negatively affect the fungi in adjacent areas by removing their habitat, disturbing soil or duff around trees or roots of trees, and affecting mycorrhizal associations with the trees or other relationships between the fungi and their hosts, potentially affecting site persistence even if the entire site is not disturbed. For some species that are found in more open habitats (e.g., *C. olympianus*, *H. caeruleus*, *S. flavida*), these microclimate changes may not affect site persistence. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor and TEWAs could make habitat within the sites no longer suitable for the species. Material storage within UCSAs would disturb understory habitat in some sites, which could also modify microhabitats near extant populations or individuals, potentially making the habitat no longer suitable for the species. Road improvements and establishment could remove habitat and extant populations or individuals of the fungi. The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-2 presents a summary of the number of sites of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-2

Fungi Sites Potentially Affected by the Project

Species	Total Affected NFS Sites a/	Affected Sites in NFS Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on all Lands in NSO Range
Albatrellus ellisii	10	3	62	102
Arcangeliella crassa	1	—	21 b/	26 b/
Boletus pulcherrimus	7	—4	31 b/	57 b/
Choiromyces alveolatus	1	—	17 b/	21 b/
Clavariadelphus occidentalis	1	—	62	171
Clavariadelphus sachalinensis	7	2	28	258
Clavariadelphus truncatus	10	4	117	311
Collybia bakerensis	2	—	143	147
Collybia racemosa	1	—	23	70
Cortinarius magnivelatus	5	—	24 b/	43 b/
Cortinarius olympianus	5	4	40 b/	69 b/
Cortinarius verrucisporus	5	—	29 b/	49 b/
Cudonia monticola	1	—	34	81
Galerina atkinsoniana	1	—	67	95
Gastroboletus subalpinus	2	—	79	89
Gomphus clavatus	3	1	99	186
Gomphus kauffmanii	7	6	91	152
Gymnomyces abietis	1	1	18 b/	21 b/

TABLE 4.6.4.3-2 (continued)

Fungi Sites Potentially Affected by the Project

Species	Total Affected NFS Sites a/	Affected Sites in NFS Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on all Lands in NSO Range
Hygrophorus caeruleus	6	—1	846 b/	55 b/
Mycena overholtsii	2	1	199	203
Polyozellus multiplex	1	1	82	86
Ramaria araiospora	3	—	67	149
Ramaria coulterae	3	1	17	65
Ramaria rubrievanescens	2	—	103	141
Ramaria rubripermanens	7	—	96	223
Rhizopogon truncatus	6	1	64	203
Sarcodon fuscoindicus	1	—	37	72
Sedecula pulvinata	1	1	3 b/	3 b/
Sparassis crispa	1	—	50	104
Spathularia flavida	5	4	76	189
Tremiscus helvelloides	1	1	61	310

a/ Affected sites are those on NFS land that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5.
b/ Although one or more sites would be affected by the Project, individuals within some of the sites would not be affected, and site persistence would be maintained for those sites following project implementation. The remaining site count includes sites that may be affected, but for which site persistence is expected to be maintained. Only sites for which site persistence would be affected were removed from the remaining site count.

The species listed below appear to be more common than previously documented or are relatively common across the NSO range based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. For these species, the Project would affect individuals or habitat at one or more sites and could affect site persistence, but the remaining sites in the NSO range would continue to provide a reasonable assurance of species persistence:

Clavariadelphus occidentalis
Clavariadelphus sachalinensis
Clavariadelphus truncatus
Collybia bakerensis
Cortinarius olympianus
Cudonia monticola
Galerina atkinsoniana
Gastroboletus subalpinus
Gomphus clavatus
Gomphus kauffmanii
lbatrellus ellisii
Mycena overholtsii
Polyozellus multiplex
Ramaria araiospora
Ramaria coulterae
Ramaria coulterae
Ramaria rubrievanescens
Ramaria rubripermanens
Ramaria rubripermanens
Ramaria stuntzii
Rhizopogon truncatus
Rhizopogon truncatus
Sparassis crispa
Spathularia flavida
Tremiscus helvelloides

The species listed below are not necessarily more common than previously documented despite new information available from pre-disturbance surveys for the Project and/or other sources since these species were listed in the 2001 ROD. For these species, the Project would affect individuals or habitat at one or more sites and could affect site persistence, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence:

Arcangeliella crassa
Boletus pulcherrimus

Choiromyces alveolatus
Collybia racemose
Cortinarius magnivelatus
Cortinarius verrucisporus
Gymnomyces abietis
Hygrophorus caeruleus
Sedecula pulvinata

The species listed below is not necessarily more common than previously documented despite new information available from pre-disturbance surveys for the Project and/or other sources since these species were listed in the 2001 ROD. For this species, the Project would affect site persistence at one or more sites, and the remaining sites in the NSO range may not provide a reasonable assurance of species persistence. These species are known from a low number of sites within a part of the NSO range, has limited habitat requirements, and has a distribution pattern in which every site may be important for dispersal opportunities to ensure the persistence of the species in the NSO range:

Sarcodon fuscoindicus

The Project would affect a portion of one site where two observations of this species have been documented on NFS lands. This site is located in the Trail Creek watershed on the ridge just east of the South Fork Cow Creek watershed between MPs 111.5 and 111.6. Approximately 1.2 acres (30 percent of the site) is associated with the construction corridor (0.8 acres) and associated UCSA (0.4 acres). The location of this site is illustrated in appendix F-5 (Section 2.27, Figure SAFU-5).

The Project would result in ground disturbance and vegetation removal in the eastern half of the site near MP 111.5. The two recorded observations within the site may be avoided by construction activities within the corridor, but fruiting bodies, if present, could be disturbed in one of the observations during material storage within a UCSA (see Figure SAFU-5). The species would also be subject to indirect effects associated with the Project based on the proximity of project activities to the observations.

Establishment of the 95-foot wide construction corridor would disturb vegetation and soils within the site. The area within the site is mostly forested, and the establishment of the corridor could modify microclimate conditions around the recorded observations. The removal of forests and host trees and disturbance to soil could negatively affect *S. fuscoindicus* in adjacent areas by removing its habitat, disturbing soil or duff around trees or roots of trees, and affecting its mycorrhizal association with the trees, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions within 100 feet of an observation as a result of the corridor could make habitat within the site no longer suitable for the species. Restored portions of the corridor would be dominated by early seral vegetation for approximately 30 years, which would result in long-term changes to habitat conditions. A 30-foot wide portion of the corridor would be maintained in low-growing vegetation for pipeline maintenance and would not provide habitat for the species during the life of the Project. Material storage within UCSAs could damage individuals and would disturb understory habitat within the site, which could modify microhabitats near individuals that are not removed or damaged, potential making the habitat no longer suitable for the species.

Based on this analysis of the site on NFS lands, *S. fuscoindicus* is not likely to persist following Project implementation. The site is the only site on NFS lands in the local area and the nearest sites on NFS lands are approximately 45 miles to the northeast and 75 miles to the southwest.

Lichens

Lichens are distinct symbiotic organisms that consist of a fungus and an algae or cyanobacterium, which make them members of two or three biological kingdoms. They play a major ecological role, particularly in old-growth forests, by cycling nutrients and producing biomass. Lichens tend to be dispersal limited and grow slower than vascular plants. The 2001 Survey and Manage ROD including the 2003 ASR modifications to the species list includes 45 lichen species. Of these, two are considered in this evaluation because they have been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on each species, while the key information used to evaluate Project-related effects is summarized in this section.

Both lichens considered in this analysis are epiphytic lichens, which grow directly on trees or shrubs. *Chaenotheca subroscida* commonly occurs on pine trees in upland habitats and *Leptogium teretiusculum* tends to be associated with riparian habitat.

Although surveys have been conducted across the Project area and in other parts of the NSO range, the difficulty in detecting some lichens because of their size has limited the ability to fully describe the range and distribution of some species within the NSO range. The lichen species considered in this analysis are listed in table 4.6.4.3-3 with the currently known number of sites in the NSO range, and the distributions of the species are briefly discussed after the table.

TABLE 4.6.4.3-3

Regional Site Count of Lichen Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Chaenotheca subroscida	396	110	73 (66%)
Leptogium teretiusculum	267	16	9 (56%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent “Riparian Reserves” across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands.

Habitat for these species has been classified as coniferous, mixed hardwood-coniferous, and/or hardwood forests, including the LSOG component of these forests. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for each species varies based on its distribution across the NSO range and habitat preferences. Additional details on habitat for these species are presented in appendix F.5.

The Project could affect site persistence of two Survey and Manage lichens at one or more sites on NFS lands in or near the Project area. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soil within sites and could result in the removal of populations or individuals of lichens. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of coniferous, mixed hardwood-coniferous, and hardwood forests, including the LSOG component of these forests, and disturbance to soil, understory substrate (e.g., rocks, downed logs), and roots of trees could negatively affect the lichens in adjacent areas by removing their habitat, disturbing soil or substrate around trees or roots of trees, and affecting associations with the trees or other substrate, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor and TEWAs could make habitat within the sites no longer suitable for the species. Material storage within UCSAs would disturb understory habitat in some sites, which could also modify microhabitats near extant populations or individuals, potentially making the habitat no longer suitable for some of the species. Road improvements and establishment could remove habitat and extant populations or individuals of the lichens. The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-4 presents a summary of the number of sites of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-4

Lichen Sites Potentially Affected by the Project

Species	Total Affected NFS Sites a/	Affected Sites in NFS Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on all Lands in NSO Range
Chaenotheca subroscida	6	4	104	382
Leptogium teretiusculum	1	1	15	261

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Using the spatial analysis process described in appendix F.5, these sites may be clipped by the Project area or fall outside the Project area, but within the analysis area.

The two lichen species analyzed appear to be more common than previously documented or are relatively common across the NSO range based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. The Project would affect site persistence at one or more sites, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

Measures incorporated into the Project as design features would be implemented to minimize soil and vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on all Survey and Manage lichens in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendment of the land management plans for the National Forests that encompass the Project area. Table 4.6.4.3-5 lists the lichen species and the number of affected sites on each National Forest.

TABLE 4.6.4.3-5

Affected Lichen Sites by National Forest

	Number of Sites Affected a/		
Species	**Umpqua**	**Rogue River-Siskiyou**	**Fremont-Winema**
Chaenotheca subroscida	—	5	1
Leptogium teretiusculum	—	1	—

a/ All sites are directly affected (i.e., are located in the Project area).

Vascular Plants

Vascular plants are the most dominant organism in LSOG forests and serve an essential role by providing a food source and cover or shelter for animals and influencing microclimate conditions for other species, such as fungi and lichens. Vascular plants include seed-bearing plants, such as flowering plants and conifer trees, and spore-bearing forms, such as ferns, horsetails, and clubmosses. The Survey and Manage 2001 ROD including 2003 ASR modifications includes 12 plant species. Of the 12 species, clustered lady's slipper (*Cyripedium fasciculatum*) is evaluated for this Project because it has been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on the species, while the key information used to evaluate Project-related effects is summarized in this section.

Surveys for vascular plants have been conducted in much of the NSO range, and the results of these surveys have contributed information to characterize the known extent of the plants in the NSO range. Additional surveys for Survey and Manage species were conducted for the Project as recently as the fall of 2018.[144] Table 4.6.4.3-6 includes the currently known number of *C. fasciculatum* sites in the NSO range. The range of *C. fasciculatum* in the NSO range is relatively well known, and more survey effort would be expected to locate additional sites of the species within its currently known range.

TABLE 4.6.4.3-6

Regional Site Count of Plant Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Cypripedium fasciculatum	1,392	1540	198 (37%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent "Riparian Reserves" across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands.

C. fasciculatum is well distributed across most of its known range in the NSO range. Sites are distributed in two general groups in the Klamath Mountains and Cascade Range in Oregon and California and the eastern Cascade Range in Washington. The species appears to be well distributed in the Klamath Mountains in California and Oregon.

General habitat for this species consists of coniferous and mixed hardwood-coniferous forests, including the LSOG component of these forests, across each species' currently known range. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for each species varies based on its distribution across the NSO range and habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of *C. fasciculatum* at one site on NFS land in the Project area. The site occurs on the Umpqua National Forest. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soil within sites and could

[144] Results from these will be incorporated into the final EIS.

result in the removal of populations or individuals of plants. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of coniferous and mixed hardwood-coniferous forests, including the LSOG component of these forests, and disturbance to soil could negatively affect the plants in adjacent areas by removing their habitat, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor and TEWAs could make habitat within the sites no longer suitable for the species. Material storage within UCSAs would disturb understory habitat in some sites, which could also modify microhabitats near extant populations or individuals, potentially making the habitat no longer suitable for some of the species. Road improvements and establishment could remove habitat and extant populations or individuals of the plants. The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-7 presents a summary of the sties that would remain after the single site is affected by Project activities; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-7

Vascular Plant Sites Potentially Affected by Project

Species	Total Affected NFS Sites a/	Affected Sites in Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on all Lands in NSO Range
Cypripedium fasciculatum	1	1	1,539	1,390

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Using the spatial analysis process described in appendix F.5, these sites may be clipped by the Project area or fall outside the Project area, but within the analysis area.

Cypripedium fasciculatum appears to be more common than previously documented based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. Many sites have been documented in southwest Oregon since the 2001 ROD was published. Should the Project be constructed, it is unlikely that the loss of one site from Project effects would affect the status of *C. fasciculatum* in the NSO range. The Project would affect site persistence at one site on NFS lands, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

Measures incorporated into the Project as design features would be implemented to minimize soil and vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on Survey and Manage plants in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendments to the land management plans for National Forests that encompass the Project area.

Mollusks

Approximately 350 species of mollusks, including land snails, aquatic snails, slugs, and clams, are found in the Pacific Northwest (Forest Service and BLM 2000). Slugs and snails are found in colonies, which may consist of hundreds to many thousands of individuals. Most mollusks are found in moist forests and riparian areas near streams, springs, and seeps. The 2001 ROD including 2003 ASR modifications includes 38 species of mollusks. Of these species, two are considered in this evaluation of the Project because they have been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on each species, while the key information used to evaluate Project-related effects is summarized in this section.

The mollusk species considered in this analysis include evening fieldslug (*Deroceras hesperium*) and Chace sideband (*Monadenia chaceana*). *Deroceras hesperium* is a land slug that requires high moisture environments and is found along the forest floor. A recent study on the molecular characteristics of *D. hesperium* revealed that the mollusk is likely a variant of the more common *D. laeve* (Roth et al. 2013), and *D. hesperium* may no longer belong on the Survey and Manage list, pending an annual species review. Since the species is on the 2003 list, it is evaluated like other Survey and Manage species on the list in this assessment. *Monadenia chaceana* is a land snail that is found in talus or under rocks in moist forests. Both mollusks may be associated with Riparian Reserves.

Surveys for mollusks have been conducted in parts of the NSO range, and the results of these surveys have contributed information to characterize the known extent of the mollusks in the NSO range. Surveys for the Project resulted in several observations of both species. The mollusk species considered in this analysis are listed in table 4.6.4.3-8 with the currently known number of sites in the NSO range. The ranges of these species in the NSO range are relatively well known, and more survey effort would be expected to locate additional sites of the species within their currently known ranges.

The distribution of the species and their ranges within the NSO range vary. *Deroceras hesperium* has a distribution pattern with limited potential for connectivity between isolated sites or site clusters. Sites are found in four general areas in Oregon, including a relatively large cluster of sites located in the southern Cascade Range, and other clustered sites located in the northern Cascade Range and southern Coast Range. Scattered sites are in the northern Cascade Range, and several isolated sites are in other areas. *Monadenia chaceana* has multiple sites or clusters of sites that are nested within a web of potential interconnections. Sites are primarily found in a large group of several clusters in the eastern Klamath Mountains and southern Cascade Range in Oregon and extreme northern California.

TABLE 4.6.4.3-8

Regional Site Count of Mollusk Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Deroceras hesperium	54	27	13 (48%)
Monadenia chaceana	258	246	34 (14%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent "Riparian Reserves" across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands.

General habitat for these species consists of a subcomponent (e.g., moist riparian areas, shaded rocky areas) of coniferous, mixed hardwood-coniferous, and hardwood forests, including the LSOG component of these forests, across each species' currently known range. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for the species varies based on its distribution across the NSO range and habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of two Survey and Manage mollusk species at one or more sites in or near the Project area. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soils within sites and could result in injury or mortality to individuals of mollusks. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of forests and understory components could negatively affect the mollusks in adjacent areas by removing their habitat, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor could make habitat within sites no longer suitable for the species. Material storage within UCSAs could disturb understory habitat in sites, which could remove rocks, logs, or woody debris, potentially making the habitat unsuitable for the species or injuring individuals.

The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-9 presents a summary of the number of sites of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-9

Mollusk Sites Potentially Affected by the Project

Species	**Total Affected NFS Sites a/**	**Affected Sites in NFS Reserves**	**Remaining Sites on NFS Lands in NSO Range**	**Remaining Sites on all Lands in NSO Range**
Deroceras hesperium	1	1	26	53
Monadenia chaceana	9	9	249	396

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Direct effects are those that would take place within the Project area, such as from ground disturbance, vegetation removal, or removal of individuals. Indirect effects are those that would take place outside of the Project area, such as from edge effects or increased open canopy. Using the spatial analysis process described in appendix F.5, these sites may be clipped by or fall outside the Project area, but within the analysis area.

Deroceras hesperium is not necessarily more common than previously documented despite new information available from pre-disturbance surveys for the Project and/or other sources since this species was listed in the 2001 ROD. The Project would affect site persistence at one site, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence. Although this species has a somewhat limited distribution in the NSO range, the affected site is part of a large cluster of sites in the southern Cascade Range in Oregon. The distribution and connectivity of the species would likely remain the same despite the loss of one site.

Monadenia chaceana appears to be more common than previously documented based on new information available from surveys for the Project and/or other sources since this species was listed in the 2001 ROD. The Project would affect site persistence at nine sites, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

Measures incorporated into the Project as design features would be implemented to minimize soil and vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on Survey and Manage mollusks in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendments to the land management plans for the National Forests that encompass the Project area. Table 4.6.4.3-10 lists the mollusk species and the number of affected sites in each National Forest.

TABLE 4.6.4.3-10

Affected Mollusk Sites by National Forest

	Number of Sites Affected a/		
Species	**Umpqua**	**Rogue River=Siskiyou**	**Fremont-Winema**
Deroceras hesperium	—	—	1
Monadenia chaceana	—	3 (5)	1

a/ First number presents sites directly affected (i.e., in Project area), number in parentheses presents sites indirectly affected (i.e., sites wholly in analysis area). a

Vertebrates

A diverse array of vertebrate species, including mammals, birds, amphibians, and reptiles, inhabit the forests of the Pacific Northwest and provide essential functions in the ecosystem, such as dispersing fungal spores and lichens and serving as a food source for predators. The 2001 ROD including the 2003 ASR modifications to the species list includes seven vertebrate species. Two vertebrate species are considered in this evaluation of the Project because they have been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on each species, and the key information used to evaluate Project-related effects is summarized in this section.

The vertebrate species considered in this analysis include red tree vole (*Arborimus longicaudus*) and great gray owl (*Strix nebulosa*). *Arborimus longicaudus* is a small arboreal rodent that lives in tree canopies of coniferous and mixed hardwood-coniferous forests and seldom goes to the forest floor (Forest Service and BLM 2001b). It is a primary prey item of the northern spotted owl, as well as other predators found in coniferous forests. *Strix nebulosa* is a forest owl that uses existing stick nests constructed by other raptors and large corvids, and nests between March 1 and July 31 (Williams 2012). It forages in natural forest openings, typically larger than 10 acres, and nests in coniferous and mixed hardwood-coniferous forests.

Surveys for the vole and owl have been conducted across much of the NSO range, and the results of these surveys have contributed information to characterize the known extent of the species in the NSO range. Surveys for the Project resulted in multiple observations of both species in the surveyed areas. The vertebrate species considered in this analysis are listed in table 4.6.4.3-11 with the currently known number of sites in the NSO range, and the distributions of the species are briefly discussed after the table. The ranges of these species in the NSO range are relatively well known, and more survey effort would be expected to locate additional sites of the species within their currently known ranges.

TABLE 4.6.4.3-11

Regional Site Count of Vertebrate Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Arborimus longicaudus	34,946	1,524	624 (34%)
Strix nebulosa	177	55	16 (12%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent "Riparian Reserves" across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands

The distribution of the species and their ranges within the NSO range vary. Both species have multiple sites or clusters of sites that are nested within a web of potential interconnections. Most *A. longicaudus* sites are found in the Klamath Mountains in Oregon, where sites are abundant and close together in large clusters or groups. Sites are more scattered in the western Cascade Range in Oregon, although they are still relatively abundant. *Arborimus longicaudus* appears to be well distributed within its range in Oregon. Most *S. nebulosa* sites are found in a large group in the southern Cascade Range and eastern Klamath Mountains, where the species appears to be well distributed.

General habitat for *A. longicaudus* consists of LSOG coniferous and mixed hardwood-coniferous forests across the species' currently known range in Oregon. General habitat for *S. nebulosa* consists of coniferous and mixed hardwood-coniferous forests, including the LSOG component of these forests, with a subcomponent of natural forest openings (e.g., meadows) that are used for foraging. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for the species varies based on its distribution across the NSO range and habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of two Survey and Manage vertebrates at more than one site or habitat area in or near the Project area. Vegetation removal in the construction corridor and TEWAs and along roads could result in the removal of trees that support *A. longicaudus* nests or cause injury or mortality to individuals. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of forests and potential nest trees could negatively affect *A. longicaudus* in adjacent areas by removing its habitat and opening the tree canopy, potentially affecting site persistence at the habitat areas even if the entire habitat area is not disturbed. In particular, modification of shading and habitat conditions as a result of the corridor, TEWAs, and roads could make entire habitat areas no longer suitable for the species because of the preference for closed canopy habitats. Activities within the corridor and TEWAs would result in extensive noise disturbance during vegetation clearing, grading, and pipeline installation and could result in *S. nebulosa* nest abandonment and loss of young during the nesting season. No active *S. nebulosa* nest sites were documented in the Project area; therefore, direct effects on the owl (e.g., removal of active nests, injury to owls) are not anticipated. Vegetation removal across the Project area would also result in a long-term loss of habitat that may be suitable for the species. Conversely, if constructed, the construction corridor would also create an early seral plant community suitable for foraging by great grey owls.

The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-12 presents a summary of the number of sites (habitat areas for *A. longicaudus*) of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

Both species appear to be more common than previously documented based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. The Project would affect site persistence at multiple sites or habitat areas of each species, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

TABLE 4.6.4.3-12

Vertebrate Sites Potentially Affected by the Project

Species	Total Affected NFS Sites a/	Affected Sites in NFS Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on All Lands in NSO Range
Arborimus longicaudus	525 (55) b/	10 (24)	1,469 c/	4,843
Strix nebulosa	1	1	54	171

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Direct effects are those that would take place within the Project area, such as from ground disturbance, vegetation removal, or removal of individuals. Indirect effects are those that would take place outside of the Project area, such as from edge effects or increased open canopy. Using the spatial analysis process described in appendix F.5, these sites may be clipped by or fall outside the Project area, but within the analysis area.
b/ *A. longicaudus* sites are habitat areas (55 sites were converted to 25 habitat areas in the analysis area), as mapped in accordance with the management recommendations for the species (Forest Service and BLM 2001b).
c/ The total of remaining sites is based on site data, not habitat areas. Habitat areas were not produced for the entire regional area, just the analysis area.

Measures incorporated into the Project as design features would be implemented to minimize vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on Survey and Manage vertebrates in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendments to the land management plans for the National Forests that encompass the Project area. Table 4.6.4.3-13 lists the vertebrate species and the number of affected sites or habitat areas in each National Forest.

TABLE 4.6.4.3-13

Affected Vertebrate Sites by National Forest

	Number of Sites Affected a/		
Species	Umpqua	Rogue River-Siskiyou	Fremont-Winema
Arborimus longicaudus b/	125	—	—
Strix nebulosa	—	0 (1)	—

a/ First number presents sites directly affected (i.e., in Project area), number in parentheses presents sites indirectly affected (i.e., sites wholly in analysis area).
b/ *A. longicaudus* sites are habitat areas, as mapped in accordance with the management recommendations for the species (Forest Service and BLM 2001b).

In conclusion, the Project could affect site persistence of 38 Survey and Manage species at one or more sites or habitat areas in or near the Project area. The remaining sites of 37 of these 38 species, however, would provide a reasonable assurance of these species persistence. The Project as proposed would affect site persistence of the fungi *Sarcodon fuscoindicus* at one or more sites, and the remaining sites may not provide a reasonable assurance of this species persistence. However, above we have recommended that Pacific Connector avoid affecting the *Sarcodon fuscoindicus* site by incorporating a pipeline route variation that avoids this site into the proposed action (see chapter 3). Therefore, the analysis summarized in this section, supported by the information presented in appendix F.5, indicate that construction and operation of the Project would provide a reasonable assurance of persistence of Forest Service Survey and Manage species that would be affected.

4.6 THREATENED, ENDANGERED, AND OTHER SPECIAL STATUS SPECIES

This section analyzes the effects of the Project on special status species. In addition to species listed as threatened or endangered under the federal ESA[133] and Oregon ESA[134], agencies and organizations such as the FWS, BLM, Forest Service, ODA, and ODFW maintain lists of species that are considered special concern, sensitive, rare, or are otherwise offered protections under agency planning documents. These species are broadly defined in this assessment as "special status species."[135] Although the term "special status species" is used differently by various agencies, for the purposes of this assessment, the term "special status species" includes:

- species that are listed or proposed for listing by the federal government as endangered or threatened, or are candidates for listing;
- species that are identified by the BLM or Forest Service as "sensitive species" or "strategic species";
- species listed by the State of Oregon as endangered, threatened, or are candidates for listing; and
- species identified by federal or state agencies as rare or protected by federal or state planning documents (e.g., Standards and Guidelines in resource management plans such as "Survey and Manage" species identified in the NWFP).

Using data from the Oregon Biodiversity Information Center (ORBIC),[136] FWS, NMFS, discussions with Forest Service and BLM specialists, and information reviews of published and unpublished information, the applicants prepared lists of threatened, endangered, proposed,

[133] Federal agencies are required by Section 7 of the ESA (Title 19 U.S.C. Part 1536[c]), as amended (1978, 1979, and 1982), to ensure that any actions authorized, funded, or carried out by the agency do not jeopardize the continued existence of a federally listed endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat of a federally listed species. The action agency (e.g., the FERC) is required to consult with the FWS and/or the NMFS to determine whether federally listed endangered or threatened species or designated critical habitat are found in the vicinity of the Project, and to determine the proposed action's potential effects on those species or critical habitats. For actions involving major construction activities with the potential to affect listed species or designated critical habitat, the federal agency must submit its BA to the FWS and/or NMFS and, if it is determined that the action may adversely affect a listed species, the federal agency must submit a request for formal consultation to comply with Section 7 of the ESA. In response, the FWS and/or NMFS would issue a BO as to whether or not the federal action would likely jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. Jordan Cove and Pacific Connector filed an applicant-prepared draft BA (APDBA) in December 2017, and a revised APDBA in September 2018. We are reviewing the revised APDBA and will prepare a BA and EFH Assessment, which will be submitted to the FWS and NMFS.

[134] Oregon has its own ESA that requires state agencies to protect and promote the recovery of state-listed threatened and endangered species. At the state level, consultation is conducted with the ODA for state listed plant species and the ODFW for fish and wildlife species. However, state regulations pertaining to the protection of botanical resources are limited to ORS 564 and OAR Chapter 603, Division 73. Oregon regulations regarding state endangered and threatened plants only apply on non-federal public lands (e.g., state, county, city, etc. lands).

[135] The term "special status species" is also used by the BLM, but in a narrower agency-specific definition than in this assessment. BLM "special status species" include species listed as threatened or endangered under the ESA, species that are proposed for listing under the ESA, species that are candidates for listing under the ESA, and species designated by the BLM as "sensitive" under criteria in BLM Manual 6840. The Forest Service uses similar designations. For the Forest Service, "Survey and Manage" are managed under specific criteria provided in the Northwest Forest Plan rather than the agency "special status species" programs. Several species are designated as both "special status species" for the Forest Service and "Survey and Manage species." Those species are noted in the assessment and are analyzed here under criteria for both programs.

[136] Formerly known as the Oregon Natural Heritage Information Center (ORNHIC).

candidate, and special status species that potentially occur near the proposed Project, as described in the following sections. Species that were initially considered but were dropped from further consideration due to a lack of habitat or because they were not detected during targeted field surveys are listed in tables I-3, I-4, and I-5 in appendix I.

4.6.1 Federally Listed Threatened and Endangered Species

Table 4.6.1-1 lists the federally endangered, threatened, and proposed species that potentially occur in the Project area and are discussed below. Additional species (beyond those listed in table 4.6.1-1) are federally listed in Oregon (i.e., the Canada lynx, bull trout Klamath River DPS, yellow-billed cuckoo Western DPS, streaked horned lark, and slender Orcutt grass); however, these species are not known or expected to occur within the Project area and are not discussed further in this document (Canada lynx: Verts and Carraway 1998, McKelvey et al. 2000, ORBIC 2006b; bull trout Klamath River DPS: FWS 1998a, 2002a, ORBIC 2006b; yellow-billed cuckoo: FWS 2013b; streaked horned lark: FWS 2017b; SBS 2008a, 2012, 2013, 2014, 2017a; and slender Orcutt grass: ORBIC 2017b, FWS 2006b). In addition, the North American wolverine occurs in Oregon and has been proposed for listing as threatened under ESA; wolverines have been occasionally documented in Oregon, most recently in the Wallowa-Whitman National Forest in Northeast Oregon during 2011-2012 (Magoun et al. 2013), but no evidence for a reproducing, self-sustaining population has been found in the state. There appears to be an extremely remote chance of a wolverine dispersing into southwest Oregon, but that is not foreseeable during the construction of the proposed action, and as a result, the North American wolverine is not discussed further in this document. The Eastern DPS of the Steller sea lion, which occurs on the west coast of the U.S. and within the Project area, was delisted on December 4, 2013 (78 FR 66139), and thus is not discussed in this section.

Table 4.6.1-1 lists all potentially affected federally listed and proposed species, indicates the portion of the Project area where they may occur, and provides our preliminary determination of effect.

TABLE 4.6.1-1

Federally Listed and Proposed Species Potentially Occurring in the Project Area

Species	Federal Status	State Status	Portion of the Project Area Where Species May Occur	Effect of Proposed Project on Species, Critical Habitat a/
Mammals				
gray wolf *Canis lupus*	Endangered	Delisted	Pacific Connector pipeline	NLAA
Pacific fisbher (West Coast DPS b/) *Pekania pennanti*	Proposed Threatened	Sensitive	Pacific Connector pipeline	NJ/LAA c/
Pacific marten (Coastal DPS b/) *Martes caurina*	Proposed Threatened	Sensitive	Jordan Cove terminal, navigation reliability improvements dredge area	NJ/NLAA c/
lue whale *Balaenoptera musculus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
fin whale *Balaenoptera physalus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
killer whale –Eastern North Pacific Southern Resident stock *Orcinus orca*	Endangered – Critical Habitat	No listing	LNG carrier transit in the waterway	NLAA, NE
humpback whale *Megaptera novaeangliae*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
Sei whale *Balaenoptera borealis*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA

TABLE 4.6.1-1 (continued)

Federally Listed and Proposed Species Potentially Occurring in the Project Area

Species	Federal Status	State Status	Portion of the Project Area Where Species May Occur	Effect of Proposed Project on Species, Critical Habitat a/
sperm whale *Physeter macrocephalus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
North Pacific right whale *Eubalaena glacialis*	Endangered – Critical Habitat	Endangered	LNG carrier transit in the waterway	NLAA, NE
gray whale (Western North Pacific Stock) *Eschrichtius robustus*	Endangered	No listing	LNG carrier transit in the waterway, navigation reliability improvements dredge area	NLAA
Birds				
short-tailed albatross *Phoebastria albatraus*	Endangered	Endangered	LNG carrier transit in the waterway	NLAA
Western snowy plover *Charadrius alexandrinus nivosus*	Threatened – Critical Habitat	Threatened	Jordan Cove terminal, navigation reliability improvements dredge area	NLAA, NLAA
marbled murrelet *Brachyrampus marmoratus*	Threatened – Critical Habitat	Threatened	LNG carrier transit in the waterway Jordan Cove terminal, navigation reliability improvements dredge area Pacific Connector pipeline	LAA, LAA
Northern spotted owl *Strix occidentalis caurina*	Threatened – Critical Habitat	Threatened	Jordan Cove terminal Pacific Connector pipeline	LAA, LAA
Fishes				
North American green sturgeon (Southern DPS) *Acipenser medirostris*	Threatened – Critical Habitat	Sensitive Critical	LNG carrier transit in the waterway Jordan Cove terminal	LAA, LAA
Coho salmon (South OR/North CA Coast ESU) *Oncorhynchus kisutch*	Threatened – Critical Habitat	Sensitive	LNG carrier transit in the waterway Pacific Connector pipeline	LAA, LAA
Eulachon (Southern DPS) *Thaleichthys pacificus*	Threatened– Critical Habitat	No listing	LNG carrier transit in the waterway Jordan Cove terminal Pacific Connector pipeline	LAA, NE
Coho salmon (Oregon Coast ESU) *Oncorhynchus kisutch*	Threatened – Critical Habitat	Sensitive	LNG carrier transit in the waterway Jordan Cove terminal Pacific Connector pipeline	LAA, LAA
Lost River sucker *Deltistes luxatus*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	LAA, NLAA
shortnose sucker *Chasmistes brevirostris*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	LAA, NLAA
Amphibians and Reptiles				
green turtle *Chelonia mydas*	Threatened – Critical Habitat	Endangered	LNG carrier transit in the waterway	NLAA, NE
leatherback turtle *Dermochelys coriacea*	Endangered – Critical Habitat	Endangered	LNG carrier transit in the waterway	NLAA, NLAA
Olive Ridley turtle *Lepidochelys olivacea*	Threatened	Threatened	LNG carrier transit in the waterway	NLAA
loggerhead turtle *Caretta caretta*	Endangered	Threatened	LNG carrier transit in the waterway	NLAA
Oregon spotted frog *Rana pretiosa*	Threatened –Critical Habitat	Sensitive Critical	Pacific Connector pipeline	NLAA, NLAA
Invertebrates				
vernal pool fairy shrimp *Branchinecta lynchi*	Threatened – Critical Habitat	No listing	Pacific Connector pipeline	LAA, NLAA

TABLE 4.6.1-1 (continued)

Federally Listed and Proposed Species Potentially Occurring in the Project Area

Species	Federal Status	State Status	Portion of the Project Area Where Species May Occur	Effect of Proposed Project on Species, Critical Habitat a/
Plants				
Applegate's milk-vetch *Astragalus applegatei*	Endangered	Endangered	Pacific Connector pipeline	LAA
Gentner's fritillary *Fritillaria gentneri*	Endangered	Endangered	Pacific Connector pipeline	LAA
Western lily *Lillium occidentale*	Endangered	Endangered	Jordan Cove terminal Pacific Connector pipeline	NLAA
large-flowered woolly meadowfoam *Limnanthes pumila* ssp. *grandiflora*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	NLAA, NLAA
Cook's lomatium *Lomatium cookii*	Endangered – Critical Habitat	Endangered	Pacific Connector pipeline	NLAA, NE
Kincaid's lupine *Lupinus suphureus* var. *kincaidii*	Threatened –Critical Habitat	Threatened	Pacific Connector pipeline	LAA, NE
rough popcornflower *Plagiobothrys hirtus*	Endangered	Endangered	Pacific Connector pipeline	NLAA

a/ Effects Key:
NLAA = Not likely to adversely affect, LAA = Likely to adversely affect, NE = No effect, NJ = not likely to jeopardize the continued existence for proposed species
b/ DPS=Distinct Population Segment
c/ This represents a provisional effect determination for this ESA proposed species. This provisional effect determination would apply if the species becomes listed prior to the completion of consultaion on the Project.

4.6.1.1 Mammals

Gray Wolf (Federal Endangered Species, State Delisted)

The federal ESA in Oregon protects gray wolves west of highways 395-78-95 (ODFW 2017e). Gray wolves were delisted from the Oregon ESA in 2015 (ODFW 2017f). Wolves are habitat generalists that only require the presence of ungulate prey and absence of excessive human-caused mortality (FWS 2013c). Wolf pack territory size is a function of prey density and can range from 25 to 1,500 square miles (FWS 2013c). Both male and female wolves disperse, sometimes greater than 600 miles (FWS 2013c).

A radio-collared male (i.e., OR7) dispersing from a pack in northeastern Oregon has been documented in southwestern Oregon and northern California since 2011, including near the Project in Jackson, Douglas, and Klamath Counties (ODFW 2013b). In 2014, a female joined the male, and they produced their first litter that year consisting of three pups (ODFW 2014e). This was the first evidence of wolves breeding in the Oregon Cascades since the early twentieth century (ODFW 2014d). The den was located within the Rogue River National Forest, between Crater Lake and Mount McLoughlin (Young 2014), approximately 6 miles from the pipeline route. Additional pups were born in 2015, 2016, and 2017 (ODFW 2018b). The Area of Known Wolf Activity (AKWA) initially mapped by ODFW for OR7 in 2014 (ODFW 2014c) is crossed by the pipeline route. The AKWA for OR7 and the Rogue Pack has shifted in size and shape since 2014. As currently mapped, it is less than 5 miles from the pipeline route in Jackson and Klamath Counties.

A second AKWA (Keno) was established in southwest Oregon in 2014 with limited evidence that three wolves inhabited an area approximately 280 square miles. ODFW recently removed the AKWA designation for the Keno wolves and is designating it as no longer active, but possibly used as a corridor for wolves moving between Oregon and California (ODFW 2018b). Approximately 2.48 miles of the pipeline route would pass through this area.

Three other radio-collared wolves dispersed from northeastern Oregon to southwest Oregon. One single male wolf (OR25) dispersed in 2015 and established an AKWA spanning northern Klamath County with portions in adjacent Jackson County and Lake County. A radio-collared female wolf (OR28) dispersed in late 2015 and was joined by a collared male (OR3) to establish the Silver Lake AKWA which coincides with the Silver Lake Wildlife Management Unit in western Lake County. The pair produced one pup in 2016 but the male was killed in 2016 (ODFW 2017g).

Given the occurrence of gray wolves in the areas affected by the Project, potential direct and indirect effects from construction and operation of the pipeline include the following:

- <u>Construction-related noise.</u> Construction would produce noise. Wolves appear most vulnerable to human disturbance in and around denning and rendezvous sites. No active denning sites are known within 1 mile of the pipeline.
- <u>Locally concentrated human activities.</u> Available evidence has shown that wolves subjected to increased vehicular traffic will avoid roads and will move pups if disturbed during denning. Wolves disturbed during winter indicated a physiological stress response to snowmobile stimuli.
- <u>Increased risk of collision with construction vehicles along Project area roadways.</u> Vehicles have killed a small number of wolves; overall, 80 percent of all wolf mortalities in the Northern Rocky Mountain population (which includes wolves in the Project area) are caused by humans but only 3 percent are due to accidental human interactions including vehicle collisions and capture mortality (FWS 2012a).
- <u>Wildland fire as an indirect effect associated with increased human presence</u>. The possibility of ignition in conifer and sagebrush/grass fuel types could range from low to extreme depending on weather conditions and patterns, current fire risk rating, moisture conditions, and fuel loadings. There is some possibility of human-caused fire, whether related to pipeline activities or to Project-induced increase of human presence in the area.
- <u>Habitat alteration</u>. Construction would remove forested habitat that might be used by some species that are preyed upon by wolves. However, corridors created within forested habitats are used for movement and foraging by big game species, which are prey for wolves.

Below is a determination of effects summary for this species and critical habitat. More details will be provided in the pending BA.

The Project **may affect** the gray wolf because:

- dispersing and resident wolves have been documented recently near the Project area;
- the OR7 wolf family den was near the pipeline route in 2014;
- construction noise could disturb wolves if present near the pipeline; and
- increased human presence associated with construction activities could affect wolf behavior and movements, including the chance of collisions with vehicles.

However, the Project is **not likely to adversely affect** the gray wolf because:

- the OR-7 den within the Rogue River National Forest is at least 6 miles from the pipeline;
- Project-related noises are not likely to be substantially different from noises produced by existing recreation and logging activities that wolves have been shown to tolerate;
- during pipeline construction, trash would be removed daily, and roadside carrion is expected to be present as an existing condition, and not substantially increased by the Project; and
- following construction, the restored and revegetated pipeline corridor is likely to increase habitat diversity and forage used by ungulates such as deer (Brusnyk and Westworth 1985; Forman 1995), which are prey for gray wolves.

No critical habitat has been designated or proposed for the gray wolf.

Pacific Marten-Coastal DPS (Federal Proposed Threatened Species, State Sensitive Species)

On October 9, 2018, the FWS proposed to list the coastal DPS of Pacific marten *(Martes caurina)* as a threatened species under the ESA (83 FR 150576). Should the rule for this species be finalized as proposed, it would be protected under ESA. The most current information for this species is provided in an updated species status assessment report, and provides a comprehensive account of the species, its life history needs, and stressors to the overall viability and extinction risk for the coastal marten (FWS 2018a). The coastal marten is a mammal in the weasel family and is native to forests of coastal Oregon and coastal California. They occur primarily in older forests, although there is one remnant population occupying the coastal dune forest of central Oregon. Coastal marten historically ranged throughout coastal Oregon and coastal northern California but have not recently been detected throughout much of the historical range, despite extensive surveys. The species exists in four small populations and is absent from the northern and southern ends of its historical range. In Oregon, there are two identified isolated small extent population areas: Central Coastal and Southern Coastal. The Jordan Cove LNG Project falls within the southern portion of the Central Coastal population area and the Pacific Connector pipeline crosses its historical range.

The Central Coastal Oregon population centers on the coastal forest of the Oregon Dunes National Recreation Area (ODNRA) and is managed by the Siuslaw National Forest. Most of this area comprises coastal forest that is less than 70 years old, and consists of shore pine and transitional shore pine/Douglas–fir–hemlock forests within the ODNRA. These forests grow on nutrient-poor sandy soils, dominated by young stands of shore pine and Sitka spruce. The dense understory is dominated by willow (*Salix hookeri*), Pacific waxmyrtle (*Myrica californica*), and berry-producing ericaceous shrubs such as evergreen huckleberry (*Vaccinium ovatum*) and salal (G*aultheria shallon*). These shore pine forests have a variable tree overstory; however, the common denominator with this habitat and older forest habitats is the presence of dense, spatially extensive ericaceous shrub understories and diverse and abundant prey. Coastal martens have a generalist diet that changes seasonally with prey availability. Overall, their diet is dominated by mammals (primarily voles in Central Coastal population area), but birds, insects, and fruits are seasonally important.

Reports by Zielinski et al. (2001) and Moriarty et al. (2016) noted a relatively high incidence of road kills in the last 30 years (i.e., 17) and it was assumed that animals were abundant. Linnell et al. (2018) used recent surveys to refine the extent of the Central Coastal population size of fewer than 87 adults divided into two subpopulations; however, there is no information at this time on long–term trends in population size. The 2018 species status assessment further divides this population into two subpopulations of approximately 30 adults each, separated by the Umpqua River, a relatively large barrier to movement and dispersal. Martens in this population occur in the highest densities reported for any North American marten subspecies (1.13 per square kilometer; Linnell et al. 2018). The Southern Coastal population area in Oregon is located over 40 miles to the south and would not be affected by the Project.

The 2018 species status assessment identifies various factors (stressors) that are directly and indirectly affecting what the coastal marten needs for long-term viability. These include loss of habitat due to wildfire, timber harvest, and vegetation management. Trapping, collisions with vehicles, and rodenticides are all impacting marten individuals, and the threat of disease carries the risk of further reducing populations. Changes in vegetation composition and distribution have also made coastal martens more susceptible to predation from larger carnivores. These threats are expected to be exacerbated by the species' small and isolated populations. Linnell et al. (2018) suggest that small population size, consistent annual human-caused mortality (primarily trapping and road kills), and isolation indicate this coastal marten population is likely to remain vulnerable to extirpation.

Section 4.4 describes five forested and two woodland vegetation types that may be suitable habitat for marten and would be affected by the construction and operation of the Jordan Cove LNG Project. The vegetation types are shown on figures 4.4-1a and 4.4-1b. Table 4.4.1.5-1 estimates that approximately 76 acres and 62 acres of forested and woodland vegetation would be cleared for the LNG facilities and temporary construction areas, respectively.

Given that the Project falls within the southern portion of the Central Coastal population area and the occurrence of marten habitat within the area of the proposed Project footprint, potential direct and indirect effects from construction and operation of the Project include the following:

- Construction-related noise. Construction would produce noise; and martens appear most vulnerable to human disturbance in and around denning and resting habitat. No active denning sites are currently known in the vicinity of the Project site.
- Locally concentrated human activities. Available evidence has shown that martens are subject to road kills and increased vehicular traffic has the potential to increased vehicle collision mortality.
- Habitat alteration. Construction would remove forested habitat that might be used by martens or species that are preyed upon by martens, or otherwise increase fragmentation within suitable habitat. However, much of the forested portions within the Jordan Cove Project boundaries are already in a disturbed state.
- Wildland fire as an indirect effect associated with increased human presence. The possibility of ignition in conifer and sagebrush/grass fuel types could range from low to extreme depending on weather conditions and patterns, current fire risk rating, moisture conditions, and fuel loadings. There is some possibility of human-caused fire, whether related to construction activities or to Project-induced increase of human presence in the area.

Below is a determination of effects summary for Pacific marten- coastal DPS. At this time, no critical habitat has been proposed or designated for this species. More details will be provided should this species become listed as threatened under ESA, including potential exceptions and/or any designation of critical habitat.

The Project **will not jeopardize the continued existence** of the Pacific marten- coastal DPS; however, in the event that Pacific marten- coastal DPS becomes listed prior to completion of the Project, a provisional effect determination is provided.

The Project **may affect** the Pacific marten- coastal DPS because:

- marten historically used the entire Oregon coastal region;
- the southern portion of the Central Coast population area overlaps with the Jordan Cove LNG Project;
- the Project would remove suitable habitat for the coastal DPS population; and
- increased human presence associated with construction activities could affect marten behavior and movements, including the chance of collisions with vehicles.

However, the Project is **not likely to adversely affect** Pacific marten-coastal DPS because:

- there is a relatively low potential for the coastal DPS individuals to occur based on historical accounts and the current low estimated number of individuals south of the Umpqua River;
- project-related noises are not likely to be substantially different from noises produced by existing recreation and logging activities that martens have been shown to tolerate;
- during Project construction, trash would be removed daily to reduce the potential for predator species; and
- construction-related vehicles and equipment would operate at slower speeds, and therefore not substantially increase the potential for vehicle collisions.

Pacific Fisher-West Coast DPS (Federal Proposed Threatened Species, State Sensitive-Critical Species)

The FWS proposed to list the West Coast DPS of the Pacific fisher as threatened under the ESA on October 7, 2014 (79 FR 60419). In April 2016, the FWS determined that the fisher does not warrant listing under the ESA (81 FR 22710). However, on September 21, 2018, the decision to deny the fisher protected status was rescinded and the comment period for the proposed rule to list the West Coast DPS of the fisher was reopened (84 FR 644). The FWS is scheduled to issue a new finding by March 22, 2019.

Fishers occur in the northern coniferous and mixed forests of Canada and the northern United States (69 FR 18770). The West Coast DPS includes fishers in Washington, Oregon, and California. In Oregon, this species is currently known to occur in Curry, Douglas, Jackson, Josephine, and Klamath Counties (Aubry and Lewis 2003; Aubry pers. comm. 2007 as cited in FWS 2014b). Currently, there are two documented populations of fisher in southern Oregon, one in the northern Siskiyou Mountains and one in the southern Cascade Range, that were believed to be genetically isolated from each other (FWS 2014b). However, recent research shows that the two populations are not genetically isolated (Barry et al. 2018).

Fisher habitat consists of mature, closed canopy coniferous and mixed conifer and hardwood forests at low to middle elevations, including riparian corridors with continuous canopies, and large stands with low levels of fragmentation and a high percentage of dead and downed timber (ODFW 2019; FWS 2016a). Fishers prefer large tracts of contiguous interior forest and typically avoid thinned or open forests, including areas where there is substancial human disturbance. A variety of large conifer tree species are used for denning and resting, including Douglas-fir, white fir, incense cedar, red fir, sugar pine, western white pine, ponderosa pine and lodgepole pine (Aubry and Raley 2006; Cummins et al. 2018). In the southern Oregon Cascades, average home range sizes for females were approximately 9.7 square miles and between 24 square miles for males during the non-breeding season and 57 square miles for males during the breeding season, based on locations of radio telemetered study animals (Aubry and Raley 2006).

Loss and fragmentation of habitat due to timber harvest and thinning, roads, urban development, recreation, and wildfire are the main reasons for the decline of the fisher in the west (FWS 2018b). Habitat loss, modification, and fragmentation continue to occur as a result of forest management practices and stand replacing wildfire, and appear to pose a substantial threat to fishers (FWS 2012b). In addition to removing forage, rest, and den sites, fragmentation can increase predation risk, impede movements, and affect prey species composition, abundance, and availability (FWS 2012b). Fragmentation can also increase energetic costs to fishers, which may result in nutritional stress that can reduce animal condition, ultimately affecting survival, reproduction, and recruitment (Lofroth et al. 2010). Additionally, linear infrastructure such as roads, power lines, and pipelines can also affect fisher populations and their habitat (FWS 2016a). As well as being sources of mortality from vehicle collision, these linear infrastructure features can result in permanent removal or alteration of potential fisher habitat and can disrupt movement patterns (FWS 2016a). However, linear infrastructure is considered to be a low-level impact to fishers currently and in the future (FWS 2016a).

Recent telemetry studies in the southern Oregon Cascades identified fisher home ranges that overlap with the Project on the Winema National Forest (Cummins 2018). Location databases show one observation within 1 mile and one observation within 1 to 3 miles of the Project on the Winema National Forest. These observations, together with the availability of suitable habitat within the pipeline ROW, indicate that there is potential for fishers to be present within the analysis area.

Section 4.5 discusses the various wildlife habitat types (from Johnson and O'Neil 2001) crossed by the Project. Late successional and old-growth forest within five forest and woodland habitat types crossed by the pipeline may provide habitat for the fisher. These habitat types include Westside Lowland Conifer-Hardwood Forest, Montane Mixed Conifer Forest, Southwest Oregon Mixed Conifer-Hardwood Forest, Westside Riparian-Wetlands, and Eastside Riparian-Wetlands. Table 4.5.1.2-5 estimates that approximately 657.9 acres of these habitat types would be cleared for the construction of the pipeline.

Given the potential for occurrence of fishers in the areas affected by the Project, potential direct and indirect effects from construction and operation of the pipeline include the following:

- <u>Construction-related noise.</u> Construction would produce noise. Fishers are vulnerable to human disturbance and fishers have been documented within 1 mile of the pipeline.

- Locally concentrated human activities. Construction activities could affect fishers by disturbing animals. Fishers are sensitive to disturbance and avoid areas used by humans (CBD 2000).
- Increased risk of collision with construction vehicles along Project area roadways. Human-caused mortality from vehicle collisions are listed as one of the threats to fisher populations (FWS 2018b).
- Habitat alteration and fragmentation. Construction would remove forested habitat and would modify habitat, particularly by removing large trees, snags, and large woody debris that are used for fisher den and rest sites. The cleared ROW could also fragment habitat, which is detrimental to fishers because they prefer large areas of contiguous, unfragmented forest (CBD 2000).
- Wildland fire as an indirect effect associated with increased human presence. The possibility of ignition in conifer, hardwood, and sagebrush/grass fuel types could range from low to extreme depending on weather conditions and patterns, current fire risk rating, moisture conditions, and fuel loadings. There is some possibility of human-caused fire, whether related to pipeline activities or to Project-induced increase of human presence in the area.

Below is a determination of effects summary for Pacific fisher-West Coast DPS. At this time, no critical habitat has been proposed or designated for this species. More details will be provided should this species become listed as threatened under the ESA, including potential exceptions and/or any designation of critical habitat.

The Project **will not jeopardize the continued existence** of the Pacific fisher-West Coast DPS; however, in the event that Pacific fisher-West Coast DPS becomes listed prior to completion of the Project, a provisional effect determination is provided.

The Project **may affect** the fisher because:

- fishers have the potential to occur in the fisher analysis area;
- suitable habitat is available within the fisher analysis area and would be impacted by the pipeline;
- construction noise could disturb fishers if present near the pipeline; and
- increased human presence associated with construction activities could affect fisher behavior and movements, including the chance of collisions with vehicles.

The following determination is warranted to receive a conference opinion of **may affect, likely to adversely affect** because:

- Recent telemetry studies in the southern Oregon Cascades identified fisher home ranges that overlap with the Project;
- 657.9 acres of suitable LSOG habitat, including snags, would be removed due to pipeline construction.
- Snags and large trees that could serve as fisher dens would be removed during pipeline construction.

Whales

Eight species of federally listed whales potentially occur off the coast of Oregon, including the blue, fin, southern resident killer, humpback, sei, north Pacific right, gray (Western North Pacific Stock) and sperm whales. All these whale species are federally protected under the MMPA. These species tend to feed during the summer in the northern latitudes and migrate to the tropical southern latitudes in the winter for breeding. However, whales could be encountered off the coast of Oregon throughout the year. Two killer whales were documented near the Project area in May 2017 during marine mammal surveys for the Project, although these were likely transient killer whales not belonging to the southern resident DPS (AECOM 2017). Gray whales have been reported in Coos Bay only on an occasional basis. Project effects on whales would be associated with LNG and construction supply vessel transits in the waterway inbound and outbound from the Jordan Cove terminal, as well as construction activities such as dredging and pile driving. Potential direct effects of the Project could include injury and/or mortality due to ship-strikes, injury or behavioral disturbance due to noise from vessels and construction activities, and potential adverse effects from a ship fuel spill. Spills could indirectly affect whales by harming or contaminating forage species. Additional details on whale densities and potential for ship strikes will be provided in the pending BA.

Below is a determination of effects summary for whales and critical habitat. More details will be provided in the pending BA.

The Project **may affect** federally listed whales because:

- federally listed whales may occur within the aquatic analysis areas (Figure 4.5-1 in section 4.5; includes the Coos Bay estuary and marine environment out approximately 12 nautical miles to the outer continental shelf) during construction and operation of the proposed action;
- vibratory sheet pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 120 decibel (dB) re 1 microPascal (μPa) at distances of up to 1.2 miles (Deveau and MacGillvray 2017) and impact pipe pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 160 dB re 1 μPa at 1.1 miles (O'Neill and MacGillvray 2017); and
- the proposed action would increase shipping traffic (LNG carriers) within the aquatic analysis areas.

However, the Project is **not likely to adversely affect** federally listed whales for the following reasons:

- ship strikes on whales off the Oregon coast are thought to be infrequent based on the Rockwood et al. (2018) assessment of potential whale/vessel collision mortalities for blue, humpback, and fin whales of less than 1 percent, and therefore thought to be discountable;
- 120 LNG carrier trips per year to the LNG terminal are expected to increase the potential in ship strikes to whales over known frequencies of incidents; however, Jordan Cove would provide a ship strike avoidance measures package to LNG carrier operators transporting cargo from the LNG terminal that would consist of multiple measures to avoid striking marine mammals;

- FERC does not have authority over the LNG carrier; however, the independent carrier operators would be required to follow all Coast Guard requirements regarding the operation of LNG carriers, including vessel speeds;
- noise from LNG carriers, dredgers, tugs, and other support vessels could result in behavioral disturbance to listed whales and effects of ship noise on whales could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise (NMFS 2016c, 2017b, 2018c), but LNG carrier noise would not exceed existing background ship noise levels and would not cause injury;
- whales inside Coos Bay in the vicinity of the Jordan Cove LNG Project may be affected by noise from piling during construction, and the use of an impact hammer has impulsive peak source levels that are high enough to cause permantent threshold shift (PTS) (an indicator of hearing damage) in these species; however, listed whales are unlikely to occur within Coos Bay during pile driving (October 1 to February 15), and Jordan Cove has indicated that these activities would be monitored and halted if a whale was detected in the area around the sound source;
- given vessel design, on-board spill kits, safety records, and implementation of Coast Guard recommendations, it is not likely that there would be a major ship spill of hazardous materials that may adversely affect water quality or aquatic species; and
- the relative population density of whales within the marine analysis area[137] would be low enough so that Project-related effects of LNG carrier transit in the waterway would be discountable.

No critical habitat has been designated or proposed for blue, fin, humpback, sei, or sperm whales.

The Project would have **no effect** on designated critical habitat units (CHUs) for the Eastern Northern Pacific Southern Resident stock of killer whales because:

- none of the designated CHUs occur within the marine analysis area off the Oregon coast.

The Project would have **no effect** on designated critical habitat for the North Pacific right whale because:

- none of the designated critical habitat occurs within the marine analysis area off the Oregon coast.

As described above, listed whales inside Coos Bay near the Jordan Cove LNG Project may be affected by noise from pile driving during construction, and the use of an impact hammer has impulsive peak source levels that are high enough to cause PTS (an indicator of hearing damage) in these species. Therefore, **we recommend that:**

- **<u>Prior to construction,</u> Jordan Cove should file with the Secretary, for review and written approval by the Director of OEP, a *Marine Mammal Monitoring Plan* that identifies how the presence of listed whales will be determined during construction,**

[137] Whale density estimates were based on habitat specific densities for blue whales, fin whales, and humpback whales (Becker et al. 2012; Calambokidis et al. 2015). Quantified comparable estimates for other species were not available, but the existing data were examined to qualitatively determine the level of risk to these species. These data sources and analyses are further described in the Applicant Prepared Draft Biological Assessment, filed with the FERC September 14, 2018.

and measures Jordan Cove will take to minimize potential noise effects on whales and other marine mammals, and ensure compliance with NMFS underwater noise criteria for the protection of listed whales.

4.6.1.2 Birds

Short-tailed Albatross (Federal Endangered Species, No State Status)

The short-tailed albatross was listed as endangered throughout its range in the United States on July 31, 2000 (FWS 2000a). In the North Pacific, the coastal habitat for the short-tailed albatross is in high-productivity areas with expansive deep water beyond the continental shelf. Short-tailed albatross rarely occur closer to the coast, but have been documented to occur off the Oregon coast near Coos Bay (in 1961, 2000, and 2001; National Audubon Society 2013). Because the closest breeding population of short-tailed albatross is within the Hawaiian Islands, the Project should not affect recovery criteria for the species. The short-tailed albatross could potentially be encountered within the LNG carrier transit route; however, short-tailed albatross are expected to avoid LNG marine traffic. Below is a determination of effects summary for the short-tailed albatross and critical habitat. More details will be provided in our pending BA.

The Project **may affect** short-tailed albatross because:

- short-tailed albatross may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area.

However, the Project is **not likely to adversely affect** short-tailed albatross for the following reasons:

- other species of albatross have infrequently collided with airplanes in flight but collisions of any albatross species with ships are unknown and are expected to be highly unlikely;
- 120 LNG carrier trips per year to the LNG terminal are expected to cause unmeasurable increase in potential ship strikes on short-tailed albatrosses;
- LNG carriers approaching Coos Bay would be traveling slowly and escorted by tractor tugs from 5 nautical miles offshore; and
- given vessel design, on-board spill kits, safety records, and implementation of Coast Guard recommendations, it is not likely that there would be a major ship spill of hazardous materials that may adversely affect water quality or aquatic species. Any oil released at sea would be in small enough quantities that potential effects on short-tailed albatrosses would be discountable.

No critical habitat has been designated or proposed for the short-tailed albatross.

Western Snowy Plover (coastal) (Federal Threatened Species with Critical Habitat, State Threatened Species)

The Pacific Coast population of western snowy plover has been listed as a threatened species under the ESA since March 5, 1993 (FWS 1993a). The Pacific coast population includes birds that nest adjacent to tidal waters, including all nesting birds on the mainland coast, peninsulas, offshore islands, adjacent bays, estuaries, and coastal rivers (FWS 1993a). The western snowy plover is a year-round, uncommon resident of the North Spit (BLM 2005); the spit supports the most productive snowy plover population segment on the Oregon coast (BLM 2008). Western snowy plovers may be encountered along the LNG carrier transit route from nearshore coastal waters to the LNG terminal. Potential effects include increased noise associated with construction of the Jordan Cove LNG Project, operation activities associated with shipping, increased recreation, increased habitat conversion, habitat degradation by human encroachment, and increased illegal harvest (Comer 1982). Conservation measures proposed to reduce effects include implementation of BMPs, education and outreach, and monitoring. CHUs OR-10 and OR-9 are located 2.6 and 6.9 miles from the LNG terminal, respectively; both units were occupied by western snowy plovers at the time of listing (1993) and in 2012. Below is a determination of effects summary for the western snowy plover and critical habitat. More details will be provided in our pending BA.

The Project **may affect** western snowy plovers because:

- the closest western snowy plover nesting habitat to the Project is on the North Spit approximately 1 mile from LNG terminal site, and contained active nests during 2016 surveys;
- temporary construction activities would occur at the Port Laydown site, which is less than 1 mile from known nesting sites;
- the meteorological station is located east of the foredune, approximately 100 feet from the northern extent of known nesting sites;
- impact hammer noise associated with the Navigation Reliability Improvement temporary facilities is expected to be above ambient levels, and may disturb wintering western snowy plovers if present along the eastern edge of the primary nesting area on the North Spit, which is within 0.25-miles of Dredge Area 1; and
- Jordan Cove terminal construction and operations personnel would likely use the North Spit for recreational purposes and increased recreational use could result in increased plover disturbance including destruction of nests by dogs, off-road vehicle traffic, inadvertent trampling, or increased predation if scavengers and predators (corvids, coyotes, striped skunk, feral cats) are attracted to nesting areas due to the presence of trash and food remains.

However, the Project is **not likely to adversely affect** western snowy plover because:

- Jordan Cove LNG Project construction noise at active nest sites (approximately 1 mile) and critical habitat (approximately 2.6 miles) is not expected be above ambient levels.
- Dredging operations would take place within the ODFW in-water work window, which is outside of the nesting period for western snowy plovers and dredging noise level is unlikely to affect wintering plovers approximately 0.25 miles away. Access to dredging areas would be by marine transport with no land-based access near primary snowy plover habitat.
- The meteorological station would be constructed outside the nesting season (March 15 to September 15) to avoid disturbance to snowy plovers and would include spikes or other deterrent measures on any potential perching surface, bird deterrent measures if guy-lines are required, and shielded security lighting to minimize glare. Operational activities would be maintenance-related and would be scheduled outside of the nesting season.
- Jordan Cove would minimize disturbance by humans, pets, vehicles or human-attracted predators through implementation of (1) BMPs to minimize predator density related to

increased human presence and habitat removal, and (2) education and outreach programs intended to train all construction and operations staff on the need for snowy plover conservation; current snowy plover regulations and recreational use restrictions; and the importance of conservation measures, including: litter control, avoidance of nesting and foraging areas, keeping pets on-leash, and remaining on established roads and trails.

Even though the northern end of CHU OR-10 on the North Spit is located approximately 2.6 miles from the Jordan Cove LNG Project, the Project **may affect** designated critical habitat for the western snowy plover because:

- temporary construction activities would occur at the Port Laydown site, which is approximately 1 mile from critical habitat;
- the Navigation Reliability Improvements Dredge Area 1 is approximately 0.25 mile from critical habitat; and
- the Project would result in a large but temporary increase in people employed on the North Spit during construction, and a much smaller long-term increase of operations staff. The additional human presence is likely to increase use of the North Spit with concomitant potential increase of pets, vehicles, and/or human-attracted predators.

However, the Project is **not likely to adversely affect** designated critical habitat for the western snowy plover because:

- dredging noise level is unlikely to affect physical or biological features (PBF) at CHU OR-10 approximately 0.25 miles away; and
- Jordan Cove would minimize potential secondary effects on the critical habitat PBF that identifies disturbance by humans, pets, vehicles or human-attracted predators through implementation of (1) BMPs to minimize predator density related to increased human presence and habitat removal, and (2) education and outreach programs intended to train all construction and operations staff on the need for snowy plover conservation; current snowy plover regulations and recreational use restrictions; and the importance of conservation measures, including: litter control, avoidance of nesting and foraging areas, keeping pets on leash, and remaining on established roads and trails.

Marbled Murrelet (Federal Threatened Species with Critical Habitat, State Threatened Species)

MAMUs in Washington, Oregon, and California were listed as threatened under the ESA on October 1, 1992 (FWS 1992a). Critical habitat for the MAMU was first designated on May 24, 1996 (FWS 1996) and subsequently revised in 2011 (FWS 2011b, 2016b). Throughout the forested portion of their range, MAMU habitat use is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low amounts of edge and fragmentation, proximity to the marine environment, and increasing forest age and height, although the presence of platforms is the most important characteristic of nesting habitat (FWS 2006c).

Through a combination of GIS data provided by the BLM and private timber companies, and field surveys conducted between 2007 and 2018, Pacific Connector identified 175 occupied and presumed occupied MAMU stands within 0.25 mile of the proposed action, or within 0.5 mile of federally-designated critical habitat that would be affected by the proposed action.

Construction of the Project would remove a total of about 806 acres of MAMU habitat (suitable, recruitment, capable), including about 78 acres of suitable habitat removed from 37 stands (18 occupied MAMU stands and 19 presumed occupied stands). There is the potential that effects could extend over a total of about 7,145 acres of suitable nesting habitat in the terrestrial nesting analysis area (i.e., the extent of disturbance/disruption of MAMU during the breeding season; FWS 2014c), where Project-related noise, primarily use of access roads, may affect MAMU behavior, including breeding activities. HDD and DP activities are not anticipated to disturb nesting MAMU as noise associated with this work would attenuate to ambient levels before reaching MAMU stands. Ten occupied and 24 presumed occupied MAMU stands occur within CHU OR-06 (b, c, and d) within the proposed terrestrial nesting analysis area. Overall, construction of the Pacific Connector Pipeline Project would remove about 4 acres of suitable MAMU nesting habitat (PBF-1) and about 12 acres of recruitment habitat and 15 acres of capable habitat (both of which make up PBF-2) within CHU OR-06-d.

Pacific Connector would implement several measures to reduce effects on MAMU habitat, including using UCSAs, and replanting conifer trees outside of the 30-foot-wide maintenance corridor on certain federal lands and non-federal lands. However, replanted trees may be harvested from non-federal lands or federal lands slated for timber harvest (i.e., Matrix lands and Harvest Land Base), and if allowed to grow would provide minimal benefit to MAMUs because it would take decades at a minimum to restore replanted forests to recruitment or suitable habitat conditions. To ensure that trees with active murrelet nests and chicks are not felled, timber would be removed outside of the entire MAMU breeding season (after September 15 but before March 31) within 300 feet of MAMU stands to avoid this direct effect on MAMU. To minimize disturbance and disruption of MAMU during operations and maintenance, vegetation maintenance activities would occur between August 1 and April 15, and Pacific Connector would apply daily timing restrictions during activities to minimize effects on MAMU during the late breeding season (August 6 – September 15).

Below is a determination of effects summary for the MAMU and critical habitat. More details will be provided in the pending BA.

The Project **may affect** MAMUs because:

- suitable habitat is available within the terrestrial nesting analysis area;
- MAMUs have been located within the terrestrial nesting analysis area during survey efforts for the proposed action; and
- MAMUs are expected to forage offshore in the marine analysis area, and within Coos Bay in the estuarine analysis area.

The Project is **likely to adversely affect** MAMUs for the following reasons:

- Disturbance associated with Pacific Connector Pipeline Project activities and construction of the Kentuck project would occur within the critical breeding season and within 0.25 mile of known MAMU stands.
- Proposed actions that generate noise above local ambient levels levels in approximately 7,145 acres of suitable habitat might disturb or disrupt MAMUs and interfere with essential nesting behaviors:

  - 82 MAMU stands (25 occupied and 57 presumed occupied) are within 0.25 mile of the pipeline that could be constructed during the breeding season.
  - 168 MAMU stands (50 occupied and 118 presumed occupied) are within 0.25 mile of access roads that could be used during pipeline construction in the breeding season.
- Blasting for the pipeline trench may occur within 0.25 mile of 11 MAMU stands between April 1 and September 30.
- Helicopter use within 0.25 mile of eight occupied MAMU stands during the breeding period (between April 1 and September 15) could occur and disturb MAMU adults and nestlings, as well as potentially blow nestlings out of the nest tree within six occupied MAMU stands from rotor wash.
- The Pacific Connector Pipeline Project would remove approximately 78 acres of suitable nesting habitat within the range of the MAMU; or approximately 0.5 percent of the 14,310 acres of suitable habitat available in the terrestrial nesting analysis area.
- The Pacific Connector Pipeline Project would remove approximately 307 acres of recruitment habitat and 421 acres of capable habitat within the range of the MAMU. These habitats do not currently support the recovery of the species.
- The Pacific Connector Pipeline Project would modify (cause other indirect effects such as increases in edge habitat and loss of interior forest habitat, including increased predation) approximately 656 acres of suitable, 2,058 acres of recruitment, and 2,449 acres of capable habitat.
- Turbidity generated during HDD if a frac-out occurred could affect local major prey species for chicks such as anchovy, sand lance, and smelt.
- LNG carrier traffic in the estuarine analysis area to the Jordan Cove terminal could cause potential behavioral effects on foraging MAMU, and fuel and lubricant spills from LNG carriers could cause injury or mortality to foraging MAMUs.

The Project **may affect** MAMU critical habitat because:

- the Project occurs within designated MAMU critical habitat; and
- the Project would affect habitat within designated critical habitat areas.

The Project is **likely to adversely affect** MAMU critical habitat because:

- the proposed action could remove or degrade individual trees with potential nesting platforms or the nest platforms themselves, resulting in a decrease in or elimination of the value of the trees for future nesting use (PBF 1, or suitable or potentially suitable habitat); and
- the proposed action could remove or degrade trees adjacent to trees with potential nesting platforms that provide habitat elements essential to the suitability of the potential nest tree or platform, such as providing cover from weather or predators (PBF 2, or recruitment/capable habitat).

As described above, construction of the pipeline (including clearing of timber, access road use, helicopter use, and blasting), as well as pipeline operation and maintenance, would occur within the MAMU breeding season and within 0.25 mile of known MAMU stands. These activities could disturb or disrupt MAMUs and interfere with essential nesting behaviors during the breeding season. Therefore, to reduce these effects during the breeding season, **we recommend that:**

- **<u>Prior to construction</u>, Pacific Connector shall file with the Secretary its commitment to adhere to FWS-recommended timing restrictions within threshold distances of MAMU and NSO stands <u>during construction, operations, and maintenance</u> of the pipeline facilities.**

The FWS timing restrictions for MAMU and NSO, as referenced in the above recommendation, were outlined in FWS (2016c).

Given the anticipated avoidance of disturbance and disruption to MAMU during the breeding season per inclusion of the recommendation above into the proposed action (i.e., implementation of distance and timing restrictions, without exception), noise and visual effects on breeding MAMU as a result of construction would be minimized. However, there would be a loss of future breeding opportunities due to the removal of suitable, recruitment, and capable habitat during construction, as there would be less suitable habitat available for nesting. Additionally, the quality of the remaining habitat would be reduced due to habitat fragmentation and the addition of edge along the pipeline corridor. Removal of suitable nesting habitat by harvest of old-growth timber has been cited as the primary reason for the species' decline (FWS 1992a). Suitable MAMU nesting habitat takes a long time to develop (more than 250 years on average); therefore, any removal of suitable habitat may affect the recovery of the MAMU. Jordan Cove has indicated an interest in working with the FWS to discuss possible mitigation and conservation measures but has not proposed compensatory mitigation. In the absence of mitigation other than avoidance and minimization, the Project would result in long-term negative effects on this this threatened species.

Northern Spotted Owl (Federal Threatened Species with Critical Habitat, State Threatened Species)

In Oregon, the NSO is found in low- and mid-elevation coniferous forest in the Coast, Siskiyou, and Cascade Ranges (Forsman 2003). Suitable habitat for NSOs provides elements necessary for nesting, roosting and foraging. NSOs generally nest in forests with multilayered, multispecies canopies with large (20–30 inches dbh or greater) overstory trees, a high basal area (greater than 240 square feet/acre), and a high diversity of different diameters of trees. NSOs have large home ranges and utilize large tracts of land containing substancial acreage to meet their biological needs and a wide array of forest types and structures are necessary to support the various life histories (FWS 2011a). Typically, a larger area is required for NSOs in more fragmented habitats (Courtney et al. 2004). NSOs remain on their home range throughout the year. As a result, NSOs have large home ranges that provide all the habitat components and prey necessary for the survival and successful reproduction of a territorial pair.

Home ranges contain three distinct use areas: 1) the nest patch, which research has shown to be an important attribute for site selection by NSOs and includes approximately 70 acres of usually contiguous forest (300-meter radius around an activity center; FWS et al. 2008), 2) the core area, which is used most intensively by a nesting pair and varies considerably in size across the geographic range, but on average encompasses approximately 500 acres around the nest site (0.5-mile radius around the activity center), and is generally made up of mostly mature/old-growth forest (FWS 2007c; Courtney et al. 2004), and 3) the remainder of the home range which is used for foraging and roosting and is essential to the year-round survival of the resident pair (FWS 2007c). NSO home range size varies by physiographic province. In the Coast Range

Physiographic Province (MP 0.00 to MP 51.74), the home range is assumed to be circular with a radius of 1.5 miles. Within the Klamath Mountains Physiographic Province (MP 51.74 to MP 122.67), the home range radius is 1.3 miles, and in the West Cascades (MP 122.67 to MP 167.76) and East Cascade Physiographic Provinces (MP 167.76 to MP 190.64) the home range radius is 1.2 miles (FWS 1992b). Surveys conducted by Pacific Connector in 2007 identified 12 NSO pairs and a resident single but no nests. In 2008, surveys found NSO pairs at 20 locations, with two nests identified, and resident singles noted at six sites. Surveys in 2015 along the Blue Ridge route did not document any NSO. In addition to NSO sites identified by these surveys, Pacific Connector also considered home range information from the BLM and Forest Service, historic home ranges, best location home ranges (alternate sites closest to proposed action), and Pacific Connector-assumed home ranges (determined by Pacific Connector's assessment of habitat maps). Taking a conservative approach, all owl sites (known, best location, and Pacific Connector-assumed) were analyzed as if occupied and reproductive.

The Project would affect habitat within 97 NSO home ranges and 9 nest patches. About 37 miles of pipeline route would cross 7 designated critical habitat sub-units. Project construction would remove a total of about 517 acres of nesting, roosting, or foraging (NRF) habitat for NSO, of which 134 acres would be permanently lost within the 30-foot-wide corridor maintained in an herbaceous state. Additionally, 214 acres of NRF habitat for NSO would be modified and used as UCSAs. Approximately 1,158 acres of dispersal habitat (high NRF, NRF, and dispersal only habitat) would be removed by the Project. Approximately 919 acres of NSO capable habitat would be removed by construction of the proposed Project, of which 216 acres would remain in a permanent herbaceous/shrub state within the 30-foot operational ROW. Approximately 13,294 acres of NSO habitat (1,307 acres of high NRF/NRF habitat, 4,147 acres of dispersal only habitat, and 5,690 acres of capable habitat) occur within 100 meters (328 feet) of habitat removal, of which 4,326 acres (or 32.5 percent of NSO habitat within 100 meters of habitat removal) of interior NSO habitat would be indirectly affected (1,586 acres of high NRF/NRF habitat, 1,388 acres of dispersal only habitat, and 1,352 acres of capable habitat). The Pacific Connector Pipeline Project would remove 442 acres from LSRs , of which 379 acres is NSO habitat or capable of becoming NSO habitat (approximately 69 acres of high NRF, 93 acres of NRF [includes about 9 acres of "post-fire" NRF], 71 acres of dispersal only habitat, and 146 acres of capable habitat).

Potential direct effects on NSOs would include the following: (1) removal of a known nest tree during the entire breeding season (March 1 through September 30), and (2) human and noise disturbance due to ROW clearing and construction during the breeding period, including noise due to blasting and helicopter support during construction, and smoke from prescribed burnings. Potential indirect effects include the following: (1) removal or modification of suitable NRF habitat, dispersal habitat, and habitat that would be capable, over the life of the Project, to achieve dispersal or NRF habitat characteristics but for the Project's effects within LSR, Riparian Reserves, or NSO home ranges; (2) habitat fragmentation; and (3) other indirect effects that occur due to Project-related increases in edge habitat and loss of interior forest habitat, including increased predation, increased competition, and effects on prey utilized by NSOs. HDD and DP activities are not anticipated to disturb nesting NSO because noise associated with this work would attenuate to ambient levels before reaching NSO sites.

Pacific Connector would minimize effects on NSO habitat using the BMPs for crossing forested lands described in section 4.4 of this EIS. Pacific Connector would reduce effects on NSO habitat by replanting conifer trees outside of the 30-foot-wide maintenance corridor on certain federal lands and non-federal lands. However, replanted trees may be harvested from non-federal lands or federal lands slated for timber harvest (i.e., Matrix lands and Harvest Land Base), and if allowed to grow would provide minimal benefit to NSOs because it would take 80 years at a minimum to restore replanted forests to suitable habitat conditions. Timber removal would occur outside the entire NSO breeding season (March 1 through September 30) within 0.25 mile of NSO activity centers, and as a result, no nest trees within activity centers would be removed during the NSO nesting period, and disturbance or disruption would also be reduced. Additionally, Pacific Connector would install the pipeline within 0.25 mile of activity centers after the critical breeding period (after July 15). However, activities from pipeline construction during the late breeding period (July 16 through September 30) could disrupt or disturb NSO at 10 NSO activity centers within 0.25 mile of the pipeline ROW, and construction activities off the ROW would occur during the entire breeding season and could disturb NSO at two known activity centers located 0.25 mile of pipeline project components, if NSO are present.

For operations and maintenance activities, Pacific Connector would not conduct vegetation maintenance activities within 0.25 mile of NSO activity centers during the entire breeding season (March 1–September 30) to minimize disturbance and disruption to NSO. Other operations and maintenance activities may occur within the breeding season. Mitigation projects such as snag creation projects proposed by the Forest Service to meet LRMP objectives would benefit NSO.

Below is a determination of effects summary for the NSO and critical habitat. More details will be provided in the pending BA.

The Project **may affect** NSOs because:

- suitable habitat is available within the Provincial Analysis Area;[138] and
- NSO pairs and resident singles have been located within the Provincial Analysis Area during survey efforts.

The Project is **likely to adversely affect** NSOs for the following reasons:

- Noise from blasting during pipeline construction within 0.25 mile of NSO sites during the late breeding season would occur and could increase the risk of predation to fledglings that are generally not as able to escape as adults during the latter part of the breeding season.
- Construction of the Pacific Connector Pipeline Project would remove approximately 517 acres of high NRF and NRF habitat (including 26 acres of "post fire NRF" within the 2015 Stouts Creek fire area) within the provincial analysis area. This would result in effects on nest patches, core areas, and home ranges of known, best location, and Pacific Connector-assumed owls, some of which are currently below thresholds needed to sustain NSOs. Once suitable NRF habitat is reduced or modified in NSOs' home ranges, there is an increased likelihood that NSOs remaining in the Project area would be subject to:
  - displacement from nesting areas;
  - concentration into smaller, fragmented areas of suitable nesting habitat that may already be occupied;

[138] The Provincial Analysis Area includes the extent of the following potential Project effects: 1) habitat removal or modification, and 2) disturbance/disruption of NSO during the breeding season

  - increased interspecific (with barred owls) and intraspecific competition for suitable nest sites and forage;
  - decreased survival due to increased predation and/or limited resource (forage) availability; and
  - diminished reproductive success for nesting pairs.
- Construction of the Pacific Connector Pipeline Project would remove and modify high NRF, NRF, dispersal only, and capable habitat for NSOs throughout the Project area, including removal of habitat within the home range of 97 NSOs, 58 of which are currently below sustainable threshold levels of suitable habitat for continued persistence in their home range and/or core area.
- Construction of the Pacific Connector Pipeline Project would bring one NSO core area (best location activity center affected by 2015 Stouts Creek fire) below the 50 percent NRF threshold, and two NSO home range (known activity centers, one of which was affected by the 2015 Stouts Creek fire) below the 40 percent NRF threshold (best location activity center).

The Project **may affect** NSO critical habitat because:

- the Project would occur within designated NSO critical habitat; and
- the Project would affect habitat within designated critical habitat areas.

The Project is **likely to adversely affect** NSO critical habitat because:

- The proposed action would remove or potentially downgrade PBFs in critical habitat sub-units ORC-6, KLE-1, KLE-2, KLE-3, KLE-4, KLE-5, and ECS-1 as defined in the Final Rule designating critical habitat for the NSO (FWS 2012b).

As described above, construction of the pipeline (including access road use, helicopter use, and blasting), as well as pipeline operations and maintenance, would occur within the NSO breeding season and within 0.25 mile of NSO activity centers. These activities would disturb or disrupt NSOs and interfere with essential nesting behaviors during the entire breeding season. Therefore, to reduce these effects during the breeding season, we have recommended that Pacific Connector adhere to FWS-recommended timing restrictions within threshold distances of NSO activity centers (FWS 2016c; see recommendation above in the MAMU section).

Given the anticipated avoidance of disturbance and disruption to NSO during the breeding season per inclusion of the recommendation above into the proposed action (i.e., implementation of distance and timing restrictions, without exception), noise and visual effects on breeding NSO as a result of construction would be minimized. However, there would be a loss of future breeding opportunities due to the removal of suitable habitat during construction, as there would be less suitable habitat available for nesting. Additionally, the quality of the remaining habitat would be reduced due to habitat fragmentation and the addition of edge along the pipeline corridor. Habitat loss and modification, whether to nesting, roosting or foraging habitats, due to forest clear-cutting has been the primary factor causing declines of the NSO (FWS 1992c). Habitat losses and habitat fragmentation have indirect effects that can affect survival and reproduction of NSOs. Jordan Cove has indicated an interest in working with the FWS to discuss possible mitigation and conservation measures but has not proposed compensatory mitigation. In the absence of mitigation other than avoidance and minimization, the Project would result in long-term negative effects on this threatened species.

4.6.1.3 Fish

In this section, we summarize the listing status, life history, and presence and determination of Project action effects on the federally listed fish species and their critical habitat that could be affected by the Project. The species addressed include the Coho Salmon-Southern Oregon/Northern California Coast ESU, Coho Salmon-Oregon Coast ESU, North American Green Sturgeon–Southern DPS, Eulachon–Southern DPS, Lost River sucker, and shortnose sucker. Project effects on waterbodies are described in section 4.3 of this EIS. Minimization measures are currently proposed to reduce effects on threatened and endangered fish species. Overall, the types, methods, and magnitude of effects on listed fish species are represented by those presented for fish in general as presented earlier in section 4.5 of this EIS.

Coho Salmon-Southern Oregon/Northern California Coast ESU (Federal Threatened Species, State Sensitive Species)

The Southern Oregon/Northern California Coast (SONCC) ESU coho salmon was listed as a threatened species on June 28, 2005, between Punta Gorda, California, and Cape Blanco, Oregon (70 FR 37160). It includes all naturally spawning populations as well as three artificial propagation programs, of which one, the Cole Rivers Hatchery (ODFW stock #52) located on the Rogue River, is within the Project area.

Critical habitat for the SONCC ESU was designated in May 5, 1999 (74 FR 24249) and includes the accessible reaches of all rivers (including water, substrate, and adjacent riparian zone of estuarine and riverine reaches) between the Mattole River in California and the Elk River in Oregon. The Pacific Connector pipeline route would cross designated critical habitat within waterbodies of the Upper Rogue HUC (17100307) below Lost Creek, Willow Creek, and Fish Lake Dams.

Major rivers, estuaries, and bays known to support coho salmon within the range of the SONCC ESU include the Rogue River, Smith River, Klamath River, Mad River, Humboldt Bay, Eel River, and Mattole River (NMFS 1999), two of which (i.e., the Rogue and Klamath Rivers) are within the Project area although this ESU is currently prevented from accessing the potential Project-affected Klamath River areas due to dam passage barriers downstream.

Direct and indirect effects on SONCC Coho salmon are not expected within the marine analysis area. Coho salmon can avoid acoustic effects from LNG carriers during transit. Potential oil and gas spills from LNG carriers in the marine analysis area are highly unlikely to occur; even if LNG spilled or leaked, it would turn to vapor and would not mix with water, and vessel response plans required to address accidental spills of LNG and other petroleum products onboard would be implemented. Effects within the riverine analysis area are expected from in-water construction activities resulting in short-term increased sediment levels that would be stressful to fish, short-term benthic food source reduction, temporary migration impedance, short-term terrestrial/riparian habitat modifications, and limited long-term reduction in LWD sources. Limited fish mortality would also occur from fish salvage.

Below is the determination of effects summary for SONCC Coho Salmon ESU and critical habitat; see the details in our pending BA.

The Project **may affect** coho salmon in the SONCC ESU because:

- several stages and activities of coho salmon (upstream adult migration, juvenile rearing, and juvenile out-migration) are expected to occur at various locations in the riverine analysis area during construction and operation of the proposed action.

The Project is **likely to adversely affect** Coho salmon in the SONCC ESU for the following reasons:

- Juveniles would be exposed to elevated TSS concentrations during standard dry open-cut construction (fluming or dam-and-pump) for 2 to 5 hours. Such an exposure could cause injury, a short-term reduction in both feeding rate and feeding success, and minor physiological stress.
- A site crossing failure while dry open-cut construction is underway could result in elevated TSS concentrations for six hours while repair of failed isolation structures occurs, which could cause moderate habitat degradation injury, a short-term reduction in both feeding rate and feeding success, impaired fish homing, and possibly major physiological stress.
- Literature-based estimates of suspended sediment effects from pipeline construction on severity of ill effect (SEV) scores suggest typical dry crossing methods could result in SEVs of 4 and 6 for Coho salmon within a few hundred feet (e.g., 150 to 500 feet) below the crossing, which may include factors ranging from short-term reduction in feeding to moderate physiological stress. If failure of sealing occurs, SEV scores for coho salmon could be as high as 8, which may include habitat degradation, major physiological stress, and long-term reduction in feeding rate or success.
- Construction-induced blasting at 13 streams (4 at streams known to contain coho) could cause mortality to fish by rupturing swim bladders, but active fish removal from area prior to blasting would reduce risk of occurrence.
- Fish salvage would occur for some dry stream crossings as discussed in Pacific Connector's *Fish Salvage Plan*.[139] Capture and handling constitutes a taking under ESA and subjects coho salmon to injury and mortality.
- Lack of LWD is a limiting factor in most streams within range of SONCC coho salmon. Removal of mid-seral riparian forest (40 to 80 years old) would have long-term effects on recruitment of LWD, and removal of LSOG forest (80 years old or older) would have permanent effects on recruitment of LWD because planted conifers would not attain those age classes within the 50-year life of the Project, plus the ongoing loss of trees within the 30-foot-wide maintance corridor.

The Project **may affect** designated critical habitat for coho salmon in the SONCC ESU because:

- the Pacific Connector pipeline crosses designated critical habitat within waterbodies of the Upper Rogue HUC (17100307) below the Lost Creek, Willow Creek, and Fish Lake Dams.

[139] Appendix L of Pacific Connector's POD filed with the FERC in January 2018.

The Project is **likely to adversely affect** designated critical habitat for coho salmon in the SONCC ESU for the following reasons:

- a failure of dry open-cut crossing could cause moderate or more severe habitat degradations in some crossing areas;
- increases in turbidity are expected to temporarily affect the water quality downstream from stream crossing sites during construction;
- food resources would potentially be affected over the short term by dry open-cut and diverted open-cut construction methods that would remove substrate and benthos at crossing sites;
- freshwater migration corridors would potentially be affected over the short term by dry open-cut and diverted open-cut construction methods that would create temporary barriers to in-stream movements; and
- approximately 17 acres of native riparian vegetation (forest, wetlands, unaltered, and nonforested habitats) and altered habitat would be removed during construction within riparian zones associated with designated critical habitat. Adverse effects on riparian zones associated with critical habitat would be long term or permanent depending on whether mid-seral riparian forests (7 acres) or LSOG riparian forests (2 acres) are removed.

Coho Salmon-Oregon Coast ESU (Federal Threatened Species, State Sensitive Species)

This Coho salmon ESU was first proposed for listing on July 25, 1995 (60 FR 38011) and subsequently listed as threatened on June 20, 2011 (76 FR 35755). The Oregon Coast ESU includes all naturally spawned populations of coho in Oregon coastal streams south of the Columbia River and north of Cape Blanco, including the Cow Creek (ODFW stock #37) coho salmon hatchery program (NMFS 1995). Critical habitat for Oregon Coast coho salmon was designated on February 11, 2008 (73 FR 7816) and includes water, substrate, and adjacent riparian zones of estuaries and rivers within the range of the Oregon Coast ESU. There are three subbasins that coincide with the Project: South Umpqua Subbasin (HUC 17100302) and Coquille Subbasin (HUC 17100305), which are crossed by the Pacific Connector pipeline; and Coos Subbasin (HUC 17100304), which includes the Coos Bay estuary where the LNG terminal, slip, navigation channel improvements, and HDD portion of the Pacific Connector pipeline route would be located contain critical habitat watersheds. Within these subbasins are eight fifth-field watersheds crossed that contain designated critical habitat. Life stage requirements of coho salmon, within freshwater habitats in the Oregon Coast ESU, are expected to be similar to those described above for Coho salmon in the SONCC ESU.

Coho salmon would be expected to avoid acoustic effects from LNG carriers during transit of marine areas, and no substantial adverse oil and gas marine spills from LNG carriers are expected. Short-term adverse effects on coho salmon in the estuarine analysis area would result from locally increased turbidity from dredging activities and LNG carrier propeller wash and ship wake, causing avoidance and short-term reduction in food supply. Entrainment and impingement of coho salmon could occur in LNG carriers' cooling water intake port during LNG carrier loading and possibly dredging. Acoustic effects would likely cause at least avoidance during LNG terminal construction. Habitat modification would occur from all dredging activity and restoration activities at the Kentuck project site. Suspended sediment released accidentally during HDD construction across Coos Bay and the Coos River would also result in elevated sediment levels.

Effects within the riverine analysis area primarily from in-water construction activities would include short-term increased sediment levels causing fish stress, reduced short-term benthic food supplies, temporary migration impedance, terrestrial/riparian habitat modifications, and limited long-term reduction in LWD sources. Limited mortality from fish salvage would also occur.

Below is the determination of effects summary for Oregon Coast Coho Salmon ESU and critical habitat; see our pending BA for details.

The Project **may affect** coho salmon in the Oregon Coast ESU because:

- several stages and activities of coho salmon (upstream adult migration, juvenile rearing, and juvenile out-migration) are expected to occur at various locations in the riverine analysis area during construction and operation of the proposed action;
- several stages and activities of coho salmon (juveniles, adults) are expected to occur within the estuarine analysis area during construction and operation of the proposed action; and
- juvenile and adult coho salmon area expected to occur within the marine analysis area during operation of the proposed action.

The Project is **likely to adversely affect** coho salmon in the Oregon Coast ESU for the following reasons:

- Short-term increase in noise associated with in-water or nearwater pile driving at various temporary construction activities throughout the bay may cause disturbance and physical injury to Oregon Coast coho if they are in proximity to the noise during construction.
- Some juvenile coho may be subject to localized entrainment by dredging associated with the access channel and Navigation Reliability Improvements, as well as ongoing maintenance dredging.
- Local short-term increases in suspended sediment in Coos Bay from in-water construction, particularly during dredging of Jordan Cove terminal access channel and navigation channel widening, may result in behavioral effects on rearing coho salmon juveniles with physiological consequences that may affect growth and survival.
- Short-term effects on the benthic community and potential food resources for Oregon Coast coho would result from dredging the proposed marine waterway modifications in Coos Bay.
- Installation of the proposed pipeline beneath Coos Bay and the Coos River using HDD construction would avoid effects on coho unless an inadvertent return of drilling fluid occurred. An inadvertent return would temporarily increase sedimentation and turbidity and likely result in behavioral avoidance of the affected area.
- Individual Coho salmon may be directly affected by local restoration activities at the Kentuck project due to short-term construction-related increases in turbidity, in-water work, and isolation measures.
- Water intakes by LNG carriers at the Jordan Cove terminal berth during engine cooling operations could entrain or impinge juvenile salmon.
- Dredging of the Jordan Cove terminal access channel in Coos Bay in the short term could remove eelgrass and benthic community that provide potential food resources and rearing habitat for Oregon Coast Coho salmon;

- Removing eelgrass from donor stocks in the bay to develop the Eelgrass Mitigation site may reduce cover and food sources for rearing juvenile coho salmon in the short term:
- Exposure to TSS concentrations during dry open-cut construction (fluming or dam-and-pump) for 2 to 6 hours could potentially cause minor physiological stress (increased coughing rate and/or increased respiration rate) in juvenile coho salmon.
- A site crossing failure while dry open-cut construction is underway could result in elevated TSS concentrations for six hours while repair of failed isolation structures could cause moderate habitat degradation, impaired homing by fish, moderate to major physiological stress, and, in very limited areas, reduced growth and reduced fish density.
- Literature-based estimates of suspended sediment effects from pipeline construction on SEV scores suggest typical dry crossing methods could result in SEVs between 4 and 6 for coho salmon within a few hundred feet (e.g., 150 to 500 feet) below the crossing, which may include factors ranging from short-term reduction in feeding to moderate physiological stress. If failure of sealing occurs, SEV scores for coho salmon could be as high as 8, which may include habitat degradation, major physiological stress, and long-term reduction in feeding rate or success.
- Blasting at 22 streams (12 known or assumed to have Coho salmon at the crossing) could cause mortality to fish by rupturing swim bladders but active fish removal from the area prior to blasting would reduce risk of occurrence.
- Fish salvage would occur within isolated construction sites, possibly when adult and juvenile coho salmon are present. Coho salmon are considered vulnerable to electrofishing, subject to injury and mortality. Seining, electrofishing, and handling during salvage may adversely affect Oregon Coast coho salmon.
- Lack of LWD is a limiting factor in most streams within range of Oregon Coast coho salmon. Removal of mid-seral riparian forest (40 to 80 years old) would have long-term effects on recruitment of LWD, and removal of LSOG forest (80 years old or older) would have permanent effects on recruitment of LWD because planted conifers would not attain those age classes within the 50-year life of the Project, plus the ongoing loss of trees within the 30-foot-wide maintance corridor.

The Project **may affect** designated critical habitat for coho salmon in the marine analysis area, the estuarine analysis area, and the riverine analysis area for the Oregon Coast ESU because:

- construction and operation of the Project would occur in or cross designated critical habitat within waterbodies of the Coos, Coquille, and South Umpqua subbasins.

The Project is **likely to adversely affect** proposed critical habitat for coho salmon in the Oregon Coast ESU for the following reasons:

- dredging of the Jordan Cove terminal access channel in Coos Bay and marine waterway modifications could remove eelgrass and benthic community that are potential food resources and rearing habitat for Oregon Coast coho salmon;
- increases in turbidity are expected to temporarily affect the water quality downstream from stream crossing sites during construction;
- TSS concentrations generated during dry open-cut construction and potential failure of isolation structures would adversely affect freshwater habitats by changing coho habitat preferences (SEV = 3) or causing moderate habitat degradations (SEV = 7 or 8);

- a failure of dry open-cut crossing lasting up to 6 hours could cause moderate or more habitat degradations in some streams;
- food resources would potentially be affected over the short term by dry open-cut and diverted open-cut construction methods that would remove substrate and benthos at crossing sites;
- freshwater migration corridors would potentially be affected over the short-term by dry open-cut and diverted open-cut construction methods that would create temporary barriers to in-stream movements; and
- approximatedly 88 acres of native riparian vegetation (forest, wetlands, and nonforested habitats) and altered habitat would be removed during construction within riparian zones associated with designated critical habitat associated with waterbodies within range of Oregon Coast coho ESU. Adverse effects on riparian zones associated with critical habitat would be long term or permanent depending on whether mid-seral riparian forests (14 acres) or LSOG riparian forests (4 acres) are removed.

North American Green Sturgeon – Southern Distinct Population Segment (Federal Threatened Species, State Sensitive-Critical Species)

On January 23, 2003 (NMFS 2003), NMFS determined that the North American green sturgeon comprises two DPSs that qualify as species under the ESA: (1) a northern DPS consisting of populations in coastal watersheds northward of and including the Eel River in California; and (2) a southern DPS consisting of coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River. On April 7, 2006, NMFS listed the southern DPS as federally threatened under the ESA, including spawning populations of green sturgeon south of the Eel River, principally the Sacramento River spawning population (71 FR 17757). Designated critical habitat extends from U.S. marine waters to 110 meters depth (360 feet) or 60 fathoms from Monterey Bay, California, north to Cape Flattery, Washington, including the Strait of Juan de Fuca (74[195] FR 52300 [October 9, 2009]). Critical habitat includes three components that are occupied by and are essential to different life stages of green sturgeon: (1) freshwater riverine systems, (2) estuarine areas, and (3) nearshore marine waters. No rivers in Oregon were included in the listing. However, many estuaries were part of the critical habitat proposal in Washington, Oregon, and California. Estuaries in Oregon proposed for inclusion were the Columbia River estuary, Winchester Bay, Yaquina Bay, Nehalem Bay, and Coos Bay. Large numbers of this green sturgeon DPS are within Coos Bay. Subadults and adults may occupy Coos Bay for feeding, optimization of growth, and thermal refuge, and the Bay supplies oversummer habitat. Similarly, coastal marine waters 110 meters deep or less. The North American green sturgeon (both northern and southern DPSs) occurs within Coos Bay and its adjacent waterbodies (Israel and May 2007) and is considered abundant in the bay (73 [174] FR 52084 [September 8, 2008]). This fish may also occur in the lower portions of the Coos River.

Green sturgeons spawn every three to five years in deep pools in large, turbulent river mainstems, generally from March through July (Tracy 1990; Moyle et al. 1992). Little is known about sturgeon feeding, but some studies have found that adults and juveniles feed on benthic invertebrates including shrimp, mollusks, amphipods, and even small fish (Moyle et al. 1992; Radtke 1966). Natural reproduction in this estuary is considered low (Wagoner et al. 1990). The Coos River system is not considered to provide suitable spawning habitat for green sturgeon (Whisler et al. 1999). Green sturgeon, likely less than three years of age, may utilize both shallow and deep-water habitats within the estuarine area, though there is no information relating individual occurrence to DPS membership. Green sturgeon may also occur in bottom areas along the LNG carrier transit route, in waters mostly less than 110 meters deep, which would be primarily only during entry and exit of the vessels as they would travel in deeper water during transit between ports.

Direct and indirect effects on green sturgeon in the southern DPS are not expected within the marine analysis area. Green sturgeon might detect noise from LNG carriers but would be able to avoid adverse effects from noise. Potential oil and gas spills from LNG carriers in the marine analysis area are unlikely to affect aquatic resources because they are highly unlikely to occur; if LNG spilled or leaked, it would turn to vapor, would not mix with water, and would not contaminate surface water; and vessel response plans required to address accidental spills of LNG and other petroleum products onboard would be implemented. Effects on green sturgeon in the estuarine analysis area include acoustic effects such as avoidance during terminal construction, increased turbidity sedimention affecting benthic food sources from dredging activities, bed and bank erosion from LNG carrier propeller wash and ship wake, loss of forage from removal of eelgrass and shallow water habitat, and elevated suspended sediment released from an accidental drilling mud release during HDD construction across Coos Bay and the Coos River. Effects within the riverine analysis area include increased turbidity and sedimentation causing short-term avoidance and food source reduction from in-water construction activities on Stock Slough.

Below is the determination of effects summary for the Southern DPS of green sturgeon and critical habitat. Details will be provided in our pending BA.

The Project **may affect** green sturgeon (Southern DPS) because:

- adult and/or subadult green sturgeon may occur within the estuarine analysis area during construction and operation of the proposed action;
- adult and/or subadult green sturgeons may occur within the marine analysis area during operation of the proposed action; and
- the proposed action may affect potential food resources and water quality during the short-term construction period and maintenance dredging within the estuarine analysis area.

The Project is **likely to adversely affect** green sturgeon (Southern DPS) because:

- short-term increase in noise generated from in-water and nearshore pile driving at various temporary construction sites throughout the bay may cause disturbance and physical injury to green sturgeon if individuals are in proximity to the noise during construction;
- exposure to TSS concentrations during dry open-cut construction (fluming or dam-and-pump) could potentially cause minor physiological stress, a short-term reduction in feeding rate, and short-term reduction in feeding success in the Stock Slough estuarine stream/river channel crossed by the pipeline if present there at the time of construction;
- on a localized basis, the proposed action may affect migratory and feeding behavior, potential food resources, and water quality (TSS) during the short-term construction period and periodic maintenance dredging within the estuarine analysis area;
- bottom disturbance from Project construction, navigation channel widening, and maintenance dredging may reduce the abundance and diversity of benthic food supply within Coos Bay; and

- short-term increased turbidity could cause avoidance in Coos Bay or lower Coos River HDD if frac-out were to occur.

The Project **may affect** critical habitat for green sturgeon (Southern DPS) because:

- Project activities would occur within portions of the Coos Bay estuary, Stock Slough, and coastal marine waters, which have been designated as critical habitat;

The Project is **likely to adversely affect** critical habitat for the southern DPS of green sturgeon because:

- bottom disturbance from Project construction, navigation channel widening, and maintenance dredging may disrupt local food supply and habitat usability within Coos Bay; and
- suspended sediment produced during dry open-cut crossing Stock Slough could affect water quality in freshwater riverine critical habitat.

Eulachon – Southern Distinct Population Segment (Federal Threatened, No State Status)

On March 18, 2010, the NMFS published in the Federal Register the final rule to list the southern DPS of the Pacific eulachon as threatened under the ESA (75 FR 13012 [March 18, 2010]). The NMFS has identified the eulachon southern DPS as those populations which spawn in rivers south of the Nass River in British Columbia, Canada, to and including the Mad River in California (NMFS 2008c). The southern DPS has been further segregated into four subareas: Klamath River, Columbia River, Fraser River, and British Columbia coastal rivers south of the Nass River (NMFS 2008c). A total of 16 distinct regions in Washington, Oregon, and California have been designated as critical habitat for Pacific eulachon (76 FR 65323 [October 20, 2011]). No part of the Project or its effects would occur within waterbodies included in the eulachon critical habitat designation.

Adult Pacific eulachon usually spend three to five years in saltwater before returning to freshwater to spawn from late winter though early summer in rivers (74 FR 10857 [March 13, 2009]). Fertilized eggs adhere to river bottoms and shortly after hatching, the larvae are carried downstream and dispersed by estuarine and ocean currents (74 FR 10857 [2009]). No recent spawning runs have been documented for the Coos River, although some may have occurred historically and have recently been found in Winchester Creek, a major tributary to South Slough that enters Coos Bay near the ocean (Willson et al. 2006; Wagoner et al. 1990, NMFS 2018b).

Little is known about the use of marine waters by eulachon and, due to paucity of sampling, little specific information exists on eulachon distribution off the U.S West Coast, including Oregon (Gustafson et al. 2010). Larvae and young juveniles become widely distributed in coastal waters, with fish found mostly at depths up to 15 meters (171 feet) but sometimes as deep as 182 meters (597 feet; Hay and McCarter 2000). Larger rearing fish have been reported to be in the near benthic habitats in open marine waters of the continental shelf between 20 and 150 meters (66 to 492 feet) deep (Barraclough 1964 as cited in Gustafson et al. 2010).

Adults and juveniles commonly forage at moderate depths (15 to 182 meters [50 to 600 feet]) in inshore waters, feeding on zooplankton, primarily eating crustaceans (Hay and McCarter 2000). Adults are found rarely in Coos Bay (64 FR 66601 [1999]), but have been reported to utilize both shallow and deep habitats in the estuary (64 FR 66601 [1999]). A 1971 report (Cummings and Schwartz 1971) noted their distribution only in the outer 7 miles of Coos Bay. Detailed larvae and juvenile fish sampling in Coos Bay over a 3.5-year period (1998-2001) found no eulachon (Miller and Shanks 2005). More recently, pelagic Tucker trawl samples over a 17-month period found larvae and small juveniles of a close relative, surf smelt, but no eulachon near the proposed terminal in Coos Bay (Shanks et al. 2011). However, given the limited survey effort and highly variable presence of eggs and larvae, eulachon occurrence in Coos Bay could not be ruled out (Storch and Van Dyke 2014).

Direct and indirect effects on eulachon in the southern DPS are not expected within the marine analysis area. Eulachon might detect noise from LNG carriers, but would be able to avoid adverse effects from noise. Potential oil and gas spills from LNG carriers in the marine analysis area are unlikely to affect aquatic resources because they are highly unlikely to occur; if LNG spilled or leaked, it would turn to vapor, would not mix with water, and would not contaminate surface water; and vessel response plans required to address accidental spills of LNG and other petroleum products onboard would be implemented. Effects on eulachon in the estuarine analysis area include increased turbidity from dredging activities and LNG carrier propeller wash and ship wake causing avoidance and reduced food supply, increased suspended sediment should an HDD construction failure occur in Coos Bay or the Coos River, entrainment and impingement in LNG carriers' water intake ports, acoustic effects including avoidance during terminal construction, habitat modification from dredging, and restoration activities at the Kentuck project site.

Below is the determination of effects summary for Pacific eulachon (Southern DPS) and critical habitat. Details will be provided in our pending BA.

The Project **may affect** Pacific eulachon (Southern DPS) because:

- Pacific eulachon may be present within the estuarine analysis area during construction and operation of the Project;
- Pacific eulachon may occur within the marine analysis area during operation of the proposed action;

The Project is **likely to adversely affect** Pacific eulachon (Southern DPS) because:

- Bottom disturbance and suspended sediment from Project construction, navigation channel widening, and maintenance dredging may affect the abundance and diversity of potential benthic and pelagic food resources, water quality, and suspended sediment during the short-term duration of these actions within the estuarine analysis area.
- Short-term increase in noise generated from the MOF land-based pile driving and in-water pile driving in various Coos Bay estuarine analysis areas may cause physical injury to individual eulachon at a limited distance during construction.
- Although eulachon would be rare in Coos Bay, and their large size would allow most to be able to avoid the LNG carrier cooling water intake, some limited number could be entrained during dredging and vessel loading in the bay.

The Project would have **no effect** on critical habitat for the Pacific eulachon (Southern DPS) because no designated critical habitat is present within the areas affected by the Project.

Lost River Sucker (Federal Endangered Species, State Endangered Species)

The Lost River sucker was listed as a federally endangered species on July 18, 1988, because of a variety of factors including loss of habitat and access to historical range, overfishing, degraded water quality, lack of adaquate recruitment, inadequate regulatory mechanisms, and a variety of other reasons resulting in declining populations (FWS 1988). Lost River sucker critical habitat was originally proposed in 1994 (59 FR 61744) but that proposal was never finalized. In 2011, a revised critical habitat designation was proposed and ultimately finalized in December 11, 2012 (77 FR 73739). Designated critical habitat for the Lost River sucker includes two units: the Upper Klamath Lake Unit and Lost River Basin Unit

The present distribution of the Lost River sucker includes Upper Klamath Lake and its tributaries, Clear Lake Reservoir and its tributaries, Tule Lake and the Lost River, the Klamath River, and Copco, Iron Gate, and John C. Boyle Reservoirs with no substantial change since listing (Reclamation 2007, 2012; FWS 2007d). They have also been found in Tule Lake (Reclamation 2012; FWS 2007d, 2013d). Critical habitat that could potentially be affected by construction of the Pacific Connector pipeline includes the Klamath River.

In the Upper Klamath Lake watershed, the Lost River sucker spawning runs are primarily limited to Sucker Springs in Upper Klamath Lake, and the Sprague and Williamson Rivers. Spawning runs also occur in the Wood River and in Crooked Creek in this watershed. In the Project vicinity, Lost River suckers spawn in the Lost River and are present in John C. Boyle Reservoir, downstream from the pipeline crossing at river mile (RM) 225 (NRC 2004). In addition to collections of Lost River suckers in John C. Boyle Reservoir, ORBIC (2012) cites records of collections in Lake Ewauna and in the Lost River Diversion Channel connecting the Klamath River (at RM 249.8) to the Lost River at the Lost River Diversion Dam, approximately 10 river miles downstream from the Pacific Connector pipeline crossing of the Lost River at RM 9.5.

The Pacific Connector pipeline route would cross Lost River (MP 212.07) 7.6 miles upstream of the known spawning area downstream of Anderson–Rose Dam, using a dry, open-cut method during low flows that coincide with the ODFW instream construction window extending from July 1 through March 31.

Spawning occurs within limited areas of the Lost River (FWS 2013d; Reclamation 2012), and occasional individuals have been found in this stream (NMFS and FWS 2013), which suggests it is possible that Lost River sucker occurs at the Pacific Connector pipeline crossing of Lost River at MP 212.07 during the non-spawning period. An additional 31 dry open-cut small intermittent stream crossings could also contain Lost River suckers as surveys have not been conducted for their presence.

Potential effects on the Lost River sucker are associated with pipeline stream crossings. These effects include the release of drilling mud from Klamath River HDD potential frac-out as well as potential entrainment or entrapment of fish, and increased turbidity and suspended sediment in occupied stream affecting fish avoidance and benthic food supply. Pacific Connector would install a temporary flowing stream crossing by lifting or spanning a structure from a bank so that equipment does not enter flowing waters. However, if it is not possible to do this safely, only equipment necessary to install the bridge would cross the stream. This would cause some limited short-term bottom benthic disruption and possibly elevated suspended sediment. Adults and juveniles subject to fish salvage associated with the Lost River crossing could be injured or killed if electrofishing is used, and stressed if seining is used. Incidental take of a Lost River sucker is possible, but salvage operations would follow Pacific Connector's *Fish Salvage Plan* which describes netting methods (e.g., beach seining, dip netting) that would be used before using electrofishing. There are additional salvage methods that have been specifically developed for these listed suckers to further reduce the potential effects of salvage (see the Klamath Project Operations Biological Opinion [Reclamation 2008] consistent with Reclamation's *Handling Guidelines for Klamath Basin Suckers).*

Below is the determination of effects summary for Lost River sucker and critical habitat. Details will be provided in our pending BA.

The Project **may affect** Lost River suckers because:

- Lost River suckers occur within the Upper Klamath River subbasin and Lost River subbasin, which would be affected during construction of the proposed action.

The Project is **likely to adversely affect** Lost River suckers because:

- Lost River suckers could occur in 19 waterbodies crossed by dry open-cut construction in the Lake Ewauna-Klamath River watershed and in 13 waterbodies west of MP 214.38 (including the Lost River) crossed in the Mills Creek-Lost River watershed and be indirectly affected by elevated suspended sediment levels, streambank erosion and stability, and aquatic nuisance species introductions; and
- fish salvage during the crossing of 31 ditches crossed by dry-open cuts and the Lost River crossing could result in injuring or killing of Lost River suckers if electroshocking is used, and stressing fish if seining is used.

The Project **may affect** designated critical habitat for the Lost River sucker because:

- there is a low risk of HDD failure during crossing of the Klamath River, resulting in a frac-out that releases drilling mud into the river.

However, the Project is **not likely to adversely affect** designated critical habitat for the shortnose sucker because:

- HDD crossing methods would avoid critical habitat in the Klamath River;
- the potential for hydraulic fracture during HDD drilling is so unlikely as to be discountable; and
- in the event of released bentonite, corrective actions would contain and temporally limit drill mud volumes.

Shortnose Sucker (Federal Endangered Species, State Endangered Species)

The shortnose sucker was listed as a federally endangered species on July 18, 1988 (FWS 1988). The final rule to list the shortnose sucker as endangered suggested several reasons for their decline, including the construction of dams, water diversions, overfishing, competition and predation by exotic species, water quality problems associated with timber harvest, removal of riparian vegetation, livestock grazing, lack of adaquate recruitment, inadequate regulatory mechanisms and agricultural practices. Shortnose sucker critical habitat was originally proposed in 1994 (59 FR 61744) but that proposal was never finalized. In 2011, a revised critical habitat designation was proposed and ultimately finalized in December 11, 2012 (77 FR 73739). Designated critical habitat for the shortnose sucker includes two units: the Upper Klamath Lake Unit and Lost River Basin Unit. The Klamath River is the only critical habitat for the shortnose sucker crossed by the pipeline or potentially affected by any Project actions.

Currently, shortnose suckers are present in upper Klamath Lake and tributaries, Lost River, Clear Lake Reservoir, the Klamath River, and three large Klamath reservoirs (Keno, Copco, and possibly Iron Gate Reservoirs) with no substantial change since listing (Reclamation 2007, 2012). They have also recently been found in Tule Lake and Gerber Reservoir (Reclamation 2012; FWS 2007d, 2013e).

Shortnose suckers live in lakes and spawn in rivers, streams or springs associated with the lake habitats, generally from early February through mid-April. After hatching, larval suckers migrate out of spawning substrates, which are usually gravels or cobbles, and drift downstream into lake habitats from early May to mid-June (FWS 1988, 1993b). The shortnose sucker is known to migrate out of Tule Lake to spawn in the Lost River below Anderson–Rose Dam about 7.6 miles downstream from the Lost River crossing. Therefore, the Pacific Connector pipeline would cross the Lost River where shortnose suckers could be present.

Potential effects on the shortnose sucker are associated with pipeline stream crossings. These effects include the release of drilling mud from Klamath River HDD potential frac-out as well as potential entrainment or entrapment of fish, and increased turbidity and suspended sediment affecting fish avoidance and benthic food sources in occupied streams, and fish being injured or killed during fish salvage efforts. Pacific Connector would install temporary flowing stream crossing by lifting or spanning a structure from a bank so that equipment does enter flowing waters. However, if it is not possible to do this safely, only equipment necessary to install the bridge would cross the stream. This would cause some limited, short-term bottom benthic disruption and possibly elevated suspended sediment. Adults and juveniles subject to fish salvage within the isolated construction site at the Lost River could be injured or killed if electroshocking is used and stressed if seining is used. Pacific Connector has included guidelines noted above under the Lost River sucker section in their *Fish Salvage Plan* that would be used near listed suckers. However, despite these measures, it is still possible that shortnose suckers could be killed by salvage operations and modifications to these plans may be needed to reduce this risk (see the Lost River Sucker section above).

Spawning occurs within limited areas of the Lost River (FWS 2013d; Reclamation 2012), and occasional individuals have been found in this stream region (NMFS and FWS 2013), suggesting it is possible that shortnose sucker could occur at the Pacific Connector pipeline crossing of Lost River at MP 212.07 during the non-spawning period. An additional 31 dry open-cut small intermittent stream crossings cannot be ruled out completely from potentially having shortnose sucker present because surveys have not been conducted for their presence.

The Project **may affect** shortnose suckers because:

- shortnose suckers occur within the Upper Klamath River subbasin and Lost River subbasin, which would be affected during construction of the proposed action.

The Project is **likely to adversely affect** shortnose suckers because:

- there is a possibility that shortnose suckers could occur within the Lost River when it would be crossed by the Pacific Connector pipeline and may be affected by elevated suspended sediment;
- shortnose suckers could occur in 19 waterbodies crossed by dry open-cut construction in the Lake Ewauna-Klamath River watershed and in 13 waterbodies west of MP 214.38 (including the Lost River) crossed in the Mills Creek-Lost River watershed and be indirectly affected by elevated suspended sediment levels, streambank erosion and stability, and aquatic nuisance species introductions; and
- adults and juveniles subject to fish salvage within the isolated construction site at 31 ditches crossed by dry-open cuts and the Lost River could be affected if electroshocking is used and stressed if seining is used.

The Project **may affect** designated critical habitat for the shortnose sucker because:

- there is a low risk of HDD failure during crossing of the Klamath River, resulting in a frac-out that releases drilling mud into the river.

However, the Project is **not likely to adversely affect** designated critical habitat for the shortnose sucker because:

HDD crossing methods would avoid critical habitat in the Klamath River;

- the potential for hydraulic fracture is so unlikely as to be discountable; and
- in the event of released bentonite during an HDD crossing, corrective actions would contain and temporally limit drill mud volumes.

4.6.1.4 Amphibians and Reptiles

Oregon Spotted Frog (Federally Threatened Species, Critical Habitat, State Sensitive-Critical)

On August 29, 2014, FWS listed the Oregon spotted frog as threatened (79 FR 51657). Critical habitat for the Oregon spotted frog was finalized in May 2016 and includes critical habitat in Oregon (Units 7 through 14; 81 FR 29335). This species is almost always found in or near a perennial body of water that includes zones of shallow water and abundant emergent or floating aquatic plants, which the frogs use for basking and escape cover (Corkran and Thoms 1996; FWS 2013f). The closest designated critical habitat unit to the Project is CHU 14 – Upper Klamath, which consists of 262 acres of lakes and creeks in Klamath and Jackson Counties and is currently occupied by Oregon spotted frogs (1 FR 2933). The Buck Lake population within CHU 14 is the closest occurrence of Oregon spotted frogs to the Project. This site includes seasonally wetted areas adjacent to the western edge of Buck Lake encompassing Spencer Creek downstream due west of Forest Service Road 46, three unnamed springs, and Tunnel Creek (81 FR 29335).

Oregon spotted frogs at Buck Lake have been consistently monitored from 2012 to 2016, along with other populations in the Oregon Cascades (Adams et al. 2017). Observations of frogs at two sites in Buck Lake and one in Tunnel Creek (both in CHU 14) indicate some variability in counts for each of several life stages but adults and larva or juveniles were found each year. Spencer Creek upstream of Buck Lake is almost equally subdivided into Buck Marsh, closest to Clover

Creek Road, and Buck Meadow, closest to Buck Lake (Lerum 2012). Buck Marsh is fed by several springs with evidence of beaver activity, and Buck Meadow is a pasture that often floods in the spring but does not stay flooded long enough to provide Oregon spotted frog breeding habitat. Further, soils in Buck Marsh are dense, possibly compacted by past heavy livestock use, and provide little water infiltration. Neither Buck Marsh nor Buck Meadow currently provide habitat for Oregon spotted frogs (Lerum 2012). Riparian vegetation is sparse and is unlikely to support beaver occupancy that could help to create suitable habitat (Lerum 2012).

The Project would cross Spencer Creek on the north side of Clover Creek Road, approximately 6,400 feet upstream from the CHU 14 at Buck Lake and pass within 280 feet of critical habitat in Spencer Creek downstream of Buck Lake. Potential effects on Oregon spotted frogs include changes to habitat quality and acoustic. Conservation measures proposed by Pacific Connector to minimize construction and operation effects on waterbodies and riparian zones would apply to Oregon spotted frogs.

Spencer Creek upstream of Buck Lake is not currently suitable habitat for Oregon spotted frogs and is unlikely to become suitable habitat and support Oregon spotted frogs at the time of construction. Clover Creek road separates the ROW from Spencer Creek downstream of Buck Lake so sediment from the construction ROW is not expected to enter Spencer Creek.

The Project **may affect** Oregon spotted frogs because:

- the Pacific Connector pipeline route would cross Spencer Creek, which is hydrologically connected to Buck Lake which is occupied by the frog; and
- the Pacific Connector pipeline route is within 280 feet of Spencer Creek and would cross tributaries to Spencer Creek downstream of Buck Lake, which is occupied by the Oregon spotted frog.

However, the Project **is not likely to adversely affect** Oregon spotted frogs for the following reasons:

- Buck Lake is approximately 6,400 feet downstream from where the pipeline route would cross Spencer Creek. Suspended sediment generated by the proposed action is expected to remain in the water column for 1,450 feet downstream from the construction site.
- Suspended sediment resulting from the crossing of Spencer Creek would pass through Buck Marsh, which Oregon spotted frogs do not currently inhabit. If the Oregon spotted frog does occur in Buck Marsh at the time of pipeline construction, conservation measures would limit potential effects due to acoustic shock, introduction of non-native species and/or disease, fuel and chemical spills, and herbicides.
- Future presence of Oregon spotted frogs in the Spencer Creek upstream of Buck Lake at the time of construction is extremely unlikely and considered to be discountable.
- Although the ROW occurs as close as 280 feet from Spencer Creek downstream of Buck Lake, they are not hydrologically connected because Clover Creek road separates the ROW from Spencer Creek; BMPs and erosion control measures should prevent sediment from the construction ROW from entering Spencer Creek.

The Project **may affect** designated critical habitat for the Oregon spotted frog because:

- the Pacific Connector pipeline route would be within 280 feet of proposed critical habitat within Spencer Creek downstream of Buck Lake.

The Project **is not likely to adversely affect** designated critical habitat for the Oregon spotted frog because:

- the designated critical habitat within 280 feet of the pipeline is not hydrologically connected to the ROW because it is separated by Clover Creek Road; and
- test water from the proposed hydrostatic discharge site at MP 169.52 is not expected to reach the critical habitat in Spencer Creek or Buck Lake, so effects on PBFs from changes in hydrology or introduction of nonnative species from the Project are discountable.

Sea Turtles

Four federally listed sea turtles potentially occur near the Project: green sea turtles, leatherback sea turtle, olive ridley sea turtle, and loggerhead sea turtle. All four species are federally threatened and state endangered.

Green sea turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south (NMFS 2007a). Green turtles primarily use three types of habitat: oceanic beaches (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas (NMFS 2007a). Reports of stranding suggest that the green turtle is a frequent visitor to the coast of California. Based on this data, green turtles are likely infrequent, transient visitors to the Oregon Coast, but may occasionally be found in the marine analysis area.

The leatherback sea turtle is the most common sea turtle in United States waters north of Mexico (NMFS and FWS 1998), and numerous sightings have been documented off the Oregon Coast. Adult leatherback turtles are highly migratory and available information indicates that eastern Pacific migratory corridors exist along the west coast of the United States (NMFS and FWS 1998). The west coast of the United States may represent some of the most important foraging habitat in the world for the leatherback turtle (NMFS and FWS 1998). Despite occasional reports of leatherbacks sighted at sea, and a growing database documenting their incidental catch in coastal and pelagic fisheries, there are very few areas where the species is routinely encountered. Exceptions include Monterey Bay, California (NMFS and FWS 1998). These data suggest that leatherback sea turtles would be present in the marine analysis area in higher densities relative to other sea turtle species, but still in low densities overall.

At-sea occurrences of olive ridley sea turtles in waters under United States jurisdiction are limited to the west coast of the continental United States and Hawaii, where the species is rare, but possibly increasing. During feeding migrations, olive ridley turtles may disperse into waters off the Pacific west coast as far north as Oregon (FWS 2013g). Based on sightings off the Oregon coast, olive ridley turtles may occasionally occur in the marine analysis area.

Loggerhead sea turtles occupy three different ecosystems during their lives—the terrestrial zone, the oceanic zone, and the neritic zone (NMFS 2007b). In the United States, occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California (NMFS 2007b). The potential importance of Oregon waters and the marine analysis area to loggerhead turtles is unknown, although two loggerhead turtles have been reported stranded in Oregon and Washington since the beginning of 1997 through 2007 (NMFS 2008d).

Direct effects of the proposed action include injury and/or mortality due to ship-strikes, underwater ship noise, and potential adverse effects from a vessel spill or ship release of LNG and fire at sea. Spills and/or release could indirectly affect federally listed sea turtles by affecting forage species. Below is a determination of effects summary for the federally listed sea turtles and critical habitat. More details will be provided in the pending BA.

The Project **may affect** federally listed sea turtles because:

- these sea turtles may occur within the marine analysis area during operation of the proposed action;
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area; and
- the continental U.S. Pacific Coast provides important foraging habitat for leatherback turtles.

However, the Project is **not likely to adversely affect** federally listed sea turtles because:

- ship strike on sea turtles would be highly unlikely;
- Jordan Cove would provide a ship strike avoidance measures package to LNG carrier operators transporting cargo from the terminal that consists of multiple measures to avoid striking marine mammals, which should also benefit sea turtles;
- The FERC does not have authority over the LNG carrier; however, the independent carrier operators would be required to follow all Coast Guard requirements regarding the operation of LNG carriers including carrier speeds;
- noise produced by LNG carriers would contribute to overall noise levels within the marine analysis area en route to the Port of Coos Bay and effects of ship noise on sea turtles could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise (NMFS 2016c, NMFS 2017b, NMFS 2018c), but would not exceed existing background ship noise levels and would not cause injury; and
- given vessel design, on-board spill kits, safety records, and implementation of Coast Guard recommendations, it is not likely that there would be a major ship spill of hazardous materials that may adversely affect water quality or aquatic species. Fuel released at sea, if any, would be in small enough quantities that potential effects on listed sea turtles would be discountable, especially given the low density of sea turtles within the marine analysis area.

No critical habitat has been designated or proposed for the olive ridley or loggerhead sea turtles. Critical habitat was established for the green turtle on Culebra Island, Puerto Rico, on September 2, 1998 (NMFS 1998); however, no critical habitat for green sea turtles occurs on the U.S. Pacific Coast, and the Project would therefore have no effect on designated critical habitat for the green turtle.

The Project **may affect** designated critical habitat for the leatherback turtle because:

- Critical habitat coincides with nearshore waters in the marine analysis area through which LNG carriers would transit to Coos Bay and the LNG terminal.

However, the Project is **not likely to adversely affect** designated critical habitat for the leatherback turtle because:

- LNG carriers and the Jordan Cove LNG Project are not likely to contribute oil, fuel, lubricants, or other contaminants to critical habitat to the extent that would adversely affect the occurrence of prey species, primarily jellyfish, of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction and development (PBF 1); and
- disturbance of benthic habitats within Coos Bay due to dredging would be of sufficiently short duration and small scale relative to the area available for settlement of larvae of the scyphozoan prey species within Area 2 that effects on PBF 1 would be unmeasurable and would therefore be discountable.

4.6.1.5 Invertebrates

Vernal Pool Fairy Shrimp (Federally Threatened Species with Critical Habitat, No State Status)

Vernal pool fairy shrimp were listed as threatened under the ESA on September 19, 1994 (FWS 1994a). This crustacean inhabits vernal pools, or seasonal wetlands that fill with water during fall and winter rains, in California and southwestern Oregon. The vernal pool fairy shrimp was identified relatively recently (in 1990) and was not discovered in Jackson County, Oregon until 1998 (FWS 2005s). As a result, it is possible that additional locations for the species will be found in Oregon in the future (FWS 2005a). Suitable vernal pool habitat occurs within and adjacent to Project facilities, some of which has not been surveyed. Additionally, a proposed pipe storage yard is in the Burrill Lumber industrial yard adjacent to the vernal pool fairy shrimp critical habitat unit VERFS 3A. Potential effects on vernal pool fairy shrimp and critical habitat include possible disturbance to pools from driving or storing equipment or pipes near or on pools or wetlands, and alteration of hydrology. Although nine vernal pools within the ROW between MPs 145.3 and 145.4 are outside the known range for vernal pool fairy shrimp, the vernal pools may provide suitable habitat for the species because the pools occur within the appropriate soils type (Agate-Winlo) for vernal pool fairy shrimp, occur near (i.e., within 8.2 miles of) the known and relatively recently (1998) expanded range of the species, and the species' absence has not been confirmed. Based on the relatively recent expansion of the known range of this species and the presence of potentially suitable habitat (including soil type) that has not been surveyed, there is potential for this species to be present within the ROW and be affected by pipeline construction.

These effects would be minimized through avoidance and minimization measures. Specifically, Pacific Connector has indicated they would avoid using areas within yards that may contain vernal pool fairy shrimp and, if this species is noted during survey efforts, they would implement proper sedimentation control barriers to minimize potential effects on the species. Below is a determination of effects summary for the vernal pool fairy shrimp and critical habitat. More details will be provided in the pending BA.

The Project **may affect** vernal pool fairy shrimp for because:

- Potentially suitable habitat for vernal pool fairy shrimp has been identified near four proposed Jackson County pipe storage yards, as well as within and adjacent to the pipeline ROW between MPs 145.30 and 145.40.

The Project is **likely to adversely affect** vernal pool fairy shrimp because:

- Effects on vernal pool fairy shrimp are possible due to the Project's crossing of potentially suitable, unsurveyed habitat within the pipeline ROW between MPs 145.30 and 145.40 (within Agate-Winlo soils).

The Project **may affect** vernal pool fairy shrimp critical habitat because:

- the Project occurs adjacent to designated vernal pool fairy shrimp critical habitat; and
- the Project may affect suitable habitat within designated critical habitat adjacent to the Project.

However, the Project is **not likely to adversely affect** vernal pool fairy shrimp critical habitat because:

- Although the proposed Burrill Lumber pipe yard occurs within 250 feet of designated vernal pool fairy shrimp critical habitat unit (VERFS 3A), it is separated from the critical habitat unit by Agate Road, which is a two-lane paved road that acts as a barrier to hydrologic connectivity that is considered a definitive boundary to the area of effects.
- Burrill Lumber pipe yard has been previously disturbed, and additional surface disturbances and/or soil compaction by heavy machinery from use within Burrill Lumber pipe storage yard should be minimal. Also, Agate Road is located between Burrill Lumber pipe yard and critical habitat unit VERFS 3A, which is raised and paved, and would serve as an existing barrier between the pipe yard and critical habitat unit. Therefore, use of the Burrill Lumber pipe storage yard is not expected to adversely modify geographic, topographic, and edaphic features potentially within 250 feet of the yard that support systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within the matrix of surrounding uplands (PBF 2).
- Proposed conservation measures would reduce the potential for increased sediment mobilization, increased fugitive dust, and the potential spread of invasive species to suitable vernal pool habitats.

4.6.1.6 Plants

A botanical analysis area applies to the extent of Project-related effects on listed plant species. The botanical analysis area for this Project extends to 98 feet (30 meters) each side of the pipeline project (i.e., construction ROW, TEWAs, UCSAs, rock source and disposal sites, proposed storage yards, and aboveground facilities) as well as the footprint for the Jordan Cove LNG Project. The botanical analysis area, in general, includes the area surveyed for sensitive and listed plant species (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands) and distance that indirect effects on plants would be expected. Surveys are incomplete in areas of potential habitat along the pipeline route where landowner permission was denied. Pacific Connector would survey these areas after the Project is certificated, but before construction begins (i.e., if the Project is approved and Pacific Connector gains access using eminent domain proceedings under Section 7h of the NGA). Pacific Connector identified unsurveyed areas that may contain suitable habitat for listed species, as will be discussed in our pending BA.

Pacific Connector has developed a *Federally-listed Plant Conservation Plan* to address how avoidance, minimization, propagation, restoration, and other conservation measures would be applied to protect listed plant species, as well as how potential effects on unsurveyed lands would be addressed. For example, if populations of listed plant species are identified where surveys were previously denied, Pacific Connector would apply mitigation measures that have been developed for surveyed lands to minimize and avoid effects on these species including (1) minor alignment or route adjustments; (2) narrowing or necking-down the construction ROW; or (3) eliminating or removing a portion of a TEWA or UCSA (depending on where new populations of these species were identified). Additional construction measures that would be implemented in areas that contain listed plants to minimize and avoid effects on these species, if they occur, include the following measures listed below.

- The construction ROW and TEWAs would be surveyed and flagged to clearly mark the limits of construction disturbance (i.e., clearing/grading).
- Where feasible, the EI would monitor the survey and flagging efforts and would provide additional protective buffers or neckdowns to ensure protection of adjacent plant populations or provide additional avoidance. The EI would consult with Pacific Connector's Chief Inspector and the construction contractor during construction to determine where additional buffer protections or neckdowns could be accommodated without affecting construction safety.
- Known plant populations adjacent to the construction ROW or other plants populations identified during preconstruction surveys would be protected by a safety fence and silt fence to ensure these plants are not inadvertently affected by Project activities.
- BMPs outlined in Pacific Connector's *Air, Noise and Fugitive Dust Control Plan*[140] to minimize wind erosion and fugitive dust emissions during construction and restoration activities would be implemented. Water would be used to control fugitive dust along the construction ROW (no Dustlok® would be used within 150 feet of any listed plants). Only enough water would be sprayed to control the dust or to reach the optimum soil moisture content to create a surface crust; no runoff would be generated.
- Equipment would be inspected and cleaned of potential noxious weed seed or plant parts consistent with the requirements of Pacific Connector's *Integrated Pest Management Plan*.
- Topsoil salvaging would occur within affected populations after species-specific seed, bulb, or whole plant salvage has occurred. The salvaged topsoil would be returned to its original location during restoration.
- During restoration, all areas would be regraded as closely as possible to the original contours to ensure preconstruction drainage patterns are not affected.

[140] Appendix B in Pacific Connector's POD filed with the FERC in January 2018,

- The construction ROW would be restored to its original contours and reseeded with an appropriate seed mixture recommended by FWS prior to the following growing season.
- When feasible, Pacific Connector would collect and bag seeds and/or bulbs of affected listed plants and provide these seeds and/or bulbs to a suggested repository. Upon FWS approval, the collected seeds would be replanted within or adjacent to the construction ROW on suitable federal lands where future protection can be managed or on private lands where a conservation easement has been acquired.
- Construction activities would occur in the fall and winter outside the critical growing, flowering, and seeding periods.
- Wetland mats would be used in travel areas in saturated soil areas to minimize soil rutting and soil compaction and protect existing plants that may be present.

The *Federally-listed Plant Conservation Plan* includes specific mitigation plans for Applegate's milk-vetch, Gentner's fritillary, Kincaid's lupine, and Cox's mariposa-lily. In addition, the Forest Service has developed mitigation measures/requirements related to their ROW Grant that may also indirectly benefit listed plant species (see chapter 2 of this EIS and appendix F).

Below is a discussion of each federally-listed plant species that could be affected by the Project. The mitigation measures discussed above would apply to all federally-listed plants discussed in this section.

Applegate's Milk-vetch (Federally Endangered Species, State Endangered Species)

FWS listed Applegate's milk-vetch (*Astragalus applegatei*) as endangered on July 28, 1993 (FWS 1993c). This species has a narrow range, known only in the Lower Klamath Basin (the plain containing Lower Klamath Lake), near the city of Klamath Falls in southern Oregon. It was believed to be extinct until its rediscovery in 1983 and at the time of listing was only known from two extant sites. Applegate's milk-vetch grows in flat-lying, seasonally moist, alkaline soils with underlying clay hardpans. The species' habitat was historically characterized by sparse, native bunchgrasses and patches of bare soil, allowing for some seed dispersal by wind. Today, dense coverage of the habitat by introduced grasses and weeds means seed dispersal is highly localized, with most seedling establishment found adjacent to mature plants (FWS 1998b). Continued destruction, modification, and/or curtailment of its habitat or range due to urban and commercial development, and loss of habitat through competition with non-native weeds, are the principal threats to the survival of the species (FWS 2009a).

The Pacific Connector Project is located within known and historic Applegate's milk-vetch range between MPs 191.20 to 214.30. The "Collins Tract site," which is located within and adjacent to the botanical analysis area between approximately MP 195.3 and MP 196.7, contains 19 sub-populations of Applegate's milk-vetch, several of which were discovered by FWS and SBS during surveys conducted for Pacific Connector. This area was revisited in 2018 and no new sites were documented. Pacific Connector has revised its proposed route slightly in this area to avoid direct effects on the plants identified in 2008 within the Collins Tract site. Survey efforts of the pipeline route subsequent to these initial survey efforts in 2007 and 2008 have not identified any additional plants; however, Pacific Connector has not surveyed all potential habitat. Additionally, in 2009, the FWS and The Nature Conservancy documented 1,260 plants within and adjacent to the proposed Klamath Falls Memorial Drive 2 pipe storage yard, in an area that has not been surveyed for the Project (ORBIC 2017a).

The route has been relocated to avoid known populations of Applegate's milk-vetch as well as suitable habitat found during surveys conducted during summer 2008; therefore, no direct effects on known plants in those sites are expected. Additionally, Pacific Connector would resurvey the Klamath Falls Memorial Drive 2 pipe storage yard prior to construction and avoid the use of the proposed yard within 30 meters of known and documented Applegate's milk-vetch plants. Project surveys of all suitable habitat have not been completed for this species; therefore, additional plants could potentially be encountered and affected by the Project. Measures to reduce impacts on unidentified plants are included in the *Applegate's Milk-vetch Mitigation Plan*; however, the FWS has indicated it may require additional mitigation for these potential impacts as part of their BO (including additional survey, seed collection, and salvage requirements). Below is a determination of effects summary for Applegate's milk-vetch and critical habitat. More details will be provided in the pending BA.

The Project **may affect** Applegate's milk-vetch because:

- suitable habitat is available within the botanical analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Applegate's milk-vetch because:

- approximately 175.3 acres of potential suitable habitat that has not been surveyed occurs within the botanical analysis area along the pipeline route, which includes 77 acres within the pipeline ROW; therefore, it is possible that unidentified plants occur within the construction ROW and workspace;
- surface disturbance and excavation would occur within potentially suitable habitats and could impact unidentified plants (including in areas where surveys have not been completed); and
- indirect effects, including potential changes in hydrology and soil characteristics, introduction and spread of invasive plants and noxious weeds, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust, could impact documented or suspected plants and habitat outside the construction ROW, but within 30 meters of the Project pipeline.

Critical habitat has not been designated for Applegate's milk-vetch.

Gentner's Fritillary (Federally Endangered Species, State Endangered Species)

FWS listed Gentner's fritillary (*Fritillaria gentneri*) as endangered on December 10, 1999 (FWS 1999). Gentner's fritillary is found in small, scattered locations in the Rogue and Klamath River watersheds in Jackson and Josephine Counties in Oregon (FWS 2003c; 2016d). This species is highly localized, with populations occurring within a 30-mile radius of Jacksonville Cemetery in Jacksonville, Oregon (FWS 2003c). Since the 2003 publication of the recovery plan, nine new Gentner's fritillary populations (approximately 131 flowering plants within 1.6 acres) have been detected outside of the four recovery unit boundaries (FWS 2016d). It is difficult to census populations of Gentner's fritillary because this species does not flower every year and individuals can remain dormant for one or more years underground.

Gentner's fritillary is often found on the edge of dry woodland and forests where the overstory can be dominated by Oregon white oak, madrone, Douglas-fir, and ponderosa pine; it also occurs in open chaparral and grassland environments. It occurs at a wide range of elevations, from 1,000 to 5,100 feet, and is usually associated with shrubs that provide protection from the wind and sun (FWS 2003c).

The Pacific Connector Project crosses the plant's range between approximately MP 113 through MP 155. Surveys for Gentner's fritillary have occurred within suitable habitat near the pipeline from 2007 through 2018. Surveys are expected to continue to complete recommended second year survey efforts, where necessary. Additionally, surveys will be initated in other areas that receive survey permission. Since 2007, survey efforts have identified Gentner's fritillary individuals in five locales: (1) approximately 0.38 mile north of MP 128.0 near Indian Creek and 50 feet below a four-wheel drive road; (2) 21 feet from TEWA 128.01-W; (3) 100 feet from proposed access road EAR-128.05; (4) near MP 129.1 approximately 54 feet from TEWA 128.96-N; and (5) within 21 feet of TEWA 142.07-N near MP 142.1. Of these five sites, three are located within the analysis area. Direct impacts on known individuals of Gentner's fritillary would be avoided; however, unidentified *Fritillaria* plants near MP 142.1 that could be Gentner's fritillary occur within the pipeline ROW and would be impacted if a reroute of the pipeline alignment is not implemented (additional details to be provided in our pending BA). Additionally, unidentified *Fritillaria* plants near MP 129 that could be Gentner's fritillary occur within the analysis area and could be indirectly affected.

Additionally, Project surveys of all suitable habitat have not been completed for Gentner's fritillary; therefore, additional plants could potentially be encountered and affected by the Project. The FWS will require two-year protocol surveys in unsurveyed, potentially suitable habitat and in suitable habitat where surveys are older than 10 years. However, indirect impacts on known individuals could be eliminated with minor modifications to the construction ROW. Therefore, **we recommend that:**

- **<u>Prior to end of the draft EIS comment period</u>, Pacific Connector should file with the Secretary revised alignment sheets that eliminate or relocate TEWA 128.01-W, TEWA 128.96-N, TEWA 142.07-N. and EAR-128.05.**

Below is the determination of effects summary for Gentner's fritillary; more details will be provided in our pending BA.

The Project **may affect** Gentner's fritillary because:

- suitable habitat is available within the analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Gentner's fritillary because:

- approximately 240.9 acres of potential suitable habitat that has not been surveyed occurs within the botanical analysis area along the pipeline route, which includes 50.4 acres within the pipeline ROW; therefore, it is possible that unidentified plants occur within the construction ROW and workspace;

- *Fritillaria* spp. have been identified within and adjacent to areas that would be affected by the Project;
- Gentner's fritillary can remain dormant underground for one year or longer, does not flower every year, and has been documented to not flower for several years; therefore, it is possible that protocol surveys conducted for the Project did not locate this species; and
- indirect effects, including potential changes in hydrology and soil characteristics, introduction and spread of invasive plants and noxious weeds, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust, could impact documented or suspected plants and habitat outside the construction ROW, but within 30 meters of the Project pipeline.

Critical habitat has not been designated for Gentner's fritillary.

Western Lily (Federally Endangered Species, State Endangered Species)

FWS listed the western lily (*Lilium occidentale*) as endangered on August 17, 1994 (FWS 1994b). This lily is currently known from 23 small populations in freshwater marshes and swamps, early successional fens (bogs), coastal scrub and prairie, openings in coastal, Sitka spruce–dominated coniferous forests, as well as other poorly drained soils along the coast of southern Oregon and northern California (FWS 2009b). Western lilies have an extremely restricted distribution, and only occur along the coast within 4 miles of the Pacific Ocean. Occurrences within the Coos Bay area are reported to occur in Blacklock soils; however, it also grows in soils that are well drained that have a substancial layer of organic soil (SHN 2013c).

The closest known western lily occurrence in relation to the Project is approximately 1 mile south of the Myrtlewood Off-site Park & Ride at the Hauser Bog (ORBIC 2017b). However, the Myrtlewood Off-site Park & Ride is located completely in the paved parking lot and does not contain suitable habitat for the western lily. There are no other known occurrences within two miles of the Project (ORBIC 2017b). There are no records of western lily north of Hauser, and the FWS typically considers Hauser the northern extent for the species along the Oregon coast.

Surveys for western lily within potential habitat in the analysis area (i.e., poorly drained bogs with acidic organic soils and within six miles of the coast below 300 feet elevation) were conducted between 2006 and 2017 (SHN 2013c; SBS 2008a, 2012, 2013, 2014, 2017a). Jordan Cove conducted surveys at the LNG terminal site in 2006, 2012, and 2013 and surveys were conducted by SBS for Pacific Connector between 2007 and 2017. No occurrences of western lily were detected during these surveys, and only limited areas of potential suitable habitat were identified. More details will be provided in our pending BA.

Although no plants were identified in the area that would be affected by the Project and potential occurrence of this species in this area is low, surveys of all potential habitat in the area have not been completed for this species; therefore, western lily could potentially be encountered and affected by the Project. Additionally, this species is difficult to detect when not flowering, and surveys may overlook western lily juveniles or vegetative adults, especially non-flowering individuals growing within dense vegetation (FWS 2008b). Below is the determination of effects summary for western lily and critical habitat.

The Project **may affect** the western lily because:

- known populations occur within 1 mile of the botanical analysis area; and
- potential suitable habitat is available within the analysis area.

The Project is **not likely to adversely affect** the western lily because:

- surveys of potential western lily habitat at the Jordan Cove site and associated facilities and along the pipeline route did not document western lily and potential suitable habitat within the botanical analysis area is limited;
- surveys in potentially suitable habitat would occur prior to ground-disturbing activities; if plants are identified, conservation measures developed to avoid or minimize effects on any documented plants would be implemented; and
- consultations with the FWS would be reinitiated if this species is found to be present in the area and effects cannot be avoided.

Critical habitat has not been designated for the western lily.

Large-Flowered Meadowfoam (Federally Endangered Species, State Endangered Species)

The large-flowered meadowfoam (*Limnanthes pumila* ssp. *grandiflora*) was federally listed as endangered on November 7, 2002 (FWS 2002b). It is an endemic species restricted mostly to the Agate Desert area in the Rogue River Valley of southern Oregon. It grows on the wetter, inner edges of vernal pools at elevations between 1,220 and 1,540 feet. The plant is capable of self-fertilization and self-pollination. In the Rogue River Valley, large-flowered meadowfoam is often found in the same vernal pool habitats as Cook's lomatium (*Lomatium cookii*) and the vernal pool fairy shrimp.

In 2010, FWS designated eight CHUs (5,840 acres) for the large-flowered meadowfoam in the Agate Desert complex in Jackson County, Oregon. Two of the units designated are shared by the designated habitat for Cook's lomatium. All designated CHUs are currently occupied (or expected to be occupied; FWS 2010b). Within the vicinity of White City, Oregon, where multiple pipe storage yards would be located, CHUs RV6 (6A through 6H) and RV8 have been designated. Industrial parks surround all units. Unit RV6C is across an existing paved road from the Burrill Lumber pipe storage yard, and Unit RV6D is 590 feet northeast of this pipe storage yard. RV8 is over 1.8 miles west of the proposed Rogue Aggregates and the other three pipe storage yards.

Botanical surveys were conducted within identified suitable habitat for this species where access was permitted, during the flowering season in April 2007. In 2007, survey efforts documented approximately 36 large-flowered woolly meadowfoam plants approximately 850 to 1,165 feet east of the proposed Burrill Lumber pipe storage yard. Additionally, ORBIC (2017a) has reported several other subpopulations of large-flowered woolly meadowfoam (approximately 16,200 plants) near proposed pipe storage yards, including within the Ken Denman State Game Management Preserve across an existing paved road east of the Burrill Lumber pipe storage yard.

No surveys have been permitted within Avenue F & 11th Street and WC Short pipe storage yards; however, off-site observations identified approximately 0.48 acre of highly modified, low-quality vernal pool habitat within 250 feet of the Avenue F & 11th Street and WC Short pipe yards. This area is associated with active industrial sites or previously disturbed industrial areas and is not expected to provide high-quality vernal pool habitat or support individuals of large-flowered woolly meadowfoam. Additionally, no direct or indirect effects on potential vernal pool habitat are expected from use of the Avenue F & 11th Street and WC Short pipe storage yards.

The Project **may affect** large-flowered woolly meadowfoam because:

- the pipeline occurs near occupied, large-flowered woolly meadowfoam habitat.

The Project is **not likely to adversely affect** large-flowered woolly meadowfoam because:

- surveys of potentially suitable habitat at proposed pipe storage yards in Jackson County and along the Project did not document large-flowered woolly meadowfoam plants;
- the 0.48-acre of unsurveyed potential habitat within the Avenue F and 11th and WC Short pipe storage yards consists of low-quality vernal pool habitat within active industrial sites or previously disturbed industrial areas and is unlikely to contain large-flowered woolly meadowfoam;
- Pacific Connector would avoid using portions of the pipe storage yards within 250 feet (indirect effect) of this species or potentially suitable vernal pool habitat;
- effects on suitable habitat are likely to be discountable to the point where no meaningful measurement, detection, or evaluation of effects would be possible (i.e., effects would not reach a level where individual plants would be lost);
- sedimentation barriers would be used, as appropriate, to prevent run-off and changes in hydrology;
- conservation measures have been developed to avoid or minimize effects on any plants identified during surveys prior to construction; and
- construction of the pipeline is not expected to adversely modify hydrology in nearby suitable habitat areas within 250 feet of proposed pipe storage yards.

The Project **may affect** designated critical habitat for large-flowered woolly meadowfoam because:

- the Project occurs adjacent to large-flowered woolly meadowfoam critical habitat.

The Project is **not likely to adversely affect** large-flowered woolly meadowfoam critical habitat because:

- Construction of the pipeline is not expected to adversely modify designated critical habitat areas within 250 feet of pipeline components (i.e., subunit RV6C); existing features (i.e., paved Agate Road) and proposed conservation measures would provide sufficient protection from adjacent development and invasive plant and noxious weed sources; and

- The Burrill Lumber pipe yard is hydrologically disconnected from subunit RV6D due to topography (flow is away from RV6D) and distance (greater than 590 feet) and is hydrologically isolated from subunit RV6C by the raised Agate Road.

Cook's Lomatium (Federally Endangered Species, State Endangered Species)

Cook's lomatium was listed as federally endangered on November 7, 2002 (FWS 2002b). Its range is on seasonally wet soils limited to two areas: (1) along vernal pools in the Agate Desert area of the Rogue River Valley, Jackson County, and (2) in seasonally wet serpentine-derived grassland meadows, sloped mixed-conifer forest openings, and and along roadsides edges in shrub dominated plant communities or adjacent to meadows within the Illinois River Valley area near Cave Junction, Josephine County. The Jackson County populations occur along the margins and bottoms of vernal pool habitats within a 20,510-acre landform known as the Agate Desert. The plant flowers from late March to May and is pollinated entirely by insects. In the Rogue River Valley, Cook's lomatium is often found in the same vernal pool habitats as the large-flowered meadowfoam and the vernal pool fairy shrimp.

In 2010, the FWS designated 16 units (6,289 acres) of critical habitat for the Cook's lomatium, including three CHUs in Jackson County, totaling 2,282 acres. Two of the designated units in Jackson County are shared by the designated habitat for large-flowered woolly meadowfoam. All designated CHUs are currently occupied (FWS 2010b). CHUs RV6 (A, F, G, and H) and RV8 have been designated within the vicinity of White City, Oregon, where multiple pipe storage yards would be located. Industrial parks surround these units. CHUs RV6A and RV6H are located approximately 0.5 mile south and 0.8 mile southeast, respectively, of the Avenue F & 11th Street and WC Short pipe storage yards.

Four pipe storage yards, Burrill Lumber, WC Short, Avenue F & 11th Street, and Rogue Aggregates, occur within the Agate Desert near White City in proximity to known occupied vernal pools. No vernal pool habitat or individuals of Cook's lomatium were observed during surveys of the Burrill Lumber and Rogue Aggregates pipe storage yards, and no potential vernal pools were located within 250 feet of the Burrill Lumber pipe storage yard. Although the layout for the Rogue Aggregates pipe storage yard has been reconfigured since surveys in 2007, unsurveyed portions do not contain suitable soil types for Cook's lomatium. Several patches of Cook's lomatium have been documented in the Denman Wildlife Management Area and Agate Desert Preserve, 0.5 mile south of the Avenue F & 11th Street and WC Short pipe storage yards (Friedman 2006, ORBIC 2017a). Surveys have not been conducted within the Avenue F & 11th Street and WC Short pipe storage yards because access has not been granted; however, based on aerial photography and off-site observation in April 2018, Avenue F and 11th and WC Short pipe storage yards do not appear to contain suitable habitat for Cook's lomatium. A long drainage ditch running along the northern edge of the Avenue F and 11th pipe storage yard, which could provide low-quality habitat for Cook's lomatium, was observed during these off-site surveys.

Below is the determination of effects summary for Cook's lomatium and critical habitat; more details will be provided in our pending BA.

The Project **may affect** Cook's lomatium because:

- suitable, occupied habitat is available within the vicinity of the Project.

The Project is **not likely to adversely affect** Cook's lomatium because:

- surveys of suitable habitat at pipe storage yards in Jackson County and along the pipeline did not document Cook's lomatium;

- Pacific Connector would avoid using portions of pipe storage yards within 250 feet of high-quality vernal pool habitat, as well as areas with potential vernal pool habitat;
- effects on suitable habitat are likely to be discountable to the point where no meaningful measurement, detection, or evaluation of effect would be possible (i.e., effect would not reach a level where individual plants would be affected);
- sedimentation barriers would be used, as appropriate, to prevent run-off and changes in hydrology;
- conservation measures have been developed to avoid or minimize effects on any plants identified during surveys prior to pipeline construction;
- known sites within the vicinity of the Project are farther than 0.5 mile from pipe storage yards; and
- unsurveyed habitat is low-quality vernal pool habitat located over 0.25 mile from known sites with no apparent hydrologic connectivity.

The Project would have **no effect** on designated Cook's lomatium critical habitat because:

- the pipeline is over 0.5 mile from the nearest critical habitat subunit RV6A; and
- the proposed action is not expected to adversely modify habitat areas that provide buffer protection from adjacent development and weed sources, continuous nonfragmented habitat, and intact hydrology (PBFs 1 and 4).

Kincaid's Lupine (Federally Threatened Species, State Threatened Species)

Kincaid's lupine was listed as federally threatened on January 25, 2000 (FWS 2000b). It is a long-lived perennial herb inhabiting native prairies and foothills (FWS 2000b). In Douglas County, Oregon, it occupies sites that are more shaded, occurring in areas with tree (i.e., Douglas-fir, California black oak, Pacific madrone, ponderosa pine, incense cedar, hairy manzanita, and poison oak) and shrub canopy cover of 50 to 80 percent (FWS 2006f). About 600 acres have been designated as critical habitat for this species; however, all of these designated habitats are located outside of areas that would be disturbed by the Project.

The pipeline is located within known or historical Kincaid's lupine range between MPs 46.8 and 99.3. Multiple populations of lupine have been identified in the Project's botanical analysis area within Douglas County, including 11 sites within 2.5 miles of the pipeline (ORBIC 2017a). Surveys in 2007 identified three populations of Kincaid's lupine in the vicinity of the pipeline: 1) within and adjacent to the construction ROW on private land between approximately MPs 57.84 and 57.92; 2) on private land near MP 59.60 (approximately 300 feet north of MP 59.60; 67 and 222 feet to the north and west of TEWA 59.30-N; and approximately 40 and 85 feet to the south and west of EAR 59.62); and 3) and on private land within the construction ROW and along proposed access roads between MPs 96.48 to 96.90.

Pacific Connector has modified the pipeline route to avoid the population located within the construction ROW between MP 57.84 and MP 57.92. No direct impacts are anticipated to the population near MP 59.60, as plants are located at least 67 feet from pipeline facilities. The two sites, near MP 57.84-57.92 and 59.60, were revisited in 2017, and both populations appeared to be stable or slightly increasing (SBS 2017b).

Pacific Connector also modified the construction ROW between MP 96.48 and 96.90 to avoid direct impacts on the Kincaid's lupine individuals identified during surveys in 2007. Additionally, the population between MP 96.48 and 96.90 was burned during the 2015 Stouts Creek fire. This population was revisited in 2016 to determine the affect of the fire, associated fire-suppression activity, and subsequent logging activities. Kincaid's lupine was observed in only 2 of the original 28 subpopulations documented in the area during surveys in 2007, and no viable plants were observed in the pipeline ROW or within proposed access roads (SBS 2016). Although no plants were relocated along the construction ROW between MP 96.48 and 96.90 in 2016, it is possible that construction of the pipeline and use of access roads could affect this population if plants resprout in this area. Pacific Connector would conduct additional surveys within the Stouts Creek fire area (MP 96.48 to 96.9) prior to ground disturbance.

No additional plants have been documented in other areas of the pipeline route, where access was granted, during subsequent surveys. However, not all suitable habitats within the Project area have been surveyed to date, indicating that additional unknown populations may be present within areas that could be affected by the Project. If other Kincaid's lupine populations are identified during additional surveys, Pacific Connector would implement applicable mitigation measures, such as necking down the construction right-of way, excluding a portion of an identified TEWA or pipe storage yard, and erecting a protective fence or barrier, to avoid or minimize impacts on newly observed populations. Persisting subpopulations at MPs 96.48 to 96.9 would be flagged/fenced to minimize potential disturbance.

The Project could affect unknown populations of Kincaid's lupine within and adjacent to the pipeline ROW. The *Federally-listed Plant Conservation Plan* contains a Kincaid's Lupine Mitigation Plan that specifically addresses mitigation that would be implemented for Kincaid's lupine; however, the FWS may require additional mitigation for these potential impacts as part of their BO (including additional survey, seed collection, and salvage requirements). Below is the determination of effects summary for Kincaid's lupine and critical habitat.

The Project **may affect** Kincaid's lupine because:

- suitable habitat is present within the analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Kincaid's lupine because:

- approximately 991.6 acres of potential suitable habitat that has not been surveyed occurs within the botanical analysis area along the pipeline route, which includes 448.7 acres within the pipeline ROW; therefore, it is possible that unidentified plants occur within the construction ROW and workspace;
- surface disturbance and excavation would occur within potentially suitable habitats, and could impact unidentified plants (including in areas where surveys have not been completed);
- indirect effects, including potential changes in hydrology and soil characteristics, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust, could impact documented or suspected plants and habitat outside of the construction ROW, but within 30 meters of the Project pipeline and along access roads; and

- trenching activities associated with the pipeline could affect below-ground stems, and the expected effect to extant plants is unknown.

The Project would have **no effect** on Kincaid's lupine critical habitat because:

- the pipeline does not occur within designated Kincaid's lupine critical habitat.

Rough Popcornflower (Federally Endangered Species, State Endangered Species)

The rough popcornflower was federally listed as endangered on January 25, 2000 (FWS 2000c). It is found in seasonal wet meadows or wet prairies in poorly drained clay or silty clay loam soils at elevations ranging from 100 to 900 feet. This plant occurs mostly on private lands in the Umpqua River drainage near Sutherlin and Yoncalla in northern Douglas County (FWS 2003d). As of 2010, there were 14 extant populations of rough popcornflower distributed from Yoncalla Creek near Rice Hill, south to Sutherlin Creek near Wilbur, of which five populations have been introduced (FWS 2010c). Six populations are considered protected and have a documented occupancy of at least 5,000 plants (FWS 2010c).

The closest known occurrences of rough popcornflower to the Project include multiple subpopulations approximately 1.7 miles north of the Winchester pipe storage yard and 17.5 miles north of the pipeline ROW at MP 68 (ORBIC 2017a, 2017c). Surveys for rough popcornflower have been conducted in potential habitat between MPs 51.7 and 67.0. To date, no individuals of rough popcornflower have been documented during surveys. However, Pacific Connector has not been granted access to approximately 99.83 acres of potentially suitable rough popcornflower habitat within the analysis area, the majority of which is associated with the Winchester pipe storage yard.

Due to the potential for the plant to occur within areas of potential habitat that have not been surveyed by Pacific Connector and may be disturbed by construction activities, the Project may affect rough popcornflower. Below is the determination of effects summary for rough popcornflower and critical habitat.

The Project **may affect** rough popcornflower because:

- populations occur near a pipe storage yard; and
- potential suitable habitat might be present within the 98-foot (30-meter) botanical analysis area.

The Project is **not likely to adversely affect** rough popcornflower because:

- where access has been granted, surveys for the Project have not documented individuals of rough popcornflower; surveys in potentially suitable habitat identified within the Winchester pipe storage yard would occur prior to ground-disturbing activities; if plants are identified, Pacific Connector would not use either the pipe storage yard or portions of the yard where plants are documented;
- surveys within potential habitat along the pipeline ROW would occur prior to ground disturbing activities; if any plants are identified, conservation measures developed to avoid or minimize effects on documented plants would be implemented; and
- consultation with the FWS would be reinitiated if this species is found to be present in the area and effects cannot be avoided.

Critical habitat has not been designated for rough popcornflower.

4.6.1.7 Conclusions and Recommendations for Threatened and Endangered Species

Based on informal consultations with the FWS and NMFS, 34 federally listed and proposed species were identified as potentially occurring near the Project. The FERC would only authorize the Project to proceed if the FWS' and NMFS' BOs find the Project, as described, would not jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat. Further, to ensure compliance with the ESA, **we recommend that:**

- **Jordan Cove and Pacific Connector <u>should not begin construction until</u>:**
  - **a. the Commission staff completes formal consultations with the NMFS and FWS; and**
  - **b. Jordan Cove and Pacific Connector have received written notification from the Director of OEP that construction and/or implementation of conservation measures may begin.**

4.6.2 State-Listed Threatened or Endangered Species

In addition to species that are federally threatened or endangered, there are 13 species designated as threatened or endangered by the State of Oregon that could potentially occur in the area affected by the Project (table 4.6.2-1).

TABLE 4.6.2-1

State-Listed Species Potentially Occurring in the Area Affected by the Proposed Project

Species	FWS Status	ODFW Status	Portion of the Project Area Where Species Potentially Occur
Mammals			
Kit fox *Vulpes macrotis*	None	Threatened	Pacific Connector Pipeline
Gray Whale *Eschrichtius robustus* (Eastern North Pacific stock)	Delisted	Endangered	LNG carrier transit in the waterway, Navigation Reliability Improvements Dredge Areas
Birds			
California brown pelican *Pelecanus occidentalis*	None	Endangered	Navigation Reliability Improvements Dredge Areas, Jordan Cove terminal
Plants			
Pink sand verbena *Abronia umbellata* ssp. *Breviflora*	Species of Concern	Endangered	Jordan Cove terminal
Point Reyes bird's-beak *Cordylanthus maritimum* ssp. palustre (*C. maritimus* ssp. *palustris*)	Species of Concern	Endangered	Jordan Cove terminal; Pacific Connector pipeline
Wayside aster *Eucephalis vialis* (*Aster vialis*)	Species of Concern	Threatened	Pacific Connector pipeline
Peck's milk-vetch *Astragalus peckii*	None	Threatened	Pacific Connector pipeline
Pumice grape-fern *Botrychium pumicola*	None	Threatened	Pacific Connector pipeline
Cox's mariposa-lily *Calochortus coxii*	Species of Concern	Endangered	Pacific Connector pipeline
Umpqua mariposa-lily *Calochortus umpquaensis*	Species of Concern	Endangered	Pacific Connector pipeline

TABLE 4.6.2-1

State-Listed Species Potentially Occurring in the Area Affected by the Proposed Project

Species	FWS Status	ODFW Status	Portion of the Project Area Where Species Potentially Occur
Dwarf woolly meadowfoam *Limnanthes pumila ssp. pumila*	Species of Concern	Threatened	Pacific Connector pipeline
Silvery phacelia *Phacelia argentea*	Species of Concern	Threatened	Jordan Cove terminal Pacific Connector pipeline
Wolf's evening primrose *Oenothera wolfii*	None	Threatened	Jordan Cove terminal

4.6.2.1 Mammals

Kit Fox (No ESA Status, State Threatened Species)

The kit fox reaches its northern limit in southern Oregon. In Oregon, it is found in arid desert valleys dominated by halophytic plants like greasewood and shadscale, intermingled with sagebrush. Although the Project may affect suitable kit fox habitat, the expected distribution of this species does not include the Project area. Because kit foxes have not been recently observed within the area affected by the Project (ORBIC 2017a), the Project is not expected to affect this species.

Gray Whale (Eastern North Pacific stock; Federal Delisted Species, State Endangered Species)

The gray whale is a large baleen whale that is distributed in the northern Pacific Ocean in western and eastern stocks. The eastern stock, found along the west coast of North America, was federally delisted on June 16, 1994 (59 FR 115), but remains state endangered in Oregon. The eastern Pacific stock feeds in the summer in the Chukchi Sea, the western Beaufort Sea, and the northern Bering Sea. They migrate south from November through early February to lagoons on the Pacific coast of central and southern Baja California. Northward migration occurs after the calving and breeding season, from early February to May. These whales have the longest known migration of any mammal. Gray whales feed on infaunal benthic species that are buried in sediments (Maser et al. 1981). Gray whales are federally protected under the MMPA.

Potential effects on gray whales include injury and/or mortality due to ship strikes, underwater ship noise, construction noise (including pile driving and dredging) and potential adverse effects from a ship fuel spill at sea. Spills could indirectly affect gray whales by impacting forage species. These potential effects would be similar to the effects on federally listed whales that are discussed above, except that gray whales migrate in coastal waters north and south parallel to the Pacific Coast, making them more susceptible to ship strikes in nearshore waters during migration.

According to the Oregon Parks and Recreation Department (OPRD 2007), gray whales are the most predominant whales seen along the Oregon coast. They migrate twice a year, in winter and spring, and about 200 of them feed along the coast during the summer months. Gray whales have on occasion entered Coos Bay beyond the Jordan Cove LNG Project site and have been seen in Coos Bay at about the same frequency as killer whales. Gray whales may be encountered along the LNG carrier transit route during their southern migration from November through early February or from early February to May during the northern migration. Based on data in Pacific waters between 1999 and 2003, gray whales are struck by ships at a rate of 1.2 whales annually (Angliss and Outlaw 2007). The increase in shipping traffic resulting from LNG carriers could cause an increase in the probability of whales being struck by ships, or of being disturbed during migration. Measures that Jordan Cove would implement to avoid or minimize effects on federally listed whales (see section 4.6.1.1) would serve to avoid or minimize effects on the gray whale.

4.6.2.2 Birds

California Brown Pelican (Federal Delisted Species, State Endangered Species)

The brown pelican was listed as a federally endangered species on June 2, 1970, within California, Oregon, Texas, and Washington states, as well as Central and South America (FWS 1970). It was delisted in December 2009 (FWS 2009c); however, Oregon still considers the brown pelican an endangered species under state law (ODFW 2017h).

The California brown pelican is a primarily coastal species, rarely seen inland or far out at sea (FWS 2005b). They feed mostly in shallow estuarine waters, normally staying within 20 miles of shore (FWS 2005b). Pelicans make extensive use of sand spits, offshore sand bars, and islets for nocturnal roosting and daily loafing, especially by non-breeders and during the non-nesting season (FWS 2005b).

Brown pelicans nest in colonies, mostly on small coastal islands in California (FWS 1985, 2007e). Brown pelicans generally breed between February and October and are most abundant in Oregon during post-breeding migration (FWS 2005b). In Oregon, numbers peak in late August through October and gradually decline from October through early November as birds move south (Gilligan et al. 1994). Since brown pelicans have wettable feathers, they return to land daily to roost and dry their feathers (FWS 2005b). Sand islands within three large estuaries in Oregon and Washington serve as primary night roosts (Jaques and O'Casey 2006 as cited in FWS 2007e). The total number of brown pelicans in Oregon in 2001 was estimated to be 6,095 (Marshall et al. 2003).

Brown pelicans are regularly seen in moderate numbers during the summer months in Coos Bay, and they also occur in small numbers in the winter (Contreras 1998). Coos Bay provides excellent habitat for this species. Brown pelicans were recorded foraging near the Project site more than 500 feet from the shore and loafing across the bay in moderate numbers daily during surveys in October 2012 (SHN 2012). The species was also observed during surveys conducted in 2005-2006 until early September (LBJ 2006). The Project site provides no nesting habitat for the brown pelican. Roosting and feeding sites have been documented within the Project area, although the last observation was in 1985. Roosting was reported on the north side of Coos Bay on a sunken jetty close to the Bay mouth and on a sand spit on the North Spit of Coos Bay, as well as on dredge spoil islands around MPs 3R through 4R (ORBIC 2017a).

In the past, California brown pelicans have been affected by human disturbances at nesting colonies and roosting habitats. Existing nesting and roosting habitats within the Coos Bay Estuary and Jordan Cove LNG Project area have not been documented. If they occur within the estuary during construction and operation of the proposed action, pelicans may be associated with on-shore fish-cleaning stations where they possibly feed on offal (Marshall et al. 2003). Existing fish-cleaning stations are present at the Empire Boat Ramp, Oceanside RV Park and Bastendorff Beach County Park, both in Charleston. Fish-cleaning could also occur at the Charleston Marina, California Street Boat Ramp, and BLM Boat Ramp, though they are not designated as such.

Noise and human activities associated with construction and operation of the Project are likely to be the only direct effect to brown pelicans if they occur within one or more of the Project's analysis areas. Jordan Cove is proposing construction of its access channel in Coos Bay during the ODFW recommended in-water work window between October 1 and February 15. This schedule would minimize effects on brown pelicans because there is a gradual decline in populations in Oregon as birds move south from October through early November (Gilligan et al. 1994). However, noise created by pile driving and construction in general is likely to affect brown pelicans if present and could disrupt brown pelican feeding behavior.

Brown pelicans that forage within the vicinity of the Jordan Cove LNG Project (i.e., the estuarine analysis area) could ingest low levels of contaminants through the food web that are re-suspended from dredging activities. However, sediments at the Jordan Cove LNG Project site and pipeline route within Coos Bay are not expected to contain levels of sediment contaminants that could adversely affect brown pelicans. Access channel dredging and maintenance dredging would not occur during the period of peak pelican abundance in the lower bay. Therefore, dredging activities would not substancially disrupt normal behavior patterns for brown pelicans.

Pacific Connector is proposing construction across Coos Bay using HDD construction in two segments (MP 0.12 to MP 1.11 and MP 1.40 to MP 3.09). It is possible that the brown pelican could be present within Coos Bay and its vicinity during the time of construction (see Contreras 1998). Therefore, noise and human activities associated with construction and operation of the pipeline are likely to affect brown pelicans as sources of disturbance and disruption if they are present and could disrupt brown pelican feeding behavior.

There is some evidence in the literature that high intensity continuous anti-collision lights on structures may result in an increased number of bird strikes, especially at night or during fog and overcast conditions. The number of strikes can apparently be reduced by strobe or blinking the anti-collision lights. The LNG storage tanks would not be illuminated with high intensity lighting. The intensity and number of lights would be limited to what is required for security and operations. With the low-intensity lighting to be used, the likelihood of adverse effects on brown pelicans from collisions with the LNG storage tanks is minimal.

Brown pelicans may be encountered during any portion of the LNG carrier transit route in the waterway. There is no evidence that pelicans are struck by current cargo ships using the Port.

During operation of the Pacific Connector pipeline, aerial inspection of the pipeline route would occur within the permanent ROW. Aerial inspections would generally occur during all times of year, although inspections would not affect nesting or breeding brown pelicans since they do not nest or breed within Coos Bay. Additionally, aerial inspection should not disturb migrating, roosting, or foraging brown pelicans since air traffic is a constant disturbance within Coos Bay from the existing North Bend airport.

The proposed action would create auditory and visual disturbances that are likely to cause foraging brown pelicans to temporarily avoid areas of high activity. The proposed action area does not contain existing nesting or roosting habitat and would not affect nesting or roosting individuals. As a result, the proposed action would temporarily affect foraging individuals but is not expected to affect nesting or roosting by brown pelicans

4.6.2.3 Plants

Pink Sand Verbena (Federal Species of Concern, State Endangered Species)

The historical range of pink sand verbena (*Abronia umbellata* ssp. *breviflora*) was from northern California to Vancouver British Columbia, Canada (ODA 2017c). Its present range is along coastal beach and foredune, predominantly from Cape Blanco (Curry County), southern Oregon to Point Reyes National Seashore in Marin County, California and sporadically along Oregon's northern and central coast. Pink sand verbena only inhabits the littoral sandy beach areas and unstabilized sand dunes of the coastal strip and usually occurs on beaches in fine sand between the high-tide line and the driftwood zone, and in areas of active sand movement below the foredune (ORBIC 2010). In the northern portion of its range, most populations of pink sand verbena occur on broad beaches and/or near the mouths of creeks and rivers.

Of the 12 reported occurrences in Oregon, only 2 have more than 50 plants; many of the populations consist of only one plant and will probably not persist. Two populations of pink sand verbena documented near the mouth of Coos Bay, contained approximately 300,000 plants when surveyd in 2012 (ORBIC 2017a). Approximately 15 miles north of the entrance to Coos Bay, 19 plants were documented in 1995 within a protected (public entry prohibited) snowy plover nesting area (ORBIC 2012). There are no known occurrences of pink sand verbena within two miles of the Jordan Cove Project area (ORBIC 2017a). No pink sand verbena plants have been reported within the Pacific Connector pipeline area (ORBIC 2006a) and the pipeline route would not affect coastal sand dune habitat; therefore, Pacific Connector has not conducted botanical surveys for this species and no incidental documentations of this species has occurred.

Jordan Cove identified suitable habitat for the plant along the eastern portion of the LNG terminal in areas of actively moving dunes and European beachgrass. However, surveys conducted at the Jordan Cove Project area in 2006, 2012, and 2013 did not locate any pink sand verbena plants (SHN 2006b, 2013c). As surveys conducted within the Jordan Cove Project area, as well as historic data, indicate that pink sand verbena is not present within the Project area, the Project is not expected to affect this species.

Point Reyes Bird's-beak (Federal Species of Concern, State Endangered Species)

Point Reyes bird's-beak (*Cordylanthus maritimum* ssp. *palustre* [*C. maritimus* ssp. *palustris*]) inhabits salt marshes along the coast, sometimes growing just above tidewater in wet areas. Its habitat requirements are specific: approximately 7.5 to 8.5 feet (2.28 to 2.59 meters) above mean lower low water, soil salinity of 34 to 55 parts per thousand, sandy substrate covered by 1 to 10 cm (0.39 to 3.93 inches) organic silt, and less than 30 percent bare soil in summer. Point Reyes bird's-beak occurs along the Pacific Coast from Tillamook County, Oregon, south to Santa Clara County, California. In Oregon, the species is restricted to Netarts Bay, Yaquina Bay, and Coos Bay, with most known occurrences located in Coos Bay. Within the counties crossed by the Project, Point Reyes bird's-beak is found in Coos County.

Several occurrences of Point Reyes bird's-beak are near both the Jordan Cove LNG Project and the Pacific Connector Pipeline Project. Populations with 1,000 to 10,000 plants are located along the margins of Coos Bay and on sand salt marshes near the edge of high water marks (ORBIC 2017a). Several occurrences of Point Reyes bird's-beak are near the Jordan Cove LNG Project, and this species is known to occur within the intertidal wetland between APCO Sites 1 and 2;

however, there is no suitable habitat on APCO Site 2 as this area is dominated by upland vegetation. This species also occurs outside the LNG terminal area along the west and southeast shoreline of the South Dunes site (ORBIC 2017a) and potential habitat for this species has also been observed along the shoreline south of the South Dunes site. Jordan Cove would conduct an additional survey in this area of potential habitat prior to construction.

The area affected by the Pacific Connector Pipeline Project is within the vicinity of documented populations of Point Reyes bird's-beak and the pipeline route would cross suitable habitat. Populations with 1,000 to 10,000 plants were located in 1982 and 1999 along the margins of Coos Bay approximately 260 feet south of TEWA 0.10 (HDD pull-back) and on sand salt marshes near the edge of high water marks on the west side of Haynes Inlet approximately 815 feet north of the Jordan Cove Meter Station near the proposed HDD across Coos Bay (ORBIC 2017a). These plants are farther than 100 feet from the pipeline route and should not be affected by construction. Surveys conducted for Pacific Connector in 2007 located one population of about 1,000 Point Reye's bird's-beak plants approximately 1.7 miles south of MP 1.7 (FERC 2009). Additional surveys occurred in 2017 along the pipeline route near MPs 0.3, 1.0, and 1.47 near the edge of high water marks where the pipeline HDD exits and enters land. Approximately 30 Point Reyes bird's beak plants were located at the margin of Coos Bay near MP 0.9, approximately 475 feet northwest of the construction right-of way and 700 feet west/northwest of TEWAs 1.09-N and 1.09-W. This portion of the pipeline would be constructed by HDD and should not affect plants observed at this location.

Point Reyes bird's-beak is found within and near the Jordan Cove and Pacific Connector Project areas; however, construction of the Project should not directly affect individual plants. Additionally, Pacific Connector has committed to protecting plants adjacent to the pipeline construction ROW through the appropriate installation of safety and silt fence as determined by Pacific Connector's EIs.

Wayside Aster (Federal Species of Concern, State Threatened Species)

The wayside aster's (*Eucephalis* [*Aster*] *vialis*) range is limited to central, southern, and western Oregon and the northern California state line (ORBIC 2010). About 100 populations are known, totaling fewer than 9,000 individuals. Most populations are centered in the southern Willamette Valley of Lane County or in southern Jackson and Josephine Counties, although a few populations exist in the adjacent counties of California (ORBIC 2010). None of the known populations are protected, and many populations are along roadsides and in areas of residential development. Wayside aster occurs in areas of natural and man-made disturbance, edges and openings in woodlands and forests, in second and old-growth, and in shaded roadsides.

Several populations of wayside aster plants have recently been documented within Douglas and Jackson Counties; however, except for one site discussed below, these records are more than 0.5 mile from the Pacific Connector Project area. Botanical surveys for this species in potential habitat have been conducted by Pacific Connector in Coos Bay, Roseburg, and Medford BLM Districts; Umpqua National Forest; and Jackson County. This species was documented in 2007 adjacent to a previously proposed existing access road that would require improvements; however, this road is no longer proposed for use as an access road. This site was revisited in 2009 and additional surveys were conducted within 0.25 mile of this site; however, no plants were located.

Although the species is documented near the Project, surveys conducted by Pacific Connector for the wayside aster did not detect this plant's presence. Construction of the pipeline, including the use of access roads, is not anticipated to affect this species.

Peck's Milk-vetch (Federal Species of Concern, State Threatened Species)

Peck's milk-vetch (*Astragalus peckii*) occurs east of the Cascades Mountain range. Most populations of Peck's milk-vetch are centered in three separate areas: one in north-central Deschutes County, another in north-central Klamath County, and the third in south-central Klamath County. These populations total about 300,000 individuals. The plant occurs in very dry sites, on loose, sandy soil or pumice, often in or along dry water courses, in sagebrush or rabbitbrush openings in ponderosa pine forests (in the south) or in western Juniper woodlands (in the north), and occasionally on barren flats.

Peck's milk-vetch has not been documented within the vicinity of the Project (ORBIC 2006a). No suitable habitat for Peck's milk-vetch occurs within the areas crossed by the pipeline route; therefore, Pacific Connector did not conduct botanical surveys for this species. As this species is not expected to occur along the pipeline route, it would probably not be affected by construction and operation of the Project.

Pumice Grape-Fern (No ESA Status, State Threatened Species)

This species is one of the rarest grape-ferns, and in Oregon is found only within the Crater Lake area and Paulina Mountains in Deschutes and Klamath Counties. Most known populations are found in fine pumice gravel at elevations above 7,800 feet (2,400 meters). It has also been located within frost pockets in lodgepole pine forests with bitterbrush, in areas with deep, sterile pumice. In Oregon, pumice grape-fern *(Botrychium pumicola*) is typically associated with Brewer's sedge and buckwheat (*Eriogonum* spp.) species (Eastman 1990; ORBIC 2010).

The Project is not located near known sites of this plant, and no suitable habitat for this plant occurs within the areas crossed by the pipeline route; therefore, Pacific Connector did not conduct botanical surveys for this species. As the pumice grape-fern is not expected to occur along the pipeline route, the Project would probably have no effect on this species.

Cox's Mariposa Lily (Federal Species of Concern, State Endangered Species)

The Cox's mariposa lily (*Calochortus coxii*) is endemic to serpentine and ultramafic soils and is limited to a small area (30 square meters) along a 10-mile serpentine ridge system in Douglas County, Oregon. All known populations are on serpentine soils, mostly on shady, north-facing, mesic sites near ridgelines, typically, growing in serpentine grasslands and forest margins. Population monitoring studies on BLM land from 2011 through 2015 demonstrated relatively high interannual variation in population estimates for Cox's mariposa lily. For example, 6,966 plants were observed in 2011, whereas 13,865 individuals were observed in 2012 (Gray and Bahm 2015). Populations are also known to occur on private lands; however, surveys haven't been conducted on private lands since the early 1990s (ORBIC 2017a; Aaron Roe, Botanist Roseburg BLM District, personal communication, February 1, 2019). Threats to this species include fire exclusion, encroachment by conifers, noxious weed invasion, logging, grazing, road construction, and off-highway vehicle recreational use (Gray and Bahm 2015; BLM and FWS 2004).

Based on existing data, the Pacific Connector pipeline route would cross one population between MP 74.1 and 75.0 on lands administered by the BLM Roseburg District (ORBIC 2017a). In 2012, surveys conducted by the BLM documented approximately 1,300 plants within and adjacent (within 100 meters) to the Project, with approximately 300 plants occurring in the construction ROW (BLM 2017c). However, modifications have been made to the pipeline route subsequent to these surveys. In 2018, surveys for Cox's mariposa lily were conducted during the flowering season on approximately 65 acres between MPs 74 and 75 of the revised pipeline route. The 2018 survey data are currently under review by the BLM. Additionally, there are approximately 45.3 acres of potential suitable Cox's mariposa lily habitat on private lands within the pipeline route that have not been surveyed.

Individuals of Cox's mariposa lily occur along the pipeline route; therefore, construction and operation of the Project would directly and indirectly affect this species and this species' habitat. In addition to the direct removal of individuals, construction of the pipeline would fragment approximately 0.9 mile of of suitable Cox's mariposa lily habitat. Potential indirect effects to documented or suspected plants and habitat include potential changes in hydrology and soil characteristics, alterations to vegetation cover and species composition of associated habitat, and effects from fugitive dust.

Pacific Connector has developed a Cox's mariposa lily specific mitigation plan (included as an attachment to the *Federally-Listed Plant Conservation Plan*[141]) to avoid and minimize potential effects on this species. As described in the mitigation plan, Pacific Connector would determine if site-specific neck-downs can be incorporated into the construction ROW to minimize direct effects on the population of Cox's mariposa lily between MPs 74 and 75. The construction ROW in this area utilizes the typical 95-foot width with TEWAs because of the steep and narrow ridgeline alignment; thus, neck-downs would be dependent on site-specific conditions and would be based on species presence and the work area requirements to ensure safe pipeline installation. Appropriate barriers would be installed along areas that contain this species to ensure that the mariposa lily populations in the vicinity are not affected by sediments and debris from the ROW. In locations where individual plants cannot be avoided by construction activities, plants would be salvaged during the late summer or fall after the growing season of the year preceding actual pipeline construction. Additional mitigation techniques that would be employed to protect these populations of Cox's mariposa lily include seed collection and bulb salvage, and site restoration and monitoring. However, there has not been any research on the effectiveness of seed collection and bulb salvage as mitigation techniques for this species. Based on comments provided by the BLM, the BLM may require additional mitigation measures for the Cox's mariposa lily as part of their review of the ROW application.

Umpqua Mariposa Lily (Federal Species of Concern, State Endangered Species)

The Umpqua mariposa lily (*Calochortus umpquaensis*) is known to occur within 17 localities; none of which are protected. This plant grows in both forests and meadows on serpentine soils at elevations below 2,500 feet, but it is the most vigorous in margins between forests and meadows. In southwestern Oregon, it is associated with a diverse array of plants, and it is found in diverse soils, aspects, and slopes.

[141] Appendix J to Pacific Connector's POD filed with the FERC in January 2018.

Several large populations of this plant (5,000 to 60,000-plus) have previously been documented approximately 1.3 and 2.5 miles east of the pipeline alignment near MP 99.55, adjacent to the Green Butte (EAR 102.30) and Callahan Creek (EAR 104.24) access roads. Pacific Connector conducted botanical surveys for this species between 2007 and 2017 in potential habitat within the vicinity[142] of the pipeline in lands administered by the Roseburg BLM District and Umpqua National Forest. In 2016, seven plants were observed adjacent to EAR 102.3 and 25 feet east of the Hatchet Quarry MP 102.3 Rock Source/Disposal Site near a previously (1992) documented population. Additionally, potential suitable habitat would also be crossed by the pipeline near the site where Cox's mariposa-lily was documented (MPs 74.08 to 75.02), although no individuals of Umpqua mariposa lily were observed during surveys conducted for the pipeline in this location.

Although, Umpqua mariposa lily individuals have been documented adjacent to EARs 102.30 and 104.24, no road improvements are necessary. Additionally, plants are separated from the access roads by topography and/or Callahan Creek; therefore, it is not expected that use of the existing access roads would directly or indirectly affect these populations. The population along EAR 102.30 and 25 feet east of the Hatchet Quarry MP 102.3 Rock Source/Disposal Site may be indirectly affected by the Pacific Connector Project; however, construction of the Project should not directly affect individual plants. Additionally, Pacific Connector has committed to protecting plants adjacent to the pipeline construction ROW through the appropriate installation of safety and silt fence as determined by Pacific Connector's EIs.

Dwarf Woolly Meadowfoam (Federal Species of Concern, State Threatened Species)

Dwarf woolly meadowfoam's (*Limnanthes pumila* ssp. *pumila*) range is restricted to two small protected areas, totaling about 2 square miles with at least 10,000 individuals (ORBIC 2010). Dwarf woolly meadowfoam inhabits small depressions in thin clay soil overlying old basalt at the edges of deep vernal pools, which are dry by mid-summer and generally exposed to full sunlight. The only known occurrences are on Table Rock in Jackson County (on Lower and Upper Table Rocks); which is over 12 miles southwest of the Pacific Connector pipeline and 1.4 to 2.4 miles north of four proposed Jackson County pipe storage yards (ORBIC 2006a).

Because the dwarf woolly meadowfoam is endemic to vernal pools at Table Rocks, Pacific Connector did not conduct botanical surveys for this species. Additionally, this species was not documented incidentally during survey efforts for other vernal pool–associated species conducted for the Project. As this species is not expected to occur along the pipeline route, it would probably not be directly affected by construction and operation of the Project.

Silvery Phacelia (Federal Species of Concern, State Threatened Species)

The silvery phacelia (*Phacelia argentea*) is known from 24 occurrences, totaling 15,000 individuals, along the coastline of Coos and Curry Counties and in adjacent northern California, Del Norte County (ORBIC 2010). In March 2015, a petition was submitted to the FWS to list the silvery phacelia as a threatened or endangered species (FWS 2015a); however, the petition was denied in 2015 due to lack of substantial information that this species was a listable entity (FWS 2015b). Silvery phacelia is the only phacelia growing along the coastline in open sand or on dunes

[142] Provided in Pacific Connector's Initial Response to the FERC staff's Environmental Information Request dated January 3, 2018, filed with the FERC on January 23, 2018.

along the south coast of Oregon. It inhabits sandy beach dunes and bluffs near the coast, and some partially-stabilized or unstabilized dunes.

Silvery phacelia has not been documented in the vicinity of the Project and the closest known plants are located more than 10 miles south of the entrance to the Coos Bay Estuary (ORBIC 2017a); however, suitable habitat for this species does exist at the LNG terminal area, in regions of active and semi-active dunes where the European beachgrass and the red fescue-salt rush herbaceous vegetation associations occur (see section 4.4 of this EIS). There is marginal habitat at the APCO Site and the meteorological station, although the European beachgrass in these areas is generally too dense to support this species. Surveys conducted by Jordan Cove have not detected this species (SHN 2006b, 2012) and, due to the lack of suitable habitat, botanical surveys for this species were not conducted along the pipeline route. Based on the lack of occurrences (from both historical data as well as surveys), it is not expected that the Project would affect this species.

Wolf's Evening Primrose (No ESA Status, State Threatened Species)

Wolf's evening primrose (*Oenothera wolfii*) occurs in well-drained sandy soils with adequate moisture in coastal bluff scrub, coastal prairie, roadsides, and coastal dune habitats from Curry County in southern Oregon to the northern California coast (Tibor 2001). This species is associated with a high disturbance regime and several occurrences in California are located along roadsides with sandy soil (CNDDB 2005 as cited in FERC 2015). Wolf's evening primrose is typically associated with low elevation coastal habitats, but there have been reported occurrences in lower montane coniferous forest in California, at elevations greater than 2,500 feet (Tibor 2001).

The closest known occurrence of Wolf's evening primrose to the Project is in Port Orford, Oregon, approximately 60 miles to the south of the Jordan Cove LNG terminal site; however, suitable habitat for this species is present at the LNG terminal site. There is marginal habitat at the APCO Site and the meteorological station, although the European beachgrass in these areas is generally too dense to support this species. Surveys conducted at the LNG terminal site did not detect the Wolf's evening primrose (SHN 2006b, 2012). Considering the lack of occurrences (based on historic and recent survey data), it is not expected that the Project would affect this species.

4.6.3 Other Special Status Species

In addition to the federal and state threatened, endangered, and proposed species described above, there are species that have been given special status designations by federal or state agencies and Indian tribes that could potentially occur in the Project area (see tables I-3, I-4, and I-5 in appendix I). The FWS and NMFS maintain a list of federal species of concern, which are species whose conservation standing is of concern but for which status information is still needed. The ODFW also assigns special status to fish and wildlife species that are not listed. State special status designations include sensitive and sensitive-critical (ORBIC 2016). Sensitive refers to fish and wildlife that are facing one or more threats to their populations and/or habitats. Species or taxa with a sensitive-critical subdesignation are sensitive species of particular conservation concern. Sensitive-critical species have current or legacy threats that are impacting their abundance, distribution, diversity, and/or habitat. They may decline to the point of qualifying for threatened or endangered status if conservation actions are not taken.

In addition to the threatened and endangered plant species described above, ODA designates candidate species for listing. ODA candidate species include any plant species designated for study by the director of ODA whose numbers are believed low or declining, or whose habitat is sufficiently threatened and declining in quantity and quality, so as to potentially qualify for listing as a threatened or endangered species in the foreseeable future (ODA 2017d).

4.6.3.1 U.S. Fish and Wildlife Service and National Marine Fisheries Service

The FWS (2006d, 2006e, 2013h, 2017c) and NMFS (2006) list 69 fish and wildlife species of concern that potentially occur in counties coinciding with the Project. The list of federal species of concern includes 14 mammals, 20 birds, 3 reptiles, 10 amphibians, 10 fish, and 12 invertebrates. These species, and expected habitat for each species, are listed in tables I-3 and I-4 in appendix I of this EIS. The FWS has noted that the Umpqua chub may be present in the Umpqua River, and this species is of concern because it has rapidly decreased in abundance. This species is discussed in detail in the BE (see appendix F.7 of this EIS).

The FWS lists one plant species as a federal candidate for listing, and 52 federal plant species of concern that potentially occur in counties coinciding with the Project. These species are listed in table I-5 in appendix I of this EIS, along with expected habitat for each species.

4.6.3.2 Oregon Department of Fish and Wildlife

The ODFW (2016) identified 71 state sensitive species that potentially occur in counties coinciding with the Project area, some of which (i.e., 37) are also considered federal species of concern. This list includes 15 mammals, 28 birds, 13 fish, 2 reptiles, and 13 amphibians. The ODFW does not assign special status for invertebrates. Tables I-3 and I-4 in appendix I provide the following information for each state special status species: expected habitat and documentation within each county, BLM district, and National Forest crossed by the Pacific Connector pipeline and vicinity.

Although the state sensitive species listed in tables I-3 and I-4 may occur in counties noted by FWS (2006d, 2006e) and ODFW (ORBIC 2006a, 2012), distributions and/or habitat associations of some preclude their potential occurrence in the area that would be affected by the Project.

4.6.3.3 Oregon Department of Agriculture

The ODA identified 41 candidates for listing that potentially occur in counties coinciding with the Project area, 26 of which are also federal species of concern. Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species as a result of the Project are presented in table I-5 in appendix I.

4.6.3.4 Tribal Species of Concern

The CIT identified the following plant and animal species as species of concern. According to the CIT, this list is not comprehensive, but does represent the most significant and important traditional cultural plant and animal species that are found on the Coquille Forest and other Tribal lands. A more complete list and description of plant usage can be found in "Ethnobotany of the Coquille Indians". Significant and important plants include, but are not limited to:

- Trees (bark and wood): Port Orford cedar, western red cedar, Sitka spruce, big leaf maple, myrtle, red alder, madrone, Pacific yew.

- Shrubs (wood, nuts and berries): elderberry (*Sambucus* spp.), willows, hazel, vine maple, rhododendron, azalea (*Rhododendron* spp.), manzanita, ocean spray, Labrador tea (*Ledum* spp.), huckleberry, salal, thimbleberry, salmonberry, Oregon grape.
- Flowers and vines (roots and fiber): yarrow (*Achillea millefolium*), camas (*Camassia*), tiger lily (*Lilium columbianum*), columbine (*Aquilegia* spp.), various *Lomatium* and *Brodiaeas*, iris (*Iris* spp.), trailing blackberry (*Rubus ursinus*), yerba buena (*Clinopodium douglasii*), beargrass (*Xerophyllum tenax*).
- Wet Meadow/Riparian Plants: cattail, tule (*Schoenoplectus* spp.), various sedges and ferns, skunk cabbage, various mosses.
- Marine/Estuary: eelgrass, giant kelp (*Macrocystis* spp.), bull kelp (*Nereocystis luetkeana*), sea lettuce (*Ulva* spp.), surfgrass (*Phyllospadix* spp.).

Impacts on these species would be similar to the impacts on vegetation described in section 4.4. Project effects on the wetland and estuary species of traditional-cultural importance would be as described for wetlands and waters in section 4.3. Species that are protected by federal and/or state jurisdictions (e.g., various sedges) are also addressed elsewhere in this section and in appendix I.5.

The following list of mammals, bird, and fish is also not comprehensive, but does represent many of the CIT's species of concern:

- Terrestrial: deer, elk, coyote, cougar, bear, bobcat, raccoon, beaver, squirrel.
- Marine/ Estuary: lamprey, salmon (all available species), shellfish, crab, sea mammals, rockfish, lingcod, sculpin, halibut, flounder, perch, herring, greenling, candlefish (i.e., eulachon), snails, mussels, barnacles, chiton, sea urchin, abalone (*Haliotis spp*.), dentalium (*Dentalium spp*.) (other seasonally available estuary species).
- Streams: salmon (all available species), lamprey, sturgeon, trout, mussels.
- Birds: Eagles, hawks, owls, cormorant, kingfisher, herons, osprey, flicker (*Colaptes auratus*), woodpeckers (particularly pileated), grebe, crows and ravens, and colorful neo-tropicals.

Impacts on these species would be similar to the impacts on wildlife and aquatic resources described in section 4.5. Species that are protected by federal and/or state jurisdictions (e.g., owls) are also addressed elsewhere in this section and in appendix I.3.

4.6.3.5 Assessment of Other Special Status Species

Of the other special status species identified above as potentially occuring in counties coinciding with the Project, only a subset have the potential to be affected by the Project. Table 4.6.3.5-1 identifies the number of these other special status mammals, birds, fish, amphibians, reptiles, invertebrates, and vascular plants potentially affected by the Project. For species that are also BLM and Forest Service sensitive species or the Forest Service's Survey and Manage species, occurrence and potential effects on federal lands are also described below in section 4.6.4, Environmental Consequences on Federal Lands.

TABLE 4.6.3.5-1

Numbers of Other Special Status Species Potentially Affected by the Project a/

Taxonomic Group	Federal Status: FWS or NMFS Species of Concern	State Status: ODFW Sensitive or ODA Candidate	Total b/
Mammals	12	12	16
Birds	19	24	31
Non-anadromous Fish	4	4	5
Anadromous Fish	3	5	7
Amphibians and Reptiles	7	9	9
Aquatic Invertebrates	3	N/A	3
Terrestrial Invertebrates	1	N/A	1
Vascular Plants	2	2	2

Sources: FWS (2006d, 2006e, 2017c), NMFS (2006d), ORBIC (2006a, 2006b, 2017a), ODFW 2016b.

a/ Other Special Status Species include FWS and NMFS fish, wildlife, and plant species of concern and candidate species, ODFW Sensitive fish and wildlife species, and ODA candidate species for listing. Forest Service sensitive and Survey and Manage species and BLM sensitive species are only tallied here if they meet this criteria for Other Special Status Species. Species are not tallied here if they are also federal or state listed or proposed.

b/ Rows do not sum because a species is tallied in multiple columns where it is considered special status by multiple agencies.

Descriptions of expected habitat, documented or suspected occurrences, and potential Project effects on these other special status species within the Project area are presented in tables I-3, I-4, and I-5, respectively, in appendix I. Additionally, effects on these species and proposed measures to minimize effects would be similar to the those described for general fish and wildlife in section 4.5 of this EIS.

4.6.4 Environmental Consequences on Federal Lands

The BLM and Forest Service maintain lists of sensitive species to ensure that their actions do not contribute to or cause a trend toward listing under the ESA. Additionally, until 2016, the BLM and Forest Service maintained a list of Survey and Manage species, or species that are rare and uncommon or poorly understood that are closely associated with late successional or old-growth forests within the range of the NSO (Forest Service and BLM 2001a). In August 2016, the BLM issued two RODs for two new RMPs (BLM 2016a and 2016b). These two plans supersede the NWFP on BLM lands, and eliminated requirements to survey and manage for species included on the 2001 ROD Survey and Manage species list on BLM lands. Potential effects on Survey and Manage species on NFS lands are discussed here.

Species that are on both the sensitive list and the Survey and Manage list are discussed on NFS land under section 4.6.4.3, Survey and Manage Species. Additionally, although the Forest Service and BLM include federal and state threatened, endangered, proposed, and candidate species on their species lists, these species are not discussed in this section as they are presented above.

4.6.4.1 Description of BLM and Forest Service Sensitive Species

The BLM maintains a list of Special Status Species (including BLM sensitive species) as required by BLM 6840, Special Status Species Manual, to ensure that BLM actions do not contribute to a loss of viability or cause a trend toward listing under the ESA. Like the BLM, the Forest Service is required by Forest Service Manual (FSM) 2760 to maintain a list of sensitive species for each region, including species listed as federally threatened, endangered, or proposed under the ESA, as well as species that are threatened by human activities. Activities on NFS lands must be managed to ensure that current federally listed species do not become extirpated or that activities do not result in ESA listing for other sensitive species. As required in FSM 2760, the Forest Service is obligated to evaluate Project effects on sensitive species in a BE (see appendix F.7).

The Pacific Northwest Regional Office of the Forest Service and Oregon/Washington State Office of the BLM established an interagency program for the conservation and management of special status species. New criteria for BLM Special Status Species and Forest Service Sensitive Species were jointly approved in 2015 by the Region 6 Regional Forester and BLM Oregon/Washington State Director for determination of species included within the BLM and Forest Service Sensitive Species Program. The new criteria were designed to make the BLM and Forest Service more consistent in their approaches to the development of lists of species with conservation concerns. The BLM (2015) and Forest Service (Forest Service 2015) identify federally listed, federally proposed, and sensitive species required under their respective policies. Additionally, they have identified "strategic species" that are not considered sensitive under those policies. Strategic species include species with information gaps (e.g., distribution, habitat, threats, taxonomy) that are suspected to occur on NFS or BLM lands.

According to Instruction Memorandum No. OR-2015-028, sensitive species are those that are documented or suspected endangered or threatened at the federal or state level, federal de-listed species, are Oregon Heritage List 1 or List 2, and have been documented on at least one Oregon BLM district. These species should be managed to ensure that activities on BLM lands do not contribute to their listing.

Strategic species are not classified as Special Status for management purposes. The only requirement for this group of species is to record sites found during any survey efforts. Therefore, strategic species are not discussed in this section unless observed during surveys.

Table 4.6.4.1-1 lists the BLM and Forest Service sensitive species documented or suspected to occur within the districts and forests crossed by the Pacific Connector pipeline (BLM 2015; Forest Service 2015).

Not all species documented or suspected in BLM districts and national forests crossed by the Project occur within the area affected by the Project. Many were excluded from consideration after review of range and habitat information. Other species were excluded if they were not known to occur in the Project vicinity based on special status species locations within 3 miles of the Project obtained from the BLM Geographic Biotic Observations (GeoBOB) database and Forest Service Natural Resource Information System (NRIS) database (BLM 2006a, 2012, 2017a; Forest Service 2006, 2012, 2017c; NSR 2012), and through ORBIC data requests (ORBIC 2006a, 2012, 2017a).

TABLE 4.6.4.1-1

Numbers of BLM and Forest Service Sensitive Species within the Four BLM Districts and Three National Forests Crossed by the Proposed Pacific Connector Pipeline a/

	Number in BLM Districts				Number in National Forests		
Taxonomic Group	**Coos Bay**	**Roseburg**	**Medford**	**Lakeview**	**Umpqua**	**Rogue River-Siskiyou**	**Fremont-Winema**
Mammals	4	5	4	6	5	6	5
Birds	8	7	9	13	11	9	12
Reptiles	1	1	1	1	1	1	1
Amphibians	1	1	3	2	1	3	2
Non-anadromous Fish	1	1	2	10	2	0	10
Anadromous Fish	5	3	4	0	3	4	0
Invertebrates	14	10	16	7	14	21	21
Fungi	13	12	14	0	11	16	4
Non-vascular Plants	34	17	18	5	26	27	12
Vascular Plants	35	36	91	44	31	99	49

Note: A species is tallied in multiple columns where it occurs and is sensitive on multiple BLM Districts or National Forests.
a/ Source: BLM 2015; Forest Service 2015

Pacific Connector conducted surveys from 2007 through 2018 for special status species, including BLM and Forest Service sensitive species. Special status mollusks, fungi, and vascular and non-vascular plants not detected during these complete, targeted surveys were determined to not be present, and thus not affected by the Project. Forest Service and BLM sensitive species that are documented or suspected to occur on BLM districts and/or national forests crossed by the Project, but were dropped from further consideration due to a lack of habitat or because they were not detected during targeted field surveys are listed in tables I-3, I-4, and I-5 in appendix I. Information provided for each of these species in appendix I includes expected habitat, county, national forest, and BLM district distribution, known occurrences in relation to the Project, and effects determination and rationale for this determination.

BLM and Forest Service sensitive species that may be affected by the Project are listed below in table 4.6.4.1-2, excluding the state and federally listed, proposed, and candidate species discussed above, and the Survey and Manage species on NFS land discussed below. Where suitable habitat was documented for a species, but species-specific surveys were not conducted, presence was assumed, and potential effects on these species are discussed here.

TABLE 4.6.4.1-2

BLM and Forest Service Sensitive Species with the Potential to be Affected by the Project a/

Common Name	Scientific Name	Forest Service Sensitive	BLM Sensitive
Mammals			
Pallid bat	*Antrozous pallidus*	X	X
Townsend's big-eared bat	*Corynorhinus townsendii*	X	X
Fringed myotis	*Myotis thysanodes*	X	X
Pacific marten	*Martes caurina*	X	X
Pacific fisher	*Pekania pennanti*	X	X
Birds			
Grasshopper sparrow	*Ammodramus savannarum*	X	
Red-necked grebe	*Podiceps grisegena*	X	X
Horned grebe	*Podiceps auritus*	X	X
American white pelican	*Pelecanus erythrorhynchos*	X	X
Snowy egret	*Egretta thula*		X
Aleutian Canada goose	*Branta canadadnsis leucopareia*		X
Harlequin duck	*Histrionicus histrionicus*	X	X

TABLE 4.6.4.1-2 (continued)

BLM and Forest Service Sensitive Species with the Potential to be Affected by the Project a/

Common Name	Scientific Name	Forest Service Sensitive	BLM Sensitive
Bufflehead	*Bucephala albeola*	X	
Franklin's gull	*Larus pipixcan*		X
White-tailed kite	*Elanus leucurus*	X	X
Upland sandpiper	*Bartramia longicauda*	X	
Bald eagle	*Haliaeetus leucocephalus*	X	X
American peregrine falcon	*Falco peregrinus anatum*	X	X
Greater sage-grouse	*Centrocercus urophasianus*	X	X
White-headed woodpecker	*Picoides albolarvatus*	X	X
Lewis' woodpecker	*Melanerpes lewis*	X	X
Purple martin	*Progne subis*	X	X
Oregon vesper sparrow	*Pooecetes gramineus affinis*		X
Tricolored blackbird	*Agelaius tricolor*	X	X
Reptiles			
Western pond turtle (formerly Pacific pond turtle)	*Actinemys marmorata*	X	X
Amphibians			
Foothill yellow-legged frog	*Rana boylii*	X	X
Terrestrial Invertebrates			
Oregon shoulderband	*Helminthoglypta hertleini*	X (also Survey and Manage)	X
Traveling sideband	*Monadenia fidelis celeuthia*	X	X
Siskiyou hesperian	*Vespericola sierranas*	X	X
Franklin's bumblebee	*Bombus franklini*	X	X
Western bumblebee	*Bombus occidentalis*	X	X
Siskiyou short-horned grasshopper	*Chloealtis aspasma*	X	X
Gray-blue butterfly	*Plebejus podarce*	X	X
Johnson's hairstreak	*Callophrys johnsoni (Mitoura johnsoni)*	X	X
Insular blue butterfly	*Plebejus saepiolus littoralis*	X	X
Mardon skipper	*Polites mardon*	X	X
Coronis fritillary	*Speyeria coronis coronis*	X	X
Aquatic Invertebrates			
Western ridgemussel	*Gonidea angulata*	X	X
California floater	*Anodonta californiensis*	X	X
A caddisfly (no common name)	*Namamyia plutonis*	X	X
Montane Peaclam	*Pisidium ulttramontanum*	X	X
Pacific walker	*Pomatiopsis californica*	X	X
Archimedes springsnail	*Pyrgulopsis archimedis*	X	
A caddisfly (no common name)	*Rhyacophila chandleri*	X	X
Lined ramshorn	*Vorticifex effusa diagonalis*	X	X
caddisfly (no common name)	*Rhyacophila leechi*		X
Non-anadramous Fish			
Umpqua chub	*Oregonichthys kalawatseti*	X	X
Millicoma dace	*Rhinichthys catarctae* ssp.		X
Anadramous Fish			
Pacific lamprey	*Entosphenus tridentata*	X	X
Chinook Salmon Southern Oregon Coast/California Coast ESU, Fall-run, Spring-run	*Oncorhynchus tshawytscha*	X	X
Steelhead Klamath Mountains Province ESU Summer/winter run	*Oncorynchus mykiss*	X	X
Steelhead Oregon Coast ESU	*Oncorynchus mykiss*	X	X

TABLE 4.6.4.1-2 (continued)

BLM and Forest Service Sensitive Species with the Potential to be Affected by the Project a/

Common Name	Scientific Name	Forest Service Sensitive	BLM Sensitive
Vascular Plants			
Rogue Canyon rockcress	*Arabis modesta*	X	X
Bensonia	*Bensoniella oregana*	X	X
Bristly sedge	*Carex comosa*	X	X
Coastal lip-fern	*Cheilanthes intertexta*	X	X
Pine woods cryptantha	*Cryptantha simulans*	X	
California globe-mallow	*Iliamna latibracteata*	X	X
Bellinger's meadowfoam	*Limnanthes floccosa* ssp. *bellingeriana*	X	X
Lichens			
no common name	*Bryoria subcana*	X	X

a/ Excluding state and federally listed, and select proposed and candidate species and Survey and Manage species, which are discussed in other sections of this EIS.

Excluding federal and state threatened, endangered, and select proposedand candidate species (discussed above), and Survey and Manage species on NFS lands (discussed below), a total of 60 BLM and Forest Service sensitive species have the potential to be affected by the Project: 5 mammal, 19 bird, 1 reptile, 1 amphibians, 20 invertebrate, 6 fish, 7 vascular plant, and 1 lichen species(table 4.6.4.1-2). Tables I-3, I-4, and I-5 in appendix I provide habitat descriptions for these species. Forest Service sensitive species that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7), and Survey and Manage species that would potentially be affected by the proposed action on NFS lands are addressed in more detail in the Survey and Manage Report (appendix F.5 of this EIS).

4.6.4.2 Assessment of BLM and Forest Service Sensitive Species

BLM and Forest Service sensitive species that may be present and potentially affected by construction of the pipeline on federal lands are described here. If species were documented during targeted surveys, those locations and potential effects are also described.

Mammals

There are five BLM and Forest Service sensitive mammals that may be present and potentially affected by construction of the pipeline on federal land: the pallid bat (*Antrozous pallidus pacificus*), Townsend's big-eared bat (*Corynorhinus townsendii*), fringed myotis (*Myotis thysanodes*), marten (*Martes caurina*), and fisher (*Pekania pennanti*). Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species within the Project area are presented in table I-3 in appendix I. As all five of these species are Forest Service sensitive, they are additionally addressed in the BE if effects are anticipated on NFS lands (appendix F.7). Marten and fisher are also discussed above as federal proposed threatened species.

Birds

There are 19 BLM and/or Forest Service sensitive birds that may be present and potentially affected by construction, maintenance, and operation of the pipeline on federal land. Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species as a result of the Project are presented in table I-3 in appendix

I. Forest Service sensitive birds that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7).

Fish

There are six BLM and/or Forest Service sensitive fish species that may be present along the LNG carrier transit route, in the waters of Coos Bay potentially affected by construction of the pipeline, or in waters crossed by the pipeline. Of these species, four are anadromous and two are non-anadromous. Descriptions of life histories, expected habitat, and potential occurrences of these special status fish species within the Project area are presented in table I-4 in appendix I. Forest Service sensitive fish that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7).

Amphibians and Reptiles

There are two BLM and Forest Service sensitive amphibians and reptiles that may be present and potentially affected by construction of the pipeline on federal land: western pond turtle (*Actinemys marmorata*) and foothill yellow-legged frog (*Rana boylii*). Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species within the Project area are presented in table I-3 in appendix I. As both species are Forest Service sensitive, they are additionally addressed in the BE (appendix F.7).

Invertebrates

Aquatic

There are nine BLM and Forest Service sensitive aquatic invertebrates that may be present and potentially affected by construction of the pipeline on federal land. All these species are associated with freshwater environments. Table I-4 in appendix I summarizes the life history, habitat associations, and occurrence of these invertebrates. Eight of these species are Forest Service sensitive aquatic invertebrates, and thus are additionally addressed in the BE if effects are anticipated on NFS lands (appendix F.7).

Terrestrial

There are 11 BLM and Forest Service sensitive terrestrial invertebrates that may be present and potentially affected by the construction of the pipeline on federal land. Descriptions of expected habitat, documented or suspected occurrences, and a description of potential Project effects on these special status species within the Project area are presented in table I-3 in appendix I. As all 11 species are Forest Service sensitive terrestrial invertebrates they are additionally addressed in the BE (appendix F.7).

Approximately 20 acres of the ROW near known populations of two Forest Service sensitive terrestrial invertebrates (Mardon skipper and short-horned grasshopper) on the Dead Indian Plateau would be restored with grasses (including *Festuca* sp.) preferred by these species in addition to the rehabilitation required under BMP guidelines. This mitigation on the Rogue River National Forest has the potential to increase the habitat and local range for these two species.

Three BLM and Forest Service sensitive mollusk species were located during surveys for the Project: Siskiyou hesperian, traveling sideband, and Oregon shoulderband. These three species are discussed in the following paragraphs; Siskiyou hesperian and traveling sideband are additionally addressed in the BE as they were observed on NFS lands during surveys (appendix F.7).

Field Survey Locations and Potential Effects

Traveling sideband is a BLM and Forest Service sensitive species (BLM 2015; Forest Service 2015) and an Oregon endemic terrestrial snail. During surveys in 2007 and 2010, this species was observed at nine locations on the Rogue River and Winema National Forests (between MP 154.9 and 175.4), and at six locations on BLM land in the Lakeview and Medford BLM Districts (MPs 116.3 to 176.9). Shells and live individuals were located within and outside the ROW, as well as within proposed TEWAs and UCSAs (SBS 2008a, 2011b). During surveys in 2012 and 2015, this species was observed at five locations on the Rogue River and Umpqua National Forests (between MP 104.9 and 162.5) and four locations on BLM land in the Roseburg and Medford BLM Districts (MPs 91.7 to 116.9), adjacent to the ROW and TEWAs.[143]. Direct mortality could occur to this species if they are within the ROW during Project clearing or construction due to their low mobility. Clearing of the ROW could affect habitat by removing forest overstory, potentially making the area unsuitable for this species. Indirect effects could result from the alteration of composition and structure of vegetation resulting in changes in microclimate. Realignments following the 2007 and 2010 surveys resulted in avoidance of some but not all the sites observed during Project surveys. As currently proposed, Pacific Connector would directly affect 5 of the 14 sites observed during Project surveys on NFS lands, and 4 of the 10 sites observed during Project surveys on BLM-managed lands. Indirect effects are expected to the traveling sideband sites observed even if direct effects on these sites are avoided because 5 and 4 of the sites are within approximately 100 feet of Project disturbance on NFS lands and BLM-managed lands, respectively, and thus would be affected by changes in microclimate conditions.

Siskiyou hesperian is a BLM and Forest Service Sensitive species (BLM 2015; Forest Service 2015) and a riparian associated terrestrial snail. During Project surveys in 2007, 2008, and 2010, this species was observed at 14 locations on the Rogue River and Umpqua National Forests (between MPs 110.2 and 164.7), and 10 locations in the Medford and Roseburg BLM Districts (MPs 79.8 to 151.5). In 2011, 2012, and 2014, this species was observed at nine locations within the Rogue River and Winema National Forests (between MPs 154.5 and 168.9), and two locations in the Medford BLM District (MP 148.7 and 153.5). Shells and live individuals were observed within and outside the ROW, as well as proposed TEWAs and UCSAs (SBS 2008, 2011b; April 27, 2015 response to FERC data request). During surveys in 2015, this species was observed at eight locations on the Rogue River National Forest (between MP 155.7 and 160.6) and one location on BLM land in the Medford BLM District (MP 128.8), within and adjacent to the ROW and TEWAs.[144] During surveys in 2017, active individuals were observed at one location on the Rogue River National Forest (MP 154.6; Tona 2018). Direct mortality to individuals could occur if they are located within the ROW during Project clearing or construction. Another potential direct effect is destruction or alteration of hydrology of riparian, wetland, or aquatic habitats used by this species. Indirect effects could result from the alteration of composition and structure of vegetation resulting in changes in microclimate. The increase in sun exposure could reduce moisture levels

[143] See Table D.3-10 in Pacific Connector's Resource Report 3, included as part of their September 2017 filing with the FERC.

[144] See Table D.3-10 in Pacific Connector's Resource Report 3, included as part of their September 2017 filing with the FERC.

and potential decrease dispersal between populations or suitable habitat. As currently proposed, Pacific Connector would directly affect 11 of the 31 sites observed during Project surveys on NFS lands, and 6 of the 13 sites observed during Project surveys on BLM-managed lands. Indirect effects are expected to the Siskiyou hesperian sites observed even if direct effects on these sites are avoided as 16 and 5 of the sites on NFS lands and BLM-managed lands, respectively, are within approximately 100 feet of Project disturbance, and thus would be affected by changes in microclimate conditions.

Oregon shoulderband is a BLM and Forest Service sensitive species (BLM 2015; Forest Service 2015) and a terrestrial snail endemic to northern California and southwest Oregon. This species is also managed as a Survey and Manage species on NFS lands; however, it was not observed on NFS lands during surveys for the Project. During Project surveys in 2007, this species was observed at five locations in the Roseburg BLM District (MPs 64.6 to 76.0). Shells and live individuals were observed within and outside the ROW (SBS 2008a). Direct mortality to individuals could occur if they are located within the ROW during Project clearing or construction. Clearing of the ROW could affect habitat by removing forest overstory, potentially making the area unsuitable for this species. Indirect effects could result from the alteration of composition and structure of vegetation resulting in changes in microclimate. The increase in sun exposure could reduce moisture levels and potential decrease dispersal between populations or suitable habitat. As currently proposed, Pacific Connector would directly affect two of the five sites observed during Project surveys on BLM-managed lands. Indirect effects are expected to the Oregon shoulderband sites observed even if direct effects on these sites are avoided as two of the sites on BLM-managed lands are within approximately 100 feet of Project disturbance, and thus would be affected by changes in microclimate conditions.

Plants and Fungi

A total of 270 BLM and/or Forest Service sensitive bryophyte, lichen, fungus, and vascular plant species were identified as potentially occurring within the Project area (see table I-5 in appendix I). Between 2007 and 2018, SBS surveyed for special status fungi and vascular and non-vascular plant species in suitable habitat, where access was granted, within 50 feet (non-federal lands) or 100 feet (federal lands) of the ROW, TEWAs, UCSAs, and access roads (note that surveys continued through 2018). Plant and fungus species documented on federal lands during surveys are described below. Descriptions of expected habitat, documented or suspected occurrences, and potential Project effects on all species within the area affected by the Project are presented in table I-5 in appendix I. Forest Service sensitive plants and fungi that would potentially be affected by the proposed action are additionally addressed in the BE (appendix F.7).

Of the 41 BLM and/or Forest Service sensitive bryophytes identified as potentially occurring within the area affected by the Project, none were documented during surveys of the currently proposed route. Two strategic bryophyte species (*Andreaea nivalis* and *Orthotrichum euryphyllum*) were documented during surveys. See table I-5 in appendix I for a list of sensitive and strategic bryophyte species identified as potentially occurring within the area affected by the Project, descriptions of their expected habitat, and documented or suspected occurrences, including documented occurrences of the two strategic species observed during Project surveys.

Lichens

There are 16 BLM and/or Forest Service sensitive lichens identified as potentially occurring within the area affected by the Project. Potential Project effects on lichens include trampling or killing of individual plants. One BLM and Forest Service sensitive species, *Bryoria subcana*, was documented during surveys of the currently proposed route. This species is also an Survey and Manage species under the 2001 ROD list (Forest Service and BLM 2001a).

Bryoria subcana is a BLM and Forest Service Sensitive coastal lichen species and was observed during Project surveys in the BLM Coos Bay District, approximately 100 feet of the ROW near MP 21.88BR. The species was observed just east of the area affected by the Project and may be avoided by activities within the corridor; however, construction would disturb vegetation and soils within 200 feet of the site and could modify microclimate conditions around the observation. The removal of trees and woody debris could negatively affect *Bryoria subcana* in adjacent areas by removing its habitat and affecting its association with the trees, affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions within 200 feet of the observation as a result of the Project construction and operation would likely make habitat within the site no longer suitable for the species. Restored portions of the corridor and TEWAs would be dominated by early seral vegetation for approximately 30 years, which would result in long-term changes to habitat conditions. A portion of the corridor would be maintained in low-growing vegetation for pipeline maintenance and would not provide habitat for the species during the life of the Project. *Bryoria subcana* is not likely to persist at the site following Project implementation; however, remaining sites of this species would continue to provide a reasonable assurance of species persistence.

Five BLM and/or Forest Service strategic lichen species (*Collema curtisporum, Collema quadrifidum, Leptogium platynum, Peltula euploca,* and *Sclerophora amabilis*) were also observed during Project surveys. See table I-5 in appendix I for a list of sensitive and strategic lichen species identified as potentially occurring within the Project area, descriptions of their expected habitat, and documented or suspected occurrences, including documented occurrences of the one sensitive and five strategic lichen species observed during Project surveys.

Fungi

Of the 25 BLM and/or Forest Service sensitive fungi identified as potentially occurring within the Project area, none were documented during surveys. Thirteen Forest Service and BLM strategic fungi were observed during surveys. See table I-5 in appendix I for the locations of these observations in relation to the Project.

Vascular Plants

There are 188 BLM and/or Forest Service sensitive vascular plants identified as potentially occurring within the Project area, 10 of which were documented during Project surveys: Rogue Canyon rockcress (*Arabis modesta*), Bensonia (*Bensoniella oregana*), Cox's mariposa lily, Umpqua mariposa lily, bristly sedge (*Carex comosa*), coastal lip fern (*Cheilanthes intertexta*), pine woods cryptantha (*Cryptantha simulans*), clustered lady's slipper (*Cypripedium fasciculatum*), California globe-mallow (*Iliamna latibracteata*), and Bellinger's meadowfoam. Two of these species—Cox's mariposa lily and Umpqua mariposa lily—are also state-listed species and are discussed above in section 4.6.2.3. One of these species, clustered lady's slipper, is a Forest Service Survey and Manage species and is discussed below under section 4.6.4.3. Potential effects on Umpqua mariposa lily, pine woods cryptantha, California globe-mallow, and Bellinger's meadowfoam on NFS lands are additionally discussed in the BE (appendix F.7 of this EIS).

Field Survey Locations and Potential Effects

Rogue Canyon rockcress is a regional endemic found within chaparral and lower montane coniferous forests in northern California and southern Oregon (CNPS 2018). In Oregon, it is only known from Jackson and Josephine Counties (NRCS 2018). This species has been found on dry, serpentine soils on exposed slopes and rocky cliffs in the Rogue River canyon at elevations between 490 and 1,480 feet (NatureServe 2018). Two sites of Rogue Canyon rockcress were observed during Project surveys in 2017 on state forest lands 24 feet and 90 feet north/northwest of TEWA 124.30-N. This species was not observed on BLM or Forest Service land during Project surveys.

Bensonia is found mainly within the Siskiyou Mountains of southwestern Oregon in Curry and Josephine Counties, with a few small disjunct populations in adjacent Humboldt County, California (NatureServe 2018). The rhizomatous species grows in wet meadows and edges near bogs and springs. Populations seem to be associated with cloud or fog banks that blanket the mountain tops at certain times of year. Most plants are in meadows on gentle slopes, and they thrive on partial shade. The species has been found at elevations between 2,000 to 4,750 feet (Hoover and Holmes 1998). One bensonia site was noted near the Project in 2011 in the Roseburg BLM District, approximately 100 feet east of the existing Signal Tree Road Quarry at MP 47. Pacific Connector surveyed this area in 2013 and no special status species were observed, including bensonia. Due to the distance between this site and the Project, no effects are anticipated.

Bristly sedge is found from Quebec to Minnesota and south, as well as in the Pacific Northwest and Montana (NatureServe 2018). This species habitat includes marshes, lakeshores, and wet meadows. In Oregon, this species is known from Columbia, Klamath, and Multnomah Counties; although it is believed to be extirpated or possibly extirpated in Columbia and Multnomah Counties (NatureServe 2018). One population of bristly sedge was documented in 2012 on private land 66 feet south of TEWA 184.30. This species was not observed on BLM or Forest Service land during Project surveys.

Coastal lip fern grows in crevices and bases of rocks and is found mainly in California, although it also occurs in Oregon and Nevada (The Jepson Herbarium 2018). In Oregon, this species is known from Douglas and Jackson counties (NRCS 2018). Two observations of coastal lip fern site were noted near the Project in the Medford BLM District. One observation is located approximately 65 feet west of the pipeline ROW near MP 148.9 and the other observation is greater than 100 feet from the pipeline ROW near MP 149.9. Due to the distance between these sites and the Project, direct effects are not anticipated; however, the Project could potentially indirectly affect individuals and/or habitat of this species.

Pine woods cryptantha is found in dry gravelly sites, disturbed areas, and open conifer forests from elevations between 820 and 8,530 feet (The Jepson Herbarium 2018). This species' range includes California north to Washington and east to Idaho (NRCS 2018). Five observations of pine woods cryptantha were documented during Project surveys in 2017. One site was located in the Rogue River-Siskiyou National Forest approximately 96 feet northwest of MP 155.8. One site was located on the Fremont-Winema National Forest pm the edge of Clover Creek Road and 10 feet from the pipeline ROW near MP 175.3, and two sites were located in the Lakeview BLM District:

1) within the ROW near MP 176.96 and 2) on the edge of Clover Creek Road near MP 176.98. Because this species was observed within the pipeline ROW, the Project may directly and indirectly affect individuals and habitat of this species.

California globe mallow is found in southwestern Oregon, extending into Humboldt County in northern California (Malaby 2005). This species inhabits moist forests, streamsides, lower montane coniferous forests, and montane chaparral; often in recently burned areas (Malaby 2005; CNPS 2018). In Oregon, California globe mallow is found in coastal ranges in Coos and Douglas counties and is also known from Curry, Jackson, Josephine, and Linn Counties. Three observations of California globe mallow were observed during Project surveys in 2017: one in the Roseburg BLM District and two in the Umpqua National Forest. The observation in the Roseburg BLM District was located within the pipeline ROW near MP 99.9, within the are burned during the Stouts Creek fire in 2015. The sites in the Umpqua National Forest are in the pipeline ROW near MP 106.2 and MP 106.7; both sites were in recently burned areas. Because this species was observed within the pipeline ROW, the Project may directly and indirectly affect individuals and habitat of this species.

Bellinger's meadowfoam (*Limnanthes floccosa* ssp. *bellingeriana*) is associated with vernally wet meadows or vernal pools and is generally found on basalt scablands at elevations between 1,000 and 4,000 feet in Jackson and Klamath Counties, Oregon, and Shasta County, California. Six Bellinger's meadowfoam populations were located in the Project area. Two populations were in the Rogue River-Siskiyou National Forest: within the pipeline ROW near MP 154.1 and within the pipeline ROW between MP 154.71 to 154.82. The other four populations were in the Medford BLM District: near MPs 120.3, MP 128.8, and MP 129.0, and TEWA 128.79-N. All these observations are located greater than 100 feet from the pipeline route, except for the observation in TEWA 128-79. Six hundred plants were observed in and near TEWA 128.79-N during Project surveys in 2017.

In 2010, 30,000 plants within less than one acre were documented between MPs 154.8 and 154.7, near Heppsie Mountain (SBS 2011a), also within the Rogue River National Forest. Potential effects on this site include removal of individuals, temporary disturbance, and permanent loss or alteration of habitat including changes in hydrology. The site is in a vernally moist scabland meadow within the ROW and a TEWA and therefore would be disturbed by the Project (SBS 2011a; Rolle 2014). Measures to avoid this site considered but excluded to avoid a rare fungus, *Gymnomyces abietis*, which was also found at the same location on the north end of the meadow at MP 154.8. *Gymnomyces abietis* is a Forest Service Survey and Manage species, discussed below in section 4.6.4.3. Although Project activities would affect the local population at MP 154.7, the species would not likely be eliminated from the site as it is able to grow on disturbed soil (Rolle 2014). Conservation measures at this site include recontouring, reseeding, and controlling for noxious weeds. Additionally, although the site that would be affected is one of only a few Bellinger's meadowfoam sites on NFS land, a large number of sites are known from BLM and private land in eastern Jackson County. More undocumented sites are likely to occur on unsurveyed private lands (Rolle 2014). Consequently, the expected loss of individuals and habitat at this site is not expected to affect the viability of Bellinger's meadowfoam over the broader geographic area of the low mountains and foothills of eastern Jackson County (Rolle 2014).

4.6.4.3 Survey and Manage Species

The BLM and Forest Service first identified Survey and Manage species in 1994 as rare amphibians, mammals, bryophytes, mollusks, vascular plants, fungi, lichens, and arthropods that occupy LSOG forests in the range of the NSO (see Forest Service and BLM 1994a, the NWFP ROD). The agencies established standards and guidelines for management of these rare species in the *Standards and Guidelines for Management for Late-Successional and Old-Growth Related Species in the Range of the Northern Spotted Owl* (Forest Service and BLM 1994b). The NWFP ROD established overall objectives for managing Survey and Manage species populations that were referred to as "persistence objectives." These objectives were based on the Forest Service viability provision in the 1982 National Forest System Land and Resource Management Planning Regulation for the National Forest Management Act of 1976.

In 2001, the Record of Decision and Standards and Guidelines for Amendments to the Survey and Manage, Protection Buffer, and other Mitigation Measures Standards and Guidelines (2001 ROD; Forest Service and BLM 2001a) modified the management direction provided in the NWFP ROD for Survey and Manage species and amended BLM and Forest Service land management plans in the range of the NSO accordingly. The management direction for Survey and Manage species varies based on its assigned category, which establishes varying levels of surveys and management of known sites (refer to the 2001 ROD and appendix F.5 to this EIS for additional details on the categories). For the Survey and Manage Standards and Guidelines, the major elements were retained with some restructuring for clarity, and the 1994 list of Survey and Manage species was modified to remove 72 species in all or part of their range because new information indicated they were secure or otherwise did not meet the basic criteria for Survey and Manage. Based on the history of the Survey and Manage rule, it should be noted that by definition, there is a general concern for persistence for any of the species listed in the 2001 ROD. That concern is the basic reason species are listed in the Survey and Manage Standards and Guidelines.

In 2004 and again in 2007, the BLM and Forest Service issued a ROD to eliminate the Survey and Manage requirements of the 2001 ROD and to provide protection for species on the Survey and Manage lists by managing them under the agencies' special-status species programs. In 2014, the Court issued a remedy order in the case of *Conservation Northwest et al. v. Bonnie et al.*, No 08-1067-JCC (W.D. Wash.)/No. 11-35729 (9th Circ.). As the latest step in the ongoing litigation challenging the 2007 ROD, this remedy order vacated the 2007 ROD to remove or modify the Survey and Manage mitigation measure standards and guidelines, which returned the agencies to the status quo in existence prior to the 2007 ROD. Thus, the 2001 ROD was reinstated, including any amendments or modifications to the 2001 ROD that were in effect as of March 21, 2004, returning the species to the category assigned in the 2001 ROD.

In accordance with the 2014 Court decision, this assessment was completed using the 2001 ROD Survey and Manage Standards and Guidelines, with the 2003 Annual Species Review (ASR) modifications for the species list and category assignments (excepting the 2003 ASR red tree vole removal).

In 2016, the BLM approved two new RMPs, including the Northwestern and Coastal Oregon RMP and the Southwestern Oregon RMP (BLM 2016a, 2016b). All lands managed by the BLM that occur in the Pacific Connector Project are within the revised RMPs' management areas. The past RMPs were developed consistent with the 1994 NWFP and thereby included Survey and Manage species measures. The 2016 RMPs revises the past RMPs in their entirety and removes all measures for Survey and Manage species, although Forest Service Survey and Manage species identified as BLM sensitive species would continue to receive protections consistent with BLM's sensitive species management program.

Although some species covered by the Survey and Manage Standards and Guidelines also occur on private land, land managed by the BLM, and areas outside the NSO range, the requirements of the 1994 NWFP and 2001 ROD apply only to lands managed by the Forest Service within the range of the NSO.

The NWFP ROD and the 2001 ROD do not prescribe a well-defined process for evaluating effects on species persistence or viability from a proposed activity. The 2001 ROD states "instead, common sense and agency expertise must be used in making determinations of compliance with the viability provision" (Standards and Guidelines). The Forest Service has embraced this approach for evaluating effects of the Project on the persistence of affected Survey and Manage species in the NSO range. The Standards and Guidelines and 2001 ROD are intended to "provide a reasonable assurance of species persistence" for all the Survey and Manage species. If the Project is constructed, it would affect numerous known sites of Survey and Manage species. This assessment seeks to determine, should the Project be constructed, whether there would be a reasonable assurance of species persistence for those Survey and Manage species affected by the Project in the NSO range. The evaluation of species persistence is presented in appendix F.5 to this EIS, and this section summarizes the results of the evaluation. Attachment A to appendix F.5 lists the Survey and Manage species considered in the persistence evaluation.

This section is organized by taxonomic group and includes a brief overview of the species considered in the persistence evaluation; a summary of the distribution of sites of the species in the NSO range; an analysis of the effects of the Project on the sites; and breakdowns of the number of sites of each species in the NSO range, the number of affected sites of each species across the analysis area, and the number of affected sites on the Umpqua, Rogue River-Siskiyou, and Fremont-Winema National Forests. Details on the methodology used for the persistence evaluation (e.g., establishment of sites for each species, mapping of general habitat and site distribution, analysis of effects on sites) and a glossary of key terms used in the evaluation available in appendix F.5. The factors used to evaluate the Project effects are outlined in appendix F.5 and were derived from the 2001 ROD criteria for species persistence and relative rarity. This persistence evaluation is not intended to serve as an annual species review or an evaluation of the relative rarity of the species. This analysis is focused only on the effects on the species that could result from implementation of the Project and is intended to provide sufficient information to support subsequent findings by the Forest Service.

This assessment provides a conservative site-specific analysis of effects on sites, which consist of the recorded observations of Survey and Manage species from agency geodatabases and a surrounding protection buffer, and generally assumes that site persistence would not be maintained following Project implementation if a site falls within the analysis area. This conservative approach was considered sufficient if Project-related effects on the sites would not substantially alter the distribution of the species across the NSO range (e.g., the species would still be well distributed or locally abundant near the Project area). However, if the initial analysis revealed that remaining sites (i.e., those not affected by the Project) may not provide a reasonable assurance of species persistence, a closer evaluation of the effects on each site was conducted to further assess effects of the Project and determine if site persistence would be maintained at any of the sites following Project implementation, or if measures would be needed to protect or avoid the site(s). Additional details on the methodology used to evaluate effects are presented in appendix F.5.

Incomplete or Unavailable Information

CEQ regulations 40 CFR 1502.22 require a discussion of incomplete or unavailable information. Information is incomplete or unavailable for:

- **Total populations of Survey and Manage species beyond those represented in the geodatabases of the agencies used in this report.** Although a statistically reliable region-wide survey has been completed for most of the Survey and Manage species (Forest Service and BLM 2007: 142), the results of those surveys have not been biologically interpreted, and the final results have not yet been published. In absence of a published interpretation of the results of those regional surveys, this assessment relies on the known sites of affected species that have been inventoried and recorded in the known site geodatabases of the BLM and Forest Service. These data constitute "best available information" for populations of Survey and Manage species and provide sufficient information to make a reasoned choice between the alternatives and to make an informed decision related to the persistence standards of the 2001 Survey and Manage ROD. A total population estimate is not necessary to make a reasoned choice between the alternatives.
- **Total acres of the specialized microsites and habitats used by certain Survey and Manage species.** This analysis was completed using geodatabase records of observations (i.e., "known sites"), regionally available vegetation inventory data, and evaluation criteria developed from the 2001 ROD. In many cases, Survey and Manage species rely on specialized habitats that may not be catalogued in agency geodatabase records or vegetation inventories. This is one of the reasons why pre-Project surveys are required for Survey and Manage species. Habitat requirements for each of the species considered are discussed in detail in appendix F.5. In this assessment, estimates are provided of the general areas where specialized habitats may be found, but these should not be interpreted as the actual acres of available specialized habitats; the actual acres of available specialized habitats are typically a fraction of the general habitat description. For example, some mollusks rely on moist microsites found in late-successional coniferous forests. A regional inventory of late-successional coniferous forests is available, but a regional inventory of moist microsites is not; there are many, many more acres of late-successional forests than there are acres of moist microsites within those forests. This assessment identifies known sites and broad habitat classifications such as "late-successional coniferous forests below 6,000 feet" where specialized habitats and the species in question may be found, but makes no estimates of, nor does the analysis rely on, estimates of specialized habitats that may exist within those broad vegetation categories. The cost of acquiring such an inventory of microsite environments over the entire area of the NWFP would be exorbitant and is not essential to making a reasoned choice between the alternatives. As noted in the Final Supplemental EIS for Survey and Manage Species, "the likelihood that an activity modifying late-successional forest will occur within the range of a truly rare or localized species population must be viewed in light of the relatively conservative degree of modification of late-successional forest projected to occur within the NWFP area. For example, management activities (timber harvest and prescribed fire) are projected to

modify approximately 3 percent of the late-successional forest within the area over the next decade" (Forest Service and BLM 2000: 180). Pre-Project survey data and existing known sites of Survey and Manage species within the area of the NWFP provide sufficient information to determine whether there is a "reasonable assurance of species persistence," which is the standard of the 2001 Survey and Manage ROD.

- **Recovery of occupied sites after disturbance.** Survey and Manage species are associated with LSOG forests on NFS lands. The construction corridor and TEWAs will be reforested and replanted with native vegetation similar to what occupied the Project area prior to disturbance. It will be at least 80 years before those areas provide late-successional habitat. A 30-foot-wide maintenance corridor centered along the pipeline route would be maintained in low growing brush and grass vegetation (no trees) for the life of the Project. When the Project is decommissioned, it would be at least an additional 80 years before this strip provides late-successional stand characteristics. Information is not generally available as to how effectively the affected Survey and Manage species will reoccupy these areas. This analysis presumes that if the "site" is within the construction clearing or TEWAs, the Project would result in a long-term loss of that site. This analysis does not speculate on when or if the affected species may reoccupy the site. Since sites are presumed lost if affected, and that provides the basis for the assessment, data related to recovery or reoccupation of sites are not essential to the decision to be made or the choice between alternatives.

Survey and Manage Species Surveys and Evaluations

Surveys conducted for the Project in and near the Project area through 2016 resulted in numerous observations of Survey and Manage species. These survey results in combination with results from prior surveys conducted near the Project area were used to identify the Survey and Manage species that could be affected by the Project. Observation data stored in agency geodatabases were converted to "sites" or "known sites" using a standardized mapping protocol based on buffer distances described in the 2001 ROD. Species evaluated include those that have sites on NFS lands in or near the Project area. The species considered include 31 fungi, 2 lichens, 1 vascular plant, 2 mollusks, 1 mammal, and 1 bird.

Fungi

The diverse fungi of the Pacific Northwest include several hundred saprobic (decomposers), parasitic, and symbiotic (mutualistic) macro- and micro-fungi species. The 2003 list includes 194 species of fungi under the Survey and Manage Standards and Guidelines. Of these species, 31 are considered in this evaluation of the Project because they have been documented on NFS lands in or near the Project area. Appendix F.5 of this EIS presents additional details on each species, while the key information used to evaluate Project-related effects is summarized in this section.

The fungi considered in this analysis consist primarily of mycorrhizal or symbiotic species, which include truffles, false truffles, chanterelles, boletes, coral fungi, and gilled mushrooms. Some of the species are saprobic gilled mushrooms or parasitic fungi. The mycorrhizal fungi form symbiotic relationships with vascular plants to exchange nutrients and water for photosynthate. The saprobic species are found on dead or decaying wood, including snags. The fungi fruit at different times of year, and many do not fruit annually, although they may still be present in the soil. Although surveys have been conducted across the Project area and in other parts of the NSO range, the difficulty in detecting fungi when fruiting bodies are not present has limited the ability to fully describe the range and distribution of many species within the NSO range. The fungi species considered in this analysis are listed in table 4.6.4.3-1 with the currently known number of sites in the NSO range. Many of these species are likely more abundant than currently documented, and more survey effort would be expected to locate additional sites of the species.

TABLE 4.6.4.3-1

Regional Site Count of Fungi Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Albatrellus ellisii	112	72	33 (46%)
Arcangeliella crassa	26	21	2 (10%)
Boletus pulcherrimus	60	34	21 (62%)
Choiromyces alveolatus	21	17	11 (65%)
Clavariadelphus occidentalis	177	63	21 (33%)
Clavariadelphus sachalinensis	273	35	20 (57%)
Clavariadelphus truncatus	332	127	56 (44%)
Collybia bakerensis	149	145	64 (44%)
Collybia racemosa	71	24	13 (54%)
Cortinarius magnivelatus	47	28	8 (29%)
Cortinarius olympianus	73	44	27 (61%)
Cortinarius verrucisporus	52	32	5 (16%)
CCudonia monticola	82	35	9 (26%)
Galerina atkinsoniana	96	68	55 (81%)
Gastroboletus subalpinus	91	81	36 (44%)
Gomphus clavatus	189	102	53 (52%)
Gomphus kauffmanii	159	99	53 (54%)
Gymnomyces abietis	21	18	10 (55%)
Hygrophorus caeruleus	56	47	14 (30%)
Mycena overholtsii	205	201	94 (47%)
Polyozellus multiplex	87	83	40 (38%)
Ramaria araiospora	152	69	26 (38%)
Ramaria coulterae	67	19	26 (32%)
Ramaria rubrievanescens	143	105	53 (50%)
Ramaria rubripermanens	231	103	35 (34%)
Rhizopogon truncatus	210	70	26 (34%)
Sarcodon fuscoindicus	74	38	18 (46%)
Sedecula pulvinata	3	3	2 (67%)
Sparassis crispa	106	51	9 (18%)
Spathularia flavida	194	81	52 (64%)
Tremiscus helvelloides	318	62	34 (55%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent “Riparian Reserves” across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in NFS reserves to total sites on NFS lands.

Habitat for these species varies and has generally been classified as coniferous, mixed hardwood-coniferous, and/or hardwood forests, including the LSOG component of these forests. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The data are the best available data on forest types across the NSO range but likely overestimate the amount of potential habitat available in the region for many of the species considered in this analysis, particularly those with microsite conditions that have not been mapped at a regional scale. The extent of potential habitat for each species varies based on its distribution across the NSO range and its habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of 31 Survey and Manage fungi at one or more sites in or near the Project area. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soil within sites and could result in the removal of populations or individuals of fungi. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase, although not all species are affected by open corridors or change in forest age (e.g., *P. fallax*, *P. piceae*, *P. sipei*, and *P. spadicea*). The removal of coniferous, mixed hardwood-coniferous, and hardwood forests, including the LSOG component of these forests, and disturbance to soil, understory substrate (e.g., rocks, downed logs), and roots of trees could negatively affect the fungi in adjacent areas by removing their habitat, disturbing soil or duff around trees or roots of trees, and affecting mycorrhizal associations with the trees or other relationships between the fungi and their hosts, potentially affecting site persistence even if the entire site is not disturbed. For some species that are found in more open habitats (e.g., *C. olympianus*, *H. caeruleus*, *S. flavida*), these microclimate changes may not affect site persistence. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor and TEWAs could make habitat within the sites no longer suitable for the species. Material storage within UCSAs would disturb understory habitat in some sites, which could also modify microhabitats near extant populations or individuals, potentially making the habitat no longer suitable for the species. Road improvements and establishment could remove habitat and extant populations or individuals of the fungi. The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-2 presents a summary of the number of sites of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-2

Fungi Sites Potentially Affected by the Project

Species	**Total Affected NFS Sites a/**	**Affected Sites in NFS Reserves**	**Remaining Sites on NFS Lands in NSO Range**	**Remaining Sites on all Lands in NSO Range**
Albatrellus ellisii	10	3	62	102
Arcangeliella crassa	1	—	21 b/	26 b/
Boletus pulcherrimus	7	—4	31 b/	57 b/
Choiromyces alveolatus	1	—	17 b/	21 b/
Clavariadelphus occidentalis	1	—	62	171
Clavariadelphus sachalinensis	7	2	28	258
Clavariadelphus truncatus	10	4	117	311
Collybia bakerensis	2	—	143	147
Collybia racemosa	1	—	23	70
Cortinarius magnivelatus	5	—	24 b/	43 b/
Cortinarius olympianus	5	4	40 b/	69 b/
Cortinarius verrucisporus	5	—	29 b/	49 b/
Cudonia monticola	1	—	34	81
Galerina atkinsoniana	1	—	67	95
Gastroboletus subalpinus	2	—	79	89
Gomphus clavatus	3	1	99	186
Gomphus kauffmanii	7	6	91	152
Gymnomyces abietis	1	1	18 b/	21 b/

TABLE 4.6.4.3-2 (continued)

Fungi Sites Potentially Affected by the Project

Species	Total Affected NFS Sites a/	Affected Sites in NFS Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on all Lands in NSO Range
Hygrophorus caeruleus	6	—1	846 b/	55 b/
Mycena overholtsii	2	1	199	203
Polyozellus multiplex	1	1	82	86
Ramaria araiospora	3	—	67	149
Ramaria coulterae	3	1	17	65
Ramaria rubrievanescens	2	—	103	141
Ramaria rubripermanens	7	—	96	223
Rhizopogon truncatus	6	1	64	203
Sarcodon fuscoindicus	1	—	37	72
Sedecula pulvinata	1	1	3 b/	3 b/
Sparassis crispa	1	—	50	104
Spathularia flavida	5	4	76	189
Tremiscus helvelloides	1	1	61	310

a/ Affected sites are those on NFS land that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5.

b/ Although one or more sites would be affected by the Project, individuals within some of the sites would not be affected, and site persistence would be maintained for those sites following project implementation. The remaining site count includes sites that may be affected, but for which site persistence is expected to be maintained. Only sites for which site persistence would be affected were removed from the remaining site count.

The species listed below appear to be more common than previously documented or are relatively common across the NSO range based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. For these species, the Project would affect individuals or habitat at one or more sites and could affect site persistence, but the remaining sites in the NSO range would continue to provide a reasonable assurance of species persistence:

Clavariadelphus occidentalis
Clavariadelphus sachalinensis
Clavariadelphus truncatus
Collybia bakerensis
Cortinarius olympianus
Cudonia monticola
Galerina atkinsoniana
Gastroboletus subalpinus
Gomphus clavatus
Gomphus kauffmanii
lbatrellus ellisii
Mycena overholtsii
Polyozellus multiplex
Ramaria araiospora
Ramaria coulterae
Ramaria coulterae
Ramaria rubrievanescens
Ramaria rubripermanens
Ramaria rubripermanens
Ramaria stuntzii
Rhizopogon truncatus
Rhizopogon truncatus
Sparassis crispa
Spathularia flavida
Tremiscus helvelloides

The species listed below are not necessarily more common than previously documented despite new information available from pre-disturbance surveys for the Project and/or other sources since these species were listed in the 2001 ROD. For these species, the Project would affect individuals or habitat at one or more sites and could affect site persistence, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence:

Arcangeliella crassa
Boletus pulcherrimus

Choiromyces alveolatus
Collybia racemose
Cortinarius magnivelatus
Cortinarius verrucisporus
Gymnomyces abietis
Hygrophorus caeruleus
Sedecula pulvinata

The species listed below is not necessarily more common than previously documented despite new information available from pre-disturbance surveys for the Project and/or other sources since these species were listed in the 2001 ROD. For this species, the Project would affect site persistence at one or more sites, and the remaining sites in the NSO range may not provide a reasonable assurance of species persistence. These species are known from a low number of sites within a part of the NSO range, has limited habitat requirements, and has a distribution pattern in which every site may be important for dispersal opportunities to ensure the persistence of the species in the NSO range:

Sarcodon fuscoindicus

The Project would affect a portion of one site where two observations of this species have been documented on NFS lands. This site is located in the Trail Creek watershed on the ridge just east of the South Fork Cow Creek watershed between MPs 111.5 and 111.6. Approximately 1.2 acres (30 percent of the site) is associated with the construction corridor (0.8 acres) and associated UCSA (0.4 acres). The location of this site is illustrated in appendix F-5 (Section 2.27, Figure SAFU-5).

The Project would result in ground disturbance and vegetation removal in the eastern half of the site near MP 111.5. The two recorded observations within the site may be avoided by construction activities within the corridor, but fruiting bodies, if present, could be disturbed in one of the observations during material storage within a UCSA (see Figure SAFU-5). The species would also be subject to indirect effects associated with the Project based on the proximity of project activities to the observations.

Establishment of the 95-foot wide construction corridor would disturb vegetation and soils within the site. The area within the site is mostly forested, and the establishment of the corridor could modify microclimate conditions around the recorded observations. The removal of forests and host trees and disturbance to soil could negatively affect *S. fuscoindicus* in adjacent areas by removing its habitat, disturbing soil or duff around trees or roots of trees, and affecting its mycorrhizal association with the trees, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions within 100 feet of an observation as a result of the corridor could make habitat within the site no longer suitable for the species. Restored portions of the corridor would be dominated by early seral vegetation for approximately 30 years, which would result in long-term changes to habitat conditions. A 30-foot wide portion of the corridor would be maintained in low-growing vegetation for pipeline maintenance and would not provide habitat for the species during the life of the Project. Material storage within UCSAs could damage individuals and would disturb understory habitat within the site, which could modify microhabitats near individuals that are not removed or damaged, potential making the habitat no longer suitable for the species.

Based on this analysis of the site on NFS lands, *S. fuscoindicus* is not likely to persist following Project implementation. The site is the only site on NFS lands in the local area and the nearest sites on NFS lands are approximately 45 miles to the northeast and 75 miles to the southwest.

Lichens

Lichens are distinct symbiotic organisms that consist of a fungus and an algae or cyanobacterium, which make them members of two or three biological kingdoms. They play a major ecological role, particularly in old-growth forests, by cycling nutrients and producing biomass. Lichens tend to be dispersal limited and grow slower than vascular plants. The 2001 Survey and Manage ROD including the 2003 ASR modifications to the species list includes 45 lichen species. Of these, two are considered in this evaluation because they have been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on each species, while the key information used to evaluate Project-related effects is summarized in this section.

Both lichens considered in this analysis are epiphytic lichens, which grow directly on trees or shrubs. *Chaenotheca subroscida* commonly occurs on pine trees in upland habitats and *Leptogium teretiusculum* tends to be associated with riparian habitat.

Although surveys have been conducted across the Project area and in other parts of the NSO range, the difficulty in detecting some lichens because of their size has limited the ability to fully describe the range and distribution of some species within the NSO range. The lichen species considered in this analysis are listed in table 4.6.4.3-3 with the currently known number of sites in the NSO range, and the distributions of the species are briefly discussed after the table.

TABLE 4.6.4.3-3

Regional Site Count of Lichen Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Chaenotheca subroscida	396	110	73 (66%)
Leptogium teretiusculum	267	16	9 (56%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent “Riparian Reserves” across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands.

Habitat for these species has been classified as coniferous, mixed hardwood-coniferous, and/or hardwood forests, including the LSOG component of these forests. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for each species varies based on its distribution across the NSO range and habitat preferences. Additional details on habitat for these species are presented in appendix F.5.

The Project could affect site persistence of two Survey and Manage lichens at one or more sites on NFS lands in or near the Project area. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soil within sites and could result in the removal of populations or individuals of lichens. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of coniferous, mixed hardwood-coniferous, and hardwood forests, including the LSOG component of these forests, and disturbance to soil, understory substrate (e.g., rocks, downed logs), and roots of trees could negatively affect the lichens in adjacent areas by removing their habitat, disturbing soil or substrate around trees or roots of trees, and affecting associations with the trees or other substrate, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor and TEWAs could make habitat within the sites no longer suitable for the species. Material storage within UCSAs would disturb understory habitat in some sites, which could also modify microhabitats near extant populations or individuals, potentially making the habitat no longer suitable for some of the species. Road improvements and establishment could remove habitat and extant populations or individuals of the lichens. The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-4 presents a summary of the number of sites of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-4

Lichen Sites Potentially Affected by the Project

Species	Total Affected NFS Sites a/	Affected Sites in NFS Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on all Lands in NSO Range
Chaenotheca subroscida	6	4	104	382
Leptogium teretiusculum	1	1	15	261

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Using the spatial analysis process described in appendix F.5, these sites may be clipped by the Project area or fall outside the Project area, but within the analysis area.

The two lichen species analyzed appear to be more common than previously documented or are relatively common across the NSO range based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. The Project would affect site persistence at one or more sites, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

Measures incorporated into the Project as design features would be implemented to minimize soil and vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on all Survey and Manage lichens in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendment of the land management plans for the National Forests that encompass the Project area. Table 4.6.4.3-5 lists the lichen species and the number of affected sites on each National Forest.

TABLE 4.6.4.3-5

Affected Lichen Sites by National Forest

	Number of Sites Affected a/		
Species	**Umpqua**	**Rogue River-Siskiyou**	**Fremont-Winema**
Chaenotheca subroscida	—	5	1
Leptogium teretiusculum	—	1	—

a/ All sites are directly affected (i.e., are located in the Project area).

Vascular Plants

Vascular plants are the most dominant organism in LSOG forests and serve an essential role by providing a food source and cover or shelter for animals and influencing microclimate conditions for other species, such as fungi and lichens. Vascular plants include seed-bearing plants, such as flowering plants and conifer trees, and spore-bearing forms, such as ferns, horsetails, and clubmosses. The Survey and Manage 2001 ROD including 2003 ASR modifications includes 12 plant species. Of the 12 species, clustered lady's slipper (*Cyripedium fasciculatum*) is evaluated for this Project because it has been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on the species, while the key information used to evaluate Project-related effects is summarized in this section.

Surveys for vascular plants have been conducted in much of the NSO range, and the results of these surveys have contributed information to characterize the known extent of the plants in the NSO range. Additional surveys for Survey and Manage species were conducted for the Project as recently as the fall of 2018.[144] Table 4.6.4.3-6 includes the currently known number of *C. fasciculatum* sites in the NSO range. The range of *C. fasciculatum* in the NSO range is relatively well known, and more survey effort would be expected to locate additional sites of the species within its currently known range.

TABLE 4.6.4.3-6

Regional Site Count of Plant Species Potentially Affected by the Project

Species	**Total Sites in NSO Range a/**	**Sites on NFS Lands in NSO Range b/**	**Sites in NFS Reserves in NSO Range c/**
Cypripedium fasciculatum	1,392	1540	198 (37%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent "Riparian Reserves" across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands.

C. fasciculatum is well distributed across most of its known range in the NSO range. Sites are distributed in two general groups in the Klamath Mountains and Cascade Range in Oregon and California and the eastern Cascade Range in Washington. The species appears to be well distributed in the Klamath Mountains in California and Oregon.

General habitat for this species consists of coniferous and mixed hardwood-coniferous forests, including the LSOG component of these forests, across each species' currently known range. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for each species varies based on its distribution across the NSO range and habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of *C. fasciculatum* at one site on NFS land in the Project area. The site occurs on the Umpqua National Forest. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soil within sites and could

[144] Results from these will be incorporated into the final EIS.

result in the removal of populations or individuals of plants. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of coniferous and mixed hardwood-coniferous forests, including the LSOG component of these forests, and disturbance to soil could negatively affect the plants in adjacent areas by removing their habitat, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor and TEWAs could make habitat within the sites no longer suitable for the species. Material storage within UCSAs would disturb understory habitat in some sites, which could also modify microhabitats near extant populations or individuals, potentially making the habitat no longer suitable for some of the species. Road improvements and establishment could remove habitat and extant populations or individuals of the plants. The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-7 presents a summary of the sties that would remain after the single site is affected by Project activities; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-7

Vascular Plant Sites Potentially Affected by Project

Species	Total Affected NFS Sites a/	Affected Sites in Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on all Lands in NSO Range
Cypripedium fasciculatum	1	1	1,539	1,390

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Using the spatial analysis process described in appendix F.5, these sites may be clipped by the Project area or fall outside the Project area, but within the analysis area.

Cypripedium fasciculatum appears to be more common than previously documented based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. Many sites have been documented in southwest Oregon since the 2001 ROD was published. Should the Project be constructed, it is unlikely that the loss of one site from Project effects would affect the status of *C. fasciculatum* in the NSO range. The Project would affect site persistence at one site on NFS lands, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

Measures incorporated into the Project as design features would be implemented to minimize soil and vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on Survey and Manage plants in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendments to the land management plans for National Forests that encompass the Project area.

Mollusks

Approximately 350 species of mollusks, including land snails, aquatic snails, slugs, and clams, are found in the Pacific Northwest (Forest Service and BLM 2000). Slugs and snails are found in colonies, which may consist of hundreds to many thousands of individuals. Most mollusks are found in moist forests and riparian areas near streams, springs, and seeps. The 2001 ROD including 2003 ASR modifications includes 38 species of mollusks. Of these species, two are considered in this evaluation of the Project because they have been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on each species, while the key information used to evaluate Project-related effects is summarized in this section.

The mollusk species considered in this analysis include evening fieldslug (*Deroceras hesperium*) and Chace sideband (*Monadenia chaceana*). *Deroceras hesperium* is a land slug that requires high moisture environments and is found along the forest floor. A recent study on the molecular characteristics of *D. hesperium* revealed that the mollusk is likely a variant of the more common *D. laeve* (Roth et al. 2013), and *D. hesperium* may no longer belong on the Survey and Manage list, pending an annual species review. Since the species is on the 2003 list, it is evaluated like other Survey and Manage species on the list in this assessment. *Monadenia chaceana* is a land snail that is found in talus or under rocks in moist forests. Both mollusks may be associated with Riparian Reserves.

Surveys for mollusks have been conducted in parts of the NSO range, and the results of these surveys have contributed information to characterize the known extent of the mollusks in the NSO range. Surveys for the Project resulted in several observations of both species. The mollusk species considered in this analysis are listed in table 4.6.4.3-8 with the currently known number of sites in the NSO range. The ranges of these species in the NSO range are relatively well known, and more survey effort would be expected to locate additional sites of the species within their currently known ranges.

The distribution of the species and their ranges within the NSO range vary. *Deroceras hesperium* has a distribution pattern with limited potential for connectivity between isolated sites or site clusters. Sites are found in four general areas in Oregon, including a relatively large cluster of sites located in the southern Cascade Range, and other clustered sites located in the northern Cascade Range and southern Coast Range. Scattered sites are in the northern Cascade Range, and several isolated sites are in other areas. *Monadenia chaceana* has multiple sites or clusters of sites that are nested within a web of potential interconnections. Sites are primarily found in a large group of several clusters in the eastern Klamath Mountains and southern Cascade Range in Oregon and extreme northern California.

TABLE 4.6.4.3-8

Regional Site Count of Mollusk Species Potentially Affected by the Project

Species	Total Sites in NSO Range a/	Sites on NFS Lands in NSO Range b/	Sites in NFS Reserves in NSO Range c/
Deroceras hesperium	54	27	13 (48%)
Monadenia chaceana	258	246	34 (14%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent "Riparian Reserves" across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands.

General habitat for these species consists of a subcomponent (e.g., moist riparian areas, shaded rocky areas) of coniferous, mixed hardwood-coniferous, and hardwood forests, including the LSOG component of these forests, across each species' currently known range. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for the species varies based on its distribution across the NSO range and habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of two Survey and Manage mollusk species at one or more sites in or near the Project area. Vegetation removal and grading activities in the construction corridor and in TEWAs would disturb vegetation and soils within sites and could result in injury or mortality to individuals of mollusks. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of forests and understory components could negatively affect the mollusks in adjacent areas by removing their habitat, potentially affecting site persistence even if the entire site is not disturbed. In addition, modification of shading, moisture, and habitat conditions as a result of the corridor could make habitat within sites no longer suitable for the species. Material storage within UCSAs could disturb understory habitat in sites, which could remove rocks, logs, or woody debris, potentially making the habitat unsuitable for the species or injuring individuals.

The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-9 presents a summary of the number of sites of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

TABLE 4.6.4.3-9

Mollusk Sites Potentially Affected by the Project

Species	**Total Affected NFS Sites a/**	**Affected Sites in NFS Reserves**	**Remaining Sites on NFS Lands in NSO Range**	**Remaining Sites on all Lands in NSO Range**
Deroceras hesperium	1	1	26	53
Monadenia chaceana	9	9	249	396

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Direct effects are those that would take place within the Project area, such as from ground disturbance, vegetation removal, or removal of individuals. Indirect effects are those that would take place outside of the Project area, such as from edge effects or increased open canopy. Using the spatial analysis process described in appendix F.5, these sites may be clipped by or fall outside the Project area, but within the analysis area.

Deroceras hesperium is not necessarily more common than previously documented despite new information available from pre-disturbance surveys for the Project and/or other sources since this species was listed in the 2001 ROD. The Project would affect site persistence at one site, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence. Although this species has a somewhat limited distribution in the NSO range, the affected site is part of a large cluster of sites in the southern Cascade Range in Oregon. The distribution and connectivity of the species would likely remain the same despite the loss of one site.

Monadenia chaceana appears to be more common than previously documented based on new information available from surveys for the Project and/or other sources since this species was listed in the 2001 ROD. The Project would affect site persistence at nine sites, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

Measures incorporated into the Project as design features would be implemented to minimize soil and vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on Survey and Manage mollusks in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendments to the land management plans for the National Forests that encompass the Project area. Table 4.6.4.3-10 lists the mollusk species and the number of affected sites in each National Forest.

TABLE 4.6.4.3-10

Affected Mollusk Sites by National Forest

	Number of Sites Affected a/		
Species	**Umpqua**	**Rogue River=Siskiyou**	**Fremont-Winema**
Deroceras hesperium	—	—	1
Monadenia chaceana	—	3 (5)	1

a/ First number presents sites directly affected (i.e., in Project area), number in parentheses presents sites indirectly affected (i.e., sites wholly in analysis area). a

Vertebrates

A diverse array of vertebrate species, including mammals, birds, amphibians, and reptiles, inhabit the forests of the Pacific Northwest and provide essential functions in the ecosystem, such as dispersing fungal spores and lichens and serving as a food source for predators. The 2001 ROD including the 2003 ASR modifications to the species list includes seven vertebrate species. Two vertebrate species are considered in this evaluation of the Project because they have been documented on NFS lands in or near the Project area. Appendix F.5 presents additional details on each species, and the key information used to evaluate Project-related effects is summarized in this section.

The vertebrate species considered in this analysis include red tree vole (*Arborimus longicaudus*) and great gray owl (*Strix nebulosa*). *Arborimus longicaudus* is a small arboreal rodent that lives in tree canopies of coniferous and mixed hardwood-coniferous forests and seldom goes to the forest floor (Forest Service and BLM 2001b). It is a primary prey item of the northern spotted owl, as well as other predators found in coniferous forests. *Strix nebulosa* is a forest owl that uses existing stick nests constructed by other raptors and large corvids, and nests between March 1 and July 31 (Williams 2012). It forages in natural forest openings, typically larger than 10 acres, and nests in coniferous and mixed hardwood-coniferous forests.

Surveys for the vole and owl have been conducted across much of the NSO range, and the results of these surveys have contributed information to characterize the known extent of the species in the NSO range. Surveys for the Project resulted in multiple observations of both species in the surveyed areas. The vertebrate species considered in this analysis are listed in table 4.6.4.3-11 with the currently known number of sites in the NSO range, and the distributions of the species are briefly discussed after the table. The ranges of these species in the NSO range are relatively well known, and more survey effort would be expected to locate additional sites of the species within their currently known ranges.

TABLE 4.6.4.3-11

Regional Site Count of Vertebrate Species Potentially Affected by the Project

Species	**Total Sites in NSO Range a/**	**Sites on NFS Lands in NSO Range b/**	**Sites in NFS Reserves in NSO Range c/**
Arborimus longicaudus	34,946	1,524	624 (34%)
Strix nebulosa	177	55	16 (12%)

a/ Total site count reflects the number of sites generated by the 8/2/17 FME extract.
b/ Site count reflects only those sites on NFS lands using land ownership data for the NSO range (dated October 2011).
c/ Site count reflects only those sites on NFS lands and in reserve land allocations based on 1994 ROD reserve land allocations for the NSO range (data dated December 2002 and September 2009) and National Hydrography Dataset, v. 2.1.0 to represent "Riparian Reserves" across the NSO range. These counts underestimate the number of sites in reserves, but regionally mapped reserve data are not available. The percentage represents the estimated proportion of sites in reserves to total sites on NFS lands

The distribution of the species and their ranges within the NSO range vary. Both species have multiple sites or clusters of sites that are nested within a web of potential interconnections. Most *A. longicaudus* sites are found in the Klamath Mountains in Oregon, where sites are abundant and close together in large clusters or groups. Sites are more scattered in the western Cascade Range in Oregon, although they are still relatively abundant. *Arborimus longicaudus* appears to be well distributed within its range in Oregon. Most *S. nebulosa* sites are found in a large group in the southern Cascade Range and eastern Klamath Mountains, where the species appears to be well distributed.

General habitat for *A. longicaudus* consists of LSOG coniferous and mixed hardwood-coniferous forests across the species' currently known range in Oregon. General habitat for *S. nebulosa* consists of coniferous and mixed hardwood-coniferous forests, including the LSOG component of these forests, with a subcomponent of natural forest openings (e.g., meadows) that are used for foraging. Forests that may provide suitable habitat have been mapped using available data for the NSO range that were also used for the NWFP Effectiveness Monitoring 15-year report to map LSOG forests (Moeur et al. 2011). The extent of potential habitat for the species varies based on its distribution across the NSO range and habitat preferences, and additional details on habitat are presented in appendix F.5.

The Project could affect site persistence of two Survey and Manage vertebrates at more than one site or habitat area in or near the Project area. Vegetation removal in the construction corridor and TEWAs and along roads could result in the removal of trees that support *A. longicaudus* nests or cause injury or mortality to individuals. Construction of the Project would create an open corridor, which would be dominated by early seral vegetation for approximately 30 years. This is a long-term effect that could modify microclimate conditions around populations or individuals adjacent to the corridor during the early seral vegetation phase. The removal of forests and potential nest trees could negatively affect *A. longicaudus* in adjacent areas by removing its habitat and opening the tree canopy, potentially affecting site persistence at the habitat areas even if the entire habitat area is not disturbed. In particular, modification of shading and habitat conditions as a result of the corridor, TEWAs, and roads could make entire habitat areas no longer suitable for the species because of the preference for closed canopy habitats. Activities within the corridor and TEWAs would result in extensive noise disturbance during vegetation clearing, grading, and pipeline installation and could result in *S. nebulosa* nest abandonment and loss of young during the nesting season. No active *S. nebulosa* nest sites were documented in the Project area; therefore, direct effects on the owl (e.g., removal of active nests, injury to owls) are not anticipated. Vegetation removal across the Project area would also result in a long-term loss of habitat that may be suitable for the species. Conversely, if constructed, the construction corridor would also create an early seral plant community suitable for foraging by great grey owls.

The specific effects on sites in and near the Project area vary by species and depend on where the sites are in proximity to the corridor and other activities. Table 4.6.4.3-12 presents a summary of the number of sites (habitat areas for *A. longicaudus*) of each species that would be affected by the Project; additional details for each species are included in appendix F.5.

Both species appear to be more common than previously documented based on new information available from surveys for the Project and/or other sources since these species were listed in the 2001 ROD. The Project would affect site persistence at multiple sites or habitat areas of each species, but the remaining sites in the NSO range would provide a reasonable assurance of species persistence.

TABLE 4.6.4.3-12

Vertebrate Sites Potentially Affected by the Project

Species	Total Affected NFS Sites a/	Affected Sites in NFS Reserves	Remaining Sites on NFS Lands in NSO Range	Remaining Sites on All Lands in NSO Range
Arborimus longicaudus	525 (55) b/	10 (24)	1,469 c/	4,843
Strix nebulosa	1	1	54	171

a/ Affected sites are those that would be directly or indirectly affected by Project activities based on the analyses presented in appendix F.5. Direct effects are those that would take place within the Project area, such as from ground disturbance, vegetation removal, or removal of individuals. Indirect effects are those that would take place outside of the Project area, such as from edge effects or increased open canopy. Using the spatial analysis process described in appendix F.5, these sites may be clipped by or fall outside the Project area, but within the analysis area.
b/ *A. longicaudus* sites are habitat areas (55 sites were converted to 25 habitat areas in the analysis area), as mapped in accordance with the management recommendations for the species (Forest Service and BLM 2001b).
c/ The total of remaining sites is based on site data, not habitat areas. Habitat areas were not produced for the entire regional area, just the analysis area.

Measures incorporated into the Project as design features would be implemented to minimize vegetation disturbance in the Project area and restore areas following construction, which could minimize adverse effects on Survey and Manage vertebrates in and near the Project area. The Forest Service will prepare and implement a monitoring plan that describes specific protocols to monitor affected sites and habitat adjacent to the sites over the long term.

For lands directly affected by the Project, the Forest Service would waive implementation of Management Recommendations for Survey and Manage species through amendments to the land management plans for the National Forests that encompass the Project area. Table 4.6.4.3-13 lists the vertebrate species and the number of affected sites or habitat areas in each National Forest.

TABLE 4.6.4.3-13

Affected Vertebrate Sites by National Forest

	Number of Sites Affected a/		
Species	**Umpqua**	**Rogue River-Siskiyou**	**Fremont-Winema**
Arborimus longicaudus b/	125	—	—
Strix nebulosa	—	0 (1)	—

a/ First number presents sites directly affected (i.e., in Project area), number in parentheses presents sites indirectly affected (i.e., sites wholly in analysis area).
b/ *A. longicaudus* sites are habitat areas, as mapped in accordance with the management recommendations for the species (Forest Service and BLM 2001b).

In conclusion, the Project could affect site persistence of 38 Survey and Manage species at one or more sites or habitat areas in or near the Project area. The remaining sites of 37 of these 38 species, however, would provide a reasonable assurance of these species persistence. The Project as proposed would affect site persistence of the fungi *Sarcodon fuscoindicus* at one or more sites, and the remaining sites may not provide a reasonable assurance of this species persistence. However, above we have recommended that Pacific Connector avoid affecting the *Sarcodon fuscoindicus* site by incorporating a pipeline route variation that avoids this site into the proposed action (see chapter 3). Therefore, the analysis summarized in this section, supported by the information presented in appendix F.5, indicate that construction and operation of the Project would provide a reasonable assurance of persistence of Forest Service Survey and Manage species that would be affected.

4.7 LAND USE

4.7.1 Jordan Cove LNG Terminal

4.7.1.1 Land Ownership and Existing Land Use

Land Ownership

The 197-acre LNG terminal site (figure 4.7-1a) is owned by Fort Chicago Holdings II US LLC (Fort Chicago Holdings), an affiliate of Jordan Cove. As depicted in figure 4.7-1a, the terminal site consists of two parcels that are connected by an access corridor. The two parcels are commonly referred to as the Ingram Yard and South Dunes properties. The associated terminal sites depicted in figures 4.7-1b and 4.7-1c are privately owned lands that Jordan Cove has secured or would secure agreements to use. Ownership of lands required for the Project is summarized in table 4.7.1.1-1. With the exception of BLM land crossed by the industrial wastewater pipeline (within an existing utility corridor), no federal lands would be used for the Jordan Cove Project.

In addition, the COE possesses a 40-acre perpetual easement that coincides with the boundaries of the Ingram Yard loading terminal site. Located between Roseburg Forest Products and Jordan Cove lands, this easement reserves: "*[t]he perpetual right, power, privilege and easement in, upon, over, and across the lands described herein for sand stabilization*." As part of the COE Section 408 process, the COE would need to issue a "consent to easement structures," which would address the COE's rights and how Jordan Cove would provide alternatives should the rights need to be exercised.

TABLE 4.7.1.1-1

Land Ownership of the Jordan Cove Project Area Facilities

Project Facility/Activity	Ownership
Construction and Operation	
LNG Terminal	Fort Chicago Holdings II US LLC
Ingram Yard	
South Dunes Site (including Workforce Housing Facility)	
Access and Utility Corridor	
Slip	
Access Channel	State of Oregon (easement)
Material Offloading Facility (MOF)	State of Oregon (easement)
Industrial Wastewater Pipeline	Designated Trans-Pacific Parkway roadway, railway, & utility corridor (permission from Coos County and an easement from BLM)
Meteorological Station Site	Oregon International Port of Coos Bay
Temporary Construction	
LNG Terminal	Fort Chicago Holdings II US LLC
Ingram Yard Laydown Area	
South Dunes Laydown, Housing, and Parking Area	
Hydraulic Dredge Pipeline	
Trans-Pacific Parkway/U.S. 101 Widening	ODOT and Coos County Rights-of-Way
Roseburg Laydown Site	Roseburg Forest Products Company
Port Laydown Site	Oregon International Port of Coos Bay
APCO Laydown Site	APCO Coos Properties, LLC
Boxcar Hill Staging Area	Oregon Dunes Sand Park, LLC
Myrtlewood Offsite Park & Ride	Private
Temporary Dredge Lines	State of Oregon (easement)
Kentuck Line	State of Oregon (easement)
Environmental Mitigation Areas	
Kentuck Project Site	Fort Chicago Holdings II US LLC and private
Eelgrass Mitigation Site	State of Oregon
Lagoon Site	Oregon International Port of Coos Bay
North Bank Site	Fort Chicago Holdings II US LLC
Panhandle Site	Oregon International Port of Coos Bay

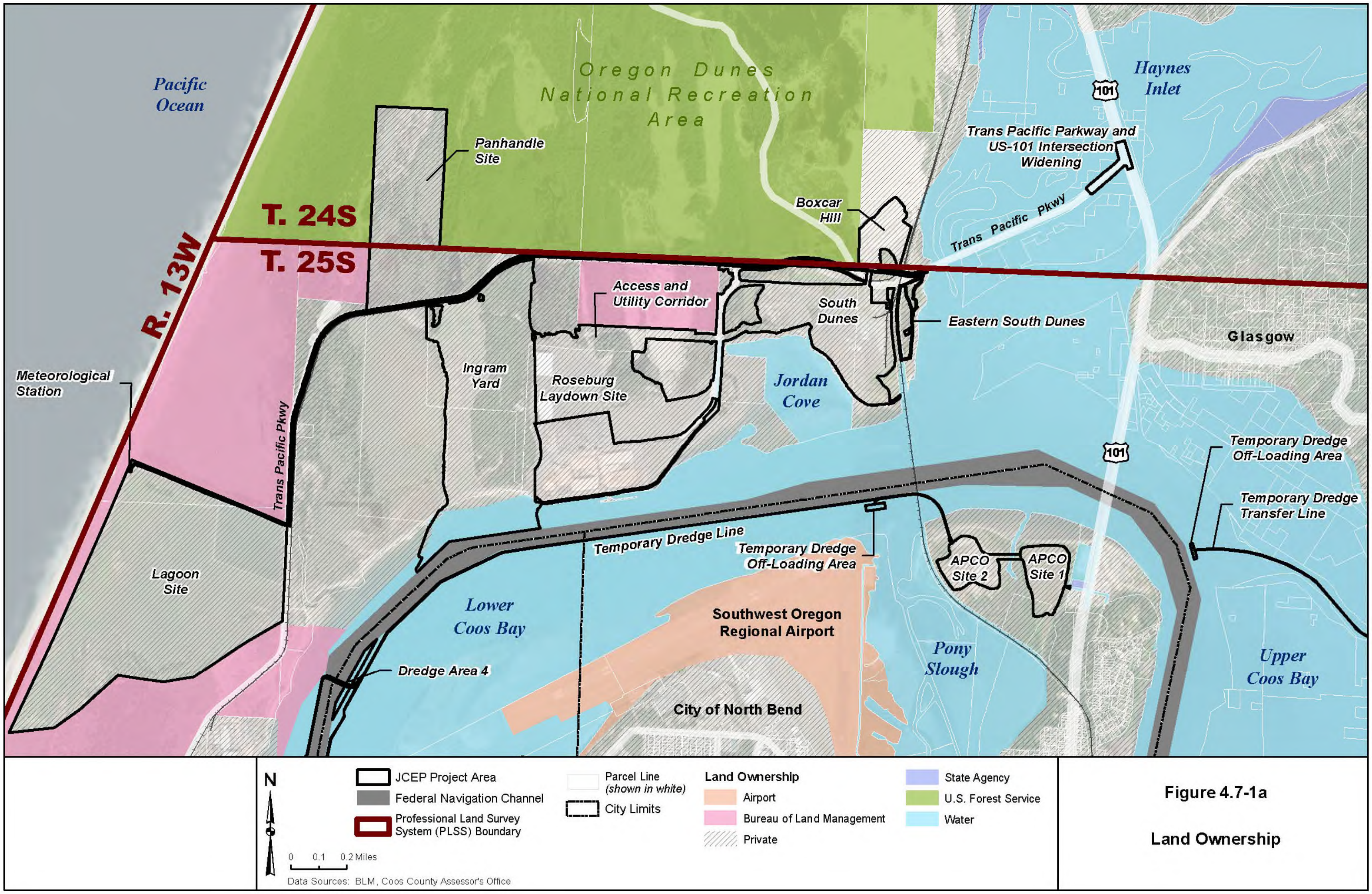


Figure 4.7-1a

Land Ownership

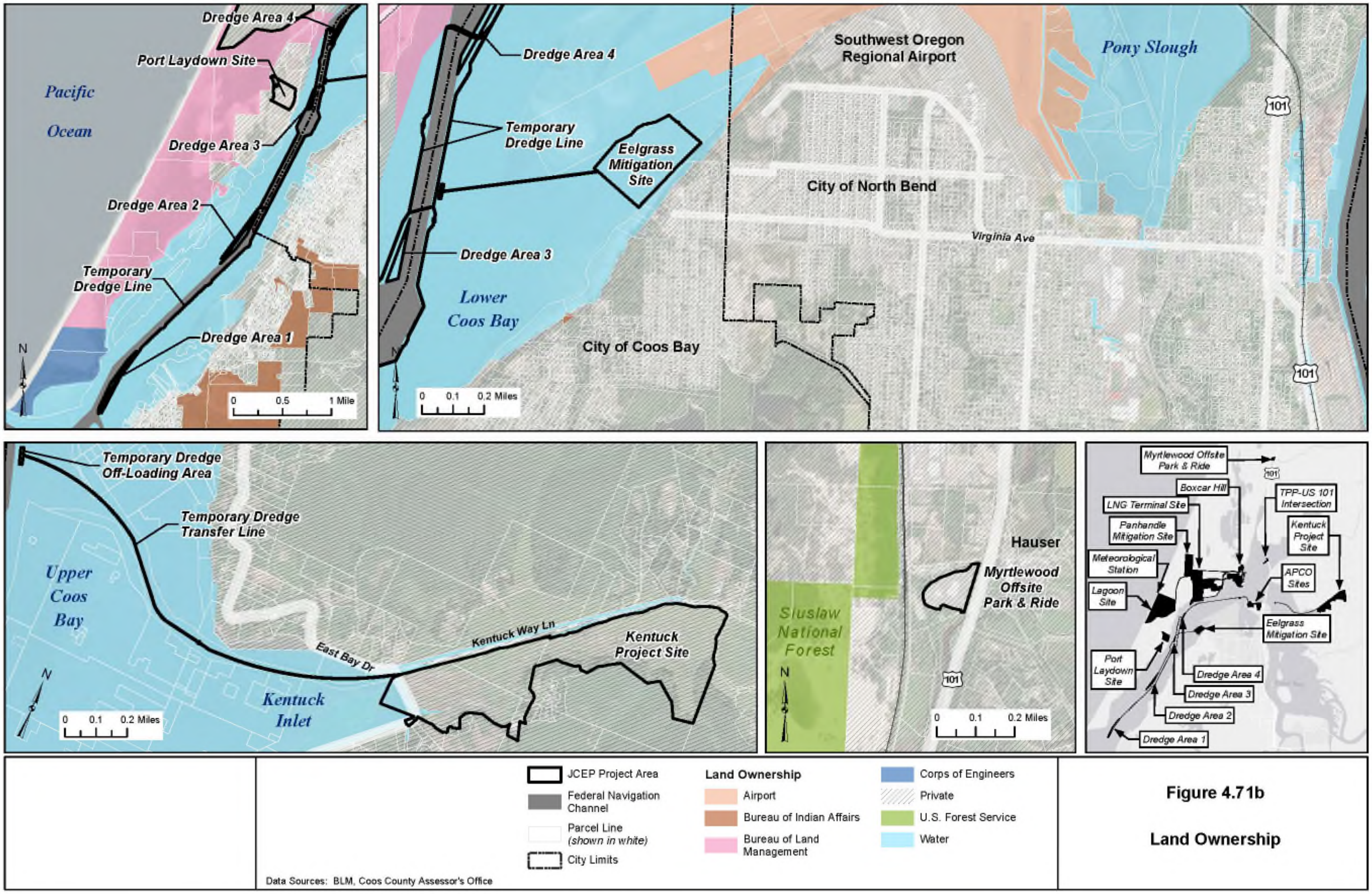
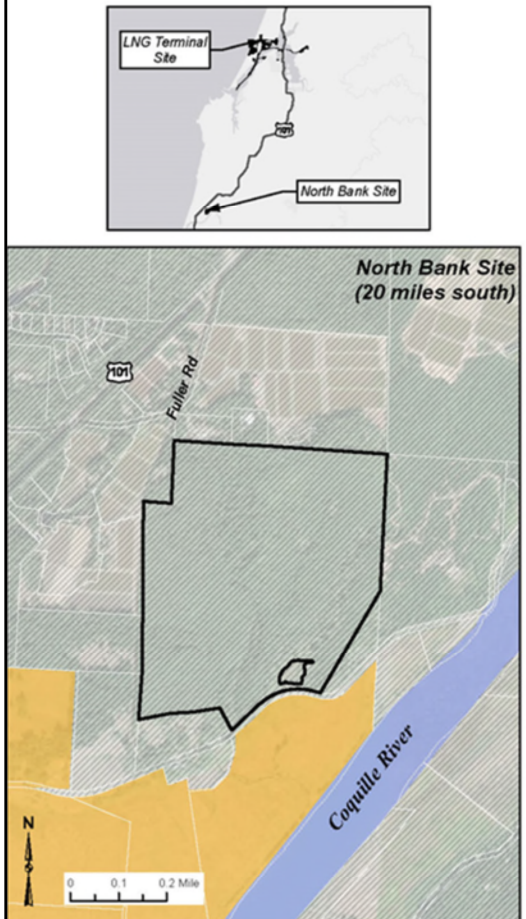


Figure 4.71b

Land Ownership



JCEP Project Area
Parcel Line (shown in white)

Land Ownership
Private
State Agency
U.S. Fish and Wildlife Service

Data Sources: BLM, Coos County Assessor's Office

Figure 4.7-1c

Land Ownership

Existing Land Use

The LNG terminal site consists of a combination of brownfield decommissioned industrial facilities, an existing landfill requiring closure, and open land covered by grasslands, sand, and shrubs, as well as an area of forested dunes (see figures 4.7-2a, 4.7-2b, and 4.7-2c). Portions of the proposed site and the Port Laydown site were previously used for disposal of dredged material.

Land uses affected by construction and operation of the LNG terminal and associated facilities are identified in table 4.7.1.1-2. Lands affected during construction include areas that would be permanently and temporarily altered. Operation-related estimates include only those lands that would be permanently affected. Lands affected by operation would be permanently converted from their former uses to the project facilities identified in table 4.7.1.1-2.

Forest/Woodland

A total of 122 acres of forest/woodland would be affected during construction, with 71 acres permanently affected (table 4.7.1.1-2). More than three-quarters of the forest/woodland affected during construction is located on the terminal site, with an additional 12 percent on the adjacent Roseburg laydown site. Almost all of the permanently affected forest/woodland is located on the terminal site. Permanently affected areas would remain cleared of vegetation for the life of the Project. Areas temporarily disturbed during construction would be restored and, to the extent possible, native plant species would be used for stabilization and to prevent erosion of the disturbed areas. Impacts on vegetation are discussed in more detail in section 4.4.

Industrial/Commercial

Industrial/commercial lands that would be used during construction include parts of the terminal site and also the Roseburg Laydown Site, Port Laydown Site, and off-site park and ride sites. With the exception of the industrial/commercial lands that would become part of the terminal site, almost all impacts on existing industrial/commercial lands would be temporary.

Open Land

Open land disturbed during construction would primarily be located on the terminal site (68 percent) and the APCO Sites 1 and 2 (14 percent) (table 4.7.1.1-2). Open land on the terminal site includes land covered by grasslands, sand, and shrubs. Approximately 73 of the 129 acres of open land that would be disturbed on the terminal site during construction would be permanently affected and converted to site uses. The remaining acres would be restored following construction. Although no permanent facilities are proposed for the APCO Sites 1 and 2, the sites would be used for dredge disposal, with disposal expected to raise site elevations above existing grade by between 37 and 49 feet over a 30 year planning horizon.

In addition to the acres of open land identified in table 4.7.1.1-2, approximately 104 acres of the Kentuck project site would be converted to a wide-ranging habitat of mudflats, salt marsh, willowed scrub/shrubs, and fish structures to provide mitigation for both the Jordan Cove and Pacific Connector projects. Formerly a golf course, the Kentuck project site is currently used for pasture.

Open Water

An estimated 77 acres of open water would be affected during construction, with 28 acres permanently affected (table 4.7.1.1-2). Open water would primarily be disturbed during construction as part of activities related to the access channel (40 percent) and the four dredge areas (40 percent). Impacts related to construction of the access channel that would connect the terminal to the Federal Navigation Channel would be permanent.

Other

The industrial wastewater pipeline would be located entirely within an existing roadway, railway, and utility corridor. Installation would disturb approximately 0.2 acre of the existing corridor, with no permanent effects anticipated.

Residential

No residential lands would be affected by construction and operation of the Project (table 4.7.1.1-2). However, mitigation activities associated with the Kentuck Project site would affect an estimated 7.4 acres currently designated for residential use. Impacts on existing residences are discussed in section 4.7.1.3.

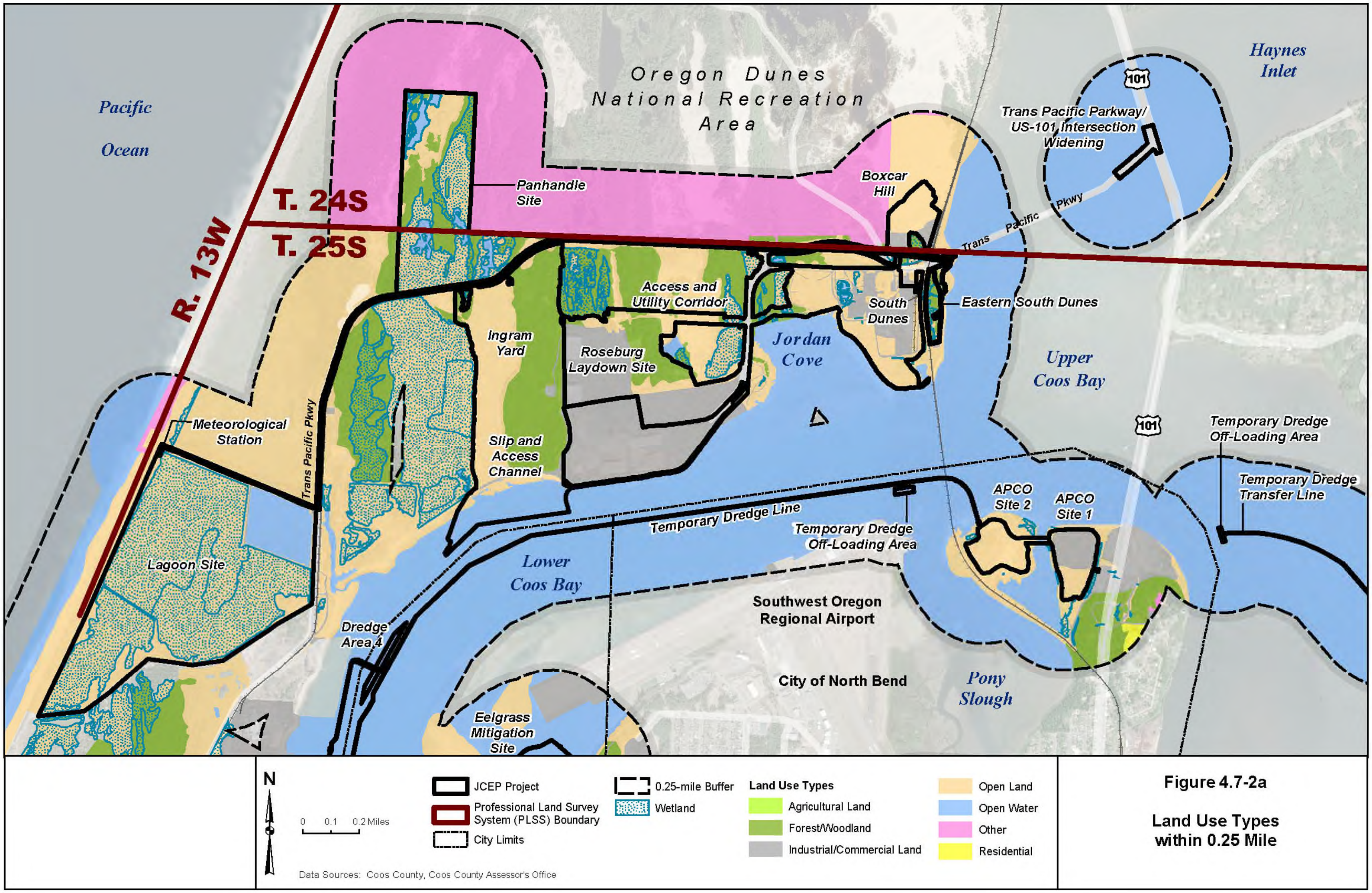
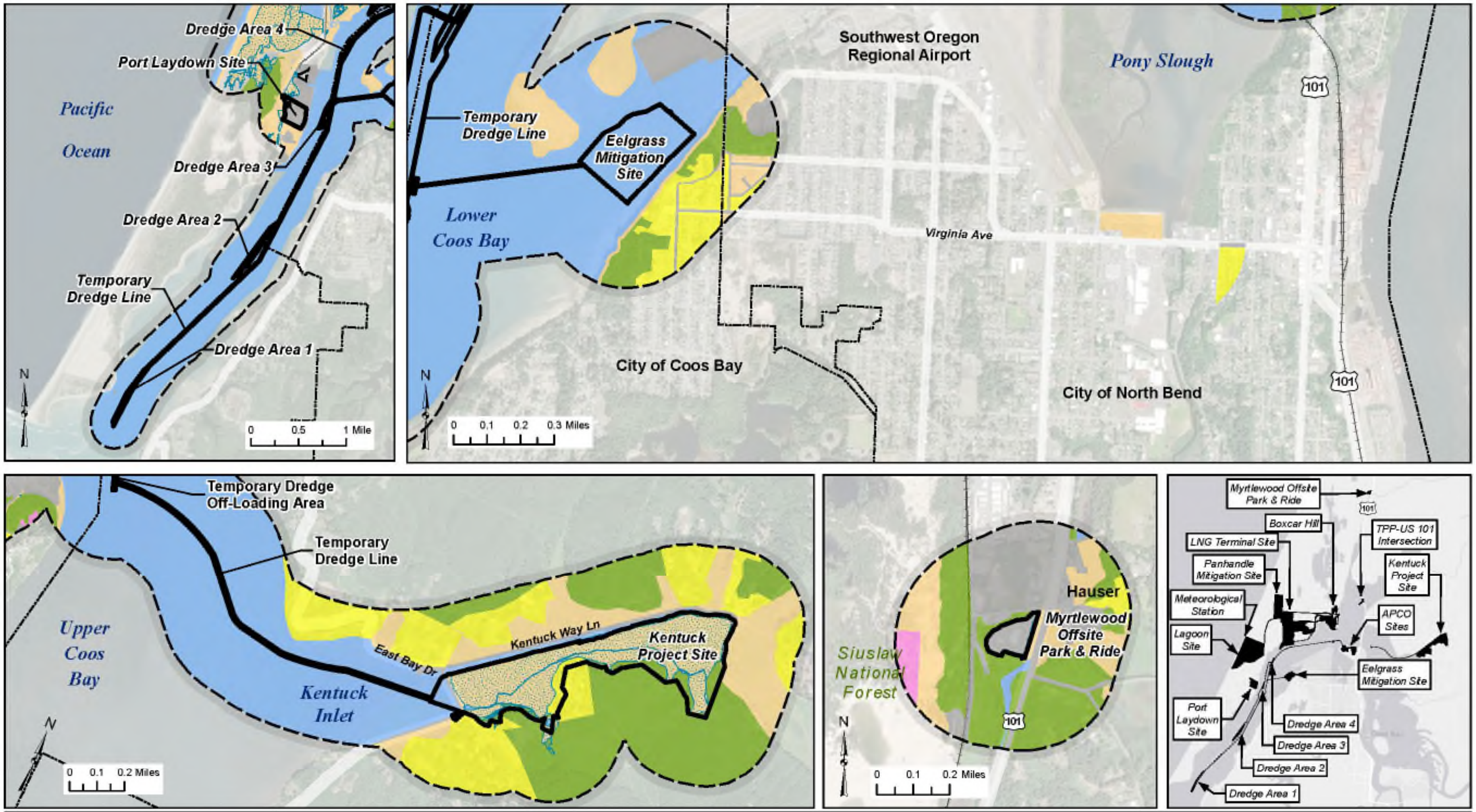


Figure 4.7-2a

Land Use Types within 0.25 Mile



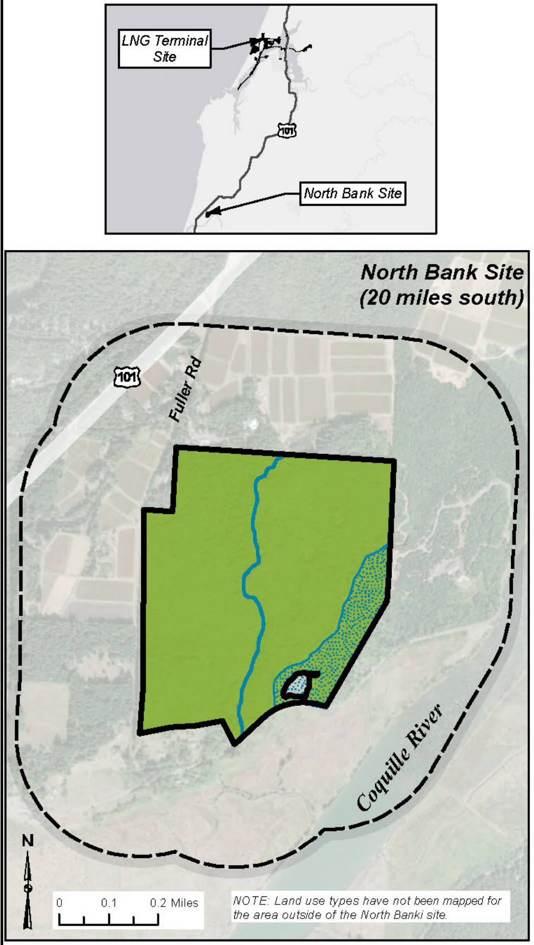
JCEP Project Area
City Limits
0.25-mile Buffer
Wetland

Land Use Types
Agricultural Land
Forest/Woodland
Industrial/Commercial Land
Open Land
Open Water
Other
Residential

Data Sources: BLM, Coos County Assessor's Office

Figure 4.7-2b

Land Use Types within 0.25 Mile



JCEP Project Area
City Limits
0.25-mile Buffer
Wetland

Land Use Types

Agricultural Land
Forest/Woodland
Industrial/Commercial Land
Open Land
Open Water
Other
Residential

Data Sources: BLM, Coos County Assessor's Office

Figure 4.7-2c

Land Use Types within 0.25 Mile

TABLE 4.7.1.1-2

Land Uses Affected by Construction and Operation of Aboveground Jordan Cove Project Area Facilities (in acres)[a/]

Project Facility/Activity	Forest/Woodland		Industrial/Commercial		Open Land		Open Water		Other		Residential	
	Const	Oper	Const	Oper	Const	Oper	Const	Oper	Const	Oper	Const	Oper
LNG Terminal Site												
Ingram Yard	72.9	45.9	4.3	2.8	40.8	34.0	0.0	0.0	0.0	0.0	0.0	0.0
South Dunes	5.7	2.5	35.0	13.8	52.2	8.7	0.8	5.7	0.0	0.0	0.0	0.0
Access and Utility Corridor, Fire Department	9.7	7.0	4.1	4.0	12.8	9.9	0.0	0.0	0.0	0.0	0.0	0.0
Hydraulic Dredge Pipeline	0.1	0.0	6.2	0.0	0.7	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Slip	16.4	16.4	1.1	1.1	22.7	20.4	0.0	0.0	0.0	0.0	0.0	0.0
Industrial Wastewater Pipeline	0.3	0.0	6.7	0.0	8.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Access Channel	0.0	0.0	0.3	0.2	4.1	4.1	29.1	27.0	0.0	0.0	0.0	0.0
Material Offloading Facility (MOF)	0.4	0.4	1.0	0.9	1.2	1.2	0.6	0.5	0.0	0.0	0.0	0.0
Trans Pacific Parkway/US-101 Widening	0.0	0.0	3.7	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
Meteorological Station and Access Road	0.0	0.0	0.6	<0.1	0.9	<0.1	0.0	0.0	0.0	0.0	0.0	0.0
Roseburg Laydown Site	16.2	0.0	60.6	0.0	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Port Laydown Site	0.0	0.0	33.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
APCO Sites 1 and 2	0.0	0.0	12.2	0.0	27.2	0.4	0.3	0.0	0.0	0.0	0.0	0.0
Off-Loading Area and Temporary Dredge Transfer Line for APCO Site 2	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
Boxcar Hill Site	0.3	0.0	5.9	0.0	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Myrtlewood Offsite Park & Ride	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Off-Loading Area and Temporary Dredge Transfer Line for Kentuck Project Site	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0
Off-Loading Area and Temporary Dredge Line for Eelgrass Mitigation Site	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
Dredge Areas	0.0	0.0	0.0	0.0	0.0	0.0	26.5	0.0	0.0	0.0	0.0	0.0
Temporary Dredge Line	0.0	0.0	0.0	0.0	<0.1	0.0	13.1	0.0	0.0	0.0	0.0	0.0
Total	**122.0**	**72.2**	**181.3**	**22.8**	**190.2**	**78.7**	**76.5**	**27.7**	**0.2**	**0.0**	**0.0**	**0.0**

a/ Note that columns may not sum correctly due to rounding.
b/ Const = construction
c/ Oper = operation

4.7.1.2 Coastal Zone Management

The Jordan Cove LNG terminal would be located within the Oregon coastal zone. The coastal zone is formally defined as extending from the Washington border on the north to the California border on the south; seaward to the extent of state jurisdiction as recognized by federal law (i.e., the territorial sea, extending 3 nautical miles offshore); and inland to the crest of the Oregon Coast Range. The Oregon Coastal Management Program of the ODLCD coordinates management of the State's coastal zone and reviews project-specific compliance and consistency with the CZMA. Procedures for ODLCD coastal zone reviews are specified in federal (15 CFR 930) and state regulations (OAR 660-035). Jordan Cove and Pacific Connector are currently in the process of filing their Coastal Zone Management Act (CZMA) application with the State. The Commission cannot authorize the start of construction until a consistency determination has been provided by the Oregon Coastal Management Program. Therefore, **we recommend that**:

- **Jordan Cove and Pacific Connector <u>should not begin construction</u> of the Project <u>until</u> they file with the Secretary a copy of the determination of consistency with the Coastal Zone Management Plan issued by the State of Oregon.**

4.7.1.3 Existing Residences, Commercial Buildings, and Planned Developments

The nearest residential structure to the LNG terminal site is about 1.1 miles to the southeast. There are no residences within 50 feet of any of the Jordan Cove LNG Project area facilities or the navigation route, with the exception of one residence located approximately 20 feet from the Kentuck project site and another located approximately 30 feet from the North Bank site. Neither of these residences are expected to be affected by Project-related construction or operations. All structures within 0.25 mile of the Project facilities are shown in figure 4.7-3a, figure 4.7-3b, and figure 4.7-3c. The following structures are located within 50 feet of the Jordan Cove facilities:

- one Coos Bay-North Bend Water Board (CBNBWB) facility approximately 50 feet from the Trans-Pacific Parkway work area;
- two structures within the construction work area for the Roseburg Laydown site;
- three structures within the construction work area for the Boxcar Hill site: one business and one shed that would not be affected, and one shed that would be removed; and
- one structure, the Myrtlewood Factory and Gift Shop, within the parking area that would be used as the Myrtlewood Off-site Park & Ride.

With the exception of the shed that would be removed from the construction work area for the Boxcar Hill site, none of these structures would be affected and no mitigation is proposed.

There are currently no planned residential or commercial developments identified within 0.25 mile of the Jordan Cove Project site. However, the Coos County Airport District is planning to extend one of the runways at the Southwest Oregon Regional Airport, which is approximately 0.55 mile south of the LNG terminal site. According to the October 2013 Southwest Oregon Regional Airport Master Plan Update (Coos County Airport District 2013), the Airport Layout Plan and the implementation plan included a proposed 400-foot-long extension of Runway 4-22; however, current plans do not identify this large of an extension. Current proposals are limited to cordoning off the northeast corner of the existing runway to gain land acreage for safety purposes to meet FAA regulations (Krug 2018).

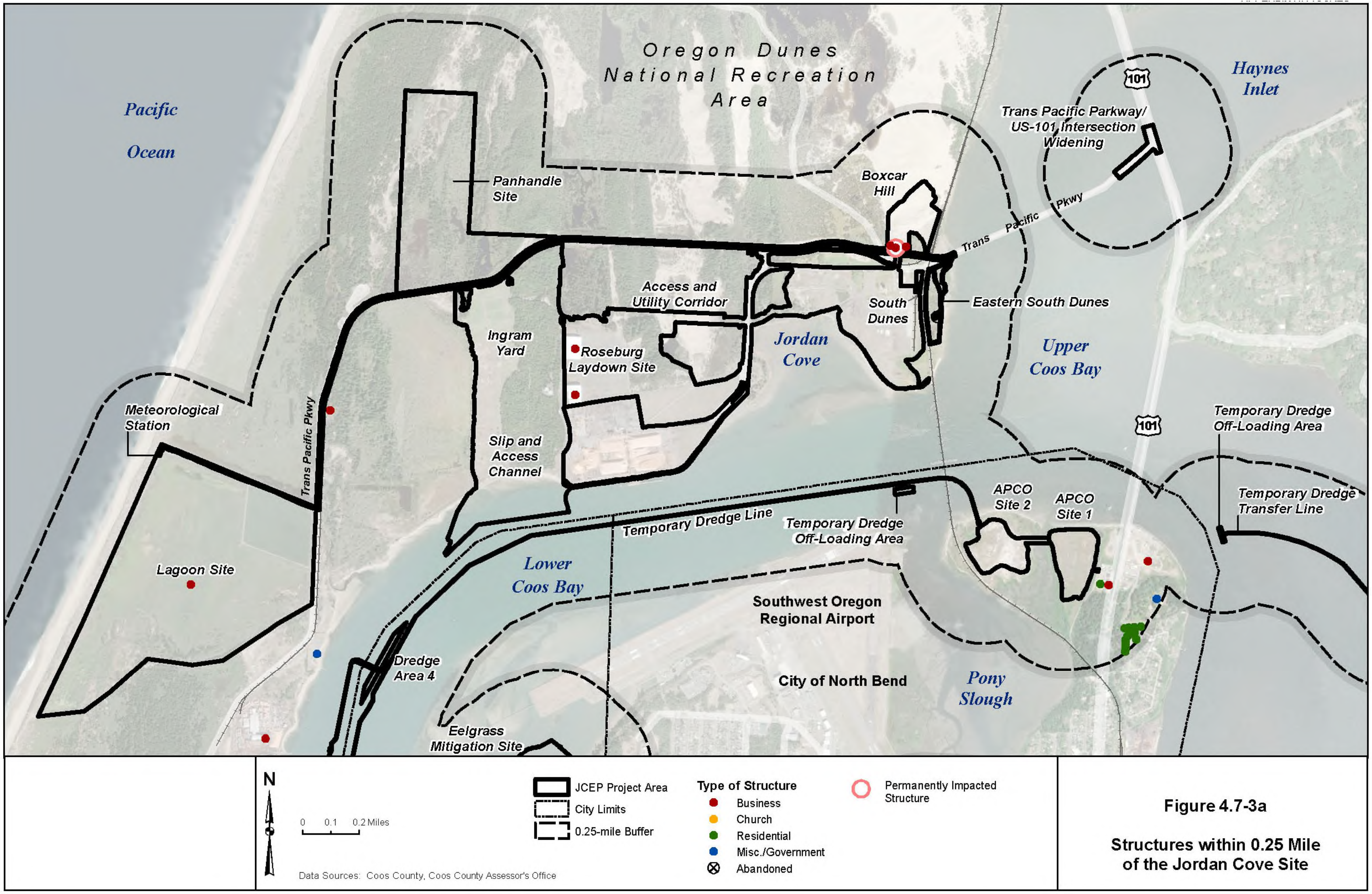


Figure 4.7-3a

Structures within 0.25 Mile of the Jordan Cove Site

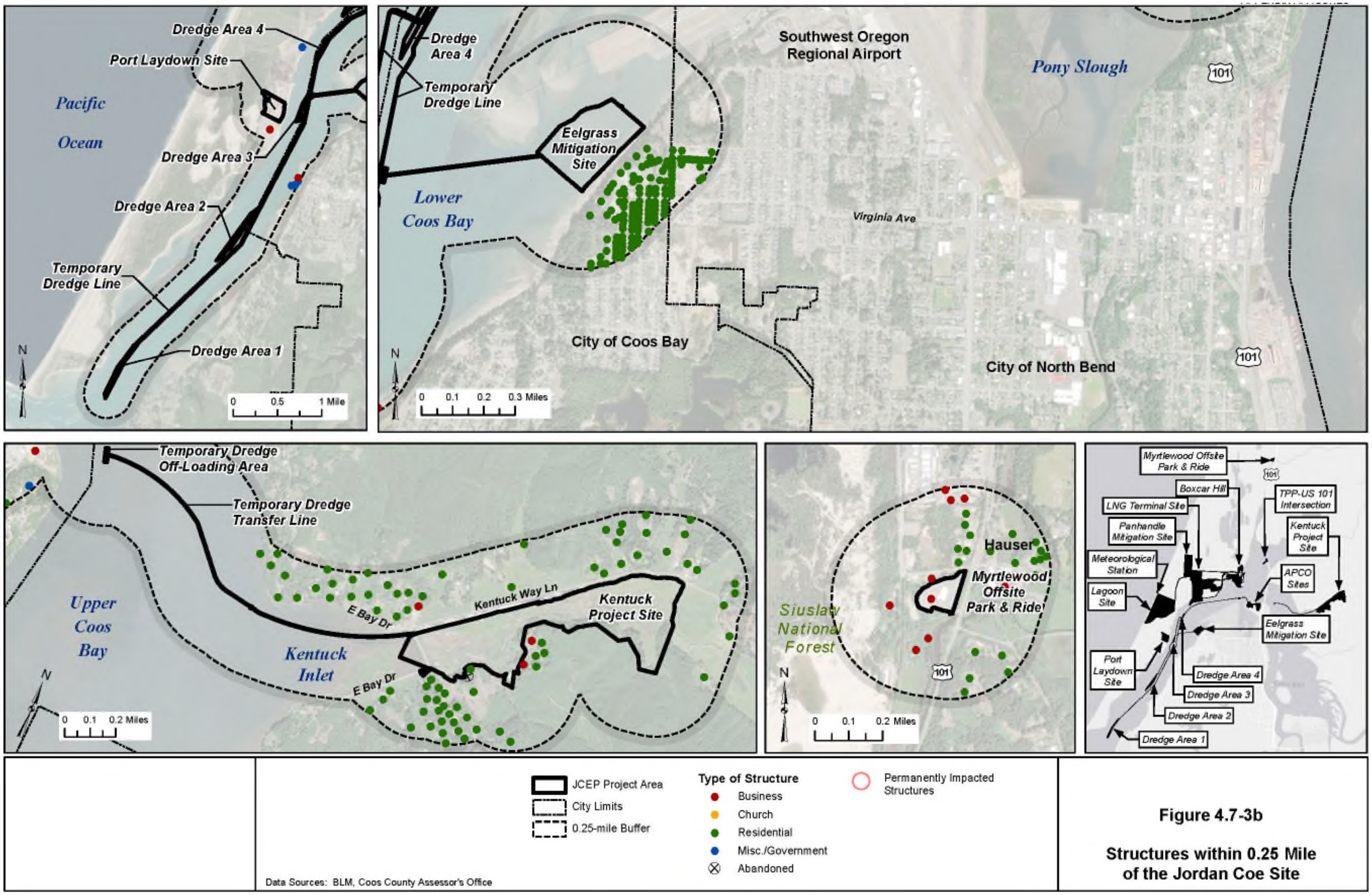
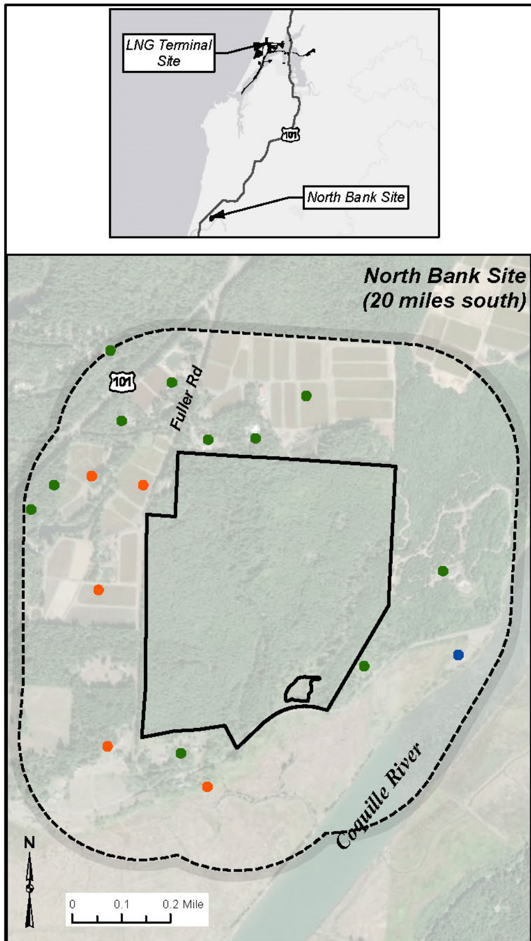


Figure 4.7-3b

Structures within 0.25 Mile of the Jordan Coe Site



JCEP Project Area

Type of Structure

- Farm Building
- Residential
- Misc./Government

Data Sources: BLM, Coos County Assessor's Office

Figure 4.7-3c

Structures within 0.25 Mile of the Jordan Cove Site

The City of North Bend has indicated that it expects to consider adoption of a proposed North Point Area Master Plan for the North Point District in the near future. The North Point District consists of approximately 80 acres made up of the northernmost parcels of North Point. The District is located southeast across Coos Bay from the LNG terminal site, and east across Pont Slough from the airport. The City of North Bend is also proposing to redevelop Simpson Park along Highway 101 to include a new Visitor Information Center and Parks Department facilities. The closest Project components to these areas would be the APCO sites. Advanced Health has demolished the McAuley Hospital in downtown Coos Bay, approximately 3 miles south of the proposed LNG terminal site, and is redeveloping the site to provide housing for Oregon Health and Science University medical students (Johnson 2018). Construction and operation of the LNG terminal is not expected to affect these plans or future uses.

4.7.1.4 Timber

The dune areas at the LNG terminal site currently contain non-merchantable timber. Before mobilizing earth-moving equipment, the trees would be felled and selectively processed for commercial timber. Scrub and stumps from across the site would be processed into mulch for use during construction operations.

4.7.2 Pacific Connector Pipeline and Associated Facilities

4.7.2.1 Land Ownership

The pipeline would cross public and private lands. Approximately 64 percent of the land crossed is privately owned, 34 percent is federal land and 2 percent is state lands (table 4.7.2.1-1). No tribal-owned lands or county lands would be crossed. Federally managed lands are discussed below.

TABLE 4.7.2.1-1

Land Crossed by the Pacific Connector Pipeline by Ownership

	Federal Land		State Land		Private Land		
County	**Miles**	**Percent of Overall Total**	**Miles**	**Percent of Overall Total**	**Miles**	**Percent of Overall Total**	**Total**
Coos	17.1	7.5	3.4	1.5	26.3	11.5	**46.8**
Douglas	21.3	9.3	0.0	0.0	43.6	19.0	**64.9**
Jackson	30.1	13.2	0.2	0.1	25.6	11.2	**56.0**
Klamath	9.2	4.0	0.2	0.1	51.9	22.7	**61.4**
Total	**77.7**	**33.9**	**3.9**	**1.7**	**147.5**	**64.4**	**229.1**

4.7.2.2 Existing Land Use

Land Use

<u>Pipeline</u>

The pipeline would cross a variety of land uses including forest land (62 percent), rangeland (14 percent), agricultural lands (14 percent), and developed land (8 percent) (table 4.7.2.2-1).

TABLE 4.7.2.2-1

Land Uses Crossed by the Pacific Connector Pipeline ROW

U.S. Geological Survey Land Use Classification			**Project Total (miles)**	**Percent of Total**
Developed Land	Residential		0.3	0.1
	Industrial		0.8	0.3
	Transportation/Communication		16.3	7.1
	Other Developed Land		1.1	0.5
		Subtotal	***18.5***	***8.1***
Agricultural Land	Cropland and Pasture		31.2	13.6
	Orchards, Groves, Vineyards, Nurseries		0.1	0.0
		Subtotal	***31.3***	***13.7***
Rangeland	Herbaceous Rangeland		8.9	3.9
	Shrub and Brush Rangeland		17.3	7.5
	Mixed Rangeland		8.0	3.5
		Subtotal	***34.2***	***14.9***
Forest Land	Deciduous Forest Land		4.4	1.9
	Evergreen Forest Land		46.2	20.2
	Clearcut Forest Land		9.6	4.2
	Regenerating Forest Land		49.2	21.5
	Mixed Forest Land		32.3	14.2
		Subtotal	***141.8***	***62.0***
Water	Streams		0.7	0.3
	Ditches and Canals		0.2	0.1
	Bays and Estuaries		2.4	1.0
		Subtotal	***3.3***	***1.4***
Other	Beaches		<0.1	<0.01
	Mines, Quarries, Gravel Pits		<0.1	0.01
		Subtotal	***<0.1***	***0.01***
		Project Total	**229.1**	**100**

Note: Rows and columns may not sum correctly due to rounding. Miles are rounded to the nearest tenth of a mile (values below 0.1 are shown as "<0.1").

A summary of acres affected by the construction and operation of the Pacific Connector pipeline is presented in table 4.7.2.2-2.

Developed Land

Pipeline construction would affect an estimated 721 acres of developed lands, mainly consisting of existing industrial land (49 percent; 350 acres) and transportation/communication corridors (44 percent; 316 acres) (table 4.7.2.2-2). The majority of the construction-related disturbance on existing industrial land (331 acres) would be related to temporary pipe storage. An estimated 111 developed acres would be permanently disturbed, with more than 91 percent of this disturbance related to the permanent ROW. The majority (86 percent) of the ROW disturbance would be located in existing transportation/communication corridors. Other developed areas disturbed during construction would be allowed to return to their existing uses.

TABLE 4.7.2.2-2

Acres of Land Affected by Construction and Operation of the Pacific Connector Pipeline Project

Project Feature	**Residential**	**Commercial**	**Industrial**	**Transportation/ Communication**	**Other Developed Land**	**Cropland/Pastureland**	**Orchards, Groves, Vineyards, Nurseries**	**Herbaceous Rangeland**	**Shrub/Brush Rangeland**	**Mixed Rangeland**	**Deciduous Forest Land**	**Evergreen Forest Land**	**Mixed Forest Land**	**Clearcut Forest Land**	**Regenerating Forest**	**Streams**	**Ditches/Canals**	**Bays and Estuaries**	**Beaches**	**Mines, Quarries, Gravel Pits**	**Total**
Construction Disturbance a/																					
Construction ROW	3.7	0.4	6.0	158.9	12.0	358.9	1.4	101.2	194.7	88.1	52.0	538.1	378.8	113.8	564.3	5.3	3.0	0.0	1.2	0.2	2,582.0
Klamath CS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.1
Temporary Extra Work Areas	3.1	0.1	12.8	66.2	16.2	173.8	0.6	39.8	73.2	59.0	16.3	103.8	101.5	29.9	192.8	3.8	1.1	0.1	6.5	22.2	922.6
Uncleared Storage Areas	0.1	0.0	0.0	19.2	0.0	0.3	0.0	3.1	10.7	2.9	5.8	159.5	215.9	66.7	191.9	0.6	0.0	0.0	0.0	0.0	676.4
Rock Source/Disposal	0.0	0.0	0.0	2.2	0.0	2.8	0.0	1.7	0.0	0.0	0.0	2.6	0.0	0.0	5.9	0.0	0.0	0.0	0.0	26.1	41.2
Contractor and Pipe Storage Yards	4.1	0.8	331.3	47.1	14.3	14.4	0.0	130.2	0.0	127.3	0.0	0.0	0.1	0.0	0.0	0.0	0.0	4.6	0.0	0.0	674.2
Access Roads (TARs/PARs) b/	0.1	0.0	0.0	22.5	0.0	2.4	0.0	0.9	0.4	1.0	0.1	0.4	0.1	0.3	0.2	0.0	0.0	0.0	0.0	0.0	28.5
Total	**11.1**	**1.4**	**350.1**	**316.0**	**42.5**	**552.4**	**2.0**	**276.9**	**296.2**	**278.2**	**74.3**	**804.4**	**696.4**	**210.8**	**955.2**	**9.7**	**4.1**	**4.6**	**7.6**	**48.5**	**4,942.1**
Operation Disturbance																					
Permanent Easement c/	2.0	0.2	4.7	94.7	6.3	188.5	0.7	53.7	104.5	47.8	26.8	279.4	197.6	60.0	299.1	3.1	1.4	2.9	0.1	0.1	1,373.7
Aboveground Facilities d/	0.0	0.0	1.7	1.7	0.0	0.4	0.0	0.5	17.4	0.4	0.0	0.0	0.2	0.1	0.3	0.0	0.0	0.0	0.0	0.0	22.8
Permanent Access Roads	0.0	0.0	0.0	0.1	0.0	0.3	0.0	0.9	0.2	0.5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Total	**2.0**	**0.2**	**6.4**	**96.5**	**6.3**	**189.3**	**0.7**	**55.0**	**122.2**	**48.8**	**26.8**	**279.5**	**197.9**	**60.1**	**299.5**	**3.1**	**1.4**	**2.9**	**0.1**	**0.1**	**1,398.6**
30-Foot Maintenance Corridor	1.1	0.1	2.8	57.9	3.8	113.3	0.4	32.2	62.8	28.4	16.0	167.8	117.6	35.5	178.4	1.7	0.8	0.0	0.1	0.1	820.6

Note: Rows and columns may not sum correctly due to rounding. Acres rounded to nearest whole acre (values below 1 are shown a "<1").
a/ Construction disturbance associated with the aboveground facilities is included in the pipeline construction ROW effects.
b/ Portions of some of the PARs are located within the construction ROW and, therefore, there is some duplication in the acreage calculations.
c/ The permanent easement is located within the disturbed acreage of the construction ROW. It is not an addition to the construction effects.
d/ Operation-related disturbance from aboveground facilities is summarized by facility in table 4.7.2.2-3.

CS = communication station; PAR = permanent access road; TAR = temporary access road

Agricultural Land

About 552 acres of cropland and pastureland would be temporarily affected by pipeline construction, with approximately 2 acres of orchards, groves, vineyards, and nurseries also expected to be affected (table 4.7.2.2-2). The majority of this disturbance would be associated with the construction ROW (65 percent) and TEWAs (31 percent). Grazing and other agricultural uses would not be allowed in the affected areas during construction. With the exception of the permanent ROW in orchards, agricultural lands disturbed during construction would be restored and returned to their original condition. Shallow-rooted crops and pasture grasses may be grown across the entire 50-foot-wide permanent easement. The planting of deep-rooted crops, such as orchards and vineyards, would not be permitted directly over the pipeline. Pacific Connector would negotiate with landowners and provide compensation for crop losses or orchards taken out of use as a result of pipeline construction. Landowners could select seed mixes or crops to be planted over the ROW in agricultural crop land or pastures.

To lessen effects on agricultural lands, Pacific Connector would segregate topsoil and repair any damaged irrigation systems or drain tiles. The segregation of topsoil is discussed in section 4.2. In addition, in agricultural areas the pipeline would have a minimum depth cover of 5 feet over the top of the pipe, where possible, to avoid operational effects. The largest proportion of agricultural lands that would be crossed by the pipeline are irrigated cropland in Klamath County.

Rangeland

Pipeline construction would affect an estimated 851 acres of rangeland (table 4.7.2.2-2). Temporary disturbance would result from the construction ROW (45 percent), TEWAs (20 percent), and pipe yards (31 percent). During construction, fences would be temporarily removed and affected lands would be unavailable for grazing. To reduce effects on rangelands (and pasture), Pacific Connector would erect temporary fences and gates to landowner specifications. Fences that are cut during construction would be braced and secured to prevent slack wires. If construction activities break or destroy a natural barrier used for livestock control, gaps would be temporarily fenced to prevent passage of livestock. After construction, fences, gates, and cattle guards (including any natural barriers broken) would be restored to their original state as soon as practical. Pacific Connector would contact the owners of fences prior to disturbing them and provide landowners with an opportunity to remove livestock from the construction ROW. Hayfields and pastures would not be cleared except in areas directly over the trench or where grading would be required to create a level working surface. Potential effects on grazing allotments on federal lands are discussed below in section 4.7.3.

Forest Land

Excluding areas along the pipeline route that have been clear cut recently and storage areas where trees would not be cleared, about 1,957 acres of upland forest would need to be cleared during pipeline construction activities. Less than one acre of forest would be permanently removed for access roads. During operation of the pipeline, a 30-foot-wide corridor centered on the pipeline would be kept in an herbaceous state, resulting in a permanent loss of about 804 acres of forest land. Outside of that 30-foot-wide corridor, forest would be restored within the remainder of the construction ROW. Pacific Connector would also follow the procedures for cutting forest along all lands crossed by its pipeline as outlined in the *Right-of-Way Clearing Plan for Federal Lands*[145] (note that although the title of the plan specifies "federal lands," the plan contains measures that would be applied on all lands). However, even with restoration, this would be a long-term to permanent effect, as it takes many years for trees to mature.

Approximately 65 miles of commercial private forestlands would be affected by the pipeline. Forest operations are not expected to be significantly altered, nor would the costs of forestry operations be expected to increase due to the presence of the pipeline; however, the Coquille Tribe raised concerned regarding the ability of operators to cross the pipeline. Surrounding forestry operators would be able to cross the pipeline ROW with heavy hauling and logging equipment, provided they coordinate those crossings with Pacific Connector and safety precautions are implemented to protect the integrity of the pipeline. While the requirement to coordinate with the pipeline operator would be an inconvenience for some forest operators, it does not constitute a significant change in forestry operations because the operator would be able to continue to cross the pipeline area in order to access or haul timber. Additionally, timber operators generally develop and carefully consider future harvesting and access plans. The need to consult with the pipeline operator if those plans include future crossings of the pipeline ROW would not represent a significant imposition or significant change in normal planning activities. The coordination requirement would also not significantly increase the cost of conducting forestry operations. In some situations, however, the presence of a pipeline along a ridge would require a change in log landing locations, which would affect timber operations. See additional discussion of potential effect on timber operations, including impacts on State Forest lands, in section 4.7.2.4.

Other

Other land uses that would be affected during construction include an estimated 8 acres of beaches and 49 acres of strip mines, quarries, and gravel pits (table 4.7.2.2-2). The affected beaches would primarily be used for TEWAs. The affected strip mines, quarries, and gravel pits would be used for TEWAs (46 percent) and rock source/disposal (54 percent). Approximately 0.1 acre of beach and 0.1 acre of strip mines, quarries, and gravel pits would be permanently affected.

Aboveground Facilities

Table 4.7.2.2-3 identifies the land uses that would be permanently affected by operation of the aboveground facilities.

TABLE 4.7.2.2-3

Acres Affected by Operation of Pacific Connector Proposed Aboveground Facilities

Facility a/	MP	Acres Disturbed During Construction b/	Land Use	Jurisdiction
Jordan Cove Meter Station, MLV #1, and Receiver c/, d/, e/	0.00	1.7	Industrial	Private
MLV #2 (Boone Creek Road)	15.1	0.1	Mixed Forest Land, Transportation	Private
MLV #3 (Myrtle Point Sitkum Road)	29.5	0.1	Cropland Pasture	Private
MLV #4 (Deep Creek Spur) e/	48.6	0.1	Mixed Forest Land	BLM
MLV #5 (South of Olalla Creek)	59.6	0.1	Cropland Pasture	Private
MLV #6, Launcher/Receiver e/	71.5	0.5	Herbaceous Rangeland	Private

[145] Included as Appendix U of Pacific Connector's POD filed on January 23, 2018.

TABLE 4.7.2.2-3 (continued)

Acres Affected by Operation of Pacific Connector Proposed Aboveground Facilities

Facility a/	**MP**	**Acres Disturbed During Construction b/**	**Land Use**	**Jurisdiction**
MLV #7 (Pack Saddle Road)	80.0	0.1	Mixed Forest Land	BLM
MLV #8 (Hwy 227)	94.7	0.1	Mixed Rangeland	Private
MLV #9 (BLM Road 33-2-12/Dead Horse Creek)	113.7	0.1	Evergreen Forest Land, Clearcut Forest Land	Private
AMLV #10 (Shady Cove) e/	122.2	0.1	Mixed Rangeland	Private
AMLV #11, Launcher/Receiver (Butte Falls) 5	132.5	0.3	Mixed Rangeland	Private
MLV #12 (Heppsie Mtn Quarry Spur)	150.7	0.1	Shrub and Brush Rangeland	BLM
MLV #13 (Clover Creek Road)	169.5	0.1	Regenerating Evergreen Forest	Private
MLV #14 and Launcher/Receiver Site	187.4	0.4	Regenerating Evergreen Forest Land, Shrub and Brush Rangeland	Private
AMLV #15 (Klamath River) e/	196.5	0.1	Cropland Pasture	Private
AMLV #16 (Hill Road) e/	211.6	0.1	Cropland Pasture	Private
Klamath Compressor Station, Klamath-Beaver and Klamath-Eagle Meter Stations, MLV #17, Launcher & Communications Tower e/	228.8	17.1	Shrub and Brush Rangeland	Private
Total		**21.1**		
Communication Sites				
Blue Ridge Communication Site – Coos County f/	~ 20	0.2	Transportation, Communications, and Utilities/Commercial	BLM
Signal Tree Communication Site – Coos County f/	~45	0.2		BLM
Sheep Hill Communication Site – Douglas County f/	~70	0.2		Private
Harness Mountain Communication Site – Douglas County g/	~75	0.0		Private
Starvout Communication Site – Jackson County f/	~115	0.2		Private
Flounce Rock Communication Site – Jackson County f/	~123	0.2		BLM
Robinson Butte Communication Site – Jackson County f/	~159	0.2		Forest Service
Stukel Mountain Communication Site – Klamath County f/	~209	0.2		BLM
	Total	**1.6**		
	Grand Total	**22.8**		

Note: Rows and columns may not sum correctly due to rounding. Miles are rounded to the nearest tenth of a mile.
a/ MLVs denoted as AMLV are automated valves and would include a 40-foot-tall communication tower.
b/ Temporary construction disturbance associated with the aboveground facilities is included within the Pipeline construction ROW, and is not double counted in total Pipeline disturbance estimates.
c/ The 17 mainline block valves (MLVs) would be located within areas disturbed by the construction right-of way or within associated aboveground facility footprints (*i.e.*, meter stations and the compressor station); however, the permanent operation acres provided would remain as permanent disturbance associated with these graded, graveled and fenced facilities.
d/ The Jordan Cove meter station would be located entirely within the proposed LNG terminal.
e/ Communication facilities are included in the disturbed areas associated with the meter station, block valves and compressor station.
f/ Communication facilities would utilize existing towers and equipment buildings, where space is available for lease, with no associated disturbance. If construction of new facilities is required, Pacific Connector would obtain an approximate 100 x 100 foot (0.23 acre) area in the immediate area of the existing communication tower facilities.
g/ The Harness Mountain Communication Tower is an existing communication facility, with no new disturbance is required.

4.7.2.3 Coastal Zone Management

Coos County and a portion of Douglas County, up to the crest of the Coastal Range, are within Oregon's coastal zone. Therefore, Pacific Connector would need to obtain a finding from the ODLCD that the portion of its pipeline within the coastal zone (MPs 1.5 R to 53) is consistent with the CZMA. This consistency determination would be made for both the pipeline portion as well as the LNG portion of the Project. Coastal zone management is discussed further in section 4.7.1.2.

4.7.2.4 Existing Residences, Commercial Buildings, and Planned Developments

Existing Residences

No commercial buildings or residences are located within 50 feet of the proposed pipeline or aboveground facility workspaces. The edge of the construction work area for the pipeline would be located within 50 feet of seven residences (see table 4.7.2.4-1). Two of these residences are abandoned and would be removed as part of the Project. For the residences within 50 feet of construction work areas, Pacific Connector developed site-specific drawings depicting the temporary and permanent ROWs and has noted special construction techniques and mitigation measures (see appendix J). We are seeking any additional comments from the affected landowners on these site-specific drawings.

TABLE 4.7.2.4-1

Residences within 50 Feet of the Construction ROW or Temporary Extra Work Areas

MP	Distance from Pipeline (feet)	Distance from Edge of Construction Work Area (feet)	Number of Residences
49.7	106	41	1
56.9 a/	0	0	1
57.5	57	17	1
65.6	112	47	1
65.9	92	15	1
199.7	161	33	1
228.8 a/	1,680	0	1

a/ Abandoned residences at MP 56.9 and 228.8 would be removed prior to construction.

Within 50 feet of residences, the edge of the construction work area would be fenced for a distance of 100 feet on either side to ensure that construction equipment and materials, including the spoil pile, remain within the construction work area. Fencing would be maintained, at a minimum, throughout the open trench phases of pipeline installation. Where possible, the width of the construction ROW would be reduced near residences, and TEWAs would be located as far away from residences as practical. Pacific Connector would also limit the period of time the trench remains open prior to backfilling in residential areas.

Pacific Connector would implement numerous measures to reduce effects on residential properties including:

- Landowners would be notified at least 45 days prior to construction, and Pacific Connector would implement a Landowner Complaint Resolution Procedure. If a landowner is not satisfied with Pacific Connector's response to a complaint, they would be directed to call or email FERC's Dispute Resolution Division for further assistance.
- Pacific Connector would install orange safety fence between the construction ROW and the residence.
- Pacific Connector would attempt to schedule activities during normal working hours. Pacific Connector does not currently plan to work on Sundays; however, certain activities, such as waterbody crossing construction and hydrotesting, may require a 24-hour work schedule.
- Pacific Connector would comply with all local noise ordinances.

- Access and traffic flows would be maintained during construction activities through residential areas, particularly for emergency vehicles. Access to residences would be maintained at all times.
- Dust minimization techniques such as watering would be used on-site and all litter and debris would be removed daily from the construction site.
- Mature trees, vegetation screens, and landscaping would be preserved to the extent possible. Landowners would be compensated for the removal of any trees.
- Immediately after backfilling the trench, all lawn areas and landscaping within the construction work area would be restored.
- Pacific Connector would provide alternative sewer facilities if septic system is disturbed during construction. Pacific Connector would repair and restore septic systems affected by construction.
- Pacific Connector would compensate landowners for damage to homes should the home be damaged by pipeline construction.

During the scoping process, many landowners expressed concern about the pipeline and requested that the pipeline be moved off their property. Section 3.4 evaluates route alternatives to lessen effects on specific tracts where landowners raised routing concerns. Other comments expressed concern about effects on water wells, utility lines, septic systems, slope erosion, farming operations, loss of future development opportunities, and effects on environmental resources. As appropriate, these comments have been addressed throughout this analysis.

Concerns were raised about the location of the pipeline relative to the Woods Valley Airport, a licensed airport located near Trail, Oregon. As currently proposed, the pipeline would cross the runway. Pacific Connector outlined the measures that it proposes to implement to reduce impacts on the airport in a filing with FERC dated January 3, 2018. These measures include crossing the grassed airstrip as a tie-in crossing, scheduling construction at a time negotiated with the landowner, and either salvaging and replacing the existing sod or installing new sod following construction. In a letter to the FERC dated August 17, 2018, legal counsel for the property owner indicated that they believed Pacific Connector's January 3, 2018 response to be inadequate and requested that FERC require Pacific Connector to relocate the pipeline to avoid crossing the airstrip. Concerns expressed in the letter include safety concerns related to burying a natural gas pipeline several feet below a runway that is the location of aircraft take-offs and landings.

Planned Developments

Pacific Connector's communications with Coos County, the City of North Bend, Douglas County, Jackson County, and Klamath County did not identify any large-scale residential, commercial, or business projects/planned developments within 0.25 mile of the pipeline.

Comments received from affected landowners and other interested parties during scoping expressed concern that the pipeline would affect the ability of landowners to undertake small-scale developments, such as adding a home site, barn, or other structure, or subdividing a lot into two parcels for development. In some cases, Pacific Connector modified the route of the pipeline to avoid improvements on private parcels, as discussed in section 3.4 (Pipeline Route Alternatives) of this EIS.

4.7.2.5 Timber

Pipeline construction would require clearing all forested vegetation and timber from a 95-foot-wide temporary ROW and associated TEWAs. Timber removal and construction activities would take place over two years. While Pacific Connector anticipates that timber clearing would typically be done from May through November (the usual dry period in Oregon), timing restrictions would be imposed within habitat for federally listed NSO and MAMU (see section 4.6). Timber clearing within MAMU stands or within 300 feet of MAMU stands would not occur during the MAMU breeding season, which occurs between April 1 to September 15, in order to prevent impacts on nesting MAMU. Habitat removal within 0.25 mile of an NSO activity center would occur outside of the NSO's breeding season (see section 4.6).

Impacts on forest and timber resources would depend on the clearing (logging) methods used, quantity of lumber removed, and the age of affected stands. The Pacific Connector pipeline would cross approximately 39.3 miles of LSOG forests, 43.7 miles of mid-seral forests, and 59.5 miles of recently harvested forested lands. Table 4.7.2.5-1 lists the log types that occur along the pipeline's route.

TABLE 4.7.2.5-1

Merchantable Timber to be Cleared for the Proposed Pacific Connector Pipeline, by Class and Age

Type of Timber	Diameter to Breast Height (inches dbh)	Inside Top Bark Height Diameter (inches)	Age
Small conifer sawlog	10-20	6-10	26–60 years
Medium conifer sawlog	20-30	8-12	61–100-125 years
Large conifer sawlog	30 and larger	8-16	125–250 years; with an unquantified population of ancient relic trees 300 to 500 years

While timber cruises have not yet been conducted, information available indicates that approximately 1,573 acres of large mature trees over 40 years in age and approximately 1,177 acres of small to medium trees under 40 years in age would be harvested to construct the pipeline. A portion of these 1,177 acres of small to medium trees would not be merchantable (e.g., those less than 25 years in age). Future timber production would be lost on these younger (small and medium) stands. The exact number and board feet of these non-merchantable trees would be determined during timber cruises. Operating the pipeline would permanently affect approximately 514 acres of forest, which would be removed from the future timber base.

Timber cruises would be conducted prior to vegetation clearing to determine timber volumes, values, and species composition within forested lands. These timber cruises would be completed on private lands in compliance with professional forestry standards and on federal lands to required federal agency standard. Information gathered from timber cruises would be used to determine damage payments during easement acquisition. Pacific Connector would be required to retain qualified foresters and logging engineers to develop site-specific logging plans for each area to be logged. These plans would identify the size, height, volume, and value of trees in each portion of the construction ROW, how the timber would be felled and yarded, where landings and log decks would be placed, the haul routes that would be used to remove the logs, and how logging debris would be disposed of. Logging methods would vary by location, and would not be known until timber contractors evaluate site-specific conditions. The exact timber harvest and decking requirement locations would be determined by the contractor within the access roads and staging areas already approved for the pipeline.

Merchantable timber would be cut and removed from the construction ROW and TEWAs. In limited areas, TEWAs have been identified for log storage and decking. Clearing of forest is a two-step process: tree felling followed by yarding. Pacific Connector's ***Right-of-WayROW** Clearing Plan for Federal Lands* outlines different scenarios that may be used to cut and remove timber from the ROW along the pipeline route, based on slope, stand density, and tree types. Ground-based skidding and cable (where feasible) logging methods would likely be the standard method.

In some isolated rugged topographic areas with poor access, helicopter logging may be used. Cable and helicopter logging methods would minimize the potential for soil compaction. Any timber cleared from the ROW that would be used for instream or upland wildlife habitat diversity structures would be stored on the edge of the ROW or in TEWAs for later use during restoration efforts. Prior to clearing operations, the EI or Pacific Connector's authorized representative would flag existing snags on the edges of the construction ROW or TEWAs where feasible to save from clearing. These snags would be saved as and used in placement projects to benefit primary and secondary cavity nesting birds, mammals, reptiles, and amphibians. During this process, other large diameter trees on the edges of the construction ROW and TEWAs would also be flagged to save/protect as green recruitment or habitat/shade trees, where feasible. Some of these trees would be girdled to create snags to augment the number of snags along the ROW to benefit cavity nesting birds, mammals, reptiles, and amphibians; however, snags that are determined to be a threat to worker safety would be removed.

Danger trees are those trees at risk of falling on workers or vehicles and thus would need to be removed for safety reasons. A tree may be at risk of falling for a number of reasons including the tree's location and the presence of defects, insects, disease, work activities, and weather conditions. Such trees would be felled in advance of logging, pipeline construction, road construction/reconstruction, and road maintenance. Additionally, danger trees could be created from trees felled for the pipeline. This would occur if trees outside of approved construction areas are damaged during felling of harvested timber. While this could result in growth loss, for which Pacific Connector would compensate the land-management agency (or landowner on private lands) for any trees removed and any loss in timber productivity, the FERC requires that all operations be contained within the certificated work areas. Danger trees would be designated by qualified Pacific Connector representatives, in accordance with OSHA standards and the Forest Service/BLM–published *Field Guide for Danger Tree Identification and Response* (Forest Service and BLM 2008). Danger trees exterior to the ROW would be directionally felled, when consistent with OSHA guidelines, away from the construction ROW if trees are to be left, and towards the construction ROW if trees are to be removed. To ensure safety during construction, Pacific Connector has requested a variance to Section IV.A.1 of the FERC's *Plan* for removing danger trees outside the approved construction limits. Pacific Connector would compensate the respective land manager/owner for any merchantable danger trees that are felled.

Logs would not be stored next to conifer trees bordering the sides of the ROW to avoid damage to live trees. Logs planned for removal from the site would be hauled off the site as soon as practical following yarding in order to prevent disease problems, as well as potential theft problems. Slash pieces larger than 8 inches in diameter may be decked for short periods in agency or landowner designated and approved storage areas or in places where roads cross the ROW and made available to the public. However, Pacific Connector has stated that they may place LWD in UCSAs adjacent to standing conifers.

Where feasible, logs yarded out of wetlands or riparian zones would be skidded with at least one end suspended from the ground so as to minimize soil disturbance. Pacific Connector proposes that any debris entering a waterbody as a result of felling and yarding of timber would be removed as soon as practical after entry into the waterbody and shall be placed outside the 100-year floodplain where practical, unless specified otherwise by the applicable landowner or land-managing agency. Logs and slash would not be yarded across perennial streams unless fully suspended. During logging/clearing operations, the direction of log or slash movement would be conducted to minimize sediment delivery to waterbodies, including intermittent streams. Logs firmly embedded in the bed or bank of waterbodies that are in place prior to felling and yarding of timber would not be disturbed, unless they prevent trenching and fluming operations. Any existing logs that are removed from waterbodies to construct the pipeline crossing would be returned to the waterbody after the pipeline has been installed, backfilling is complete, and during the time the streambanks are being restored.

In addition to the above mentioned impact minimization measures, Pacific Connector would implement the following measures to further reduce impacts on timber:

- All tree felling and vegetation clearing would occur within the certificated construction work areas, except for danger trees adjacent to the ROW, additional work areas, and travel corridors. Trees within the certificated construction work areas would be directionally sheared or felled so as to prevent damage to adjacent trees, facilities, or structures.
- Where ground skidding is used, the following measures would be employed to minimize significant detrimental soil disturbance (compaction and displacement):
  - low ground weight (pressure) vehicles would be used;
  - logging machinery would be restricted to the 30-foot permanent ROW wherever possible to prevent soil compaction;
  - the removal of soil duff layers would be avoided in order to maintain a cushion between the soil and the logs and the logging equipment;
  - designed skid trails would be used to restrict detrimental soil disturbance (compaction and displacement) to a smaller area of the ROW over the pipeline trenching area; and
  - landings, yarding, and load-out areas used for timber harvesting would be scarified or after use and prior to the rainy season where the potential for sediment delivery to waterbodies is possible.
- Material designated to remain on site to meet resource concerns would be placed in designated UCSAs along the edge of the ROW and then scattered/redistributed across the ROW during final cleanup and reclamation (following seeding). In upland areas, stump removal would be limited to the trenchline and areas where grading is necessary to construct a safe, level working plane.
- Off-site slash disposal and/or burning may occur in areas where slash is concentrated, such as landings. Slash would be machine or hand piled with the outer edge of piles no closer than 20 feet from the outer drip line of live trees, and burned according to state burning

requirements and landowner, BLM, and Forest Service stipulations. Burns would occur during the wet season.

- Outside of the 30-foot-wide permanent pipeline easement, which would be kept clear of trees with roots that could compromise the integrity of the pipeline coating, the temporary construction area would be restored and revegetated using native seeds, to the extent possible, and saplings according to the ECRP.

State Lands

The proposed route would cross the Southwest Oregon and the Eastern Oregon Forest Practices Regions, which contain mature forest. Trees within this portion of the ROW would be cut and merchantable trees would be sold as directed by Oregon Department of Forestry (ODF). As stipulated within ORS 527.670(3), a written plan must be submitted to the ODF State Forester before extracting timber within:

- 100 feet of a stream classified as Type F (stream with fish or fish and domestic water use) or Type D (stream with domestic water use but no fish use);
- 300 feet of a specific site involving threatened or endangered wildlife species, or sensitive nesting, roosting, or water sites;
- 300 feet of any resource site identified in OAR 629-665-0100 (Sensitive Bird Nesting, Roosting, and Watering Resource Sites on Forestlands), OAR 629-665-0200 (threatened and endangered species that use Resource Sites on Forestlands), or OAR 629-645-0000 (Significant Wetlands); and
- 300 feet of any nesting or roosting site, or critical habitat of threatened or endangered species listed by the FWS or by the ODFW Commission.

If necessary, Pacific Connector would prepare and submit to the ODF State Forester for approval a written plan describing how the pipeline would be in compliance with the Forest Practices Act (OAR 629-605-0170), prior to harvesting activities. In addition to the written plan, Pacific Connector would be required to submit a Notification to the ODF. The Notification serves three purposes: notification of a forest operation (ORS 527.670), a request for a Permit to Use Fire or Power Driven Machinery (PDM, ORS Chapter 477), and notice to the Department of Revenue of timber harvest (ORS 321.550).

4.7.3 Environmental Consequences on Federal Lands

4.7.3.1 Land Requirements on Federal Lands

The Pacific Connector pipeline would cross approximately 31 miles of NFS lands and 47 miles of BLM lands (table 4.7.3.1-1). Between MPs 200.5 and 227.2, the pipeline would cross 31 irrigation facilities that fall under the jurisdiction of Reclamation.

Temporary impacts of the pipeline on federal lands would include timber and brush clearing, grading, trenching, impacts to visual quality at some locations, and soil compaction as a result of equipment driving and storage of logs, slash, pipe lengths, and other supplies. Long-term impacts include the time it would take trees to grow back within the temporary construction ROW. Permanent impacts would include the conversion of forest to herbaceous vegetation within a 30-foot-wide corridor kept clear of trees, and prohibitions of use of the operating pipeline easement. The pipeline and associated facilities would not cross, and therefore no acreage would be removed from, any federally designated wilderness, wildlife refuge areas, or inventoried roadless areas.

TABLE 4.7.3.1-1

Federal Lands Affected by the Pacific Connector Pipeline Project

Pipeline Facility/Component	Jurisdiction BLM	Forest Service	Reclamation
Miles Crossed by Pipeline	46.8	30.6	0.3
Temporary Construction Acreage Requirements (acres)			
Construction ROW	535	350	4
Temporary Extra Work Areas	166	103	<1
Uncleared Storage Areas	184	124	0
Off-site Source/Disposal	7	9	0
Existing Roads Needing Improvements in Limited Locations	2	1	0
Temporary Access Roads (TAR)	<1	0	0
Hydrostatic Discharge Locations Outside the ROW	<1	0	0
Total Temporary Impacts (acres)	**894**	**587**	**4**
Permanent Construction Acreage Requirements (acres)			
Permanent Easement	245	185	2
Permanent Access Roads (PAR)	<1	0	0
Existing Roads Needing Improvements in Limited Locations a/	2	1	0
Aboveground Facilities	<1	0	0
Total Permanent Impacts (acres)	**248**	**186**	**2**
ROW (acres)			
30-Foot Maintained ROW (acres)	147	111	1

Note: Columns may not sum correctly due to rounding. Miles rounded to the nearest tenth of a mile (values below 0.1 are shown as "<0.1"). Acres rounded to the nearest whole acre (values less than 1 shown as "<1").

a/ Road improvements necessary for construction would not be restored; however, no additional maintenance would occur on access roads improved for construction of the Project. Acres are not included in the Permanent Construction acres total.

Pacific Connector would protect its pipeline from corrosion over time through a CP system. The CP system would consist of a number of sites where below ground rectifier/anode beds would be installed that input a low voltage electrical charge into the pipeline. These rectifier/anode beds would typically be spaced about 15 to 20 miles apart, usually installed within the previously disturbed pipeline construction ROW. The CP system would be installed about one year after the pipeline would be constructed, to allow the trench to stabilize and for collection of post-construction data on electro-conductivity soil potentials, which is required before the system can be designed and installed. Pacific Connector would consult with appropriate federal, state, and local regulatory agencies after pipeline construction to acquire the permits necessary for the CP system. A *Corrosion Control Plan* was included as Appendix F to Pacific Connector's POD. Based on a preliminary analysis of CP sites that could create a potential for new electrical service, there is no need for new electrical service on federal lands.

Table 4.7.3.1-2 provides acres affected by the pipeline broken out by land use type and ownership for each federal jurisdiction.

TABLE 4.7.3.1-2

Federal Lands Required for Construction and Operation of the Pacific Connector Pipeline by Land Use Type (acres)

Jurisdiction/ Project Element	Residential	Industrial	Transportation/ Communication	Cropland/Pastureland	Orchards, Groves, Vineyards, Nurseries	Herbaceous Rangeland	Shrub/Brush Rangeland	Mixed Rangeland	Deciduous Forest Land	Evergreen Forest Land	Mixed Forest Land	Clearcut Forest Land	Regenerating Forest Land	Streams	Ditches	Forested Wetlands	Nonforested Wetlands	Strip Mines, Quarries, Gravel Pits	Total
Coos Bay BLM																			
Construction a/	0	0.1	30.05	1.09	0.01	0	0	0	0	99.51	71.09	5.00	76.83	0.22	0	0.38	.07	0.39	**284.64**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Operational Easement b/	0	0	14.24	0.19	0.01	0	0	0	0	39.19	24.58	1.49	23.45	0.12	0	0.20	0.03	0	**103.48**
Permanent Access Roads c/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
30-Foot Maintenance Corridor	0	0	6	<1	0	0	0	0	0	24	1	1	8	<1	0	<1	0	0	**39**
Roseburg BLM																			
Construction a/	0	0	22.71	0	0	0.36	4.87	0	0	74.29	144.75	4.90	64.38	0.04	0	0	0.01	0	**316.32**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0	0	0	0	0.18	0	0	0	0	0	0	0	**0.18**
Operational Easement b/	0	0	7.65	0	0	0.06	1.61	0	0	22.32	33.24	.73	15.21	0.02	0	0	0	0	**80.84**
Permanent Access Roads c/	0	0	0.03	0	0	0	0	0	0	0	0.13	0	0.03	0	0	0	0	0	**0.18**
30-Foot Maintenance Corridor	0	0	2	0	0	<1	<1	1	0	27	0	<1	19	<1	0	0	0	0	**50**
Medford BLM																			
Construction a/	0.01	0	5.64	0	0	11.62	55.78	2.73	30.86	71.82	64.23	0	30.19	0.40	0.05	0	0.07	0	**273.38**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0.09	0	0	0	0	0	0	0	0	0	0	0	**0.09**
Operational Easement b/	0	0	1.75	0	0	3.90	19.09	1.30	10.51	23.93	20.30	0	10.84	0.14	0.03	0	0.03	0.0	**91.83**
Permanent Access Roads c/	0	0	0.03	0	0	0.01	0.12	0	0	0	0	0	0	0	0	0	0	0	**0.16**
30-Foot Maintenance Corridor	0	0	1	0	0	3	11	<1	8	13	11	<1	8	<1	<1	<1	0	<1	**55**
Lakeview BLM																			
Construction a/	0	0	1.19	0	0	0	0.67	0.64	0	15.85	0	0	0	0.02	0	0	0	0	**18.37**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Operational Easement b/	0	0	0.65	0	0	0	0.22	0.16	0	6.81	0	0	0	0.01	0	0	0	0	**7.85**
Permanent Access Roads c/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
30-Foot Maintenance Corridor	0	0	<1	0	0	0	<1	<1	0	4	0	0	0	<1	0	0	0	0	**5**
Umpqua National Forest																			
Construction a/	0	0	14	0	0	0	0	0	0	162	0	0	23	<1	<1	<1	<1	12	**211**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Operational Easement b/	0	0	4	0	0	0	0	0	0	52	0	0	9	<1	<1	<1	0	0	**66**

TABLE 4.7.3.1-2 (continued)

Federal Lands Required for Construction and Operation of the Pacific Connector Pipeline by Land Use Type (acres)

Jurisdiction/ Project Element	Residential	Industrial	Transportation/ Communication	Cropland/Pastureland	Orchards, Groves, Vineyards, Nurseries	Herbaceous Rangeland	Shrub/Brush Rangeland	Mixed Rangeland	Deciduous Forest Land	Evergreen Forest Land	Mixed Forest Land	Clearcut Forest Land	Regenerating Forest Land	Streams	Ditches	Forested Wetlands	Nonforested Wetlands	Strip Mines, Quarries, Gravel Pits	Total
Permanent Access Roads c/	0	0	<1	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	<1
30-Foot Maintenance Corridor	0	0	3	0	0	0	0	0	0	31	0	0	6	<1	<1	<1	0	0	**39**
Rogue River National Forest																			
Construction a/	0	0	15	0	0	<1	7	3	0	131	0	<1	109	<1	0	0	0	16	**283**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Operational Easement b/	0	0	5	0	0	<1	1	1	0	45	0	<1	32	<1	0	0	0	0	**83**
Permanent Access Roads c/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
30-Foot Maintenance Corridor	0	0	2	0	0	<1	1	1	0	27	0	<1	19	<1	0	0	0	0	**50**
Winema National Forest																			
Construction a/	0	0	3	0	0	1	0	0	0	56	0	<1	31	<1	0	<1	0	0	**92**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Operational Easement b/	0	0	1	0	0	<1	0	0	0	23	0	<1	12	<1	0	<1	0	0	**37**
Permanent Access Roads c/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
30-Foot Maintenance Corridor	0	0	<1	0	0	<1	0	0	0	14	0	<1	7	<1	0	<1	0	0	**22**
Bureau of Reclamation																			
Construction a/	0	0	0	<1	0	0	4	0	0	0	0	0	0	0	<1	0	0	0	**4**
Aboveground Facilities Outside the ROW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Operational Easement b/	0	0	0	<1	0	0	2	0	0	0	0	0	0	0	<1	0	0	0	**2**
Permanent Access Roads c/	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
30-Foot Maintenance Corridor	0	0	0	<1	0	0	1	0	0	0	0	0	0	0	<1	0	0	0	**1**

Note: Rows may not sum correctly due to rounding. Acres rounded to nearest whole acre (values below 1 are shown as "<1".

a/ Construction disturbance associated with pipeline facilities including construction ROW, TEWAs, UCSAs, TARs, existing roads needing improvements, pipe yards, off-site source and disposal areas, and hydrostatic discharge locations outside the ROW.

b/ The operational ROW is located within the disturbed acreage of the construction ROW. It is not an addition to the construction impacts.

c/ Portions of some of the PARs are located within the construction ROW and, therefore, there is some duplication in the acreage calculations.

BLM Lands

The Pacific Connector pipeline would cross approximately 47 miles of BLM lands within the Coos Bay, Roseburg, Medford, and Lakeview Districts. Of the aboveground facilities, three MLVs would be located on BLM lands. Pacific Connector also proposes to construct one new TAR to support construction and three new PARs on BLM lands to support construction and operation.

Acres of BLM lands, by land use classification, that would be affected by pipeline construction and operation are listed above in table 4.7.3.1-2. For all of the BLM land crossed combined, construction of the Pacific Connector pipeline would affect about 669 acres of forest, 60 acres of rangeland, 54 acres of transportation-utility lands, less than 0.1 acre of agricultural land, 0.8 acre of wetlands, 1 acre of water, and about 2 acres of barren lands/quarries. The BLM expressed concerns regarding impact of the pipeline on current and future forest management activities on federally administered lands that might result from prohibited or restricted land management and use activities within or near the pipeline ROW. In response, Pacific Connector provided a list of activities that would be prohibited or restricted on the pipeline ROW (table 4.7.3.1-3).

TABLE 4.7.3.1-3

Land Management and Land Use Activities That Would be Prohibited or Restricted on the Proposed Pacific Connector Pipeline Construction and Operational Rights-of-Way

Location	Prohibited/ Restricted Activities	Duration
Directly over the pipeline	Obstructions that may endanger, hinder or conflict with the construction, operation, inspection, protection, maintenance and use of the pipeline (i.e. trees, engineered structures, buildings, roads-parallel, other utilities-parallel, logging, blasting, mining)	During the construction, operations, and maintenance of the pipeline facilities.
Within the pipeline ROW clearing limits	Obstructions that may endanger, hinder or conflict with the construction, operation, inspection, protection, maintenance and use of the pipeline (i.e. engineered structures, buildings, roads-parallel, limited logging, blasting, mining)	During the construction of the pipeline facilities.
Within the pipeline ROW	Obstructions that may endanger, hinder or conflict with the construction, operation, inspection, protection, maintenance and use of the pipeline (i.e. engineered structures, buildings, roads-parallel, limited logging, blasting, mining)	During the construction, operations, and maintenance of the pipeline facilities.
Within one-quarter mile of the pipeline	Some blasting and mining	During operation and maintenance of the pipeline facilities.
On existing federally managed roads and trails	Only when within the ROW, obstructions that may, endanger, hinder or conflict with the construction, operation, inspection, protection, maintenance, and use of the pipeline as described above; otherwise none	During the construction, operations, and maintenance of the pipeline facilities.

The BLM also expressed concerns about how prohibited or restricted activities within the pipeline ROW may affect parties who hold valid existing rights of federal lands in the Project area. In response, Pacific Connector stated that such situations would be handled on a case-by-case basis. In general, Pacific Connector would identify all landowners and interested parties in each of these situations and would work with them, following the guidelines in the Williams Gas Pipeline Developers' Handbook. The BLM also asked Pacific Connector to identify the requirements and timelines for notification to Pacific Connector when activities are planned on the federal lands, either by the agency or a third party. Pacific Connector responded that for any aboveground alterations Pacific Connector would rely on its Operations & Maintenance Manual Public Awareness and Damage Prevention (Policy 10.17.00.09). This policy requires the company to notify in writing at least once per year any landowner or interested party within 660 feet from either side of the pipeline. The notification would include written information of where the pipeline is and who and how to reach Pacific Connector for any concerns they may have with the pipeline. These notifications would provide the landowner or interested party with the information they need to contact the company to discuss any work around the pipeline or ROW.

National Forest System Lands

The pipeline would cross through approximately 30.6 miles of NFS lands within the Umpqua, Rogue River, and Winema National Forests. Acreages of NFS lands, by land use classification, that would be affected by pipeline construction or operation of the Pacific Connector pipeline and associated aboveground facilities are included above in table 4.1.3.1-2. On NFS land, the pipeline would affect about 512 acres of forest, 32 acres of transportation-utility lands, 28 acres of barren lands/quarries, 8 acres of rangelands, 0.5 acre of water, and 0.6 acre of wetlands.

Reclamation Lands

Between MPs 200.5 and 227.2, Pacific Connector's pipeline route would cross two parcels of withdrawn land totaling 0.7 mile, and 31 irrigation facilities that are managed by Reclamation's Klamath Basin Area Office of the Mid-Pacific Region. Acres of Reclamation land, by land use classification, that would be affected by the Project are included above in table 4.1.3.1-2. Construction of the Pacific Connector pipeline across Reclamation lands and facilities would affect less than half an acre of agricultural land, about 4 acres of rangeland, and less than a tenth of an acre of irrigation ditches.

Construction in the Klamath Basin would occur between October 15 and March 15 to minimize impacts to agricultural activities in the area and to cross the Reclamation irrigation facilities when they are not likely to be used or contain water. Pacific Connector included a *Klamath Facilities Crossing Plan* as Appendix O of its POD, and a *Winter Construction Plan for the* Klamath Basin as Appendix 1E in Resource Report 1 of its 2017 application to the FERC.

During construction across Reclamation lands and features, their use would be temporarily interrupted. However, after pipeline installation, Pacific Connector would restore those lands and features to their original condition and use.

4.7.3.2 Grazing Allotments on BLM and NFS Lands

The proposed Pacific Connector pipeline route would cross 11[146] livestock grazing allotments, 5 of which occur on NFS lands managed by the Umpqua, Rogue River, and Winema National Forests, and 6 of which occur on BLM lands managed by the Medford and Lakeview Districts (see table's 4.7.3.2-1 and 4.7.3.2-2). Pacific Connector believes grazing deferments would not be necessary for the Project because grazing is not a dominant land use crossed by the pipeline route. Pacific Connector has consulted with the BLM and the Forest Service regarding grazing resources.

[146] One additional allotment (Fish Lake) on the Rogue River National Forest would also be included. The pipeline corridor does not cross this allotment; the only portion affected by Pacific Connector is an old quarry which has been identified as a rock source and disposal area near MP 160.4.

TABLE 4.7.3.2-1

Grazing Allotments on National Forest System Lands Crossed by the Pacific Connector Pipeline Project

Allotment Number	Allotment Name/Pasture	MP	Allotment Acres	Management Category a/	Total AUMs b/	3-Year Average AUMs	Season Used	Livestock Kind	Grazing System	Notes
Umpqua National Forest – Tiller Ranger District										
00R12	Diamond Rock	105.4 - 113.2	23,565	PB: I, A, F	680	187	5/1-10/31	Cow/Calf	Continuous Season	Managed in conjunction with an adjoining allotment.
Rogue River National Forest – Ashland Ranger District										
00R08	South Butte	153.8 - 167.5	25,592	PB: A, F	230	230	6/1-10-15	Cow/Calf	Continuous	1035 AUs
00R07	Deadwood	167.5 - 167.9	21,337	PB: A, F	382/150 Total of 532	382/150	6/1-10/15 See notes	Cow/Calf	Deferred	Managed with BLM Odd yrs. = 6/1–8/15 on FS Even yrs. = 8/16–10/15 on FS
Winema National Forest – Klamath Ranger District										
OR250	Indian	167.9 - 171.3	10,619	PB: I,A, F	906	665	7/1-10/15	Cow/Calf	Continuous Season	Managed with Buck Allotment as 1 Allotment.
OR220	Buck	171.3 - 172.4	15,932	PB: I,A, F						Same as Indian, managed as 1 Allotment.

a/ 'PB' classification indicates that allotments that have potential to be managed under a quality management strategy. Basic resource damage is not occurring.
P = lack of permittee interest participation;
I = lack of total AMP implementation;
A = lack of reliable range analysis data, and
F = lack of funding to implement quality management.
b/ AUM = animal unit month

TABLE 4.7.3.2-2

Grazing Allotments on BLM Lands Crossed by the Pacific Connector Pipeline Project

Allotment Number	Allotment Name/Pasture	MP	Allotment Acres	Management Category a/	Total AUMs	3-Year Average AUMs	Season Used	Livestock Kind	Grazing System b/	Notes
Medford District										
10038	Crowfoot	123.5 - 128.4	7,400	I			4\15-6\30	Cattle	SS	
10031	Summit Prairie/McNeil	131.4 - 131.8	30,578	I	1,158	827	6\1-10\30	Cattle	DF	
10024	Big Butte	133.6 - 141.9	21,802	I	1,663	301	4\16-5\31	Cattle	SL	Rice Place pasture now closed to grazing
00126	Heppsie Mountain	148.8 - 153.8	4,105	I	294	277	5/1-10/15	Cattle	SL	
Lakeview District										
0147	Grubb Spring	178.3 - 189.1	3,564 e/	C	130 c/	130 c/	5/1 – 9/15	Cattle	d/	
0848	Pope	216.5 - 216.8	446 f/	C	48 c/	63 c/	5/1 – 7/31	Cattle	d/	

a/ I = intensive management
C = custodial
M = maintain

b/ SS = Spring/Summer: Use throughout the critical growing season annually.
DF = Deferred: Delay of livestock grazing on an area for an adequate period of time to provide for plant reproduction, establishment of new plants, or restoration of vigor of existing plants.
SL = Season Long: Season long use annually, including during the growing season (spring, summer, and fall).

c/ BLM licensed AUMs only.

d/ Grazing is every year for the listed season; no other specific grazing system.

e/ BLM Klamath Falls Resource Area acres only listed

f/ A portion of the allotment was recently sold reducing the acreage.

Potential impacts to grazing allotments may occur from the temporary loss of forage from Project vegetation clearing and grading activities. In addition, construction activities could disturb improvements such as developed springs and fences or other barriers that restrict livestock to the allotment. From current survey activities, Pacific Connector is not aware of any range improvements such as springs that would be impacted. Pacific Connector does not believe it is necessary to remove livestock from the allotments during construction activities because of the significant size of most of the allotments crossed. Prior to construction, Pacific Connector would coordinate with the BLM and Forest Service regarding lease holder notifications.

Pacific Connector would mitigate impacts on grazing allotments during construction by installing temporary fences as needed to control livestock movement. After construction, permanent repairs to fences and natural barriers or other improvements that were disrupted by construction activities would occur to equivalent or better standards to ensure that livestock do not trail outside the allotment. Additional permanent fences may also be required during operation. After the pipeline is installed, the ROW would be restored and revegetated, as discussed in section 4.4. Revegetation is expected to return allotment forage quantity and values to preconstruction conditions within one to two growing seasons.

4.7.3.3 BLM and Forest Service Land Use Plans and Land Allocations

Federal lands are managed under a framework of laws passed by Congress, regulations promulgated through the federal rule-making process by the Secretaries of the Interior and Agriculture to implement these laws passed, Executive Orders issued by the President, and policies developed by the agencies to govern day-to-day actions. Each administrative unit of the BLM and Forest Service has a land management plan that provides a framework for on-the-ground implementation of these various laws, regulations and agency policies.

Overview of Statutes Applicable to Federal Land Use Planning

Although a number of federal statutes apply to the Pacific Connector pipeline where it crosses federal lands, there are six primary federal land-use laws that provide the framework for federal land use plans:

- The Multiple Use, Sustained Yield Act of 1960 (MUSY)
- The National Environmental Policy Act of 1969 (NEPA),
- The Endangered Species Act of 1973 (ESA),
- The Federal Land Policy and Management Act of 1976 (FLPMA),
- The National Forest Management Act of 1976 (NFMA), and
- The Oregon and California Revested Lands Sustained Yield Management Act of 1937 (O&C Act).

Three of these statutes—NEPA, ESA, and FLPMA—apply to both the BLM and the Forest Service. The relevance of NEPA and ESA to federal land management along the route of the Pacific Connector pipeline is discussed in chapter 1 of this EIS. For the Pacific Connector pipeline, the O&C Act applies primarily to BLM lands and to a lesser degree to NFS lands. BLM's RMPs are based on the requirements of FLPMA. The Forest Service's LRMPs are based on the requirements of the NFMA. FLPMA and NFMA were enacted in a manner to complement each other. Reclamation does not have any land use plans or land allocations administered by the

Klamath Basin Area Office that would be amended or modified or which need to be addressed in this EIS.

The O&C Act of 1937 applies to lands granted by the federal government to the Oregon and California Railroad Company. These lands were reconveyed to the federal government when the Oregon and California Railroad (O&C) went bankrupt. A similar, but smaller land grant in 1869 to the Southern Oregon Company was associated with the Coos Bay Wagon Road. These lands were also subsequently reconveyed to the federal government. The O&C Act of 1937 requires the Secretary of the Interior to manage Coos Bay Wagon Road lands and O&C lands for permanent forest production in conformity with the principle of sustained yield. These lands must also be managed in accordance with BLM RMPs in addition to applicable environmental laws such as the ESA. The O&C and Coos Bay Wagon Road land grants resulted in a patchwork of alternating federal and non-federal parcels across western Oregon and northern California. Table 4.7.3.3-1 lists the O&C and Coos Bay Wagon Road lands crossed by the Pacific Connector pipeline.

TABLE 4.7.3.3-1

O&C Lands, Coos Bay Wagon Road Lands, and Reserved Public Domain Lands Crossed by the Pacific Connector Pipeline (miles) a/

Jurisdiction	O&C Lands	Coos Bay Wagon Road Lands	Reserved Public Domain Lands b/	Total
BLM – Coos Bay District	1.14	15.8	0.13	17.07
BLM – Roseburg District	10.84	1.79	0.72	13.35
BLM – Medford District	12.29	0.0	2.86	15.15
BLM – Lakeview District	1.03	0.0	0.26	1.29
Total BLM	**25.3**	**17.59**	**3.97**	**46.86**
Forest Service– Umpqua NF	3.44	0.0	7.37	10.81
Forest Service– Rogue River NF	0.0	0.0	13.72	13.72
Forest Service – Winema NF	0.0	0.0	6.05	6..05
Total NFS	**3.44**	**0.0**	**27.14**	**30.58**
Total	**28.5**	**17.59**	**30.98**	**77.44**

Note: Rows and columns may not sum correctly due to rounding. Miles are rounded to the nearest tenth of a mile (values below 0.1 are shown as "<0.1").
a/ Source: Table 8.5-5, Resource Report 3, p. 36.
b/ Reserved Public Domain Lands are the remaining lands not classified as O&C or Coos Bay Wagon Road lands

Enacted in 1976, the FLPMA established a unified, comprehensive, and systematic approach to managing and conserving public lands to provide for multiple uses and sustained yield of goods and services from public lands. The act includes provisions for withdrawing or otherwise designating or dedicating federal lands for specified purposes. It also establishes procedures for disposing of public lands, acquiring non-federal lands for public purposes, exchanging lands consistent with the prescribed mission of the department or agency involved and for issuing ROW Grants across lands administered by multiple federal agencies. The BLM is the authorizing agency for the Pacific Connector pipeline ROW grant application.

The BLM under Title II of the FLPMA, and the Forest Service under the provisions of the MUSY, are required to manage lands sustainably for multiple uses. Although there are distinct differences between the BLM and Forest Service planning regulations, the following elements are common to the two agencies:

- use of a systematic, interdisciplinary approach that utilizes information from the physical, biological, economic, and other sciences;
- considering present and potential uses of public lands;
- giving priority to areas of critical environmental concern;
- considering the relative scarcity of the various values of public lands;
- weighing long-term and short-term public benefits;
- complying with applicable pollution control laws; and
- coordinating land-use planning with other relevant federal and state agencies.

The Forest Service is also subject to the requirements of the NFMA, which was enacted as an amendment to the 1974 Forest and Rangeland Renewable Resources Planning Act. In NFMA, Congress established a comprehensive notice and comment process for adopting, amending, and revising LRMPs for units of the NFS (e.g., National Forests). Planning regulations later promulgated by the Secretary of Agriculture explain that National Forest planning and decision making occurs at four levels: nationwide, region wide, LRMPs, and projects. One of the statutory requirements of the NFMA is to "specify…guidelines for LRMPs developed to achieve the goal of providing for diversity of plant and animal communities based on the suitability and capability of the specific lands area in order to meet multiple use objectives." This biodiversity requirement led to the development of the NWFP, which currently guides the management of NFS lands in southwest Oregon and meets the NFMA's biodiversity goal.

Northwest Forest Plan

In 1994, the Secretaries of Agriculture and Interior jointly signed a *Record of Decision for Amendments to Forest Service and BLM Planning Documents within the Range of the Northern Spotted Owl* (otherwise known as the Northwest Forest Plan (NWFP); Forest Service and BLM 1994a). This decision amended national forest LRMPs and established the following land allocations to be used on NFS lands in the area covered by the NWFP.[147]

- **Congressionally Reserved Areas -** Lands reserved by act of Congress including National Parks and Monuments, Wilderness Areas, Wild and Scenic Rivers, National Wildlife Refuges and Department of Defense lands.

- **Late-Successional Reserves** (LSRs) - in combination with other land allocations and standards and guidelines are intended to maintain functional, interactive LSOG forest ecosystems for species that are dependent on this type of habitat.[148]

- **Adaptive Management Areas -** Areas designed to develop and test new management approaches to integrate and achieve ecological, economic and other social and community objectives.

[147] When the NWFP was signed in 1994, it applied to both national forest and BLM lands in the range of the northern spotted owl. Subsequently in August 2016 the BLM revised its management plans in southwest Oregon and replaced the management direction from the NWFP. As a result, the NWFP no longer applies to BLM lands.
[148] Appendix F.3 of this EIS provides a comprehensive discussion of LSRs as they relate to the Project.

- **Administratively Withdrawn Areas—**Areas identified in Forest Service LRMPs not scheduled for timber harvest (e.g., recreation sites, administrative facilities).
- **Key Watersheds—**Large watersheds that are a system of refugia that either provide, or are expected to provide, high-quality habitat that is crucial for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. Key Watersheds are not a designated area or matrix but overlay all land allocations. Tier 1 Key Watersheds contribute directly to conservation of at-risk stocks of anadromous salmonids, bull trout and resident fish. While Tier 2 Key Watersheds may not contain at-risk fish species, they are important sources of high-quality water.
- **Riparian Reserves—**Areas along all streams, wetlands, ponds, lakes and unstable and potentially unstable areas where the conservation of aquatic and riparian-dependent terrestrial resources receives primary emphasis. Riparian Reserves are also intended to serve as connectivity corridors between other reserves and the Matrix lands.[149] Riparian Reserves exist within all land allocations of the NWFP.
- **Matrix—**The lands outside the other designated areas listed above. Matrix lands are the area in which most timber harvest and other silvicultural activities would be conducted.

Attachment A to the NWFP ROD, "Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Species within the Range of the Northern Spotted Owl," provides detailed requirements and instructions for how land managers should treat forest lands subject to the NWFP (Forest Service and BLM 1994b).[150] Some standards and guidelines apply to all NFS lands, while others are only applicable to certain land allocations or activities. More than one set of standards and guidelines may apply in some areas. Where standards and guidelines overlap, both are applied. Where there are conflicts, the standard and guideline that provides the most protection for LSOG-associated species governs. The acres of NWFP allocations affected by the Pacific Connector pipeline are displayed in table 4.7.3.3-2.

Forest Service Land and Resource Management Plans

Current Forest Service LRMPs for the Rogue River, Umpqua, and Winema National Forests were adopted in the early 1990s (Forest Service 1990a, 1990b, and 1990c). In 1994, the NWFP ROD amended the LRMPs for those portions of National Forests within the range of the NSO to include the NWFP land allocations and standards and guidelines in addition to the existing direction in those plans. Wherever there were conflicts between the NWFP and the underlying land management plan, the direction that provided the most protection for late-successional and old-growth–dependent species was adopted.

[149] Appendix F.4 of this EIS provides a comprehensive discussion of Riparian Reserves as they relate to the Project.

[150] Standards and Guidelines: "the rules and limits governing actions, and the principles specifying environmental conditions or level to be achieved or maintained" (Forest Service and BLM 1994b: C-1).

TABLE 4.7.3.3-2

Forest Service NWFP Land Allocations – Acres Impacted by the Pipeline a/

Project Component	Late Successional Reserves	Unmapped LSRs	Matrix	Riparian Reserves b/
Forest Service – Umpqua				
Construction ROW	57.18	0.00	66.74	8.92
TEWAs	10.05	0.00	30.66	5.60
UCSAs	17.23	0.00	23.57	0.00
Off-site Source/Disposal	4.93	0.00	15.87	3.93
Temporary Access Roads (TAR)	0.00	0.00	0.16	0.00
Existing Roads Improvements	0.73	0.00	0.88	0.92
Total Temporary Impacts	90.12	0.00	137.88	19.37
Permanent Easement	30.33	0.00	35.16	4.76
Permanent Access Roads (PAR)	0.00	0.00	0.06	0.00
30-Foot Maintained	18.19	0.00	21.11	2.85
Forest Service – Rogue River-Siskiyou				
Construction ROW	157.11	0.00	0.00	2.66
TEWAs	49.99	0.00	0.00	0.89
UCSAs	69.53	0.00	0.00	0.93
Off-site Source/Disposal	15.27	0.00	4.91	0.00
Temporary Access Roads (TAR)	0.00	0.00	0.00	0.00
Existing Roads Improvements	0.00	1.00	0.00	1.00
Total Temporary Impacts	291.90	1.00	4.91	5.48
Permanent Easement	83.17	0.00	0.06	1.52
Permanent Access Roads (PAR)	0.00	0.00	0.00	0.00
Aboveground Facilities	0.00	0.00	0.00	0.00
30-Foot Maintained	49.90	0.00	0.00	0.90
Forest Service – Fremont-Winema				
Construction ROW	0.00	0.00	68.64	3.94
TEWAs	0.49	0.00	11.55	0.29
UCSAs	0.00	0.00	11.55	0.43
Temporary Access Roads (TAR)	0.00	0.00	0.00	0.00
Existing Roads Improvements	0.00	0.00	0.00	0.00
Total Temporary Impacts	**0.49**	**0.00**	**91.74**	**4.66**
Permanent Easement	0.00	0.00	36.67	2.20
30-Foot Maintained	0.00	0.00	22.00	1.34

a/ Due to differences between the landownership and land use allocation shapefiles, the acres will vary slightly when compared to the vegetation and land use tables organized by jurisdiction.
b/ Riparian Reserves overlay other land use allocations.

BLM Resource Management Plans

The BLM revised its management plans in August 2016. Land allocations in BLM plans provide a sustained yield of timber, contribute to the conservation and recovery of an threatened and endangered species, provide clean water in watersheds, provide recreation opportunities, and coordinate management of land surrounding the Coquille Forest with the Coquille Tribe.

The **Northwestern and Coastal Region Record of Decision** applies to the Coos Bay and the Swiftwater Field Office of Roseburg District. Land allocations are as follows:

- **Congressionally Reserved Lands and National Conservation Areas –** Lands reserved by act of Congress including National Parks and Monuments, Wilderness Areas, Wild and Scenic Rivers, National Wildlife Refuges, and Department of Defense lands.

- **District Designated Reserves –** Lands reserved from sustained-yield timber production for other purposes

  - **Areas of Critical Environmental Concern –** Lands managed to maintain or restore relevant and important values in Areas of Critical Environmental Concern, including Research Natural Areas and Outstanding Natural Areas.

  - **Timber Production Capability Classification –** Manage areas identified as unsuitable for sustained-yield timber production through the Timber Production Capability Classification system, for other uses if those uses are compatible with the reason for which the BLM has reserved these lands (as identified by the Timber Production Capability Classification codes).

  - **Lands Managed for their Wilderness Characteristics –** Protect wilderness characteristics (i.e., roadlessness, naturalness, opportunities for solitude and primitive unconfined recreation, and identified supplemental values), while allowing competing resource demands that do not conflict with preserving long-term wilderness characteristics.

- **Harvest Land Base—** Manage forest stands to achieve continual timber production that can be sustained through a balance of growth and harvest.

  - **Low Intensity Timber Area –** Use low intensity management to provide complex early-successional ecosystems, develop diverse late-successional ecosystems for a portion of the rotation and provide a variety of forest structural stages distributed both temporally and spatially.

  - **Moderate Intensity Timber Area –** Use moderate intensity management to provide complex early-successional ecosystems, develop diverse late-successional ecosystems for a portion of the rotation and provide a variety of forest structural stages distributed both temporally and spatially.

- **Late Successional Reserve –** Lands are managed to maintain nesting-roosting habitat for the northern spotted owl and nesting habitat for the marbled murrelet, promote the development of nesting-roosting habitat for the northern spotted owl in stands that do not currently support northern spotted owl nesting and roosting, promote the development of nesting habitat for the marbled murrelet in stands that do not currently meet nesting habitat criteria, promote the development and maintenance of foraging habitat for the northern spotted owl, including creating and maintaining habitat to increase diversity and abundance of prey for the northern spotted owl.

- **Riparian Reserves –**Areas along streams and wetlands where the conservation of aquatic and riparian-dependent terrestrial resources receives primary emphasis. Riparian Reserves exist in all land allocations. Conservation and recovery of ESA-listed fish species and their habitats and provide for conservation of Bureau Special Status fish and other Bureau Special Status riparian-associated species.

The **Southwestern Oregon Record of Decision and Approved Resource Management Plan** applies to the Klamath Falls Field Office of Lakeview District, Medford District, and South River Field Office of Roseburg District. Land allocations are as follows:

- **Congressionally Reserved Lands and National Conservation Areas –** Lands reserved by act of Congress including National Parks and Monuments, Wilderness Areas, Wild and Scenic Rivers, National Wildlife Refuges, and Department of Defense lands.

- **District Designated Reserves –** Lands reserved from sustained-yield timber production or for other purposes.

  - **Areas of Critical Environmental Concern –** Lands managed to maintain or restore relevant and important values in Areas of Critical Environmental Concern, including Research Natural Areas and Outstanding Natural Areas.

  - **Timber Production Capability Classification –** Manage areas identified as unsuitable for sustained-yield timber production through the Timber Production Capability Classification system, for other uses if those uses are compatible with the reason for which the BLM has reserved these lands (as identified by the Timber Production Capability Classification codes).

  - **Lands Managed for their Wilderness Characteristics –** Protect wilderness characteristics (i.e., roadlessness, naturalness, opportunities for solitude and primitive unconfined recreation, and identified supplemental values), while allowing competing resource demands that do not conflict with preserving long-term wilderness characteristics.

- **Harvest Land Base—** Manage forest stands to achieve continual timber production that can be sustained through a balance of growth and harvest.

  - **Low Intensity Timber Area –** Use low intensity management to provide complex early-successional ecosystems, develop diverse late-successional ecosystems for a portion of the rotation and provide a variety of forest structural stages distributed both temporally and spatially.

  - **Moderate Intensity Timber Area –** Use moderate intensity management to provide complex early-successional ecosystems, develop diverse late-successional ecosystems for a portion of the rotation and provide a variety of forest structural stages distributed both temporally and spatially.

  - **Harvest Land Base –** Uneven Aged Timber Area – Use uneven – aged timber management to increase diversity of stocking levels and size classes within and among the stands.

- **Late Successional Reserve –** Lands are managed to maintain nesting-roosting habitat for the northern spotted owl and nesting habitat for the marbled murrelet, promote the development of nesting-roosting habitat for the northern spotted owl in stands that do not currently support northern spotted owl nesting and roosting, promote the development of nesting habitat for the marbled murrelet in stands that do not currently meet nesting habitat criteria, promote the development and maintenance of foraging habitat for the northern spotted owl, including creating and maintaining habitat to increase diversity and abundance of prey for the northern spotted owl.

- **Late-Successional Reserve Dry –** Applied variously on drier sites, lands are managed to Enable forests to: (1) recover from past management measures, (2) respond positively to climate-driven stresses, wildfire and other disturbance with resilience, (3) ensure positive or neutral ecological impacts from wildfire, and (4) contribute to northern spotted owl recovery.

- **Riparian Reserves** –Areas along streams and wetlands where the conservation of aquatic and riparian-dependent terrestrial resources receives primary emphasis. Riparian Reserves exist in all land allocations. Conservation and recovery of ESA-listed fish species and their habitats and provide for conservation of Bureau Special Status fish and other Bureau Special Status riparian-associated species. Riparian Reserves are further disaggregated into moist and dry zones that recognize the broad diversity of BLM landscapes by applying different implementing standards and guidelines.

Although Late Successional Reserves and Riparian Reserves are land allocations on both BLM and NFS lands and have similar objectives, implementing standards and guidelines in BLM management plans vary significantly from those on NFS lands because of the greater geologic and geographic diversity of BLM lands. BLM east-side management area land allocations do not apply to the Pacific Connector project area. The acres of BLM RMP allocations affected by the Pacific Connector pipeline is displayed in table 4.7.3.3-3.

TABLE 4.7.3.3-3

BLM RMP Land Allocations – Acres Impacted by the Pacific Connector Pipeline

Pipeline Component	District-Designated Reserve (No Harvest)	District-Designated Reserve (Non-Forest)	Eastside Manage-ment Area	Harvest Land Base (Low Intensity Timber Area)	Harvest Land Base (Moderate Intensity Timber Area)	Harvest Land Base (Uneven-Aged Timber Area)	Late-Succes-sional Reserve (Dry Forest)	Late-Succes-sional Reserve (Moist Forest)	Riparian Reserve (Dry Forest)	Riparian Reserve (Moist Forest)	Totals
BLM – Coos Bay District											
Construction ROW	0.47	4.74	0.00	8.24	23.36	0.00	0.00	67.69	0.00	15.97	120.47
TEWAs	0.08	1.34	0.00	1.27	7.76	0.00	0.00	17.03	0.00	6.07	33.55
UCSAs	0.36	0.16	0.00	0.65	1.75	0.00	0.00	10.91	0.00	1.05	14.88
Off-Site Source/Disposal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.51	0.00	1.50	4.01
Temporary Access Roads (TAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.69	0.69
Total Temporary Impacts	**0.91**	**6.24**	**0.00**	**10.16**	**32.87**	**0.00**	**0.00**	**98.14**	**0.00**	**25.28**	**173.60**
Permanent Easement	0.22	2.89	0.00	4.36	12.13	0.00	0.00	38.09	0.00	8.54	66.23
Aboveground Facilities	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30-Foot Maintained	0.13	1.69	0.00	2.62	7.32	0.00	0.00	22.96	0.00	5.03	39.75
BLM – Roseburg District											
Construction ROW	0.72	18.74	0.00	0.09	23.37	29.62	56.80	17.50	2.03	1.33	150.20
TEWAs	0.09	7.56	0.00	0.00	10.77	10.44	19.54	2.27	1.26	0.42	52.35
UCSAs	1.96	4.87	0.00	0.00	18.44	34.93	54.37	3.18	4.67	0.00	122.42
Off-site Source/Disposal	0.37	1.20	0.00	0.00	2.26	0.49	2.13	0.14	0.00	0.00	6.59
Temporary Access Roads (TAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Temporary Impacts	**3.14**	**32.37**	**0.00**	**0.09**	**54.84**	**75.48**	**132.84**	**23.09**	**7.96**	**1.75**	**331.56**
Permanent Easement	0.45	11.07	0.00	0.01	11.60	14.45	30.51	9.16	0.96	0.69	78.90
Aboveground Facilities	0.00	0.00	0.00	0.00	0.09	0.00	0.09	0.00	0.00	0.00	0.18
30-Foot Maintained	0.24	7.13	0.00	0.00	6.81	8.57	18.14	5.49	0.55	0.41	47.34
BLM – Medford District											
Construction ROW	58.57	25.82	0.00	7.78	0.00	23.02	48.42	0.00	10.72	0.00	174.33
Hydrostatic Test Site [3]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TEWAs	18.97	9.12	0.00	1.70	0.00	7.12	25.46	0.00	2.19	0.00	64.56
UCSAs	8.26	2.71	0.00	3.24	0.00	9.71	9.51	0.00	0.87	0.00	34.30
Temporary Access Roads (TAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Temporary Impacts	**85.80**	**37.65**	**0.00**	**12.72**	**0.00**	**39.85**	**83.39**	**0.00**	**13.78**	**0.00**	**273.19**
Permanent Easement	30.52	13.92	0.00	4.16	0.00	12.13	25.50	0.00	5.59	0.00	91.82
Aboveground Facilities	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.09
30-Foot Maintained	18.31	8.41	0.00	2.49	0.00	7.25	15.30	0.00	3.35	0.00	55.11

TABLE 4.7.3.3-3 (continued)

BLM RMP Land Allocations – Acres Impacted by the Pacific Connector Pipeline

Pipeline Component	District-Designated Reserve (No Harvest)	District-Designated Reserve (Non-Forest)	Eastside Manage-ment Area	Harvest Land Base (Low Intensity Timber Area)	Harvest Land Base (Moderate Intensity Timber Area)	Harvest Land Base (Uneven-Aged Timber Area)	Late-Succes-sional Reserve (Dry Forest)	Late-Succes-sional Reserve (Moist Forest)	Riparian Reserve (Dry Forest)	Riparian Reserve (Moist Forest)	Totals
LM – Lakeview District											
Construction ROW	0.00	0.74	2.96	0.00	0.00	10.90	0.00	0.00	0.22	0.00	14.82
TEWAs	0.00	0.18	0.58	0.00	0.00	2.72	0.00	0.00	0.06	0.00	3.54
Temporary Access Roads (TAR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Temporary Impacts	**0.00**	**0.92**	**3.54**	**0.00**	**0.00**	**13.62**	**0.00**	**0.00**	**0.28**	**0.00**	**18.36**
Permanent Easement	0.00	0.29	1.56	0.00	0.00	5.88	0.00	0.00	0.11	0.00	7.84
30-Foot Maintained	0.00	0.16	0.94	0.00	0.00	3.54	0.00	0.00	0.07	0.00	4.71

4.7.3.4 Proposed Amendments to BLM and Forest Service Land Management Plans

Amendment of BLM Resource Management Plans

BLM lands are managed according to the direction in Resource Management Plans (RMP). Approximately 46.9 miles of the proposed Pacific Connector pipeline route would cross federal land administered by the BLM in southwest Oregon. The Coos Bay District and the Roseburg District-Swiftwater Field Office are managed according to the provisions of the Northwestern and Coastal Oregon RMP (BLM 2016a). The Lakeview District-Klamath Field Office, Medford District and the Roseburg District-South River Field Office are managed according to the provisions of the Southwestern Oregon RMP (BLM 2016b).

FLPMA as amended, and its implementing regulations in Title 43, CFR part 1600 requires all projects on BLM lands, including third-party projects authorized by permits or right of way grants, to be consistent with the RMP of the administrative unit where the project occurs. Where projects would not be consistent with the underlying RMP, the project cannot be implemented unless the RMP is amended to make provision for the project, or the project is modified to be consistent with RMP direction. An RMP does not authorize projects or activities or commit the BLM to act. A plan may constrain the agency from authorizing or carrying out projects and activities, or the manner in which they may occur.

For the Pacific Connector pipeline project, the BLM worked cooperatively with the FERC staff, other cooperating agencies, and the applicant to incorporate BMPs, design features and project requirements which would avoid, minimize, rectify, reduce or eliminate environmental consequences (40 CFR 1502.14(f) and 1508.20(a-d)). The BMPs, design features, or requirements specific to BLM lands are included as attachments to the project proponent's POD. There are 28 appendices in the POD; they include draft monitoring elements to ensure that the actions are implemented. Collectively, the POD is incorporated into the project's description, and is summarized in section 2.6.3 of the DEIS.

Given the linear nature of the pipeline corridor, resources on BLM lands and the topography of BLM lands in southwest Oregon it is not possible for the Pacific Connector project to conform to every requirement of the respective BLM RMPs. Pacific Connector has cooperated with the BLM to make its proposal consistent with the BLM RMPs as much as is feasible, but even with route adjustments, modified project design features, and BMPs, the proposed ROW for the Project on BLM-managed lands would not conform to the Southwestern Oregon RMP and the Northwestern and Coastal RMP (RMPs for Western Oregon). Amendment of these RMPs would be necessary to make provision for the project to allow it to proceed.

The RMPs for Western Oregon allow for the construction of linear rights-of-way within the LSR "as long as northern Spotted Owl (NSO) nesting-roosting habitat continues to support nesting and roosting at the stand level, and NSO dispersal habitat continues to support movement and survival at the landscape level", and construction of linear rights-of-way "as long as the occupied stand continues to support marbled murrelet nesting" (Southwestern Oregon ROD page 71, Northwestern and Coastal ROD, page 65). BLM staff initially evaluated that the proposed ROW would cross approximately 268 acres of LSR and approximately 116 acres of known or presumed occupied MAMU habitat and/or NSO nesting-roosting habitat within the LSR land allocation. Additional analysis concluded that the clearing and removal of vegetation required within the LSR for the proposed Project would result in the loss of stand-level NSO nesting and roosting habitat and MAMU nesting habitat in the project corridor.

BLM management direction in the RMPs for Western Oregon specific to wildlife prohibits activities that "disrupt marbled murrelet nesting at occupied sites ... within all land use allocations within 35 miles of the Pacific Coast and... within reserved land use allocation between 35-50 miles of the Pacific Coast" (Southwestern Oregon ROD, page 118, Northwestern and Coastal ROD, page 98). BLM staff concluded that construction of the Project would likely result in disruption of MAMU nesting at some occupied sites within these two discrete geographic ranges.

In order to consider the ROW Grant, the BLM must address these inconsistencies by amending the affected RMPs to make provisions for the Pacific Connector project. BLM therefore proposes to amend the RMPs to re-allocate all lands within the proposed temporary use area and ROW to a District-Designated Reserve, with management direction to manage said lands for the purposes of the Pacific Connector Gas Pipeline ROW. Approximately 885 acres would be re-allocated from existing land allocations in the affected RMPs to the District Designated Reserves (see Resource Report 8).

District-Designated Reserve is an existing land use allocation in both the Northwestern and Coastal Oregon RMP and the Southwestern Oregon RMP. Under these RMPs, District-Designated Reserves encompass a wide variety of lands, including constructed facilities, infrastructure, roads, communication sites, seed orchards, quarries, lands biologically or physically unsuitable for timber production, Areas of Critical Environmental Concern, and lands managed for their wilderness characteristics. District-Designated Reserves are reserved from sustained-yield timber production in order to manage them for another set of specific values and resources. Within the District-Designated Reserve, the BLM would maintain the values and resources necessary for construction, operation, maintenance, and decommissioning of the proposed Pacific Connector project.

Specifically, BLM proposes to add the following text to the RMPs for Western Oregon (Northwestern and Coastal ROD, page 59, Southwestern Oregon ROD, page 57):

District-Designated Reserve – Pacific Connector Gas Pipeline

Management Objectives

- *See District-Designated Reserves management objectives.*
- Maintain the values and resources for which the BLM has granted the ROW for the Pacific Connector Gas Pipeline Project.

Management Direction

Allow the construction, operation, maintenance, and decommissioning of the Pacific Gas Connector Pipeline, notwithstanding the restrictions and requirements of management direction described for resource programs.

District-Designated Reserve allocations establish specific management for a specific use or to protect specific values and resources. The project-specific amendment would not change RMP requirements for other projects or authorize any other actions within the *District-Designated Reserve – Pacific Connector Gas Pipeline* .Other uses that are compatible with the purpose of the District-Designated Reserve maybe authorized on a case-by-case basis following completion of environmental analysis. The environmental consequences of this proposed amendment are the same as the environmental consequences of construction and operation of the Pacific Connector project and are discussed at length elsewhere in this EIS.

Therefore, the resource impacts of the proposed plan amendments are those associated with construction, operation, maintenance and decommissioning of the proposed pipeline. With this amendment, the granting of a ROW on BLM-managed lands for the Pacific Connector Project would conform to the Southwestern Oregon Record of Decision and Resource Management Plan (BLM 2016b) and the Northwestern and Coastal Oregon ROD and RMP (BLM 2016a).

Amendments to Forest Service Land and Resource Management Plans

This section summarizes DEIS appendix F2 (Forest Service Forest Plan Amendments and Compensatory Mitigation), which contains the full text of the independent Forest Service analysis. Reviewers who seek additional information should review the applicable sections in appendix F.2. Section numbers that refer to sections in the appendix are so noted.

The Forest Service amendment process is described in section 1.3.3 of this DEIS and in section 1.1 of appendix F.2. The proposed amendments to Forest Service LRMPs are described in section 2.1.3.2 of this DEIS and in section 2 of appendix F.2. The Forest Service compensatory mitigation plans are discussed in sections 1.3.3 and 2.1.5 of this DEIS and throughout appendix F.2. The proposed Forest Plan amendments and related compensatory mitigation evaluated in this section are unique for each national forest and are addressed separately in the following sections.

Evaluation of Umpqua National Forest Proposed Forest Plan Amendments

The proposed Pacific Connector pipeline incorporates the most up-to-date engineering and technological practices for pipeline construction and operation. However, even with following these practices, it has been determined that one Forest Plan standard associated with rare and/or isolated species (Survey and Manage), and three Forest Plan standards associated with the soil, water, and riparian resources, would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Umpqua National Forest LRMP as amended by the NWFP and the January 2001 Record of Decision for Amendments to the Survey and Manage Protection Buffer, and Other Mitigation Measures Standards and Guidelines (Survey and Manage ROD). One additional amendment proposes to reallocate acres from the Matrix land allocation to the LSR land allocation.

Forest Plan Amendments Related to Rare Aquatic and Terrestrial Plant and Animal Communities (FS-1, UNF-4):

*Amendment FS-1**:** Project-Specific Amendment to Exempt Management Recommendations for Survey and Manage Species on the Umpqua National Forest.*

One Forest Plan standard associated with rare and/or isolated species (Survey and Manage) would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Umpqua National Forest LRMP as amended. This standard is:

- Management Direction: Manage All Known Sites (Survey and Manage ROD, Standards and Guidelines Page 8). Current and future known sites will be managed according to the

Management Recommendation for the species. Professional judgment, Appendix J2 in the Northwest Forest Plan Final SEIS, and appropriate literature will be used to guide individual site management for those species that do not have Management Recommendations.

The proposed amendment to this standard is:

- Management Direction: Manage All Known Sites (Survey and Manage ROD, Standards and Guidelines Page 8). Current and future known sites will be managed according to the Management Recommendation for the species, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Professional judgment, Appendix J2 in the Northwest Forest Plan Final SEIS, and appropriate literature will be used to guide individual site management for those species that do not have Management Recommendations. (Proposed amendment FS-1 on the Umpqua National Forest)

While the amendment would provide an exception to meeting this standard, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore, any effects of the pipeline's construction and operation on Survey and Manage species within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

The purpose of this project-level amendment is to make the proposed Pacific Connector pipeline project consistent with the Umpqua National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to this amendment are:

- 36 CFR 219.9(a)(2)(ii) – [the plan must include plan components to maintain or restore] "Rare aquatic and terrestrial plant and animal communities."
- 36 CFR 219.9(b)(1) – "The responsible official shall determine whether or not the plan components required by paragraph (a) provide ecological conditions necessary to: …maintain viable populations of each species of conservation concern within the plan area."

Because the proposed amendment is "directly related" to these two substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendment (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the amendment, it is important to recognize that the applicable sections of 36 CFR 219.9(a) and (b) that are described above, requires plan components to maintain or restore rare aquatic and terrestrial plant and animal communities, across the entire planning area (i.e., the Umpqua National Forest). This plan amendment does not alter these LRMP plan requirements for managing rare plant and animal communities across 99.98 percent of the Umpqua National Forest. The proposed pipeline construction corridor including the temporary extra work areas (TEWAs) and the uncleared storage areas (UCSAs) is approximately 205 acres of the 983,129 acre Umpqua National Forest. Within this 205 acre construction corridor surveys have identified 107 Survey and Manage sites that could be potentially impacted by construction activities. The proposed amendment does not waive the persistence objective for Survey and Manage species. The analysis that was conducted (see section 4.6.4.3 of the DEIS and appendix F.5) determined the Survey and Manage persistence objectives would be met. This means that for Umpqua National Forest lands within the project area, individual sites of Survey and Manage species may be impacted or lost to construction activities, but affected species are expected to persist within the range of the NSO despite the loss of these individual sites.

The amendment modifies this standard so that in the 205 acres of the project construction area the project need not be in compliance with this standard' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 205 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the management requirement described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.9(a) and (b) rule requirements within the "scope and scale" of the proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.9(a) and (b) requirements are being addressed.

How the Required Mitigation Measures would Maintain or Restore Effects to Rare Aquatic and Terrestrial Plant and Animal Communities and Meet the Applicable 36 CFR 219.9(a) and 36 CFR 219.9 (b) Requirements

The Forest Service has worked to inventory, analyze, and evaluate rare aquatic, terrestrial plant and animal communities that could be affected by this project. In addition, a third-party consultant for technical support was also utilized in reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures incorporated into amendments for Survey and Manage species are designed to minimize, maintain or restore the potential for habitat fragmentation, edge effects, and loss of long-term habitats associated with effected species. To ensure adequate restoration and revegetation of the ROW, design features are identified in the *Erosion Control and Revegetation Plan* (POD I), *Right-of-Way Clearing Plan* (POD U), *Leave Tree Protection Plan* (POD P). In addition, routing considerations were identified during project development to ensure avoidance of known populations of rare plant and animal communities (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands). As well as, appendix F.5, *Survey and Manage Persistence Evaluations*, and proposed amendment UNF-4 Reallocation of Matrix Lands to LSR.

As a basis for Survey and Manage determinations, appendix F.5 provides background research on Survey and Manage species that could be affected by the Pacific Connector Project; a review of survey reports prepared by others for the Pacific Connector Project; and processing and analysis of spatial data obtained from the BLM, Forest Service, and other sources over the past 12 years. Background information was used in combination with new information available as a result of surveys for the Pacific Connector Project and recent surveys in other portions of old growth forests to discuss the currently known distribution of the species in old growth forests within the NSO range. Impacts to sites as a result of the Pacific Connector Project were analyzed to determine if the species would continue to have a reasonable assurance of persistence in the NSO range following implementation of the Pacific Connector Project, taking into consideration the status and distribution of the species and general habitat in the NSO range.

Some of the required mitigation measures in the POD sections to protect rare plant and animal communities include: flagging existing snags on the edges of the construction ROW or TEWAs where feasible to save from clearing; snags would be saved as and used in LWD placement post-construction to benefit primary and secondary cavity nesting birds, mammals, reptiles, and amphibians; other large diameter trees on the edges of the construction ROW and TEWAs would also be flagged to save/protect as green recruitment or habitat/shade trees, where feasible; trees would be girdled to create snags to augment the number of snags along the ROW to benefit cavity nesting birds, mammals, reptiles, and amphibians. See POD's P & U and 4.7—*Land Use* of the DEIS for a complete list of applicable mitigation measures for pipeline construction. Additional measures include low ground weight (pressure) vehicles would be used; logging machinery would be restricted to the 30-foot permanent ROW wherever possible to prevent soil compaction; the removal of soil duff layers would be avoided in order to maintain a cushion between the soil and the logs and the logging equipment; designed skid trails would be used to restrict detrimental soil disturbance (compaction and displacement) to a smaller area of the ROW over the pipeline trenching area; and the temporary construction area would be restored and revegetated using native seeds, to the extent possible, and saplings (POD I).

In an effort to minimize, maintain or restore the impacts to Survey and Manage species, Pacific Connector adopted route variations to avoid certain species identified in the Survey and Manage Persistence Evaluations by co-locating the proposed construction corridor adjacent to existing roads, through managed timber stands or otherwise avoid unique LSOG habitats to the maximum extent practicable (See chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands).

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (Environmental Briefings and Compliance Plan, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer's designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to soil, water and riparian resources, are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

Amendment UNF-4: Reallocation of Matrix Lands to LSR

The other proposed Forest Plan amendment related to rare aquatic and terrestrial plant and animal communities on the Umpqua National Forest is UNF-4. This proposed amendment would change the designation of approximately 585 acres from the Matrix land allocation to the LSR land allocation in Sections 7, 18, and 19, T.32S., R.2W.; and Sections 13 and 24, T.32S., R.3W., W.M., OR. (see figure 2.1-4). This change in land allocation is proposed as mitigation for the potential adverse impact of the Pacific Connector Pipeline project on LSR 223 on the Umpqua National Forest. This is a plan level amendment that would change future management direction for the lands reallocated from Matrix to LSR (for additional information on consistency with LSR Standards and Guidelines see section 4.7.3.6. and appendix F.3 of the DEIS).

The purpose of this amendment is to make the proposed Pacific Connector pipeline project consistent with the Umpqua National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to this amendment are:

- 36 CFR 219.8(a)(1)(i) – [the plan must include plan components to maintain or restore] "Interdependence of terrestrial and aquatic ecosystems in the plan area."
- 36 CFR 219.8(b)(1) – [the plan must include plan components to guide the plan area's contribution to social and economic sustainability] "Social, cultural and economic conditions relevant to the area influenced by the plan."
- 36 CFR219.9(b)(1) "The responsible official shall determine whether or not the plan components required by paragraph (a) of this section provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area,"
- 36 CFR 219.9(a)(2)(ii) – [the plan must include plan components to maintain or restore] "Rare aquatic and terrestrial plant and animal communities."

Because the proposed amendment is "directly related" to these four substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendment (36 CFR 219.13 (b)(5)). However, because this proposed amendment would simply modify the area to which existing direction applies, the existing formatting for the planning requirements listed above would be retained (36 CFR 219.13(b)(4)).

In considering the "scope and scale" of the amendment, it is important to recognize that the applicable sections of 36 CFR 219.8 and 219.9 that are described above, requires plan components to maintain or restore rare aquatic and terrestrial plant and animal communities, and provide for social and economic sustainability across the entire planning area (i.e., the Umpqua National Forest). This plan amendment does not alter these LRMP plan requirements across 99.94 percent of the Umpqua National Forest. The proposed land reallocation is approximately 585 acres of the 983,129 acre Umpqua National Forest. The proposed amendment would benefit rare aquatic and terrestrial plant and animal communities by placing these acres in a late successional reserve where providing habitat for these species is the primary goal.

The timber probable sale quantity (directly related to economic conditions) would not be affected before the Umpqua National Forest LRMP is revised because the Forest has the capacity to maintain probable sale quantity without the acres of matrix lands that would be reallocated to LSR. If a linear relationship between acres and outputs is assumed, the potential effect would be less than two-tenths of one percent of the Forest's probable sale quantity since this proposed amendment would affect less than two-tenths of one percent of the Forest's matrix land base. This proposed amendment would not prevent future vegetation management activities such as thinning that would benefit LSR habitat and could also contribute to the local forest products industry.

How the Compensatory Mitigation Actions would help to Maintain or Restore Rare Aquatic and Terrestrial Plant and Animal Communities in the Plan Area (36 CFR 219.9(a), 36 CFR 219.9 (b)).

In addition to reallocation of 585 acres of Matrix to LSR, the CMP on the Umpqua National Forest includes proposals for stand density fuel breaks on 3,105 acres, stand density management on 816 acres, terrestrial habitat improvements on 478 acres and decommissioning approximately 5 miles of roads that would benefit rare plant and animal communities. The CMP on the Umpqua National Forest also includes proposals to improve aquatic and riparian habitat that would benefit rare aquatic plant and animal communities (see the discussion of *How the Compensatory Mitigation Actions would help to Maintain or Restore the Ecological Integrity of Riparian Areas, Soils, and Soil productivity in the Plan Area (36 CFR 219.8(a)(3)(i), (36 CFR 219.8(a)(2)(ii))* below for a discussion of benefits to aquatic habitats).

Stand density fuel breaks would reduce the threat of losing late-successional habitat to fire. High intensity fire has been identified as the single factor most impacting late successional and old growth forest habitats on federal lands in the area of the NWFP. Construction of the pipeline and associated activities removes both mature and developing stands and would increase fire suppression complexity; however the corridor also provides a fuel break. Fuels reduction adjacent to the corridor would increase the effectiveness of the corridor as a fuel break. Density management would increase longevity of existing mature stands by reducing losses from disease, insects and fire. Stand density management and fuels reduction would lower the risk of loss of developing and existing mature stands and other valuable habitats to high-intensity fire.

Stand density management would enhance LSOG habitat by increasing the growth, health, and vigor of the trees remaining in the stands, and restoring species and structural diversity to those considered characteristic under a natural disturbance regime. Thinning of young stands is a recognized treatment within LSR if designed to accelerate development of late-successional habitat characteristics. The proposed treatments include 228 acres of pre-commercial thinning, 288 acres of commercial thinning and 300 acres of off-site pine removal. The Pacific Connector pipeline would result in additional fragmentation and preclude the recovery of fragmented habitat for those stands adjacent to the pipeline corridor. Both mature stands and developing stands would be removed during pipeline construction. Density management of forested stands would assist in the recovery of late-seral habitat, impact from fragmentation, reduction in edge effects and enhance resilience of mature stands over time. Accelerating development of mature forest characteristics would shorten the impacts of those biological services loss due to pipeline construction.

Terrestrial habitat improvements include proposals for large woody debris placement on 164 acres, snag creation on 324 acres, noxious weed treatments on 6.7 miles of road and 124 acres of Lupine meadow restoration. Large wood replacement would partially mitigate for the barrier effect of the corridor by creating structure across the corridor for use by small wildlife species. Placement in wood deficient areas adjacent to the corridor allows for scattering of stockpiled wood, reducing localized fuel loads while improving habitat in deficient stands. Larger logs maintain moisture longer and are less likely to be fully consumed by fire. Managing for the proposed levels provide for a greater assurance of species abundance. The objective of snag creation is to mitigate for the immediate and future impacts to snag habitat from the clearing of the pipeline ROW. The construction and operation of the pipeline project has the potential to create vectors for noxious weeds. The proposed noxious weed treatments are intended to reduce populations of noxious weeds that are in close proximity to the pipeline project ROW. The long-term benefits of meadow restoration would include the restoring of native plant populations and species diversity. Restoring native plant communities and increasing vegetation diversity generally contributes to restoring habitat for a broad group of plant and animal species.

Although the Pacific Connector project has been routed to avoid LSOG habitat as much as possible, the project would cause habitat fragmentation within LSR 223. Road decommissioning reduces the edge effects over time by revegetating road surfaces and eliminating road corridors. Revegetating selected roads in conjunction with the density management proposed for adjacent plantations would create larger blocks of late successional habitat in the future.

These projects have been designed by an interdisciplinary team of resource professionals on the Umpqua National Forest with input and coordination with the U.S. Fish and Wildlife Service, NOAA Fisheries, and State agencies. They were planned within the watersheds that would be affected by the Pacific Connector pipeline project. They are a component of the Pacific Connector application and would be a requirement of the ROW grant. Overall, these projects would help maintain and restore rare aquatic and terrestrial plant and animal communities on the Umpqua National Forest (see table 2.1.1-3 and 2.1.1-4 and figure 2.1-1 through 2.1-5 in appendix F.2 for additional information).

Forest Plan Amendments Related to Soil, Water and Riparian Areas (UNF-1, UNF-2, and UNF-3):

Three Forest Plan standards associated with the soil, water, and riparian resources would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Umpqua National Forest LRMP. These standards are:

- Standard & Guideline 1 (UNF LRMP IV-33). Maintain all effective shading vegetation on perennial streams. Utilize silvicultural practices to establish shade on perennial streams where currently lacking.

- Prescriptions C2-II (LRMP IV-173 par.1, 1st sentence) and C2-IV (LRMP IV-177 last par. last sentence) Utility/transportation corridors, roads or transmission lines may cross but must not parallel streams and lake shores within the riparian unit.
- Standard & Guideline 1 (UNF LRMP IV-67). The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling or severely burned) within an activity area (e g., cutting unit, range allotment, site preparation area) should not exceed 20 percent. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition, and are included as part of this 20 percent.

The proposed amendments to these standards are:

- Standard & Guideline 1 (UNF LRMP IV-33). Maintain all effective shading vegetation on perennial streams, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Utilize silvicultural practices to establish shade on perennial streams where currently lacking. (proposed amendment UNF-1)
- Prescriptions C2-II (LRMP IV-173 par.1, 1st sentence) and C2-IV (LRMP IV-177 last par. last sentence) Utility/transportation corridors, roads or transmission lines may cross but must not parallel streams and lake shores within the riparian unit, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. (proposed amendment UNF-2)
- Standard and Guideline 1 (UNF LRMP IV-67). The combined total amount of unacceptable soil condition (detrimental compaction, displacement, puddling or severely burned) within an activity area (e g., cutting unit, range allotment, site preparation area) should not exceed 20 percent. All roads and landings, unless rehabilitated to natural conditions, are considered to be in detrimental condition, and are included as part of this 20 percent, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. (proposed amendment UNF-3)

While the amendments would provide an exception to meeting these standards, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore any effects of the pipeline's construction and operation on the soil, water and riparian resources within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

The purpose of these three project-level amendments is to make the proposed Pacific Connector pipeline project consistent with the Umpqua National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to these three amendments are:

- 36 CFR 219.8(a)(3)(i) – The plan must include plan components "to maintain or restore the ecological integrity of riparian areas in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity.

- 36 CFR 219.8(a)(2)(ii) – [The plan must include plan components to maintain or restore] "soils and soil productivity, including guidance to reduce soil erosion and sedimentation."

Because the three proposed amendments are "directly related" to these two substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendments (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the three amendments, it is important to recognize that the applicable sections of 36 CFR 219.8(a) that are described above, requires plan components to "maintain or restore" the soil, water and riparian resources across the entire planning area (i.e., the Umpqua National Forest). These plan amendments do not alter these LRMP plan requirements for managing the soil, water, and riparian resources across 99.98 percent of the Umpqua National Forest. The proposed pipeline construction corridor including the TEWAs and the UCSAs is approximately 205 acres of the 983,129 acre Umpqua National Forest. Of the 205 acres of pipeline corridor construction it is estimated that approximately 4 of these acres would not meet the standards for riparian area management described above and approximately 54 to 127 acres would not meet standards for soils described above.

The amendments modify three standards so that in the 205 acres of the project construction area the project need not be in compliance with these standards' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 205 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the three management requirements described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.8(a) rule requirements within the "scope and scale" of these proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.8(a) requirements are being addressed.

How the Required Mitigation Measures would Maintain or Restore Effects to Soil, Water, and Riparian Resources and Meet the Applicable 36 CFR 219.8(a) Requirements

The Forest Service has worked with Pacific Connector Gas Pipeline to inventory, analyze, and evaluate the geologic, soil, and hydrologic resources that could be affected by this project. In addition, a third-party consultant for technical support was also utilized in reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration are enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures, incorporated into amendments for soil, water, and riparian resources are designed to minimize, maintain or restore the potential for soil movement, slope stability, water quality, and to ensure adequate restoration and revegetation. These measures are identified in: the

Erosion Control and Revegetation Plan (POD I); *Right-of-Way Clearing Plan* (POD U); *Wetland and Waterbody Crossing Plan* (POD BB); the *Forest Service Site Specific Stream Crossing Prescriptions* (NSR 2014); the *Stream Crossing Risk Analysis*; and *Stream Crossing Risk Analysis Addendum* (GeoEngineers 2017d, 2018a). Pacific Connector would also follow the FERC's applicant prepared Wetland Procedures and the Best Management Practices for the State of Oregon. To further reduce potential for landslides on steep slopes, the Forest Service, BLM, and FERC are also recommending additional industry best management practices and measures identified from the *Technical Report on Soil Risk and Sensitivity Assessment* (NSR 2014) be incorporated into Pacific Connector's terms and conditions of the ROW Grant as described in the POD's identified above. See 4.2.3.3 of the DEIS for a description of soil risk and sensitivity assessment.

Areas with soils rated moderate to very high for risk or sensitivity (39 acres total) would be recommended for more site-specific validation of the risk criteria used in the *Technical Report on Soil Risk and Sensitivity Assessment* (NSR 2014) to confirm that specific locations merit consideration of the more aggressive soil remediation measures, such as: a 2- to 3-inch organic mulch surface application (80 percent coverage) of woodchips, logging slash, and/or straw; adaptive seed mixes and vegetation to better fit site conditions; deep subsoil decompaction with hydraulic excavators that leave constructed corridor mounded and rough with maximum water infiltration so that water cannot flow downhill for any appreciable distance; more aggressive use of constructed surface water runoff dispersion structures such as closely placed and more pronounced slope dips and water bars, etc.; more aggressive use of constructed surface runoff entrapments such as silt fencing, sediment settling basins, or straw bale structures, etc.; more aggressive placement (100 percent coverage) and depth (3 to 4 inches) of ground cover using woodchips, logging slash, straw bales, wattles (see POD's U and I). In efforts to protect soil productivity, topsoil segregation would be required for pipeline construction at wetland and waterbody crossings on NFS lands (POD U).

Some of the required mitigation measures in the POD BB and *Forest Service Site Specific Stream Crossing Prescriptions* (NSR 2014) to protect wetlands and minimize, maintain or restore compaction include: limiting the construction ROW width to 75 feet through wetlands; placing equipment on mats; using low-pressure ground equipment; limiting equipment operation and construction traffic along the ROW; locating temporary workspace (TEWAS) more than 50 feet away from wetland boundaries; cutting vegetation at ground level; limiting stump removal to the construction trench; segregating the top 12 inches of soil, or to the depth of the topsoil horizon; using "push-pull" techniques in saturated wetlands; limiting the amount of time that the trench is open by not trenching until the pipe is assembled and ready for installation; not using imported rock and soils for backfill; and not using fertilizer, lime, or mulch during restoration in wetlands. Pacific Connector must also follow the FERC Waterbody and Wetland Construction and Mitigation Procedures. See 4.3.3.2 of the DEIS for a complete list of applicable mitigation measures for pipeline construction at specific waterbody and stream crossings.

In an effort to minimize, maintain or restore the impacts to streams and riparian areas, Pacific Connector adopted route variations to co-locate the proposed construction corridor adjacent to existing roads and along dry ridge tops (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands). In addition, Pacific Connector has committed to limit construction at waterbody crossings to times of dry weather or low water flow. Pacific Connector would implement the required erosion control measures at the proposed stream crossings to minimize, maintain or restore potential erosion and sedimentation impacts. The applicable mitigation measures and monitoring requirements in the POD relating to water waterbody crossings are included in the *Site Specific Forest Service Stream Crossing Prescriptions, and Wetland and Waterbody Crossing Plan* (POD BB). In addition, applicable mitigation measures from the FERC approved applicant prepared Procedures for Wetland and Waterbody Crossings would be required.

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to: facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (Environmental Briefings and Compliance Plan, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer's designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to soil, water and riparian resources, are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

How the Compensatory Mitigation Actions would help to Maintain or Restore the Ecological Integrity of Riparian Areas, Soils, and Soil productivity in the Plan Area (36 CFR 219.8(a)(3)(i), (36 CFR 219.8(a)(2)(ii)).

Part of the CMP on the Umpqua National Forest includes proposals to remove eleven old culverts that may block fish passage either by poor design or by failure over time, decommission approximately 7.2 miles and storm proof approximately 11.4 miles of road.

Removing culverts that block fish passage and replacing them with fish-friendly designs can allow fish and other aquatic organisms to access previously unavailable habitat. Stream crossing replacement would directly improve stream connectivity and habitat for aquatic species by immediately restoring access to formerly inaccessible habitats. Indirectly, these projects would reduce potential sediment levels in the long term by decreasing the potential for road failure. Stream crossing projects also reduce stream velocities by increasing stream crossing sizes, eliminating flow restrictions and allowing passage to additional reaches of habitat by removing barriers to aquatic species which improves access to spawning and rearing habitat and allows unrestricted movement throughout stream reaches during seasonal changes in water levels (Hoffman 2007).

Decommissioning and storm proofing roads can substantially reduce sediment delivery to streams (Madej 2000; Keppeler et al. 2007). Proposed road decommissioning and storm proofing would increase infiltration of precipitation, reduce surface runoff, and reduce sediment production from road-related surface erosion in the watershed where the impacts from the Project would occur. Decommissioning roads would restore natural drainage patterns and thereby avoid large volumes of added sediment to the stream network that would be likely to eventually occur. In addition limited road maintenance dollars could be focused on the remaining road systems resulting in more maintenance of culverts and ditchlines resulting in less potential for catastrophic failure. Madej (2000) concluded that by eliminating the risk of stream diversions and culvert failures, road removal treatments significantly reduce long-term sediment production from retired logging roads.

These projects have been designed by an interdisciplinary team of resource professionals on the Umpqua National Forest with input and coordination with the U.S. Fish and Wildlife Service, NOAA Fisheries, and State agencies. They were planned within the watersheds that would be affected by the Pacific Connector pipeline project. They are a component of the Pacific Connector application and would be a requirement of the ROW grant. Overall, these projects would help maintain and restore riparian and soil resources on the Umpqua National Forest (see table 2.1.1-3 and 2.1.1-4 and figure 2.1-1 through 2.1-5 in appendix F.2 for additional information).

Evaluation of Rogue River National Forest Proposed Forest Plan Amendments

The proposed Pacific Connector pipeline incorporates the most up-to-date engineering and technological practices for pipeline construction and operation. However, even with following these practices, it has been determined that one Forest Plan standard associated with rare and/or isolated species (Survey and Manage), two Forest Plan standards associated with the soil, water, and riparian resources, and four Forest Plan standards associated with visual resources would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Rogue River National Forest LRMP as amended by the NWFP and the January 2001 Survey and Manage ROD.

Forest Plan Amendments Related to Rare Aquatic and Terrestrial Plant and Animal Communities (FS-1, RRNF-7):

*Amendment FS-1**:** Project-Specific Amendment to Exempt Management Recommendations for Survey and Manage Species on the Rogue River National Forest.*

One Forest Plan standard associated with rare and/or isolated species (Survey and Manage) would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Rogue River National Forest LRMP as amended by the NWFP and the January 2001 Survey and Manage ROD. This standard is:

- Management Direction: Manage All Known Sites (Survey and Manage ROD, Standards and Guidelines Page 8). Current and future known sites will be managed according to the Management Recommendation for the species. Professional judgment, Appendix J2 in the Northwest Forest Plan Final SEIS, and appropriate literature will be used to guide individual site management for those species that do not have Management Recommendations.

The proposed amendment to this standard is:

- Management Direction: Manage All Known Sites (Survey and Manage ROD, Standards and Guidelines Page 8). Current and future known sites will be managed according to the Management Recommendation for the species, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Professional judgment, Appendix J2 in the Northwest Forest Plan Final SEIS, and appropriate literature will be used to guide individual site management for those species that do not have Management Recommendations. (Proposed amendment FS-1 on the Rogue River National Forest)

While the amendment would provide an exception to meeting this standard, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore any effects of the pipeline's construction and operation on Survey and Manage species within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

The purpose of this project-level amendment is to make the proposed Pacific Connector pipeline project consistent with the Rogue River National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to this amendment are:

- 36 CFR 219.9(a)(2)(ii) – [the plan must include plan components to maintain or restore] "Rare aquatic and terrestrial plant and animal communities."
- 36 CFR 219.9(b)(1) – "The responsible official shall determine whether or not the plan components required by paragraph (a) provide ecological conditions necessary to: …maintain viable populations of each species of conservation concern within the plan area."

Because the proposed amendment is "directly related" to these two substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendment (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the amendment, it is important to recognize that the applicable sections of 36 CFR 219.9(a) and (b) that are described above, requires plan components to maintain or restore rare aquatic and terrestrial plant and animal communities, across the entire planning area (i.e., the Rogue River National Forest). This plan amendment does not alter these LRMP plan requirements for managing rare plant and animal communities across 99.97 percent of the Rogue River National Forest. The proposed pipeline construction corridor including the TEWAs and the UCSAs is approximately 206 acres of the 628,443 acre Rogue River National Forest. Within this 206 acre construction corridor surveys have identified 36 Survey and Manage sites that could be potentially impacted by construction activities. The proposed amendment does not waive the persistence objective for Survey and Manage species. The analysis that was conducted (see section 4.6.4.3 of the DEIS and appendix F.5) determined the Survey and Manage persistence objectives would be met. This means that for Rogue River National Forest lands within the project area, individual sites of Survey and Manage species may be impacted or lost to construction activities, but affected species are expected to persist within the range of the NSO despite the loss of these individual sites.

The amendment modifies this standard so that in the 206 acres of the project construction area the project need not be in compliance with this standard' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 206 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the management requirement described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.9(a) and (b) rule requirements within the "scope and scale" of the proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.9(a) and (b) requirements are being addressed.

How the Required Mitigation Measures would Maintain or Restore Effects to Rare Aquatic and Terrestrial Plant and Animal Communities and Meet the Applicable 36 CFR 219.9(a) and 36 CFR 219.9 (b) Requirements

The Forest Service has worked to inventory, analyze, and evaluate rare aquatic, terrestrial plant and animal communities that could be affected by this project. In addition, a third-party consultant for technical support was also utilized in reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures incorporated into amendments for Survey and Manage species are designed to minimize, maintain or restore the potential for habitat fragmentation, edge effects, and loss of long-term habitats associated with effected species. To ensure adequate restoration and revegetation of the ROW, design features are identified in the *Erosion Control and Revegetation Plan* (POD I), *Right-of-Way Clearing Plan* (POD U), *Leave Tree Protection Plan* (POD P). In addition, routing considerations were identified during project development to ensure avoidance of known populations of rare plant and animal communities (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands). As well as, appendix F.5, *Survey and Manage Persistence Evaluations*, and proposed amendment RRNF-7 Reallocation of Matrix Lands to LSR.

As a basis for Survey and Manage determinations, appendix F.5 provides background research on Survey and Manage species that could be affected by the Pacific Connector Project; a review of survey reports prepared by others for the Pacific Connector Project; and processing and analysis of spatial data obtained from the Bureau of Land Management (BLM), Forest Service, and other sources over the past 12 years. Background information was used in combination with new information available as a result of surveys for the Pacific Connector Project and recent surveys in other portions of old growth forests to discuss the currently known distribution of the species in old growth forests within the NSO range. Impacts to sites as a result of the Pacific Connector Project were analyzed to determine if the species would continue to have a reasonable assurance of persistence in the NSO range following implementation of the Pacific Connector Project, taking into consideration the status and distribution of the species and general habitat in the NSO range.

Some of the required mitigation measures in the POD sections to protect rare plant and animal communities include: flagging existing snags on the edges of the construction ROW or TEWAs where feasible to save from clearing; snags would be saved as and used in LWD placement post-construction to benefit primary and secondary cavity nesting birds, mammals, reptiles, and amphibians; other large diameter trees on the edges of the construction ROW and TEWAs would also be flagged to save/protect as green recruitment or habitat/shade trees, where feasible; trees would be girdled to create snags to augment the number of snags along the ROW to benefit cavity nesting birds, mammals, reptiles, and amphibians. See POD's P & U and 4.7—*Land Use* of the DEIS for a complete list of applicable mitigation measures for pipeline construction. Additional measures include low ground weight (pressure) vehicles would be used; logging machinery would be restricted to the 30-foot permanent ROW wherever possible to prevent soil compaction; the removal of soil duff layers would be avoided in order to maintain a cushion between the soil and the logs and the logging equipment; designed skid trails would be used to restrict detrimental soil disturbance (compaction and displacement) to a smaller area of the ROW over the pipeline trenching area; and the temporary construction area would be restored and revegetated using native seeds, to the extent possible, and saplings (POD I).

In an effort to minimize, maintain or restore the impacts to Survey and Manage species, Pacific Connector adopted route variations to avoid certain species identified in the Survey and Manage Persistence Evaluations by co-locating the proposed construction corridor adjacent to existing roads, through managed timber stands or otherwise avoid unique LSOG habitats to the maximum extent practicable (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands).

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (Environmental Briefings and Compliance Plan, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer's designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to soil, water and riparian resources, are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

Amendment RRNF-7: Reallocation of Matrix Lands to LSR

The other proposed Forest Plan amendment related to rare aquatic and terrestrial plant and animal communities on the Rogue River National Forest is RRNF-7. This proposed amendment would change the designation of approximately 522 acres from the Matrix land allocation to the LSR land allocation in Section 32, T.36S., R.4E. W.M., OR. (see figure 2.2-1). This change in land allocation is proposed as mitigation for the potential adverse impact of the Pacific Connector Pipeline project on LSR 227 on the Rogue River National Forest. This is a plan level amendment that would change future management direction for the lands reallocated from Matrix to LSR (for additional information on consistency with LSR Standards and Guidelines see section 4.7.3.6. and appendix F.3 of the DEIS).

The purpose of this amendment is to make the proposed Pacific Connector pipeline project consistent with the Rogue River National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to this amendment are:

- 36 CFR 219.8(a)(1)(i) – [the plan must include plan components to maintain or restore] "Interdependence of terrestrial and aquatic ecosystems in the plan area."
- 36 CFR 219.8(b)(1) – [the plan must include plan components to guide the plan area's contribution to social and economic sustainability] "Social, cultural and economic conditions relevant to the area influenced by the plan."
- 36 CFR219.9(b)(1) "The responsible official shall determine whether or not the plan components required by paragraph (a) of this section provide the ecological conditions necessary to: contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern within the plan area,"
- 36 CFR 219.9(a)(2)(ii) – [the plan must include plan components to maintain or restore] "Rare aquatic and terrestrial plant and animal communities."

Because the proposed amendment is "directly related" to these four substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendment (36 CFR 219.13 (b)(5)). However, because this proposed amendment would simply modify the area to which existing direction applies, the existing formatting for the planning requirements listed above would be retained (36 CFR 219.13(b)(4)).

In considering the "scope and scale" of the amendment, it is important to recognize that the applicable sections of 36 CFR 219.8 and 219.9 that are described above, requires plan components to maintain or restore rare aquatic and terrestrial plant and animal communities, and provide for social and economic sustainability across the entire planning area (i.e., the Rogue River National Forest). This plan amendment does not alter these LRMP plan requirements across 99.92 percent of the Rogue River National Forest. The proposed land reallocation is approximately 522 acres of the 628,443 acre Rogue River National Forest. The proposed amendment would benefit rare aquatic and terrestrial plant and animal communities by placing these acres in a late successional reserve where providing habitat for these species is the primary goal.

The timber probable sale quantity (directly related to economic conditions) would not be affected before the Rogue River National Forest LRMP is revised because the Forest has the capacity to maintain probable sale quantity without the acres of matrix lands that would be reallocated to LSR. If a linear relationship between acres and outputs is assumed, the potential effect would be less than one-half of one percent of the Forest's probable sale quantity since this proposed amendment would affect less than one-half of one percent of the Forest's matrix land base. This proposed amendment would not prevent future vegetation management activities such as thinning that would benefit LSR habitat and could also contribute to the local forest products industry.

How the Compensatory Mitigation Actions would help to Maintain or Restore Rare Aquatic and Terrestrial Plant and Animal Communities in the Plan Area (36 CFR 219.9(a), 36 CFR 219.9 (b)).

In addition to the reallocation of 522 acres of Matrix to LSR, the CMP on the Rogue River National Forest includes proposals for stand density management on 618 acres, terrestrial habitat improvements on 1153 acres and decommissioning approximately 57.5 miles of roads that would benefit rare plant and animal communities. The CMP on the Rogue River National Forest also includes proposals to improve aquatic and riparian habitat that would benefit rare aquatic plant and animal communities (see the discussion of **How the Compensatory Mitigation Actions would help to Maintain or Restore the Ecological Integrity of Riparian Areas, Soils, and Soil productivity in the Plan Area (36 CFR 219.8(a)(3)(i), (36 CFR 219.8(a)(2)(ii))** below for a discussion of benefits to aquatic habitats).

Stand density management would enhance LSOG habitat by increasing the growth, health, and vigor of the trees remaining in the stands, and restoring species and structural diversity to those considered characteristic under a natural disturbance regime. Thinning of young stands is a recognized treatment within LSR if designed to accelerate development of late-successional habitat characteristics. The proposed treatments include 618 acres of pre-commercial thinning. The Pacific Connector pipeline would result in additional fragmentation and preclude the recovery of fragmented habitat for those stands adjacent to the pipeline corridor. Both mature stands and developing stands would be removed during pipeline construction. Density management of forested stands would assist in the recovery of late-seral habitat, impact from fragmentation, reduction in edge effects and enhance resilience of mature stands over time. Accelerating development of mature forest characteristics would shorten the impacts of those biological services loss due to pipeline construction.

Terrestrial habitat improvements include proposals for large woody debris placement on 511 acres, snag creation on 622 acres, and 20 acres of habitat planting for the Mardon Skipper butterfly. Large wood replacement would partially mitigate for the barrier effect of the corridor by creating structure across the corridor for use by small wildlife species. Placement in wood deficient areas adjacent to the corridor allows for scattering of stockpiled wood, reducing localized fuel loads while improving habitat in deficient stands. Larger logs maintain moisture longer and are less likely to be fully consumed by fire. Managing for the proposed levels provide for a greater assurance of species abundance. The objective of snag creation is to mitigate for the immediate and future impacts to snag habitat from the clearing of the pipeline ROW. The Dead Indian Plateau region is one of four known sites for Mardon Skipper butterflies in the world. It is also adjacent to a known site for Short-horned grasshoppers. Both of these species are on the Regional Forester's Sensitive Species list. As a long-term opening, the pipeline corridor would provide a unique opportunity to develop habitat for these two species. Planting the corridor with plants preferred by these species has the potential to increase the habitat and local range for both species. This action would provide both short-term and long-term habitat for the local population of Mardon Skipper butterflies and Short-horned grasshoppers.

Although the Pacific Connector project has been routed to avoid LSOG habitat as much as possible, the project would cause habitat fragmentation within LSR 227. Road decommissioning reduces the edge effects over time by revegetating road surfaces and eliminating road corridors. Revegetating selected roads in conjunction with the density management proposed for adjacent plantations would create larger blocks of late successional habitat in the future.

These projects have been designed by an interdisciplinary team of resource professionals on the Rogue River National Forest with input and coordination with the U.S. Fish and Wildlife Service, NOAA Fisheries, and State agencies. They were planned within the watersheds that would be affected by the Pacific Connector pipeline project. They are a component of the Pacific Connector application and would be a requirement of the ROW grant. Overall, these projects would help maintain and restore rare aquatic and terrestrial plant and animal communities on the Rogue River National Forest (see table 2.2.1-3 and 2.2.1-4 and figure 2.2-1 and 2.2-2 in appendix F.2 for additional information).

Forest Plan Amendments Related to Soil, Water and Riparian Areas (RRNF -5, RRNF-6):

Two Forest Plan standards associated with the soil, water, and riparian resources would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Rogue River National Forest LRMP. These standards are:

- Management Prescription 26 Restricted Riparian Standard & Guidelines for Facilities (10), (RRNF LRMP 4-308). Helispots and transmission corridors should be located outside this management area.
- Standard & Guideline for Soils (3) (RRNF LRMP 4-41, 4-83, 4-97, 4-123, 4-177, 4-307). No more than 10 percent of an activity area should be compacted, puddled or displaced upon completion of project (not including permanent roads or landings). No more than 20 percent of the area should be displaced or compacted under circumstances resulting from previous management practices, including roads and landings. Permanent recreation facilities or other permanent facilities are exempt.

The proposed amendments to these standards are:

- Management Prescription 26 Restricted Riparian Standard & Guidelines for Facilities (10), (RRNF LRMP 4-308). Helispots and transmission corridors should be located outside this management area, **with the exception of the operational right-of-way and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented**. (Proposed amendment RRNF-5)

- Standard & Guideline for Soils (3) (RRNF LRMP 4-41, 4-83, 4-97, 4-123, 4-177, 4-307). No more than 10 percent of an activity area should be compacted, puddled or displaced upon completion of project (not including permanent roads or landings). No more than 20 percent of the area should be displaced or compacted under circumstances resulting from previous management practices, including roads and landings, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Permanent recreation facilities or other permanent facilities are exempt. (Proposed amendment RRNF-6)

While the amendments would provide an exception to meeting these standards, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore any effects of the pipeline's construction and operation on the soil, water and riparian resources within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

The purpose of these two project-level amendments is to make the proposed Pacific Connector pipeline project consistent with the Rogue River National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to these three amendments are:

- 36 CFR 219.8(a)(3)(i) – The plan must include plan components "to maintain or restore the ecological integrity of riparian areas in the plan area, including plan components to maintain or restore structure, function, composition, and connectivity
- 36 CFR 219.8(a)(2)(ii) – [The plan must include plan components to maintain or restore] "soils and soil productivity, including guidance to reduce soil erosion and sedimentation."

Because the two proposed amendments are "directly related" to these two substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendments (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the two amendments, it is important to recognize that the applicable sections of 36 CFR 219.8(a) that are described above, requires plan components to "maintain or restore" the soil, water and riparian resources across the entire planning area (i.e., the Rogue River National Forest). These plan amendments do not alter these LRMP plan requirements for managing the soil, water, and riparian resources across 99.97 percent of the Rogue River National Forest. The proposed pipeline construction corridor including the TEWAs and the UCSAs is approximately 206 acres of the 628,443 acre Rogue River National Forest. Of the 206 acres of pipeline corridor construction it is estimated that approximately 2.5 of these acres would not meet the standards for riparian area management described above and approximately 62 to 144 acres would not meet standards for soils described above.

The amendments modify two standards so that in the 206 acres of the project construction area the project need not be in compliance with these standards' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 206 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the two management requirements described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.8(a) rule requirements within the "scope and scale" of these proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.8(a) requirements are being addressed.

How the Required Mitigation Measures would Maintain or Restore Effects to Soil, Water, and Riparian Resources and Meet the Applicable 36 CFR 219.8(a) Requirements.

The Forest Service has worked with Pacific Connector Gas Pipeline to inventory, analyze, and evaluate the geologic, soil, and hydrologic resources that could be affected by this project. In addition, a third-party consultant for technical support was also utilized in reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration are enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures, incorporated into amendments for soil, water, and riparian resources are designed to minimize, maintain or restore the potential for soil movement, slope stability, water quality, and to ensure adequate restoration and revegetation. These measures are identified in: the *Erosion Control and Revegetation Plan* (POD I); *Right-of-Way Clearing Plan* (POD U); *Wetland and Waterbody Crossing Plan* (POD BB); the *Forest Service Site Specific Stream Crossing Prescriptions* (NSR 2014); the *Stream Crossing Risk Analysis*; and *Stream Crossing Risk Analysis Addendum* (GeoEngineers2017d, 2018a). Pacific Connector would also follow the FERC's applicant prepared Wetland Procedures and the Best Management Practices for the State of Oregon. To further reduce potential for landslides on steep slopes, the Forest Service, BLM, and FERC are also recommending additional industry best management practices and measures identified from the *Technical Report on Soil Risk and Sensitivity Assessment* (NSR 2014) be incorporated into Pacific Connector's terms and conditions of the ROW Grant as described in the POD's identified above. See 4.2.3.3 of the DEIS for a description of soil risk and sensitivity assessment.

Areas with soils rated moderate to very high for risk or sensitivity (17 acres total) would be recommended for more site-specific validation of the risk criteria used in the *Technical Report on Soil Risk and Sensitivity Assessment* (NSR 2014) to confirm that specific locations merit consideration of the more aggressive soil remediation measures, such as: a 2- to 3-inch organic mulch surface application (80 percent coverage) of woodchips, logging slash, and/or straw; adaptive seed mixes and vegetation to better fit site conditions; deep subsoil decompaction with hydraulic excavators that leave constructed corridor mounded and rough with maximum water infiltration so that water cannot flow downhill for any appreciable distance; more aggressive use of constructed surface water runoff dispersion structures such as closely placed and more pronounced slope dips and water bars, etc.; more aggressive use of constructed surface runoff entrapments such as silt fencing, sediment settling basins, or straw bale structures, etc.; more aggressive placement (100 percent coverage) and depth (3 to 4 inches) of ground cover using woodchips, logging slash, straw bales, wattles (see POD's U and I). In efforts to protect soil productivity, topsoil segregation would be required for pipeline construction at wetland and waterbody crossings on NFS lands (POD U).

Some of the required mitigation measures in the POD BB and *Forest Service Site Specific Stream Crossing Prescriptions* (NSR 2014) to protect wetlands and minimize, maintain or restore compaction include: limiting the construction ROW width to 75 feet through wetlands; placing equipment on mats; using low-pressure ground equipment; limiting equipment operation and construction traffic along the ROW; locating temporary workspace (TEWAS) more than 50 feet away from wetland boundaries; cutting vegetation at ground level; limiting stump removal to the construction trench; segregating the top 12 inches of soil, or to the depth of the topsoil horizon; using "push-pull" techniques in saturated wetlands; limiting the amount of time that the trench is open by not trenching until the pipe is assembled and ready for installation; not using imported rock and soils for backfill; and not using fertilizer, lime, or mulch during restoration in wetlands. Pacific Connector must also follow the FERC Waterbody and Wetland Construction and Mitigation Procedures. See 4.3.3.2 of the DEIS for a complete list of applicable mitigation measures for pipeline construction at specific waterbody and stream crossings.

In an effort to minimize, maintain or restore the impacts to streams and riparian areas, Pacific Connector adopted route variations to co-locate the proposed construction corridor adjacent to existing roads and along dry ridge tops (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands). In addition, Pacific Connector has committed to limit construction at waterbody crossings to times of dry weather or low water flow. Pacific Connector would implement the required erosion control measures at the proposed stream crossings to minimize, maintain or restore potential erosion and sedimentation impacts. The applicable mitigation measures and monitoring requirements in the POD relating to water waterbody crossings are included in the *Site Specific Forest Service Stream Crossing Prescriptions, and Wetland and Waterbody Crossing Plan* (POD BB). In addition, applicable mitigation measures from the FERC approved applicant prepared Procedures for Wetland and Waterbody Crossings would be required.

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to: facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (Environmental Briefings and Compliance Plan, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer's designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to soil, water and riparian resources, are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

How the Compensatory Mitigation Actions would help to Maintain or Restore the Ecological Integrity of Riparian Areas, Soils, and Soil Productivity in the Plan Area (36 CFR 219.8(a)(3)(i), 36 CFR 219.8(a)(2)(ii)).

Part of the CMP on the Rogue River National Forest includes proposals to place large woody debris in-stream for 1.5 miles, repair stream crossings at 32 sites, and decommission approximately 57.5 miles of road.

Placement of LWD in streams adds structural complexity to aquatic systems by creating pools and riffles, trapping fine sediments and can contribute to reductions in stream temperatures over time (Tippery et al. 2010). Placing LWD in streams affects channel morphology, the routing and storage of water and sediment, and provides structure and complexity to stream systems. Complex pools and side channels created by instream wood provide overwintering habitat to stream salmonids and other aquatic organisms (Solazzi et. al. 2000). They also provide cover from predators during summer low flow periods when predation is at its highest. Providing more stream channel structure results in better over wintering habitat, improved summer pool habitat, and more abundant spawning gravels.

Restoring stream crossings reconnects aquatic habitats by allowing the passage of aquatic biota and restoring riparian vegetation. Stream crossing replacement would directly improve stream connectivity and habitat for aquatic species by immediately restoring access to formerly inaccessible habitats. Indirectly, these projects would reduce potential sediment levels in the long term by decreasing the potential for road failure. Stream crossing projects also reduce stream velocities by increasing stream crossing sizes, eliminating flow restrictions and allowing passage to additional reaches of habitat by removing barriers to aquatic species which improves access to spawning and rearing habitat and allows unrestricted movement throughout stream reaches during seasonal changes in water levels (Hoffman 2007).

Decommissioning roads can substantially reduce sediment delivery to streams (Madej 2000; Keppeler et al. 2007). Proposed road decommissioning and stormproofing would increase infiltration of precipitation, reduce surface runoff, and reduce sediment production from road-related surface erosion in the watershed where the impacts from the Project would occur. Decommissioning roads would restore natural drainage patterns and thereby avoid large volumes of added sediment to the stream network that would be likely to eventually occur. In addition limited road maintenance dollars could be focused on the remaining road systems resulting in more maintenance of culverts and ditchlines resulting in less potential for catastrophic failure. Madej (2000) concluded that by eliminating the risk of stream diversions and culvert failures, road removal treatments significantly reduce long-term sediment production from retired logging roads.

These projects have been designed by an interdisciplinary team of resource professionals on the Rogue River National Forest with input and coordination with the U.S. Fish and Wildlife Service, NOAA Fisheries, and State agencies. They were planned within the watersheds that would be affected by the Pacific Connector pipeline project. They are a component of the Pacific Connector application and would be a requirement of the ROW grant. Overall, these projects would help maintain and restore riparian and soil resources on the Rogue River National Forest (see table 2.2.1-3 and 2.2.1-4 and figure 2.2-1 and 2.2-2 in appendix F.2 for additional information).

Forest Plan Amendments Related Visual Resources (RRNF -2, RRNF-3, RRNF-4):

- Four Forest Plan standards associated with visual resources would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Rogue River National Forest LRMP. These standards are:
- Management Strategy 6, Foreground Retention, Standard and Guideline (1), (RRNF LRMP 4-72). Manage the area for Retention Visual Quality Objective. Catastrophic occurrences may dictate a need for short term departure from Retention. Assess the impacts to visual resources in all project environmental analysis. Specifically address how the visual quality objective will be met.
- Management Strategy 7, Foreground Partial Retention, Standard and Guideline (4), (RRNF LRMP 4-86). Correct unacceptable form, line, color or texture as a result of management activities either during the operation or within two years after completion of the activity.
- Management Strategy 7, Foreground Partial Retention, Standard and Guideline (1), (RRNF LRMP, 4-86). Manage the area for Partial Retention Visual Quality Objective. Catastrophic occurrences may dictate a need for short-term departure from Partial Retention Visual Quality Objective. Blend and shape regeneration openings with the natural terrain to the extent possible. Assess the impacts to visual resources in all project environmental analysis. Specifically address how the visual quality objective will be met.
- Management Strategy 9, Middle Ground Partial Retention, Standard and Guideline (1), (RRNF LRMP, 4-112). Manage the area for Partial Retention Visual Quality Objective. Catastrophic occurrences may dictate a need for short-term departure from Partial Retention Visual Quality Objective. Blend and shape regeneration openings with the natural terrain to the extent possible. Assess the impacts to visual resources in all project environmental analysis. Specifically address how the visual quality objective will be met.

The proposed amendments to these standards are:

- Management Strategy 6, Foreground Retention, Standard and Guideline (1), (RRNF LRMP 4-72). Manage the area for Retention Visual Quality Objective (VQO), with the exception of the Pacific Connector Pipeline ROW, where the VQO would be amended to Foreground Partial Retention where the pipeline would cross the Big Elk Road. The applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Catastrophic occurrences may dictate a need for short term departure from Retention. Assess the impacts to visual resources in all project environmental analysis. Specifically address how the visual quality objective will be met. (Proposed amendment RRNF-2)
- Management Strategy 7, Foreground Partial Retention, Standard and Guideline (4), (RRNF LRMP 4-86). Correct unacceptable form, line, color or texture as a result of management activities either during the operation or within two years after completion of the activity,

with the exception of the Pacific Connector Pipeline ROW which shall attain the amended VQO within 10 - 15 years after completion of the construction phase of the project where the pipeline crosses the Big Elk Road. The applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. (Proposed amendment RRNF-2)

- Management Strategy 7, Foreground Partial Retention, Standard and Guideline (1), (RRNF LRMP, 4-86). Manage the area for Partial Retention Visual Quality Objective. Catastrophic occurrences may dictate a need for short-term departure from Partial Retention Visual Quality Objective (VQO), with the exception of the Pacific Connector Pipeline ROW, where the VQO would be amended to Modification where the pipeline would cross the Pacific Crest Trail. The applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented**.** Blend and shape regeneration openings with the natural terrain to the extent possible. Assess the impacts to visual resources in all project environmental analysis. Specifically address how the visual quality objective will be met. (proposed amendment RRNF-3)
- Management Strategy 7, Foreground Partial Retention, Standard and Guideline (4), (RRNF LRMP 4-86). Correct unacceptable form, line, color or texture as a result of management activities either during the operation or within two years after completion of the activity, with the exception of the Pacific Connector Pipeline ROW which shall attain the amended VQO within 15 - 20 years after completion of the construction phase of the project where the pipeline crosses the Pacific Crest Trail. The applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. (Proposed amendment RRNF-3)
- Management Strategy 9, Middle Ground Partial Retention, Standard and Guideline (1), (RRNF LRMP, 4-112). Manage the area for Partial Retention Visual Quality Objective, with the exception of the Pacific Connector Pipeline ROW which shall attain the VQO within 10 - 15 years after completion of the construction phase of the project where the pipeline is adjacent to Highway 140.[151] The applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Catastrophic occurrences may dictate a need for short-term departure from Partial Retention Visual Quality Objective. Blend and shape regeneration openings with the natural terrain to the extent possible. Assess the impacts to visual resources in all project environmental analysis. Specifically address how the visual quality objective will be met. (Proposed amendment RRNF-4)

While the amendments would provide an exception to meeting these standards, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore any effects of the pipeline's construction and operation on the visual resources within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

[151] Duration of impact specifications are found in the National Forest Landscape Management Handbook 462 (USDA Forest Service 1974). The recommended duration to meet standards for Middleground Partial Retention is 3 years (see RRNF LRMP FEIS p. III-119).

The purpose of these five project-level amendments is to make the proposed Pacific Connector pipeline project consistent with the Rogue River National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to these five amendments are:

- 36 CFR 219.10(a)(1) – […the responsible official shall consider: …] "(1) Aesthetic values,… scenery,... viewsheds...".
- 36 CFR 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities,…and scenic character…"

Because the proposed amendments are "directly related" to these two substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendments (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the five amendments, it is important to recognize that the applicable sections of 36 CFR 219.10 that are described above, requires plan components to provide for aesthetic values and scenic character across the entire planning area (i.e., the Rogue River National Forest). These plan amendments do not alter these LRMP plan requirements for managing visual resources across 99.99 percent of the Rogue River National Forest. The proposed pipeline construction corridor including the TEWAs and the UCSAs is approximately 206 acres of the 628,443 acre Rogue River National Forest. Of the 206 acres of pipeline corridor construction it is estimated that approximately 19 of these acres would not meet the standards for visual resources described above.

The amendments modify four standards so that in the 206 acres of the project construction area the project need not be in compliance with these standards' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 206 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the four management requirements described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.10 rule requirements within the "scope and scale" of these proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.10 requirements are being addressed.

How the Required Mitigation Measures would Consider, Minimize, Maintain or Restore Effects to Aesthetic Values and Scenic Character and Meet the Applicable 36 CFR 219.10(a) and 36 CFR 219.10(b) Requirements.

The Forest Service has worked to inventory, analyze, and evaluate visual resources, view sheds, and aesthetics that could be affected by this project. Forest Service landscape architect provided technical support to FERC and Forest Service third-party contractors by reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures incorporated into amendments for Visual Quality Objectives, are designed to minimize, maintain or restore the potential for long-term impacts to visually sensitive areas. To ensure adequate restoration and revegetation of the ROW, design features are identified in the *Erosion Control and Revegetation Plan* (POD I), *Right-of-Way Clearing Plan* (POD U), *Leave Tree Protection Plan* (POD P), *Aesthetics Management Plan* (POD A), and *Recreation Management Plan* (POD S). In addition, routing considerations were identified during project development to ensure reduced visual impacts at the Pacific Crest Trail crossing by modifying the route to include a 45 degree angle and avoiding straight line impacts to trail users. (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands)

A visual assessment was conducted to determine the potential effects on visual resources associated with the pipeline. Representative viewpoint points (also referred to as KOPs) were identified within the view shed for the pipeline, defined as the area from which the pipeline would be potentially visible. Photographs of existing visual conditions were used in preparing computerized visual simulations for each KOP. Because the appearance of the pipeline ROW would change with time, a series of simulations were prepared to illustrate how the pipeline ROW would look at different timeframes following construction. These KOPs would also serve as monitoring points for mitigation.

Pacific Connector produced POD A that outlined measures to reduce visual impacts along its pipeline route. To the extent feasible, Pacific Connector would use revegetation efforts to shape and blend the pipeline easement, enhance the setting, and mimic the natural features of the landscape. These measures would consist of revegetating all disturbed areas and replanting trees in TEWAs and any other areas of the temporary construction ROW that were forested prior to construction (see POD I).

On Forest Service lands, Pacific Connector would maintain a cleared 30-foot width centered over the pipe allowing the remainder of the permanent easement to be reforested. This allows trees to naturally reestablish along the edges of the permanent easement at a staggered, more natural-looking interval. Replacing slash in forested areas of the ROW during restoration activities would immediately affect the visual contrast in color and texture of the disturbed ROW areas. Over time, as the ROW revegetates and narrows in width and changes in form, texture and color, potential visual impacts would diminish.

Additionally, a row, or if necessary, clusters of trees and/or shrubs would be planted across the ROW to provide visual screens at key road and trail crossings in sensitive view sheds. For all revegetation practices, Pacific Connector and/or its contractors would only use agency-approved tree and plant species, in compliance with management plan objectives and in consultation with agency specialists.

Site Specific Crossing Prescriptions:
<u>Big Elk Road (MP 161.41).</u> Within the Rogue River National Forest, the Pipeline crosses an area managed for Foreground Retention with high scenic integrity. Pacific Connector would neck down to a width of 50 feet immediately adjacent to either side of the Big Elk Road crossing. The construction ROW would then expand from 50 feet to the full 95-foot construction ROW width at

100 feet from either side of the road. To ensure that the appropriate large trees are conserved on either side of Big Elk Road, Pacific Connector's Environmental Inspectors would verify the limits of the staked construction limits in conjunction with a Forest Service representative (see POD P). Pacific Connector would implement the mitigation recommendations detailed in Section 3.2 and 3.3 and further described in the POD I to minimize, maintain or restore potential visual effects at this road crossing, and a buffer of vegetation would mask the ROW on both sides of the road. Pacific Connector would additionally revegetate the ROW using large native trees and shrubs to begin the mitigation process.

<u>Pacific Crest National Scenic Trail Corridor.</u> The area where the Pipeline intersects the PCT on the Rogue River National Forest supports a stand of old-growth forest and is managed for Foreground Partial Retention to maintain the aesthetic forest appeal for trail users. The typical construction ROW width is 95 feet, which could devalue this trail crossing segment during construction. To minimize, maintain or restore impacts to the scenic quality of the area, Pacific Connector would "neck down" the construction ROW from 95 feet to 75 feet in width for a distance of more than 300 feet on either side of the trail. UCSAs (no tree clearing) have also been located behind these neck downs, outside of the immediate foreground visual area, to minimize, maintain or restore disturbance. These UCSAs would be used to store slash and stumps during construction that would be redistributed across the ROW during restoration. To further minimize, maintain or restore potential visual impacts at the PCT crossing, the route was realigned at the request of the Forest Service to shorten the potential visual corridor down the ROW. Additional impact minimization measures include:

- Identifying trees along the edge of the construction ROW that can be saved from clearing, based on hazard tree and construction safety.
- Scalloping adjacent edges of timber as directed by the Forest Service landscape architect.
- Salvaging topsoil (duff and A horizon) to a depth of 12-inches along the trench line, segregate from spoil material, and replace during restoration.
- Minimizing grading within the 75-foot construction ROW based on safety requirements. Stumps would be removed, or gridded as necessary to provide a safe equipment working plane.
- Replanting a 75-foot wide visual screen on either side of the trail with nursery trees and shrubs within 6 days of final grading, dependent on seasonal planting constraints (and not within the 30 foot-operational easement). Replanting would be with mixed conifer species of differing age class per the Forest Service landscape plan and would include hydro-mulch seeding.
- Revegetating the remaining ROW with nursery trees and shrubs planted along the edges of the ROW in scalloped arrangement.
- Hydro-mulch seeding all disturbed soils.
- Placing logs and LWD in the construction ROW as directed by the Forest Service landscape plan.
- Using a gravity drip irrigation system with a water source from the well at Brown Mountain Shelter, to improve replanting establishment.
- Replanting would occur if mortality exceeds 30 percent.

Construction of the trail crossing would also be completed as a "tie-in" so that trenching, pipe stringing, and installation activities do not interrupt trail users for extended periods. It is expected that construction of the trail tie-in would be completed within 48 hours or less to minimize, maintain or restore potential impacts to trail users and reduce the need for trail detours.

Upon completion of construction in the area, Pacific Connector would revegetate the construction ROW using native trees (not within the 30 foot-operational easement), shrubs, and plants. Section 3.0 of the POD A describes additional measures to be used on federal lands for protecting and mitigating for visual resources. Pacific Connector would coordinate with the Forest Service and the Pacific Crest Trail Association regarding the need for and location of trail detours.

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to: facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (*Environmental Briefings and Compliance Plan*, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer's designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to visual resources and recreational resources are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

Evaluation of Winema National Forest Proposed Forest Plan Amendments

The proposed Pacific Connector pipeline incorporates the most up-to-date engineering and technological practices for pipeline construction and operation. However, even with following these practices, it has been determined that one Forest Plan standard associated with rare and/or isolated species (Survey and Manage), two Forest Plan standards associated with the soil, water, and riparian resources, and three Forest Plan standards associated with visual resources would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Winema National Forest LRMP as amended by the NWFP and the January 2001 Survey and Manage ROD.

Forest Plan Amendments Related to Rare Aquatic and Terrestrial Plant and Animal Communities (FS-1):

One Forest Plan standard associated with rare and/or isolated species (Survey and Manage) would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Winema National Forest LRMP as amended by the NWFP and the January 2001 Survey and Manage ROD. This standard is:

- Management Direction: Manage All Known Sites (Survey and Manage ROD, Standards and Guidelines Page 8). Current and future known sites will be managed according to the Management Recommendation for the species. Professional judgment, Appendix J2 in the Northwest Forest Plan Final SEIS, and appropriate literature will be used to guide individual site management for those species that do not have Management Recommendations.

The proposed amendment to this standard is:

- Management Direction: Manage All Known Sites (Survey and Manage ROD, Standards and Guidelines Page 8). Current and future known sites will be managed according to the Management Recommendation for the species, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Professional judgment, Appendix J2 in the Northwest Forest Plan Final SEIS, and appropriate literature will be used to guide individual site management for those species that do not have Management Recommendations. (Proposed amendment FS-1 on the Winema National Forest)

While the amendment would provide an exception to meeting this standard, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore any effects of the pipeline's construction and operation on Survey and Manage species within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

The purpose of this project-level amendment is to make the proposed Pacific Connector pipeline project consistent with the Winema National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to this amendment are:

- 36 CFR 219.9(a)(2)(ii) – [the plan must include plan components to maintain or restore] "Rare aquatic and terrestrial plant and animal communities."
- 36 CFR 219.9(b)(1) – "The responsible official shall determine whether or not the plan components required by paragraph (a) provide ecological conditions necessary to: …maintain viable populations of each species of conservation concern within the plan area."

Because the proposed amendment is "directly related" to these two substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendment (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the amendment, it is important to recognize that the applicable sections of 36 CFR 219.9(a) and (b) that are described above, requires plan components to maintain or restore rare aquatic and terrestrial plant and animal communities, across the entire planning area (i.e., the Winema National Forest). This plan amendment does not alter these LRMP plan requirements for managing rare plant and animal communities across 99.99 percent of the Winema National Forest. The proposed pipeline construction corridor including the TEWAs and the UCSAs is approximately 92 acres of the 1,043,547 acre Winema National Forest. Within this 92 acre construction corridor surveys have identified 45 Survey and Manage sites that could be potentially impacted by construction activities. The proposed amendment does not waive the persistence objective for Survey and Manage species. The analysis that was conducted (see section 4.6.4.3 of the DEIS and appendix F.5) determined the Survey and Manage persistence objectives would be met. This means that for Winema National Forest lands within the project area, individual sites of Survey and Manage species may be impacted or lost to construction activities, but affected species are expected to persist within the range of the NSO despite the loss of these individual sites.

The amendment modifies this standard so that in the 92 acres of the project construction area the project need not be in compliance with this standard' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 92 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the management requirement described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.9(a) and (b) rule requirements within the "scope and scale" of the proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.9(a) and (b) requirements are being addressed.

How the Required Mitigation Measures would Maintain or Restore Effects to Rare Aquatic and Terrestrial Plant and Animal Communities and Meet the Applicable 36 CFR 219.9(a) and 36 CFR 219.9 (b) Requirements

The Forest Service has worked to inventory, analyze, and evaluate rare aquatic, terrestrial plant and animal communities that could be affected by this project. In addition, a third-party consultant for technical support was also utilized in reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures incorporated into amendments for Survey and Manage species are designed to minimize, maintain or restore the potential for habitat fragmentation, edge effects, and loss of long-term habitats associated with effected species. To ensure adequate restoration and revegetation of the ROW, design features are identified in the *Erosion Control and Revegetation*

Plan (POD I), *Right-of-Way Clearing Plan* (POD U), *Leave Tree Protection Plan* (POD P). In addition, routing considerations were identified during project development to ensure avoidance of known populations of rare plant and animal communities (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands, as well as, appendix F.5, *Survey and Manage Persistence Evaluations*).

As a basis for Survey and Manage determinations, appendix F.5 provides background research on Survey and Manage species that could be affected by the Pacific Connector Project; a review of survey reports prepared by others for the Pacific Connector Project; and processing and analysis of spatial data obtained from the Bureau of Land Management (BLM), Forest Service, and other sources over the past 12 years. Background information was used in combination with new information available as a result of surveys for the Pacific Connector Project and recent surveys in other portions of old growth forests to discuss the currently known distribution of the species in old growth forests within the NSO range. Impacts to sites as a result of the Pacific Connector Project were analyzed to determine if the species would continue to have a reasonable assurance of persistence in the NSO range following implementation of the Pacific Connector Project, taking into consideration the status and distribution of the species and general habitat in the NSO range.

Some of the required mitigation measures in the POD sections to protect rare plant and animal communities include: flagging existing snags on the edges of the construction ROW or TEWAs where feasible to save from clearing; snags would be saved as and used in LWD placement post-construction to benefit primary and secondary cavity nesting birds, mammals, reptiles, and amphibians; other large diameter trees on the edges of the construction ROW and TEWAs would also be flagged to save/protect as green recruitment or habitat/shade trees, where feasible; trees would be girdled to create snags to augment the number of snags along the ROW to benefit cavity nesting birds, mammals, reptiles, and amphibians. See POD's P & U and 4.7—*Land Use* of the DEIS for a complete list of applicable mitigation measures for pipeline construction. Additional measures include low ground weight (pressure) vehicles would be used; logging machinery would be restricted to the 30-foot permanent ROW wherever possible to prevent soil compaction; the removal of soil duff layers would be avoided in order to maintain a cushion between the soil and the logs and the logging equipment; designed skid trails would be used to restrict detrimental soil disturbance (compaction and displacement) to a smaller area of the ROW over the pipeline trenching area; and the temporary construction area would be restored and revegetated using native seeds, to the extent possible, and saplings (POD I).

In an effort to minimize, maintain or restore the impacts to Survey and Manage species, Pacific Connector adopted route variations to avoid certain species identified in the Survey and Manage Persistence Evaluations by co-locating the proposed construction corridor adjacent to existing roads, through managed timber stands or otherwise avoid unique LSOG habitats to the maximum extent practicable (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands).

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (Environmental Briefings and Compliance Plan, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer's designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to soil, water and riparian resources, are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

How the Compensatory Mitigation Actions would help to Maintain or Restore Rare Aquatic and Terrestrial Plant and Animal Communities in the Plan Area (36 CFR 219.9(a), 36 CFR 219.9 (b)).

The CMP on the Winema National Forest includes proposals to improve aquatic and riparian habitat that would benefit rare aquatic plant and animal communities (see the discussion of *How the Compensatory Mitigation Actions would help to Maintain or Restore the Ecological Integrity of The Soils and Soil Productivity, including guidance to reduce soil erosion and sedimentation in the Plan Area (36 CFR 219.8(a)(2)(ii))* below for a discussion of benefits to aquatic habitats). The CMP also includes proposals to decommission approximately 29.2 miles of road.

Although the Pacific Connector project has been routed to avoid LSOG habitat as much as possible and is aligned along existing roads, the project would still cause some habitat fragmentation. Road decommissioning reduces the edge effects over time by revegetating road surfaces and eliminating road corridors. Revegetating selected roads could create larger blocks of late successional habitat in the future.

These projects have been designed by an interdisciplinary team of resource professionals on the Winema National Forest with input and coordination with the U.S. Fish and Wildlife Service, NOAA Fisheries, and State agencies. They were planned within the watersheds that would be affected by the Pacific Connector pipeline project. They are a component of the Pacific Connector application and would be a requirement of the ROW grant. Overall, these projects would help maintain and restore rare aquatic and terrestrial plant and animal communities on the Winema National Forest (see table 2.3.1-3 and 2.3.1-4 and figure 2.3-1 and 2.3-2 in appendix F.2 for additional information).

Forest Plan Amendments Related to Soil, Water and Riparian Areas (WNF -4, WNF-5):

Two Forest Plan standards associated with the soil, water, and riparian resources would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Winema National Forest LRMP. These standards are:

- Detrimental Soils Conditions, Standard and guideline 12-5, (WNF LRMP, 4-73). The cumulative effects of detrimental soil conditions should not exceed 20 percent of the total acreage within the activity area: any reason for exceeding the limitation shall be documented in an environmental assessment. Detrimental soil conditions include compaction, displacement, puddling, and moderately or severely burned soil from all activities (including roads, skid trails, and landings). Sites where the standards for displacement, puddling, and compaction are not currently met will require rehabilitation such as ripping, backblading, or fertilization. The potential for creating detrimental soil conditions will be specifically addressed through project environmental analyses. If needed, alternative management practices will be developed, and mitigating measures will be planned and implemented.
- Soil and Water, Standard & Guideline 3 (WNF LRMP 4-137). The cumulative total area of detrimental soil conditions in riparian areas shall not exceed 10 percent of the total riparian acreage within an activity area. Detrimental soil conditions include compaction, displacement, puddling, and moderately or severely burned soil.

The proposed amendments to these standards are:

- Detrimental Soils Conditions, Standard and guideline 12-5, (WNF LRMP, 4-73). The cumulative effects of detrimental soil conditions should not exceed 20 percent of the total acreage within the activity area: any reason for exceeding the limitation shall be documented in an environmental assessment, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Detrimental soil conditions include compaction, displacement, puddling, and moderately or severely burned soil from all activities (including roads, skid trails, and landings). Sites where the standards for displacement, puddling, and compaction are not currently met will require rehabilitation such as ripping, backblading, or fertilization. The potential for creating detrimental soil conditions will be specifically addressed through project environmental analyses. If needed, alternative management practices will be developed, and mitigating measures will be planned and implemented. (Proposed amendment WNF-4)
- Soil and Water, Standard & Guideline 3 (WNF LRMP 4-137). The cumulative total area of detrimental soil conditions in riparian areas shall not exceed 10 percent of the total riparian acreage within an activity area, with the exception of the operational ROW and the construction zone for the Pacific Connector Pipeline, for which the applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. Permanent recreation facilities or other permanent facilities are exempt. (Proposed amendment WNF-5)

While the amendments would provide an exception to meeting these standards, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore any effects of the pipeline's construction and operation on the soil, water and riparian resources within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

The purpose of these two project-level amendments is to make the proposed Pacific Connector pipeline project consistent with the Winema National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to these two amendments are:

- 36 CFR 219.8(a)(2)(ii) – [The plan must include plan components to maintain or restore] "soils and soil productivity, including guidance to reduce soil erosion and sedimentation."

Because the two proposed amendments are "directly related" to this substantive requirement, the Responsible Official must apply the requirements within the scope and scale of the proposed amendments (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the two amendments, it is important to recognize that the applicable sections of 36 CFR 219.8(a) that are described above, requires plan components to "maintain or restore" the soil resources across the entire planning area (i.e., the Winema National Forest). These plan amendments do not alter these LRMP plan requirements for managing the soil resources across 99.99 percent of the Winema National Forest. The proposed pipeline construction corridor including the TEWAs and the UCSAs is approximately 92 acres of the 1,043,547 acre Winema National Forest. Of the 92 acres of pipeline corridor construction it is estimated that approximately 27 to 62 acres would not meet standards for soils described above.

The amendment modifies 2 standards so that in the 92 acres of the project construction area the project need not be in compliance with these standards' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 92 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the two management requirements described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.8(a) rule requirements within the "scope and scale" of these proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.8(a) requirements are being addressed.

How the Required Mitigation Measures would Maintain or Restore Effects to Soil, Water, and Riparian Resources and Meet the Applicable 36 CFR 219.8(a) Requirements.

The Forest Service has worked with Pacific Connector Gas Pipeline to inventory, analyze, and evaluate the geologic, soil, and hydrologic resources that could be affected by this project. In addition, a third-party consultant for technical support was also utilized in reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration are enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures, incorporated into amendments for soil, water, and riparian resources are designed to minimize, maintain or restore the potential for soil movement, slope stability, water quality, and to ensure adequate restoration and revegetation. These measures are identified in: the *Erosion Control and Revegetation Plan* (POD I); *Right-of-Way Clearing Plan* (POD U); *Wetland and Waterbody Crossing Plan* (POD BB); the *Forest Service Site Specific Stream Crossing Prescriptions* (NSR 2014); the *Stream Crossing Risk Analysis*; and *Stream Crossing Risk Analysis Addendum* (GeoEngineers2017d, 2018a). Pacific Connector would also follow the FERC's applicant prepared Wetland Procedures and the Best Management Practices for the State of Oregon. To further reduce potential for landslides on steep slopes, the Forest Service, BLM, and FERC are also recommending additional industry best management practices and measures identified from the *Technical Report on Soil Risk and Sensitivity Assessment* (NSR 2014) be incorporated into Pacific Connector's terms and conditions of the ROW Grant as described in the POD's identified above. See 4.2.3.3 of the DEIS for a description of soil risk and sensitivity assessment.

Areas with soils rated moderate to very high for risk or sensitivity (28 acres total) would be recommended for more site-specific validation of the risk criteria used in the *Technical Report on Soil Risk and Sensitivity Assessment* (NSR 2014) to confirm that specific locations merit consideration of the more aggressive soil remediation measures, such as: a 2- to 3-inch organic mulch surface application (80 percent coverage) of woodchips, logging slash, and/or straw; adaptive seed mixes and vegetation to better fit site conditions; deep subsoil decompaction with hydraulic excavators that leave constructed corridor mounded and rough with maximum water infiltration so that water cannot flow downhill for any appreciable distance; more aggressive use of constructed surface water runoff dispersion structures such as closely placed and more pronounced slope dips and water bars, etc.; more aggressive use of constructed surface runoff entrapments such as silt fencing, sediment settling basins, or straw bale structures, etc.; more aggressive placement (100 percent coverage) and depth (3 to 4 inches) of ground cover using woodchips, logging slash, straw bales, wattles (see POD's U and I). In efforts to protect soil productivity, topsoil segregation would be required for pipeline construction at wetland and waterbody crossings on NFS lands (POD U).

Some of the required mitigation measures in the POD BB and *Forest Service Site Specific Stream Crossing Prescriptions* (NSR 2014) to protect wetlands and minimize, maintain or restore compaction include: limiting the construction ROW width to 75 feet through wetlands; placing equipment on mats; using low-pressure ground equipment; limiting equipment operation and construction traffic along the ROW; locating temporary workspace (TEWAS) more than 50 feet away from wetland boundaries; cutting vegetation at ground level; limiting stump removal to the construction trench; segregating the top 12 inches of soil, or to the depth of the topsoil horizon; using "push-pull" techniques in saturated wetlands; limiting the amount of time that the trench is open by not trenching until the pipe is assembled and ready for installation; not using imported rock and soils for backfill; and not using fertilizer, lime, or mulch during restoration in wetlands. Pacific Connector must also follow the FERC Waterbody and Wetland Construction and

Mitigation Procedures. See 4.3.3.2 of the DEIS for a complete list of applicable mitigation measures for pipeline construction at specific waterbody and stream crossings.

In an effort to minimize, maintain or restore the impacts to streams and riparian areas, Pacific Connector adopted route variations to co-locate the proposed construction corridor adjacent to existing roads and along dry ridge tops (See Chapter 3, DEIS Route Design and Modifications on Forest Service Managed Lands). In addition, Pacific Connector has committed to limit construction at waterbody crossings to times of dry weather or low water flow. Pacific Connector would implement the required erosion control measures at the proposed stream crossings to minimize, maintain or restore potential erosion and sedimentation impacts. The applicable mitigation measures and monitoring requirements in the POD relating to water waterbody crossings are included in the *Site Specific Forest Service Stream Crossing Prescriptions, and Wetland and Waterbody Crossing Plan* (POD BB). In addition, applicable mitigation measures from the FERC approved applicant prepared Procedures for Wetland and Waterbody Crossings would be required.

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to: facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (Environmental Briefings and Compliance Plan, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer’s designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to soil, water and riparian resources, are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

How the Compensatory Mitigation Actions would help to Maintain or Restore the Ecological Integrity of The Soils and Soil Productivity, including guidance to reduce soil erosion and sedimentation in the Plan Area (36 CFR 219.8(a)(2)(ii)).

Part of the CMP on the Winema National Forest includes proposals to place large woody debris in-stream for 1.0 miles, repair stream crossings at 25 sites, provide Riparian Planting for 0.5 miles, provide Riparian Fencing for 6.5 miles, and decommission approximately 29.2 miles of road.

Placement of LWD in streams adds structural complexity to aquatic systems by creating pools and riffles, trapping fine sediments and can contribute to reductions in stream temperatures over time (Tippery et al. 2010). Placing LWD in streams affects channel morphology, the routing and storage of water and sediment, and provides structure and complexity to stream systems. Complex pools and side channels created by instream wood provide overwintering habitat to stream salmonids and other aquatic organisms (Solazzi et. al. 2000). They also provide cover from predators during summer low flow periods when predation is at its highest. Providing more stream channel structure results in better over wintering habitat, improved summer pool habitat, and more abundant spawning gravels.

Riparian planting is proposed along Spencer Creek just upstream of Buck Lake. This is a meadow site that has lost streamside vegetation and has compacted soils. There is an overall need to restore health and vigor to riparian stands by maintaining and improving riparian reserve habitat. Shade provided by the plantings would contribute to moderating water temperatures in Spencer Creek. Root strength provided by new vegetation would increase bank stability, decrease erosion and sediment depositions to Spencer Creek and provide habitat for species that use riparian habitats. Riparian fencing would serve to divide the Buck Indian Allotment into pastures north and south at Clover Creek Road. This fence would keep cattle from grazing newly revegetated areas in the construction corridor, including areas where the corridor crosses Spencer Creek, thus helping to ensure that erosion control and revegetation objectives are met. It would also serve to separate anticipated increased cattle grazing of the construction corridor from the highway; greatly reducing a safety hazard for vehicles traveling the Clover Creek road.

Restoring stream crossings reconnects aquatic habitats by allowing the passage of aquatic biota and restoring riparian vegetation. Over time, these actions reduce sediment and restore shade. Restoration of these crossings includes riparian planting as a mitigation which would help offset the impact of shade removal at pipeline crossings. The proposed pipeline would cross Spencer Creek upstream of Buck Lake. It is occupied by redband trout. Spencer Creek has been identified by NMFS as habitat for federally listed Southern Oregon/Northern California Coast Coho salmon. Additionally, once fish passage is provided through the Klamath River hydro facilities, steelhead would re-colonize Spencer Creek. Improving habitat quality at Spencer Creek provides the opportunity to be pro-active in providing quality habitat for SONC Coho, mitigating for any detrimental effects to other SONC Coho habitats, while improving habitat for redband trout and other aquatic species. Spencer Creek appears on the Oregon DEQ 303(d) list as water quality impaired from increased sedimentation. Improvements at this location would immediately benefit all downstream aquatic habitats and the species associated with those habitats.

Decommissioning roads can substantially reduce sediment delivery to streams (Madej 2000; Keppeler et al. 2007). Proposed road decommissioning and stormproofing would increase infiltration of precipitation, reduce surface runoff, and reduce sediment production from road-related surface erosion in the watershed where the impacts from the Project would occur. Decommissioning roads would restore natural drainage patterns and thereby avoid large volumes of added sediment to the stream network that would be likely to eventually occur. In addition limited road maintenance dollars could be focused on the remaining road systems resulting in more maintenance of culverts and ditchlines resulting in less potential for catastrophic failure. Madej (2000) concluded that by eliminating the risk of stream diversions and culvert failures, road removal treatments significantly reduce long-term sediment production from retired logging roads.

These projects have been designed by an interdisciplinary team of resource professionals on the Winema National Forest with input and coordination with the U.S. Fish and Wildlife Service, NOAA Fisheries, and State agencies. These projects have been planned within the watersheds that would be affected by the Pacific Connector pipeline project. These projects have been proposed by the Applicant as part of their application and would be a requirement of the ROW grant. These projects would help maintain and restore soil resources including reducing soil erosion and sedimentation on the Winema National Forest (see table 2.3.1-3 and 2.3.1-4 and figure 2.3-1 and 2.3-2 in appendix F.2 for additional information).

Forest Plan Amendments Related Visual Resources (WNF -1, WNF-2, WNF-3):

Three Forest Plan standards associated with visual resources would need to be modified so that the proposed construction and operation of the Pacific Connector pipeline can be in compliance with the Winema National Forest LRMP. These standards are:

- Management Area 3, Lands, Standard and Guideline (4), (WNF LRMP 4-103). This management area is an avoidance area for new transportation and utility corridors.
- Management Area 3A, Foreground Retention, Standard and Guideline Scenic (1), (WNF LRMP 4-103 and 104). Evidence of management activities from projects that produce slash (tree harvest) or charred bark (underburning) will not be noticeable one year after the work has been completed.
- Management 3B, Foreground Partial Retention, Standard and Guideline Scenic (1), (WNF LRMP, 4-107). Evidence of management activities from projects that produce slash (tree harvest) or charred bark (underburning) should not be noticeable from two to three years after the work has been completed.

The proposed amendments to these standards are:

- Management Area 3, Lands, Standard and Guideline (4), (WNF LRMP 4-103). This management area is an avoidance area for new transportation and utility corridors, with the exception of the Pacific Connector Pipeline ROW. The applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. (Proposed amendment WNF-1)
- Management Area 3A, Foreground Retention, Standard and Guideline Scenic (1), (WNF LRMP 4-103 and 104). Evidence of management activities from projects that produce slash (tree harvest) or charred bark (underburning) will not be noticeable one year after the work has been completed, with the exception of the Pacific Connector Pipeline ROW which shall attain the VQO within 10 - 15 years after completion of the construction phase of the project where the pipeline crosses Management area 3A. The applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. (Proposed amendment WNF-2)
- Management 3B, Foreground Partial Retention, Standard and Guideline Scenic (1), (WNF LRMP, 4-107). Evidence of management activities from projects that produce slash (tree harvest) or charred bark (underburning) should not be noticeable from two to three years after the work has been completed, with the exception of the Pacific Connector Pipeline ROW, which shall attain the VQO within 10 - 15 years after completion of the construction phase of the project where the pipeline crosses Management area 3B. The applicable

mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented. (proposed amendment WNF-3)

While the amendments would provide an exception to meeting these standards, there would also be requirements to do what is appropriate, applicable and feasible to minimize, maintain or restore any effects of the pipeline's construction and operation on the visual resources within the area affected by the pipeline. Consequently, each amended standard includes the requirement that the "applicable mitigation measures identified in the POD and Pacific Connector project design requirements must be implemented".

The purpose of these three project-level amendments is to make the proposed Pacific Connector pipeline project consistent with the Winema National Forest LRMP. Thus, the substantive planning rule requirements that are directly related to these three amendments are:

- 36 CFR 219.10(a)(1) – […the responsible official shall consider: …] "(1) Aesthetic values,… scenery,... viewsheds...".
- 36 CFR 219.10(b)(i) – [the responsible official shall consider] "Sustainable recreation; including recreation settings, opportunities,…and scenic character…"

Because the proposed amendments are "directly related" to these two substantive requirements, the Responsible Official must apply the requirements within the scope and scale of the proposed amendments (36 CFR 219.13 (b)(5)).

In considering the "scope and scale" of the three amendments, it is important to recognize that the applicable sections of 36 CFR 219.10 that are described above, requires plan components to provide for aesthetic values and scenic character across the entire planning area (i.e., Winema National Forest). These plan amendments do not alter these LRMP plan requirements for managing visual resources across 99.99 percent of the Winema National Forest. The proposed pipeline construction corridor including the TEWAs and the UCSAs is approximately 92 acres of the 1,043,547 acre Winema National Forest. Of the 92 acres of pipeline corridor construction it is estimated that approximately 70 of these acres would not meet the standards for visual resources described above.

The amendments modify three standards so that in the 92 acres of the project construction area the project need not be in compliance with these standards' specific requirements but instead, it is the "applicable mitigation measures identified in the POD and the Pacific Connector Project design requirements" that must be implemented. Or stated in another way, for the 92 acres of National Forest lands that would be within the operational ROW and construction zone for the Pacific Connector Pipeline, the three management requirements described above would be replaced with the full set of management requirements that comprise the "applicable mitigation measures identified in the POD and Pacific Connector Project Design requirements". The inclusion of these management requirements as a part of the plan component language for the LRMP in this plan amendment, addresses the applicable 36 CFR 219.10 rule requirements within the "scope and scale" of these proposed plan amendments. The sections below describe in more detail how the applicable 36 CFR 219.10 requirements are being addressed.

How the Required Mitigation Measures would Consider, Minimize, Maintain or Restore Effects to Aesthetic Values and Scenic Character and Meet the Applicable 36 CFR 219.10(a) and 36 CFR 219.10(b) Requirements.

The Forest Service has worked to inventory, analyze, and evaluate visual resources, view sheds, and aesthetics that could be affected by this project. Forest Service landscape architect provided technical support to FERC and Forest Service third-party contractors by reviewing the information gathered for the project. The POD is a document developed between the Forest Service, BLM, FERC, and Pacific Connector that contains the design features, mitigation measures, roles and responsibilities, monitoring, and procedures for the construction and operation of the pipeline on NFS lands. In addition, FERC's applicant prepared Plan and Procedures for construction and restoration enforceable, where applicable, for additional design features and mitigation. The design requirements and mitigation measures of the POD would be required by the modified standards and incorporated into BLM's ROW grant.

The mitigation measures incorporated into amendments for Visual Quality Objectives are designed to minimize, maintain or restore the potential for long-term impacts to visually sensitive areas. To ensure adequate restoration and revegetation of the ROW, design features are identified in the *Erosion Control and Revegetation Plan* (POD I), *Right-of-Way Clearing Plan* (POD U), *Leave Tree Protection Plan* (POD P), *Aesthetics Management Plan* (POD A), and *Recreation Management Plan* (POD S).

A visual assessment was conducted to determine the potential effects on visual resources associated with the pipeline. Representative viewpoint points (also referred to as KOPs) were identified within the view shed for the pipeline, defined as the area from which the pipeline would be potentially visible. Photographs of existing visual conditions were used in preparing computerized visual simulations for each KOP. Because the appearance of the pipeline ROW would change with time, a series of simulations were prepared to illustrate how the pipeline ROW would look at different timeframes following construction. These KOPs would also serve as monitoring points for mitigation.

Pacific Connector produced POD A that outlined measures to reduce visual impacts along its pipeline route. To the extent feasible, Pacific Connector would use revegetation efforts to shape and blend the pipeline easement, enhance the setting, and mimic the natural features of the landscape. These measures would consist of revegetating all disturbed areas and replanting trees in TEWAs and any other areas of the temporary construction ROW that were forested prior to construction (see POD I).

On Forest Service lands, Pacific Connector would maintain a cleared 30-foot width centered over the pipe allowing the remainder of the permanent easement to be reforested. This allows trees to naturally reestablish along the edges of the permanent easement at a staggered, more natural-looking interval. Replacing slash in forested areas of the ROW during restoration activities would immediately affect the visual contrast in color and texture of the disturbed ROW areas. Over time, as the ROW revegetates and narrows in width and changes in form, texture and color, potential visual impacts would diminish.

Additionally, a row, or if necessary, clusters of trees and/or shrubs would be planted across the ROW to provide visual screens at key road and trail crossings in sensitive view sheds. For all revegetation practices, Pacific Connector and/or its contractors would only use agency-approved tree and plant species, in compliance with management plan objectives and in consultation with agency specialists.

Site Specific Crossing Prescriptions:

Clover Creek Road (intersection of Dead Indian Memorial Highway and Clover Creek Road). Viewsheds in this area are managed for Foreground and Middleground Retention and Partial Retention, but also contain areas of private lands with recently harvested timber and several clusters of rural residential homes. The proposed alignment would cross the Dead Indian Memorial Highway perpendicularly in a thick forest foreground setting (at MP 168.83). Pacific Connector would implement the mitigation recommendations detailed in Section 3.2 and 3.3 and further described in the POD I. These pipeline restoration efforts would include regrading to the approximate original contours, reseeding, scattering slash across the ROW, and replanting, which would minimize, maintain or restore visual contrast of the ROW. During restoration, Pacific Connector would plant trees within forested areas to within 15 feet of the Pipeline, which would allow a strip of trees to establish along the easement and between the Pipeline and the road in this area. Because the Pipeline was recommended to abut the road and to eliminate the strip of trees between the road and the Pipeline easement, the Forest Service and BLM would specify if tree planting would occur on federal lands between the centerline and Clover Creek Road (but not within 15 feet of the pipeline). Pacific Connector would also implement the mitigation recommendations in the Federal Lands Scenery Management Analysis at this location which include:

During construction of the Project, Compliance Monitors representing FERC are present on a full-time basis to inspect construction procedures and mitigation measures and provide regular feedback on compliance issues to FERC and the Forest Service. Objectives of the Compliance Monitoring program are to: facilitate the timely resolution of compliance issues in the field; provide continuous information to FERC regarding noncompliance issues and their resolution; and review, process, and track construction-related variance requests. Changes to previously approved mitigation measures, construction procedures, and construction work areas due to unforeseen or unavoidable site conditions would require various levels of regulatory approval from the applicable land management agencies. FERC would have the authority to stop any activity that violates an environmental condition of the FERC authorization issued to Pacific Connector.

Additionally, environmental compliance oversight responsibilities for Pacific Connector, FERC, Forest Service and BLM are described in the POD (*Environmental Briefings and Compliance Plan*, POD G) that would apply to the construction, operation, and maintenance of the project specifically on NFS lands. The Forest Service Authorized Officer would coordinate with the BLM in administering and enforcing ROW grant provisions and would have stop-work authority. The Forest Service Authorized Officer's designated representatives would ensure that the stipulations and mitigation measures included in the POD that are designed to minimize, maintain or restore the effects to visual resources and recreational resources are adhered to during project construction, operation, and maintenance. The BLM Authorized Officer would coordinate with the Forest Service to ensure the work is being conducted in accordance with the ROW grant and agreed upon conditions. BLM and the Forest Service would have stop-work authority. Field variance requests would be coordinated with the Authorized Officers.

How the Compensatory Mitigation Actions would help to Provide for Aesthetic Values and Scenic Character in the Plan Area (36 CFR 219.10(a)(1), 36 CFR 219.10(b)(i)).

Part of the CMP on the Winema National Forest includes a proposal to reduce stand densities on 114 acres in a way that would help soften the visual impact of the Pacific Connector Project. The Pacific Connector pipeline would create a hard line along the timbered edge of the corridor that does not fit with the visual objectives for the Clover Creek Road or the Dead Indian Memorial Highway. Thinning and fuels treatments can be used to soften the edge to a more natural appearing texture by restoring stand density to more natural levels and creating small openings that are consistent with the landscape. This proposal would restore stand density, species diversity, and structural diversity more characteristic under a natural disturbance regime.

This project has been designed by an interdisciplinary team of resource professionals on the Winema National Forest with input and coordination with the FWS, NOAA Fisheries, and State agencies. It was planned within the watersheds that would be affected by the Pacific Connector pipeline project. It is a component of the Pacific Connector application and would be a requirement of the ROW grant. This project would help to restore visual resources on the Winema National Forest (see table 2.3.1-3 and 2.3.1-4 and figure 2.3-1 and 2.3-2 in appendix F.2 for additional information).

4.7.3.5 Resource Values and Conditions on Federal Lands: The Aquatic Conservation Strategy on National Forest System Lands

Introduction

This section summarizes appendix F.4, Aquatic Conservation Strategy (ACS) Technical Report, which contains the full text of the independent Forest Service analysis. Those who seek additional information should review the applicable section in appendix F.4. Section, figure, and table numbers that refer to sections in appendix F.4 are so noted.

Background of the Aquatic Conservation Strategy

The ACS was developed as an element of the NWFP to "restore and maintain the ecological health of watersheds and aquatic ecosystems on public lands contained within them" within the range of the northern spotted owl (Forest Service and BLM 1994a, 1994b). The ACS applies on the Umpqua, Rogue River – Siskiyou national forests and portions of the Winema national forest within the range of the northern spotted owl. The ACS does not apply to lands managed by the BLM.[152]

The ACS established Riparian Reserves and Key Watersheds as land allocations on NFS lands. The ACS also established watershed assessment requirements, management objectives and special standards and guidelines for management and protection of aquatic resources. Forest Service line officers must determine whether activities that occur on NFS lands retard or prevent attainment of the ACS objectives on their respective national forests (Forest Service and BLM 1994a, 1994b;). Projects that retard or prevent attainment of the ACS objectives would not be consistent with the ACS. In making the ACS consistency finding (Goodman et al. 2007), the decision maker must:

[152] The ACS also applied to BLM lands managed under the BLM's 1995 Resource Management Plans (RMP) as amended. The ACS was replaced by Riparian Management Areas in BLM RMPs in 2016 when those RMPs were revised. As a result, the ACS is no longer applicable on BLM lands.

- Review projects against the ACS objectives at the project or site scale, rather than only at the watershed scale.
- Evaluate the immediate (short-term) impacts, as well as long-term impacts of an action.
- Provide a description of the existing watershed condition, including the important physical and biological components of the 5th field watershed.
- Provide written evidence that the decision maker considered relevant findings of watershed analysis.

Appendix F.4 and this summary provide the basis for Forest Supervisors of the Rogue River, Umpqua and Winema National Forests to independently determine whether the Pacific Connector Pipeline Project would retard or prevent attainment of ACS objectives or otherwise be inconsistent with the ACS objectives.

Overview of the Project

The Pacific Connector Pipeline Project would traverse approximately 31 miles of NFS lands and 47 miles of BLM lands on its 232 -mile route from Malin to Coos Bay, Oregon. This assessment and appendix F.4 apply only to the portion of the Pacific Connector Project on NFS lands.

Table 4.7.3.5-1 provides a breakdown of provinces, river basins and fifth field watersheds on NFS lands where the ACS applies.

TABLE 4.7.3.5-1

Provinces, River Basins and Watersheds on NFS Lands Subject to the ACS

Province	River basin	Fifth field Watershed	Hydrologic Unit Code	Key Water-shed	Total Miles All Owners	Umpqua NF Miles	Rogue River NF Miles	Winema NF Miles	Total Forest Service Miles
Klamath Siskiyou	Umpqua	Days Cr.-S. Umpqua	1710030205	Yes	19.15	1.56	0.00	0.00	1.56
Klamath Siskiyou — Western Cascades	Umpqua	Elk Cr.-S. Umpqua	1710030204	Yes	3.26	2.67	0.00	0.00	2.67
Klamath Siskiyou — Western Cascades	Umpqua	Upper Cow Cr.	1710030206	No	5.27	4.50	0.00	0.00	4.50
Western Cascades	Upper Rogue	Trail Cr.	1710030706	No	10.68	2.09	0.00	0.00	2.09
Western Cascades — High Cascades	Upper Rogue	Little Butte Cr.	1710030708	Yes	32.93	0.00	13.75	0.00	13.75
High Cascades	Upper Klamath	Spencer Cr.	1801020601	Yes	15.13	0.00	0.00	6.05	6.05
Total Project Miles where the ACS Applies					**—**	**9.82**	**13.75**	**6.05**	**30.62**

Ecological Provinces Crossed by the Pacific Connector Pipeline Project

<u>Klamath-Siskiyou Province MP 47–105, 118–153</u>

The Klamath-Siskiyou Province encompasses the Klamath and Siskiyou Mountains and lies between the Coast Range and the Cascades, south of the Willamette Valley. The Project would traverse the northeast corner of the Klamath-Siskiyou Province for approximately 93 miles (appendix F.4, figure 1-1). It includes parts of the Umpqua and Rogue River National Forests. This landscape is typified by deeply dissected valleys and jutting ridges and foothills. Much of this province lies within a rain shadow sheltered from the Pacific maritime influences by the mountains of the Coast Range. The region has a rugged landscape, with high peaks and deep canyons. Elevations range from about 1,000 to 7,000 feet above MSL.

The Klamath-Siskiyou Province is known for its highly complex geology. Most of the area is composed of highly deformed volcanic and marine sedimentary rocks with some metamorphic terranes. Also included are deformed pieces of oceanic crust and granitic intrusive bodies. Bedrock is often intensely metamorphosed and fractured. Well-developed floodplains and terraces near major rivers give way to highly dissected mountains with high-gradient streams. Many streams in this province flow only intermittently because of high gradients and low summer precipitation.

Erosional processes in the Klamath-Siskiyou Province are dominated by mass wasting associated high-intensity rainfall events. Erosional processes are accelerated where these rainfall events overlap with large, high severity stand-replacing fires. Precipitation gradients decrease from west to east, so landslide frequency decreases with decreased precipitation. Hydraulic mining during the 19th century dramatically altered landscapes and downstream channels where this activity occurred.

Western Cascades Province MP 105-113

Approximately eight miles of the pipeline corridor cross the north-south trending Western Cascades Province (appendix F.4, figure 1-1). This province, which drains westward to the Pacific Ocean, reaches elevations of 4,400 feet above MSL in watersheds crossed by the Pacific Connector Pipeline Project. Portions of the Upper Cow Creek and Trail Creek fifth-field watersheds are in the Western Cascades Province.

The landforms in the Western Cascades Province are distinguished from the High Cascades by older volcanic activity and longer glacial history. Ridge crests at generally similar elevations are separated by steep, deeply dissected valleys. Complex volcanoclastic formations juxtapose relatively stable volcanic deposits that weather to thick soils and are subject to earthflows. Unconsolidated alluvial and glacial deposits are subject to streambank erosion and landslides. Tributary channels flow at large angles into wide, glaciated valleys. Stream gradients are typically moderate to high (2 to 30 percent).

High Cascades Province MP 153-180

Approximately 23 miles of the Project corridor would be in the High Cascades Province (appendix F.4, figure 1-1). This Province consists of one north-south trending mountain chain that drains both westward to the Pacific Ocean and eastward into Klamath and Columbia Basins (see appendix F.4, figure 1-1). The High Cascades Province reaches a peak elevation of 9,493 feet MSL at the summit of Mt. McLoughlin. Portions of the Little Butte Creek and Spencer Creek fifth-field watersheds are in this province.

The province consists of volcanic landforms with varying degrees of historic glaciation. Lava flows form relatively stable plateaus, capped with pumice and ash deposits by the recent Cascade volcanoes. Drainages are generally not yet well developed or otherwise disperse into highly permeable volcanic deposits. Geologically recent volcanic pumice and ash deposits are subject to large debris flows when saturated by snowmelt. This province is composed primarily of approximately 3 million year old volcanic material, primarily andesite and basalt that were subsequently glaciated. Mountains in this province are moderately dissected. Headwater streams have medium to high gradients and are often associated with large meadow-spring complexes. Expansive pumice plateaus associated with the eruption of Mt. Mazama about 5,000 years ago (Dead Indian Plateau, Clover Creek) with droughty soils characterized by high snowmelt infiltration and low summer water retention fill valley floors adjacent to volcanic peaks.

Watersheds Crossed by the Pacific Connector Pipeline Project

The Project would cross portions of 19 fifth-field watersheds, six of which include NFS lands where the ACS applies. Figure 4.7-4 (reproduced from figure 1-1 in appendix F.4) shows watersheds and aquatic provinces crossed by the Pacific Connector Pipeline Project.

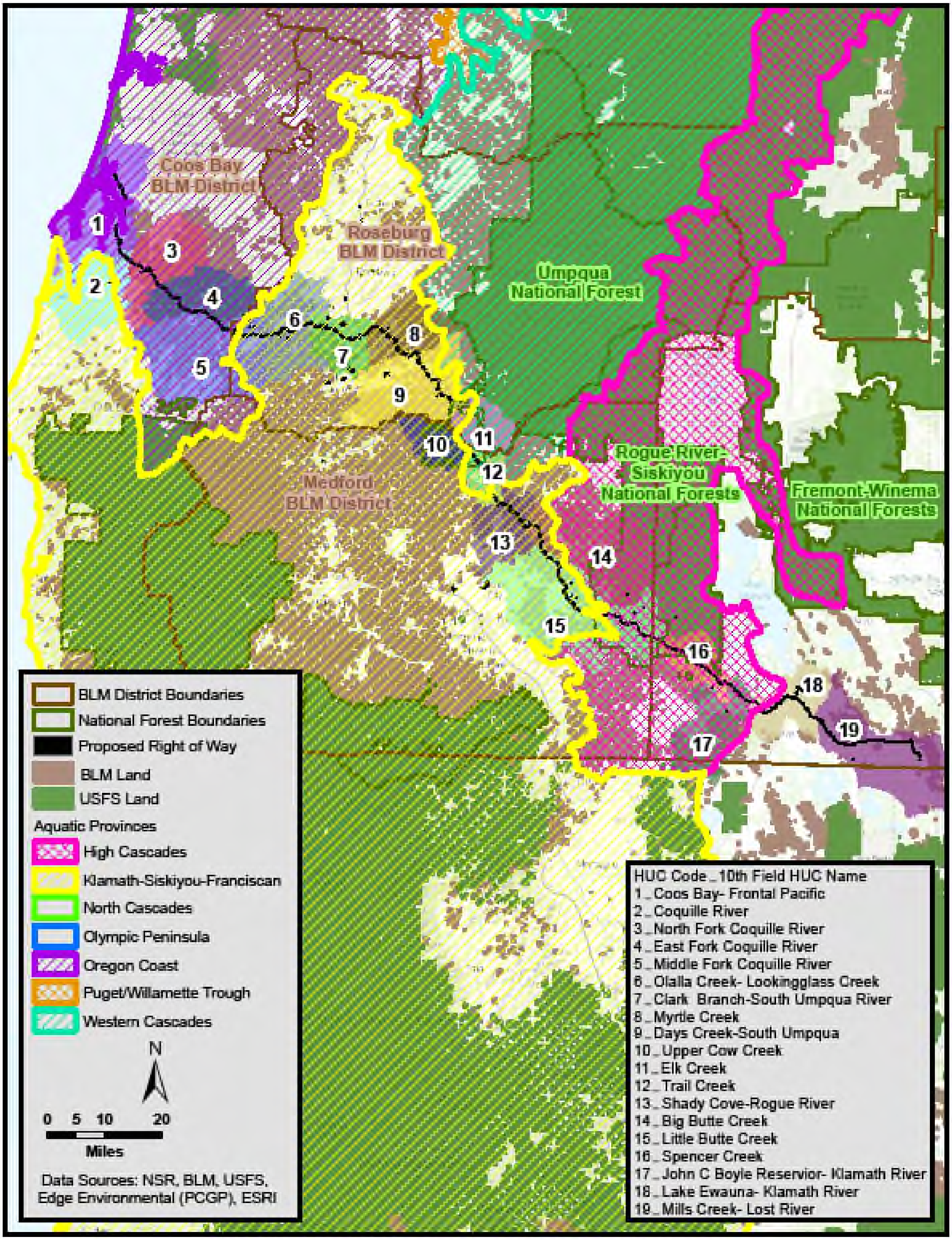


Figure 4.7-4. Provinces, and Watersheds Crossed by the Pacific Connector Pipeline Project

Table 4.7.3.5-2 summarizes (1) the number and acreage of Riparian Reserves of perennial and intermittent streams and forested wetlands that would be “crossed” by the pipeline NFS lands, and (2) the number and acreage of Riparian Reserves that would be “clipped” where a portion of the Riparian Reserve is impacted without the pipeline trench crossing a waterbody or wetland.

Table 4.7.3.5-3 shows the age-class structure of vegetation that would be cleared within the proposed Pacific Connector ROW. Most of the Pacific Connector Pipeline Project is routed on ridge tops to avoid stream and riparian-area crossings. To the degree possible, Project routing has avoided late-successional and old-growth forest in Riparian Reserves. Of the vegetation cleared in the construction corridor and TEWAs, approximately 67 percent or about 15.3 acres of the 22.7 acres are in in mid or early seral vegetation while approximately 33 percent or 7.4 acres are in late-successional or old-growth forest.

Table 4.7.3.5-4 (table 2-3 from appendix F.4) summarizes forest plan land allocations for the watersheds crossed by the Pacific Connector.

TABLE 4.7.3.5-2

Summary of Riparian Reserves, Stream Channels and Wetlands Crossed by the Pacific Connector Pipeline on NFS Lands by Administrative Unit

	Perennial Streams Crossed a/		Intermittent Streams Crossed		Wetlands Crossed b/		Total Stream Channels or Wetlands Crossed		Riparian Reserves Clipped without Stream or Wetland Crossings c/		Total d/	
Agency a/	**Stream Channels Crossed e/ (number)**	**Riparian Reserves Cleared (Acres)**	**Stream Channels Crossed (number)**	**Riparian Reserves Cleared (Acres)**	**Wetlands Crossed (number)**	**Riparian Reserves Cleared (Acres)**	**Total Crossed (number)**	**Total Riparian Reserves Cleared (Acres)**	**Riparian Reserves Clipped (number)**	**Total Riparian Reserves (Acres)**	**Affected Riparian Reserves (number)**	**Cleared (Acres)**
Umpqua National Forest	4	7.29	3	6.27	1	2	8	15.56	3	1.44	11	17
Rogue River National Forest	1	2.45	1	1.64	0	0.00	2	4.09	2	0.64	4	4.73
Winema National Forest	0	0.00	2	3.28	2	2.48	4	5.76	4	2.55	8	8.31
Total Forest Service	5	9.74	6	11.19	3	4.48	19	25.41	9	4.63	28	30.04

Data Source: Resource Report 3, table 2A-3A and FS Riparian Reserve Assessment, database.

a/ "Crossed" means that the pipeline trench (cleared or modified land) crosses the stream channel or delineated wetland area.

b/ "Wetlands" refers to delineated wetland areas that are not already counted as streams. Where the Riparian Reserve of a wetland is fully encompassed in the adjacent Riparian Reserve of a stream channel, the acres are counted as part of the stream channel to avoid double counting and are shown as 0 in this table.

c/ "Clipped" means that the Riparian Reserve associated with a stream channel or wetland was cleared as part of the construction corridor, Temporary Extra Work Area (TEWA) or Hydrostatic Test, but the pipeline trench did not cross the stream channel or delineated wetland area.

d/ This table includes only areas where vegetation is cleared in the construction corridor, hydrostatic test sites, and TEWAs. An additional 11.45 acres of Riparian Reserves are used as Uncleared Storage Areas (UCSA) where habitat may be modified but vegetation is not removed.

e/ Irrigation ditches or other man-made water conveyances are crossed by the Project, but they do not create Riparian Reserves and are not subject to the requirements of the ACS

TABLE 4.7.3.5-3

Vegetation Age Class Structure of Riparian Reserves Cleared in Construction Corridor and TEWAs by Administrative Unit, Forest Service

		LSOG (>80 Years) Forest Cleared (Acres)				Mid Seral (40-80 Years) Cleared (Acres)				Early Seral (0-40 Years) Cleared (Acres)							
Administrative Unit	**Waterbody Type**	**Conifer Forest**	**Hardwood Forest**	**Mixed Conifer and Hardwood Forest**	**Total LSOG Cleared**	**Conifer Forest**	**Hardwood Forest**	**Mixed Conifer and Hard-wood Forest**	**Total Mid-Seral Cleared**	**Conifer Forest**	**Mixed Conifer and Hardwood Forest**	**Shrub or Brush-field**	**Grass-lands and Non-forest**	**Total Early Seral Cleared**	**Total All Vegetation Classes (Acres)**	**Stream Channel or Wetland Area within Corridor (Acres)**	**Total within Cleared Area (Acres)**
Umpqua NF	Perennial Stream	2.83			2.83	0.82			0.82	3.02				3.02	6.67	0.19	6.86
	Intermittent Stream					3.04			3.04	0.47				0.47	3.51	0.05	3.56
	Wetland					1.56			1.56						1.56		1.56
	Total	2.83			2.83	5.42			5.42	3.49				3.49	11.74	0.24	11.98
Rogue River NF	Perennial Stream	1.33			1.33					1.04				1.04	2.37	0.04	2.41
	Intermittent Stream					0.12			0.12	0.72			0.19	0.91	1.03	0.1	1.13
	Wetland	0.13			0.13					0.39				0.39	0.52		0.52
	Total	1.46			1.46	0.12			0.12	2.15			0.19	2.34	3.92	0.14	4.06
Winema NF	Perennial Stream																
	Intermittent Stream	2.2			2.2					1.91				1.91	4.11	0.1	4.21
	Wetland	0.91			0.91	0.58	0.26		0.84	1.01			0.17	1.18	2.93	0.01	2.94
	Total	3.11			3.11	0.58	0.26		0.84	2.92			0.17	3.09	7.04	0.11	7.15
Total Forest Service	Perennial Stream	4.16			4.16	0.82			0.82	4.06				4.06	9.04	0.23	9.27
	Intermittent Stream	2.2			2.2	3.16			3.16	3.1			0.19	3.29	8.65	0.25	8.9
	Wetland	1.04			1.04	2.14	0.26		2.4	1.4			0.17	1.57	5.01	0.01	5.02
	Total	7.4			7.4	6.12	0.26		6.38	8.56			0.36	8.92	22.7	0.49	23.19

Note: Minor rounding differences may result in totals across rows tallying to slightly different totals than column totals and subtotals. These differences are on the order of hundredths of an acre and are not significant.

TABLE 4.7.3.5-4

Fifth-Field Watersheds and Land Allocations Crossed by the Pacific Connector Gas Pipeline Corridor ROW on NFS Lands

	LSR				**Matrix**				**Riparian Reserves**			
	Project Area (acres)		**% of Total LSR in Unit**		**Project Area (acres)**		**% of Total Matrix in Unit**		**Project Area (acres)**		**% of Total Riparian Reserves in Unit**	
Unit	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**	**Cleared**	**Modified**
Days Cr.-S. Umpqua	9.81	18.55	0.35	0.66	11.01	13.03	2.84	3.36	0.15	1.56	0.02	0.16
Elk Cr.-South Umpqua	21.23	0.00	0.15	0.00	7.43	1.20	0.04	0.01	0.00	0.00	<0.01	0.00
Upper Cow Creek	36.58	0.00	1.56	0.00	37.07	0.00	0.19	0.00	10836	0.00	0.13	0.00
Trail Creek	0.00	0.00	0.00	0.00	41.28	8.99	1.05	0.23	<0.01	0.00	<0.01	0.00
Little Butte Creek	205.26	69.50	0.45	0.15	0.00	0.00	0.00	0.00	7.66	2.56	0.09	0.03
Spencer Creek	0.05	0.02	<0.01	<0.01	71.06	10.05	0.70	0.10	8.63	1.35	0.52	0.08
Total	**272.93**	**1,924.5**	**0.39**	**2.76**	**167.85**	**33.72**	**0.30**	**0.06**	**27.27**	**5.47**	**0.09**	**0.02**

Source: Appendix F.4, table 2-3

The proposed Pacific Connector pipeline route would follow ridgelines and existing rights-of-way, such as powerlines and roads, wherever possible. To the extent possible, route location avoided crossing or modifying Riparian Reserves. In 30.6 miles of Right of Way on NFS lands, approximately 32.74 acres or 0.11 percent of Riparian Reserves on NFS lands in the affected watersheds would be cleared or modified by the Pacific Connector (appendix F.4, table 2-3).

Project impacts on aquatic habitats at stream crossings are generally comparable to construction of a road crossing with a culvert installation. Possible short-term impacts could include sediment transport to waterbodies where construction at stream crossings causes surface erosion, disturbance of banks and stream bottoms, and minor increases in water temperature from removal of effective shade.

Removal of mid and late seral forest vegetation at stream crossings would result in a long-term change in vegetative condition at the site scale. Early seral vegetation removed would recover as early seral vegetation and is less of a change in condition. Use of roads, including standards for reconstruction, would be subject to applicable ACS standards and guidelines. In order to minimize potential adverse impacts on fish, timing of instream work in streams with flowing water would be tied to work windows established by the ODFW. These time periods were established to avoid the vulnerable life stages of potentially affected fish species, including migration, spawning, and rearing.

The ACS is intended to prevent long-term adverse on riparian dependent resources (Forest Service and BLM 1994c, p. 3.4-69). This summary and appendix F.4 show that other than change in vegetative condition, impacts on NFS Riparian Reserves and aquatic habitats would be temporary or minor in scale in any given fifth-field watershed or sixth-field subwatershed. Changes in vegetation at stream crossings are a long-term effect because the 50-foot-wide maintenance corridor for the Pacific Connector pipeline must be kept in low-growing vegetation. This would not prevent attainment of the ACS objectives because the widely dispersed nature of crossings and the small amount of vegetation removed at each site. See appendix F.4 for a complete discussion and analysis of environmental consequences.

Project Effects Related to the ACS in Affected Watersheds on NFS Lands

Umpqua River Basin, Days Creek–South Umpqua River Watershed, HUC 1710030205, Umpqua National Forest

Discussions of watershed analysis recommendations, natural disturbances, range of variability and other elements of the ACS are found in appendix F.4. Table 4.7.3.5-5 (table 2-11 from appendix F.4) compares the Project effects against the objectives of the ACS. The Project does not cross any stream channels in this watershed. It affects approximately 1.71 acres of the Riparian Reserves of which 0.15 acres would be cleared and 1.56 acres would be modified. All affected Riparian Reserves are associated with isolated forested wetland swales on or near the watershed divide between Stouts Creek and Corn Creek that have no apparent surface connection to drainages.

TABLE 4.7.3.5-5

Compliance of the Project with ACS Objectives, Days Creek–South Umpqua River Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are landscape-scale features that would be affected by the Project. The Project ROW would impact 2.2% of the NFS land in the Days Creek–South Umpqua River watershed. Approximately 0.15 acre of Riparian Reserves would be cleared. All of the vegetation cleared would be mid seral. While the cutting of trees where the Project ROW intersects two localized Riparian Reserves would result in a long-term change in vegetation condition, it would be minor in scale and well within the range of natural variability for vegetative change, given the fire history of the Days Creek–South Umpqua River watershed. The application of BMPs and erosion control measures, use of native vegetation, and the anticipated rapid revegetation of disturbed areas would likely further reduce Project impacts. The level of impacts is well within the range of natural variability for disturbance processes described by Everest and Reeves (2007) and Agee (1993) and as documented in the South Umpqua Watershed Assessment (BLM 2001). The NFS lands in the Days Creek–South Umpqua River watershed are approximately 32% LSOG.
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The Project is not expected to affect spatial or temporal connectivity on NFS lands in the Days Creek–South Umpqua River watershed. No streams would be crossed and impacts in Riparian Reserves would be minimal. Any residual levels of disturbance are anticipated to be well within the range of natural variability.
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	The Project would have no discernible impact on streambanks or bottoms in the Days Creek–South Umpqua River watershed because no stream channels would be crossed. The few impacts in Riparian Reserves are associated with near ridge-top intermittent streams or ridge top (wetland) swales that have no apparent surface connectivity to the drainage system. Therefore, there would be little influence on the physical integrity of the aquatic system.

TABLE 4.7.3.5-5 (continued)

Compliance of the Project with ACS Objectives, Days Creek–South Umpqua River Watershed

ACS Objective	Project Impacts
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Sediment impacts are expected to be as described in Appendix F.4, Section 1.4.1. Minor amounts of sediment would be mobilized during construction, but these impacts are expected to be short term and limited to the immediate Project area. Connectivity to aquatic systems is limited since no stream channels would be crossed. With application of the ECRP and BMPs, no long-term impacts associated with sediment transport are anticipated. No impacts on water temperature are expected because the two waterbodies that would be crossed are isolated and not connected to an intermittent or perennial stream and no effective shade would be removed.
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	Areas of unstable soils have been avoided in Project routing. There would be no stream channels crossed in the watershed because the route lies on a ridge top and connections to aquatic systems that would transport sediment do not exist. Sediment fluxes are expected to be minor, short-term, and well within the range of natural variability for the Klamath-Siskiyou Province with implementation of the erosion control measures in ECRP and BMPs as well as the anticipated rapid revegetation that is characteristic of the province. Erosional impacts are, therefore, expected to be consistent with those described in appendix F.4, Section 1.4.1.
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	It is highly unlikely that the Project would affect flows because there is no connectivity between the two isolated wetlands to any drainage system. The Project routing is on a ridge top in the watershed and would not cross any stream channels. The watershed is hydrologically recovered (BLM 2001:143) and the Project would affect less than 0.5% of the watershed (appendix F.4, table 2-6) so changes in peak flows as a result of construction are highly unlikely.
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	Two small forested wetlands would be crossed in or near a ridge top swale in the Stouts Creek subwatershed at MP 102.1 and 102.2. Trench plugs would be installed on each side of these wetlands to block subsurface flows and maintain water table elevations, as required by FERC's Wetland and Waterbody Construction and Mitigation Procedures. By restricting crossings to the dry season (July 1 to Sept. 15), possible impacts on water tables of these wetland areas are expected to be minor and short-term. These features appear to have no surface connectivity with the Stouts Creek drainage network.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	Approximately 0.15 acre or less than 0.01% of Riparian Reserves in the watershed would be cleared by the Project. All affected Riparian Reserves are located at or near ridge tops and contribute little to the thermal regulation, nutrient filtering, bank erosion, and channel stability of the drainage networks in the watershed. Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Replanting with native species would facilitate recovery of vegetation communities. These restoration and off-site mitigation efforts would contribute to the maintenance and restoration and physical functions of the Riparian Reserves in the watershed.
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	Impacts to Riparian Reserves would be minimal. All of the Riparian Reserves are located at or near ridge tops. To maintain riparian habitat, construction BMPs would be implemented. Revegetation would be encouraged by planting of native riparian species. The persistence of riparian-dependent Survey and Manage species would not be threatened by Project construction and operation in the watershed (see appendix F.5).

Source: Appendix F.4, table 2-11

It is highly unlikely that construction and operation of the Project would prevent attainment of ACS objectives due to the relatively small portion of NFS lands affected, the relative lack of intersections with waterbodies, and the small acreage of Riparian Reserve affected in the Days

Creek-South Umpqua River watershed. No Project impacts relevant to the ACS have been identified that are outside of the range of natural variability for disturbance processes in the watershed (appendix F.4, table 2-17). The proposed amendment to the Umatilla National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the Project does not threaten the persistence of any riparian-dependent Survey and Manage species. Mitigations associated with the Project are responsive to watershed assessment recommendations and would improve watershed conditions where they are applied (appendix F.4, table 2-10).

Umpqua River Basin, Elk Creek–South Umpqua River Watershed, HUC 1710030204, Umpqua National Forest

Discussions of watershed analysis recommendations, natural disturbances, range of variability and other elements of the ACS are found in appendix F.4. Table 4.7.3.5-6 (table 2-21 in appendix F.4) and this section shows Project effects compared to each of the nine ACS objectives. The Project does not cross any stream channel or clip any riparian reserve on NFS lands.

TABLE 4.7.3.5-6

Compliance of the Project with ACS Objectives, Elk Creek–South Umpqua River Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are landscape-scale features that are affected by the Project. The Project affects (cleared and modified) 0.09% of the NFS land in the Elk Creek-South Umpqua River watershed (Appendix F.4, table 2-12). No Riparian Reserves are crossed or clipped in the Elk Creek watershed since the Project is routed on a ridgetop. The application of BMPs and erosion control measures, use of native vegetation, and the anticipated rapid revegetation of disturbed areas would likely further reduce Project effects. The level of impact is well within the natural range of variability for disturbance processes described by Everest and Reeves (2007) and Agee (1993) and as documented in the South Umpqua Watershed Assessment (Forest Service 1996b).
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The Project is not expected to impact spatial or temporal connectivity on NFS lands in the Elk Creek–South Umpqua River watershed. No streams are crossed, and no riparian reserves are clipped. Aquatic system connectivity would be enhanced by replacement of five culverts within the watershed. Any residual levels of disturbance are anticipated to be well within the range of natural variability (see appendix F.4, table 2-17).
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	The Project would have no discernible impact on streambanks or bottoms in the Elk Creek–South Umpqua River watershed because no stream channels are crossed. Off-site mitigations involving LWD within Riparian Reserves would help restore physical integrity and complexity (appendix F.4, p. 2-47).
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Minor amounts of sediment would be mobilized during construction, but these effects are expected to be short-term and limited to the immediate Project area. Connectivity to aquatic systems is limited since no stream channels are crossed. With application of the ECRP and BMPs, there should be no long-term effects associated with sediment transport and delivery. No impacts to water temperature are expected because no channels are crossed, and no effective shade is removed. Any sediment transport to aquatic systems that may occur would be offset by off-site road drainage enhancement, surface upgrade, and storm-proofing mitigation Projects.

TABLE 4.7.3.5-6 (continued)

Compliance of the Project with ACS Objectives, Elk Creek–South Umpqua River Watershed

ACS Objective	Project Impacts
Maintain and restore the sedimentary erosion, transportation and deposition regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	Areas of unstable soils have been avoided in Project routing. There are no stream channels crossed in the watershed and the route lies on a ridge top; therefore, connections to aquatic systems that would transport sediment do not exist. As a result, sediment fluxes are expected to be minor and short-term and well within the range of variability for the Klamath–Siskiyou Province due to implementation of the erosion control measures in ECRP, BMPs, and the anticipated rapid revegetation that is characteristic of the province. As a result, erosional effects are expected to consistent with those described in Section 1.4.1. Road decommissioning and storm proofing would help reduce sediment effects in the watershed and move the sediment regime closer to the desired condition (appendix F.4 p. 2-47-51).
Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	It is highly unlikely that the Project would impact flows because of the lack of connectivity to aquatic systems. The Project routing is on a ridge top in the watershed and does not cross any stream channels. The watershed is hydrologically recovered, and the Project affects 0.07% of the watershed (appendix F.4, table 2-13). In addition, analysis by FERC showed that the Project was highly unlikely to contribute to increases in peak flows because of the small area affected by the Project as a proportion of the watershed (FERC 2009).
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The Project would not affect floodplains and water table elevations in meadows because these features are not crossed by the Project in the Elk Creek–South Umpqua River watershed.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	No vegetation in Riparian Reserves is removed. Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Replanting with native species would facilitate recovery of vegetation communities. LWD placement within 26 acres of Riparian Reserves would help to enhance physical complexity of the aquatic habitats (appendix F.4, p. 2-47-51). These restoration efforts, along with the limited effects to which they are directed, would maintain and restore biological and physical functions of the Riparian Reserves in the watershed.
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	Existing herbaceous and brush cover would be maintained to the extent practicable. To maintain riparian habitat, construction BMPs would be implemented. LWD placement within 26 acres of Riparian Reserves would help to enhance physical complexity of the aquatic habitats (appendix F.4, p. 2-47-51). Revegetation would be encouraged by planting of native riparian species. The Project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not threaten the persistence of riparian-dependent Survey and Manage species or prevent attainment of the ACS objectives (see appendix F.5).

Source: Appendix F.4, table 2-21

It is highly unlikely that the Project construction and operation would prevent attainment of ACS objectives on NFS land in the Elk Creek–South Umpqua River watershed based on the Project's ridgetop location and the lack of intersection with waterbodies or riparian reserves. Amendments of the Umatilla National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the Project does not threaten the persistence of any riparian-dependent species (appendix F.5). No Project effects relevant to the ACS have been identified that are outside of the range of variability for disturbance processes in the watershed (see appendix F.4, table 2-17).

Umpqua River Basin, Upper Cow Creek Fifth Field Watershed, HUC 1710030206, Umpqua National Forest

Discussions of watershed analysis recommendations, natural disturbances, range of variability and other elements of the ACS are found in appendix F.4. Table 4.7.3.5-7 (table 2-35 in appendix F.4) and this section evaluates Project effects against each of the ACS objectives. National Forest System lands where the ACS applies comprise about 51 percent of the Upper Cow Creek watershed (appendix F.4, table 2-22). Timber harvest and removal of LWD from creek channels has reduced structural complexity of the aquatic habitat and its ability to retain sediments. Chronic, fine-grained sediment deposition, primarily related to roads, has negatively affected aquatic habitats. The presence of roads has segregated some stream reaches from upslope habitats that are needed for replenishment of LWD (appendix F.4, p. 2-66-69). A total of 10.83 acres or 0.13 percent of the Riparian Reserves in the (appendix F.4, table 2-25) watershed would be cleared on:

- Four perennial stream channel crossings,
- Two intermittent stream channel crossings,
- One forested wetland crossing,
- One intermittent stream and six forested wetlands where Riparian Reserves are clipped, but the associated waterbodies are not crossed by the Project.

TABLE 4.7.3.5-7

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Upper Cow Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed-scale features that would be affected by the Project. There would be four perennial and two intermittent stream crossings in the South Fork Cow Creek subwatershed. [Note that Hydrofeature N at MP 111.01 is a perennial stream but, because of an upstream diversion, it is dry in the summer. It is counted here as an intermittent stream since that it is its current condition]. One small shrub-dominated wetland is also crossed. Riparian Reserves associated with1 perennial stream and 6 forested wetlands are clipped. The Project ROW is located primarily in early or mid seral forests and largely on or near ridge tops to minimize impacts on aquatic habitats. The Project ROW would affect 73.76 acres or about 0.31% of NFS lands in the Upper Cow Creek watershed and about 10.06 acres or 0.13% of the Riparian Reserves within the watershed. Impacts to aquatic systems are expected to be short-term and minor and limited to the Project scale because of application of BMPs and erosion control measures. LWD cleared in construction of the corridor would be used to stabilize and restore stream crossings. Off-site mitigation measures including road decommissioning and installation of fish-friendly culverts are expected to improve watershed conditions in the Upper Cow Creek watershed (appendix F.4, p. 2-89-90; table 2-33). While there are long-term changes in vegetation in Riparian Reserves from construction clearing of the corridor, these would be minor in scale and well within the range of natural variation given the disturbance history of the Upper Cow Creek watershed (see appendix F.4, p. 2-70-83).

TABLE 4.7.3.5-7 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Upper Cow Creek Watershed

ACS Objective	Project Impacts
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The Project is not expected to affect spatial or temporal connectivity in the Upper Cow Creek watershed except during the construction period because the pipeline would be buried in all aquatic habitats crossed, consistent with the requirements of the Wetland and Waterbody Crossing Plan. In the short-term, connectivity would be disrupted during construction. At each crossing, the corridor would be narrowed down to 75 feet wide. Bed and bank disturbances associated with equipment and trenching are small (<15 feet wide). After construction, all disturbed areas would be returned to their approximate original contours to restore preconstruction contours and drainage patterns. The temporary construction ROW would be restored and revegetated with native grasses, forbs, conifers, and shrubs, as outlined in the ECRP. After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions. By implementing these measures, lateral and longitudinal connectivity at the site scale would be maintained, although in the short-term during construction, connectivity may be disrupted. Except for a few days during the construction of the crossing, access to areas necessary for life-histories of aquatic- and riparian-dependent species would not be obstructed. By restricting stream crossing operations to the ODFW in-stream work window, possible impacts to sensitive life stages of aquatic biota would be minimized. Connectivity would be improved by installation of fish-friendly culverts at six sites that currently preclude passage of aquatic organisms (see appendix F.4 table 1-14, p. 2-89-91). The residual levels of disturbance are anticipated to be well within the range of natural variability in the Klamath–Siskiyou Province.
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	Impacts to the beds and banks of aquatic features would be minor and limited to the site of construction because the pipeline would be buried, and the actual area of bank and stream bottom disturbance associated with equipment crossing and trenching is small at each crossing (<15 feet wide). After construction, key habitat components such as LWD and boulders would be restored onsite and the beds and banks would be returned to preconstruction conditions, consistent with the POD requirements. By implementing these measures, the physical integrity of the aquatic system at the site scale would be maintained, although in the short-term (during construction), elements of the aquatic system could be disturbed. This level of disturbance is well within the range of natural variability for the watersheds of the Klamath-Siskiyou Province.
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Mercury from abandoned mercury mines in the South Fork Cow Creek subwatershed is a known issue. Broeker (2010b) and GeoEngineers (2013d) assessed the potential risk of release of mercury from disturbance of affected sediments. Mercury concentration of 0.29 parts per million (ppm)), which is in exceedance of the ODEQ threshold of 0.1 ppm, was detected in soil and stream sediment samples at one site. Special measures including maintenance of 100% effective ground cover have been adopted as recommended by ODEQ. As a result, the presence of inorganic mercury is not anticipated to cause any health risk. Minor amounts of sediment would be mobilized during construction, particularly during the dry open-cut and dam and pump crossing of the East Fork Cow Creek and its perennial tributaries (GeoEngineers 2013b). Water quality impacts from sediment are expected to be short-term and limited to the general area of construction (section appendix F.4 Section 1.4.1.2). No long-term impacts on water quality are expected because of application of the ECRP, including maintenance of effective ground cover (Section 1.3.1 and previous discussion) and BMPs during construction. Approximately 3.1 total acres of effective shading vegetation would be removed at four perennial stream crossings. A site-specific shade analysis conducted by Pacific Connector (NSR 2009, 2014) showed minor temperature increases were possible at the Project scale but no impacts would occur beyond the immediate area of construction; there were no temperature impacts at the stream-network scale. Water quality is expected to remain within the range that supports aquatic biota.

TABLE 4.7.3.5-7 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Upper Cow Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Upper Cow Creek watershed sediment regime was historically characterized by pulse-type disturbances (Forest Service 1995a, Everest and Reeves 2007). The East Fork Cow Creek, a drainage in the South Fork Cow Creek subwatershed, is characterized in the Cow Creek watershed analysis as being "in balance" for sediment transport and deposition. The Project is not likely to alter these conditions. Eighty percent (3.73 of 5.27 miles) of the Project in the Upper Cow Creek watershed is on ridge tops with little or no aquatic connectivity. Site-specific field reviews by geologists show the Project is unlikely to cause landslides or activate currently stable earth-flow terrains because unstable areas have been avoided (GeoEngineers 2009b; Hanek 2011; Koler 2012). Surface erosion and sediment transport to streams would be minimized because the Project would maintain 100% effective ground cover, effective sediment barriers, and other erosion control measures as needed (see the sediment discussion at the beginning of this section). Sediment generated during construction is expected to be minor and to be limited to the general area of construction using dry dam-and-pump measures that isolate the crossing from flowing water during construction (section 1.3.1). The Project is not expected to alter the balance of sediment transport and storage in the East Fork Cow Creek. The Project is not expected to alter either the pulse-type disturbance or surface erosion sediment regimes of the Upper Cow Creek watershed (appendix F.4, Section 1.4.1.2). A pulse of sediment could be observed following the first seasonal rain, but this is likely to dissipate within a few hundred feet and would be indistinguishable from background levels.
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	Instream flows would be interrupted for a short time during installation of dams during dam and pump crossings. The area of construction that is between upstream and downstream dams would be dewatered during the actual crossing construction. During construction, water would be pumped around the construction site to maintain downstream flows. It is possible that there would be local increases in runoff from canopy removal but, at the watershed scale, flow regimes would not be altered by the Project because of the small scale of the Project relative to the watershed, the relatively high proportion (85%) of the watershed that is hydrologically recovered, and the lack of connectivity of most of the route to any stream network. See the discussion of peak flow processes in appendix F.4, p. 2-70-83 for additional information.
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The Project ROW clips the Riparian Reserve of six forested wetlands and crosses one delineated wetland. Trench plugs would be installed on each side of these wetlands as needed to block subsurface flows and maintain water table elevations, as required by FERC's Wetland and Waterbody Construction and Mitigation Procedures. Regardless, Project construction may have short-term impacts on water tables in these isolated forest wetlands. These site-specific impacts would be minor (i.e., limited to the general area of construction) and are not connected to larger wetland areas; they may also be regulated under Section 404 of the Clean Water Act. By restricting crossings to the dry season (July 1 to Sept. 15), possible impacts on water tables of these wetland areas are expected to be minor and short-term.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	Project impacts on riparian vegetation in the Upper Cow Creek watershed would be minor. In the short term, all vegetation would be removed from the Project ROW. About 4.45 acres of the Riparian Reserves to be cleared in the Project ROW are LSOG (table 2-25). Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Overall, Project construction would affect ~0.13% of the Riparian Reserves in the watershed (table 2-25). Following construction, replanting with native species would facilitate reestablishment of vegetation communities. LWD and boulders from the corridor would be returned to disturbed riparian areas. These restoration efforts, along with the limited impacts to which they are directed, would maintain and restore biological and physical functions of the Riparian Reserves in the watershed.

TABLE 4.7.3.5-7 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Upper Cow Creek Watershed

ACS Objective	Project Impacts
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	Project impacts on riparian vegetation in the Upper Cow Creek watershed would be minor (10.06 acres, or 0.13%, of the Riparian Reserves in the watershed) (table 2-25). Existing herbaceous and brush cover within the Project clearing limits would be maintained to the extent practicable. Consistent with the requirements of the POD, LWD and boulders removed from the corridor during construction would be replaced to restore and stabilize channel crossings. Revegetation would be accomplished using native riparian species. The persistence of riparian-dependent Survey and Manage species would not be threatened by Project construction and operation in the watershed. See appendix F.5.

Source: Appendix F.4, table 2-35

Through application of the ECRP BMPs and the FERC Wetland and Waterbody plans, sediment transport would be minimized, and instream flow regimes would be maintained (appendix F.4, section 1.4.1). No known riparian-related Survey and Manage species would be affected by Project construction and operation (see appendix F.5).

The South Fork Cow Creek subwatershed has four perennial stream crossings within one mile. This is the highest number of perennial stream crossings in one subwatershed on NFS lands. Construction of the Project in the Upper Cow Creek watershed has high potential for impacts that could prevent attainment of ACS objectives particularly as related to sediment, water temperature and mobilization of naturally occurring mercury (see appendix F.4, p. 2-70-84). The Project has addressed these issues as follows:

- **Project Routing—**Approximately 80 percent of the route in the Upper Cow Creek watershed is on a ridgetop with little or no connectivity to aquatic habitats or Riparian Reserves. Between MPs 109 and 110 in the South Fork Cow Creek subwatershed, the route has been selected and modified to avoid potentially unstable areas. The Forest Service has participated extensively in routing of the Project and concurs that the location is unlikely to trigger mass wasting or excessive surface erosion.
- **Implementation of Water Quality Best Management Practices—**A site-specific BMP implementation plan based on construction impact and site-response risk has been prepared that is expected to maintain water quality (GeoEngineers 2013b). Within Riparian Reserves for all hydrologic features crossed by the pipeline between MPs 109 and 110, the Project would provide 100 percent post-construction ground cover on all disturbed areas. Wood fiber is the preferred material. In addition, the Project would construct water bars at 50-foot intervals. Other erosion control measures would be used as needed to prevent surface erosion associated with stream crossings or to prevent sediment transport and deposition that may affect riparian systems.
- **Mitigation of Potential Impacts on Stream Temperature—**A temperature analysis on perennial stream crossings showed the Project may have minor temperature impacts (~

0.1°C) at the project scale (NSR 2009, NSR 2014).[153] Although the analysis showed there would be no impact at the next downstream reach below the crossings because of ground water discharge, flow volumes and existing shade, the Project would transplant larger conifers to riparian areas and use logs and slash to provide shade at perennial crossings in the East Fork Cow Creek to mitigate for temperature impacts at the project scale. Temperatures are expected to remain below those specified by the State of Oregon for streams in the Umpqua basin.

- **Mercury--** The Forest Service contracted with a professional consulting geologist with extensive local experience to collect soil and stream sediment samples for analytical testing and reporting of mercury and other naturally-occurring minerals along a 2,000-foot section of the proposed pipeline route between MP 109 and the East Fork Cow Creek (Broeker 2010b; GeoEngineers 2013a). Geochemical analysis of the soil and stream sediment samples have been determined to have very low to nominal concentrations of naturally occurring mercury mineralization. The mercury level at one of the stream sediment sites was 0.29 part per million, which was above the Level II screening level value of 0.1 part per million for invertebrates (ODEQ 1998, cited in GeoEngineers 2013c). In order to prevent this naturally-occurring mercury from mobilizing during and after construction, additional erosion control measures and monitoring would be conducted at these sites. The proposed pipeline construction activities by Pacific Connector within the East Fork Cow Creek subwatershed are not anticipated to disturb and expose soils and bedrock strata that contains more than low amounts of natural occurring mercury mineralization; and any sediment that is generated is not likely to reach the aquatic environment due to implementation of short-term and permanent mitigation measures outlined in Pacific Connector's ECRP and as listed in GeoEngineers (2013a).

There are approximately 7,849.12 acres of Riparian Reserves (NFS lands only) in the Upper Cow Creek watershed (appendix F.4, table 2-22) of which approximately 3,313.66 acres are LSOG. Approximately 10.83 acres of Riparian Reserves or 0.13 percent of the Riparian Reserves on NFS lands in the watershed would be cleared (appendix F.4, table 2-3, 2-24). Of this, approximately 2.81 acres are LSOG (appendix F.4, table 2-25). This is about 0.13 percent of the LSOG in Riparian Reserves on NFS lands in the Upper Cow Creek watershed. Early and mid-seral forest vegetation constitutes the remaining 8.02 acres of the affected Riparian Reserve vegetation. LSOG (2.81 acres) and mid-seral vegetation (4.37 acres) cleared (7.18 acres total) in the corridor would be a change in vegetation condition that is long-term but well within the range of natural variability for the Upper Cow Creek watershed considering its history of disturbance from stand replacement fire and subsequent landslides (appendix F.4, 2-70-83). Federal lands are currently 35.20 percent LSOG and exceed minimum watershed thresholds for LSOG forest after consideration of Pacific Connector Pipeline Project impacts (appendix F.4, p. 2-56).

Several site-specific proposed amendments of the Umatilla National Forest LRMP are required to make provision for the Pacific Connector Project. These proposed amendments are not expected

[153] A temperature increase of this scale is so small that may be outside the confidence limits of the model for precise predictions. In other words, this is possibly "noise" in the metrics, and may not actually occur in the field. Even if the predicted temperature increase does occur, it would quickly dissipate because of downstream shade, hyporheic flows and input from other streams (NSR 2009).

to prevent attainment of the ACS in the Upper Cow Creek watershed (appendix F.4, p. 2-83; table 2-32):

- Proposed amendment UNF-1 would allow removal of effective shade on perennial streams. This amendment would not prevent attainment of ACS objectives because a site-specific temperature assessment (NSR 2009, 2014) showed that any temperature increase resulting from removal of effective shade would be minor and limited to the point of maximum impact at the site of construction.
- Proposed amendment UNF-2 would allow the Pacific Connector corridor to run parallel to an existing stream within the riparian zone. The amendment would not prevent attainment of ACS objectives because an uncut buffer 30 to 60 feet wide remains between the corridor and the East Fork Cow Creek. An estimated 94 percent of the effective shade is maintained adjacent to the East Fork Cow Creek, erosion control measures specified in the ECRP are expected to be effective at controlling surface erosion and LWD would not be removed from the stream. Sources of LWD would remain on both sides of the channel.
- Proposed amendment UNF-3 would allow the Project to exceed detrimental soil conditions within the construction corridor. This would not prevent attainment of ACS objectives because soil decompaction and remediation required in Riparian Reserves is expected to effectively moderate detrimental soil conditions. Implementation of measures in the ECRP is expected to effectively control surface erosion and restore native vegetation (see section 4.3.4 of this EIS).
- Proposed amendment UNF-4 would reallocate approximately 588 acres from the matrix land allocation to the LSR allocation. This would benefit aquatic habitats because this area would be managed for late-successional stand conditions that provide additional aquatic protections.
- Proposed amendment of the Umatilla National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the Project does not threaten the persistence of any riparian-dependent species (see appendix F.5).

The routing of the Project through NFS lands, coupled with the relatively small area of NFS land affected by Project construction (73.76 acres or 0.31 percent of the NFS lands in the fifth-field watershed – appendix F.4, table 2-23), makes it highly improbable that Project impacts could affect watershed conditions. Although there are project-level impacts (e.g., short-term sediment and a long-term change in vegetative condition at stream crossings), these would be minor in scale and largely limited to the boundaries of the Project area (appendix F.4, Section 1.4.1.2).

No Project-related impacts that would prevent attainment of ACS objectives have been identified (table 4.7.3.5-7 or appendix F.4, table 2-35). All relevant Project impacts are within the range of natural variability for watersheds in the Western Cascades and Klamath Provinces, although some of these processes have been altered from their natural condition (appendix F.4, p. 2-70-83).

Rogue River Basin, Trail Creek Fifth-Field Watershed HUC 1710030706, Umpqua National Forest

Discussions of watershed analysis recommendations, natural disturbances, range of variability and other elements of the ACS are found in appendix F.4. Table 4.7.3.5-8 (table 2-44 in appendix F.4) compares the Project impacts to the objectives of the ACS for the Trail Creek watershed. The

Project would not affect any Riparian Reserves in the watershed (appendix F.4, table 2-3, 2-38). National Forest System lands where the ACS applies comprise about 12 percent of the Trail Creek watershed (appendix F.4, p. 2-99). Watershed conditions and recommendations are found in the Trail Creek watershed assessment (BLM 1999) and described in detail in appendix F.4. In the Trail Creek watershed, timber harvest and removal of LWD from creek channels has reduced structural complexity of the aquatic habitat and its ability to retain sediments. Chronic, fine-grained sediment, most recently related to roads and timber harvest, has negatively affected aquatic habitats by adding large volumes of sediment. The presence of roads has segregated some stream reaches from upslope habitats that are needed for replenishment of LWD.

TABLE 4.7.3.5-8

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Trail Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed landscape-scale features that would be affected by the Project. No Riparian Reserves are affected in the Trail Creek watershed (table 2-41). On NFS lands subject to the ACS, the Project ROW is located primarily in early or mid seral forests (table 2-41). There are no river or stream crossings on NFS lands, and the Project ROW is located largely on or near ridge tops to minimize impacts on aquatic habitats. No wetlands or streams are crossed or clipped in the watershed. Use of native vegetation and the anticipated rapid revegetation of disturbed areas would likely further reduce Project impacts. Off-site mitigation measures including road stormproofing and decommissioning are expected to improve watershed conditions in the Trail Creek watershed (see appendix F.4, p.2-113-115).
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The Project is not expected to affect spatial or temporal connectivity in the Trail Creek watershed because no wetlands or waterbodies are crossed. No rivers or streams would be crossed on NFS lands.
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	No stream channels are crossed on NFS lands where the ACS applies so the physical integrity of banks and stream bottoms would not be affected.
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	No wetlands or streams are crossed on NFS lands in the Trail Creek watershed. No long-term impacts on water quality are expected because of application of the ECRP, including maintenance of effective ground cover and BMPs during construction (see Section 1.4.1 and previous discussion).

TABLE 4.7.3.5-8 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Trail Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Trail Creek watershed was historically characterized by pulse-type depositions of coarser sediments from landslides and surface erosion following major disturbances such as fires and high-intensity winter storms (BLM 1999, Everest and Reeves 2007). Chronic erosion and deposition of fine sediments, primarily from roads and to a lesser degree from land use, have replaced these pulse-type disturbances in the watershed. Project construction and operation are not likely to alter sediment erosion and deposition in the watershed nor are they likely to exacerbate these conditions. Proposed mitigation projects would contribute to a reduction of adverse sediment scouring and depositing and restoration of aquatic functions (see appendix F.4, p. 2-113-115).
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	The Project is not likely to affect peak flows in the Trail Creek watershed because of its predominately ridge top location, the relatively small area of the watershed affected (less than 1%), the absence of stream crossings, and the relative lack of connectivity to aquatic systems. The Trail Creek watershed assessment noted that increases in peak flows are a low risk in all the subwatersheds and in the watershed as a whole.
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The Project would not cross any meadows or wetlands in the Trail Creek watershed on NFS lands, so there would be no impact from the Project on water tables or seasonal inundation of these areas
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	The Project would not affect Riparian Reserves in the Trail Creek watershed (table 2-39). Following construction, replanting with native species would facilitate reestablishment of vegetation communities.
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	The Project would not affect any Riparian Reserves in the Trail Creek watershed (table 2-39). Consistent with the requirements of the POD, LWD and boulders removed from the corridor during construction would be replaced to restore and stabilize channel crossings. Revegetation would be accomplished using native riparian species. The Project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not threaten the persistence of riparian-dependent Survey and Manage species or prevent attainment of the ACS objectives (see appendix F.5).

Source: Appendix F.4, table 2-44

Given the ridgetop location of the pipeline corridor on NFS lands, the lack of intersects with waterbodies, and lack of impacts to Riparian Reserves it is highly unlikely that Project construction and operation would prevent attainment of ACS objectives on NFS land in the Trail Creek watershed.

The high clay-content soils in the watershed (BLM 1999:1-4) presents a potential issue with respect to possible compaction and sediment that could be mobilized by overland flow. Subsoil ripping (including the use of hydraulic excavators) is a proven method to reduce soil compaction. Measures in the ECRP including soil remediation with organic materials, rapid revegetation and maintenance of effective ground cover are likely to successfully control surface erosion. The Forest Service may require additional erosion control measures if needed.

Off-site mitigation measures, identified by the Forest Service, would supplement onsite minimization, mitigation, and restoration actions. These proposed offsite mitigation measures are responsive to recommendations in the Trail Creek watershed assessment and would contribute to improving terrestrial and aquatic conditions within the watershed (see appendix F.4, p. 2-113-115).

A site-specific amendment of the Umatilla National Forest LRMP to waive limitation on detrimental soil compaction is proposed to make a provision for the Project. This proposed amendment is minor in scope and is not expected to prevent attainment of ACS objectives because of implementation of the ECRP and the fact that there are no stream intersects on NFS lands in the Trail Creek watershed. The proposed amendment of the Umatilla National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because species viability would be maintained (see appendix F5).

The relatively small area of NFS land affected by Project construction (50.27 acres or 1.15 percent of NFS lands in the watershed), makes it highly improbable that Project impacts could affect watershed conditions beyond the site scale. Although there are project-level impacts such as short-term surface erosion these would be minor and limited to the boundaries of the Project area (see appendix F.4, section 1.4.1).

No Project-related impacts that would retard or prevent attainment of ACS objectives have been identified (appendix F.4, table 2-44). Impacts, as they relate to relevant ecological processes, are within the range of natural variability for watersheds in the Western Cascade and Klamath-Siskiyou Provinces, although some of these processes have been altered from their natural condition (appendix F.4, p. 2-105-109, table 2-40).

Rogue River Basin, Little Butte Creek Fifth Field Watershed, HUC 1710030708, Rogue-Siskiyou National Forest

Discussions of watershed analysis recommendations, natural disturbances, range of variability are found in appendix F.4. Table 4.7.3.5-9 (table 2-62 in appendix F.4) compares the Project impacts to the objectives of the ACS for the Little Butte Creek watershed. National Forest System lands where the ACS applies comprise approximately 59,900.38 acres or 25.10 percent of the Little Butte Creek watershed (appendix F.4, table 2-45). Riparian Reserves comprise approximately 8,096.50 acres (about 3.39 percent of the entire watershed [appendix F.4, table 2-45]) on NFS lands. Watershed conditions and recommendations are found in the Little Butte Creek watershed assessment (BLM and Forest Service 1997). A total of 10.22 acres or 0.13 percent of the Riparian Reserves in the watershed would be affected of which 7.66 acres are cleared and 2.56 acres (appendix F.4, table 2-47) are modified on:

- One perennial stream channel crossing
- One intermittent stream channel crossing
- One intermittent stream and one wetland where Riparian Reserves are clipped, but the associated waterbodies are not crossed by the Project.

TABLE 4.7.3.5-9

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Little Butte Creek

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed-scale features. The Project would affect about 10.22- acres or about 0.13% of Riparian Reserves on NFS lands in the Little Butte Creek watershed (table 2-47). There is one intermittent and one perennial stream channel crossed in the Little Butte Creek watershed on NFS lands. Impacts to aquatic systems are expected to be short-term and minor and limited to the project scale because of application of BMPs and erosion control measures (see appendix F.4, Section and 1.4.1). Large woody debris cleared in construction of the Project would be used to stabilize and restore stream crossings. Off-site mitigation measures including 57.5 miles of road decommissioning, approximately 1.5 -miles of instream projects, snag creation and coarse woody debris placement are expected to improve watershed conditions in the Little Butte Creek watershed (see appendix F.4, p. 2-149 158, tables 2-57, 2-58, 2-59, 2-60). While there are long-term changes in vegetation in Riparian Reserves from construction clearing of the Project ROW, these would be minor in scale and well within the range of natural variability given the disturbance history of the watershed (see appendix F.4, p. 2-105-109, table 2-40).
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The Project is not expected to affect spatial or temporal connectivity in the Little Butte Creek watershed because the pipeline would be buried in all aquatic habitats crossed, consistent with the requirements of the exhibits specified in the Wetland and Waterbody Crossing Plan. At each crossing, bed and bank disturbances from equipment crossing and trenching are small (<15 -feet -wide). After construction, all disturbed areas would be returned to their approximate preconstruction contours and drainage patterns. The temporary construction ROW would be restored and revegetated with native grasses, forbs, conifers, and shrubs, as outlined in the ECRP. After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions. By implementing these measures, lateral and longitudinal connectivity at the site scale would be maintained, although in the short-term during construction, connectivity may be disrupted. Except for a few days during the construction of the crossings, access to areas necessary for life-histories of aquatic and riparian dependent species would not be obstructed. By restricting stream crossing operations to the ODFW in-stream work window, possible impacts to sensitive life stages of aquatic biota would be minimized. Road decommissioning that occurs within Riparian Reserves (approximately 18-acres) would contribute to restoration of aquatic connectivity. The residual levels of disturbance are anticipated to be well within the range of natural variability in the Klamath-Siskiyou Province and the High Cascades Province. (appendix F.4, p. 2-136-141, table 2-54)
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	Impacts to the bed and banks of aquatic features would be minor and limited to the site of construction because the pipeline would be buried, and the actual area of bank and stream bottom disturbance is small at each crossing (<15-feet -wide). This level of disturbance is comparable to a bank slough (see Section 1.4.1.) or a culvert installation and well within the range of natural variability that for watersheds of the Klamath-Siskiyou Province and the High Cascades Province (see (appendix F.4, p. 2-136-141, table 2-54)). After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions, consistent with the exhibits to the POD. By implementing these measures, the physical integrity of the aquatic system at the site scale would be maintained.

TABLE 4.7.3.5-9 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Little Butte Creek

ACS Objective	Project Impacts
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Minor amounts of sediment would be mobilized during construction. These impacts are expected to be short-term and limited to the general area of construction (see appendix F.4, Section 1.4.1). No long-term impacts on water quality are expected because of application of the ECRP that includes maintenance of effective ground cover and BMPs during construction (see appendix F.4, Section 1.4.1.1). Effective shade would be removed at the crossing of the South Fork Little Butte Creek at MP 162.45. A site-specific shade analysis (NSR 2009) found no temperature impacts at the site or at the stream network scale at this crossing.
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Little Butte Creek watershed sediment regime was historically characterized by pulse-type depositions of coarser sediments from landslides and surface erosion following major disturbances such as fires and high-intensity winter storms (BLM and Forest Service 1997). The current sediment regime in the watershed has replaced these pulse-type disturbances with more chronic erosion and deposition of fine sediments primarily from urban and agricultural land use, timber harvest and roads. Project construction and operation is not likely to alter this sediment pattern nor is it likely to exacerbate these conditions because of implementation of measures in the ECRP (see Section 1.4.1) including maintenance of effective ground cover, water bars to dissipate overland flows and maintenance of sediment barriers until revegetation is successful. Sediment impacts from construction are expected to be like those described in section 1.4.1.2. A pulse of sediment could be observed following the first seasonal rain, but that this is likely to dissipate within a few hundred feet and would be indistinguishable from background levels. Any sediment impacts are expected to be well within the range of natural variability for the Klamath-Siskiyou Province and the High Cascades Province (see appendix F.4, p. 2-134 140, table 2-54). Proposed mitigation projects including road decommissioning would contribute to reduction of sediments and restoration of aquatic functions at the watershed scale (see appendix F.4, p. 2-148-158, table 2-57).
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	The Project is unlikely to affect peak flows in the Little Butte Creek watershed because of the dispersed nature of impacts, the current hydrologically recovered conditions in the watershed, the relatively small proportion of the watershed affected (0.25%), and the relative lack of connectivity to aquatic systems (see appendix F.4, table 2-54, p. 2-139). Decommissioning roads (57.5 miles) as part of the offsite mitigation plan would contribute substantively the restoration of flow patterns by restoring hydrologic connectivity at stream crossings that are decommissioned (see appendix F.4, p. 2-148-158, table 2-57).
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The Project clips one small wetland on NFS land but does not cross it. Application of the ECRP including maintenance of effective ground cover and BMPs during construction will be applied (see section 1.4.1.1). In addition, decommissioning 57.5 miles of roads, 18- acres of which are in Riparian Reserves (see appendix F.4, p. 2-148-158, table 2-57)) would contribute substantially to restoring floodplain functions where these projects occur.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	The Project impacts on riparian vegetation in the Little Butte Creek watershed would be minor. Approximately 10.22 acres or 0.13% of the Riparian Reserves in the watershed are potentially affected by the Project (table 2-48). Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the Project ROW would be returned to disturbed riparian areas. Coarse woody debris placement and snag creation on 126- acres in Riparian Reserves, along with revegetation on 18 acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves (see appendix F.4, p. 2-148-158, table 2-57).

TABLE 4.7.3.5-9 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Little Butte Creek

ACS Objective	Project Impacts
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	The Project impacts on riparian vegetation in the Little Butte Creek watershed would be minor. Approximately 10.22 acres or 0.13% of the Riparian Reserves in the watershed are potentially affected by the Project. Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the Project ROW would be returned to disturbed riparian areas. Coarse wood placement and snag creation on 126- acres in Riparian Reserves, along with revegetation on 18 acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves. The Project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not prevent attainment of the ACS objectives because the viability of riparian-dependent Survey and Manage species would not be threatened. (see appendix F.5).

Source: Appendix F.4, table 2-62

The Little Butte Creek watershed is the largest, and in some ways, the most complex watershed crossed by the Project. With 13.75 miles of corridor, and 207.17 acres of clearing on NFS lands, this watershed has the most NFS land area affected of all watersheds crossed by the Project. The watershed is geologically complex with both Klamath-Siskiyou Province and the High Cascades Province landscapes. It is ecologically diverse and important, providing some of the most productive coho salmon streams in the Upper Rogue Basin. Little Butte Creek watershed is a Tier 1 Key Watershed above the confluence of the North and South Forks of Little Butte Creek (appendix F.4, table 1-2), and roughly 88 percent of the NFS lands in the watershed are managed as LSR (appendix F.4, table 1-1). Against this backdrop, compliance with the ACS is an important measure of Project impacts.

Pacific Connector has modified the Project to respond to the ACS objectives and has incorporated measures consistent with the Riparian Reserve Standards and Guidelines into the ECRP and other elements of their plan of development (e.g., Wetlands and Water Body Crossing Plan). The assessment in appendix F.4 demonstrates that short-term impacts associated with the Project would occur to streambanks, and substrates at the site scale. Change in vegetative condition from clearing of forest within the Project ROW is a long-term impact. These impacts, however, are well within the range of natural variability given the disturbance processes that function in the watershed (see appendix F.4, p. 2-134 – 2-141, table 2-54). This is especially apparent when considering the total amount of Riparian Reserves that are located within the Little Butte Creek watershed (8,096.50 acres) and the amount of clearing (10.22 acres) in Riparian Reserves (0.13 percent of the Riparian Reserves in the watershed) (appendix F.4, table 2-47). Also, because of the linear characteristic of the pipeline, the Riparian Reserve crossings would be spread out across the landscape.

Off-site mitigation measures including over 66 miles of road decommissioning (57.5 miles are within Key Watershed), 1.5 miles of LWD instream projects, identified by the Forest Service, would supplement onsite minimization, mitigation, and restoration actions. These proposed offsite mitigation measures are responsive to recommendations in the Little Butte Creek watershed assessment (1997) and the South Cascades Late-Successional Reserve Assessment (1998).

Mitigations measures encompassed with the Project description described in chapter 2 of this EIS are responsive to watershed assessment recommendations and would improve watershed conditions where they are applied (see appendix F.4, p. 2-148-158, table 2-57, 2-58).

To make provisions for the Project, three site-specific amendments of the Rogue River National Forest LRMP related to the ACS are proposed (see appendix F.4, p. 143-148).

- Proposed amendment RRNF-5 would allow the Project to cross the MA-26 Restricted Riparian land allocation at one location on the South Fork of Little Butte Creek a perennial stream. This amendment would not prevent attainment of ACS objectives because a site-specific temperature assessment (NSR 2009) showed there would be no temperature increase from shade removal at this location, effective ground cover and sediment barriers would be maintained and implementation of the ECRP is expected to control surface erosion and reestablish native vegetation.
- Proposed amendment RRNF-6 would allow the Project to exceed detrimental soil conditions within the construction corridor. This would not prevent attainment of ACS objectives because the Project would require soil remediation as needed with biosolids or other organic materials in areas with potential revegetation difficulty, soil decompaction, maintenance of effective ground cover, application of BMPs, and application of offsite mitigations. Therefore, any sediment impacts from detrimental soil conditions are expected to be minor and short term and the methods described above would be expected to effectively moderate detrimental soil conditions. Implementation of measures in the ECRP is expected to effectively control surface erosion and restore native vegetation (see section 4.3.4 in this EIS).
- Proposed amendment of the Rogue River National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the persistence of riparian dependent survey and manage species would not be threatened (see appendix F.5).

The Project is otherwise consistent with Standards and Guidelines for activities in Riparian Reserves for the Rogue River National Forest.

The routing of the pipeline through NFS lands, coupled with the relatively small area of NFS land affected by Project construction (0.46 percent of NFS lands in the fifth-field watershed), makes it highly improbable that Project impacts could affect watershed conditions. The relative lack of intersections with aquatic systems serves to further minimize possible impacts. Although there are project-level impacts from short-term sediment and long-term change in vegetative condition at stream crossings, these would be minor in scale (appendix F.4, table 2-62).

No Project-related impacts that would prevent attainment of ACS objectives have been identified (appendix F.4, section 1.4.1, table 2-62). All relevant Project impacts are within the range of natural variability for watersheds in the Klamath-Siskiyou and High Cascades Provinces, although some of these processes have been altered from their natural condition (appendix F.4, p. 2-236).

Klamath River Basin, Spencer Creek Fifth Field Watershed, HUC 180102206, Winema National Forest

Discussions of watershed analysis recommendations, natural disturbances, range of variability etc. are found in appendix F.4. Table 4.7.3.5-10 (table 2-77 in appendix F.4) and this section compares the Project impacts to the objectives of the ACS for the Spencer Creek watershed. National Forest System lands where the ACS applies comprise approximately 41 percent of the Spencer Creek watershed (appendix F.4, table 1-1). Watershed conditions and recommendations are found in the Spencer Creek watershed analysis (BLM et al. 1995). The Project would include approximately 6.05 miles on NFS lands. A total of 9.98 acres of Riparian Reserves or 0.60 percent of the Riparian Reserves in the watershed (appendix F.4, table 2-65) would be affected of which 8.63 acres are cleared and 1.35 acres (appendix F.4, table 2-3 are modified on:

- Four intermittent stream channels and two wetlands crossed by the Project.
- Four intermittent streams and two wetlands where Riparian Reserves are clipped but the associated stream channel or wetland is not crossed.

TABLE 4.7.3.5-10

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Spencer Creek Watershed

ACS Objective	Project Impacts
Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations, and communities are uniquely adapted.	Riparian Reserves are watershed-scale features. The Project would clear about 8.63-acres or about 0.52% of Riparian Reserves on NFS lands in the Spencer Creek watershed (table 2-67). There are four intermittent stream channels crossed in the Spencer Creek Watershed. No perennial streams are crossed. Riparian Reserves associated with two forested wetlands and four intermittent streams are clipped. Impacts to aquatic systems are expected to be short-term or minor and limited to the project scale because of application of BMPs and erosion control measures (see appendix F.4, section 1.4.1.). Clearing of 4.58 -acres of LSOG vegetation in Riparian Reserves is a long-term change in condition, but is minor in scale, and within the range of natural variability given the disturbance processes in Spencer Creek (appendix F.4, p. 2-176-2-181). Spencer Creek watershed remains above the 15% threshold on federal lands for LSOG vegetation established in the NWFP (appendix F.4, p. 1-174). Large woody debris cleared in construction of the Project ROW would be used to stabilize and restore stream crossings. Off-site mitigation measures including 29.2-miles of road decommissioning, one mile of instream projects, fencing and riparian planting projects are expected to improve watershed conditions in the Spencer Creek watershed. While there are long-term changes in vegetation in Riparian Reserves from construction clearing of the Project ROW, these would be minor in scale and well within the range of natural variability given the disturbance history of the watershed (see appendix F.4, p. 2-176-2-181).

TABLE 4.7.3.5-10 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Spencer Creek Watershed

ACS Objective	Project Impacts
Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life-history requirements of aquatic and riparian-dependent species.	The Project is not expected to affect spatial or temporal connectivity in the Spencer Creek watershed because the pipeline would be buried in all aquatic habitats crossed, consistent with the requirements of the exhibits specified in the POD (i.e., Wetland and Waterbody Crossing Plan). Additionally, all the channels crossed in Spencer Creek are intermittent and are likely to be dry at the time of crossing. In the short-term, during construction, connectivity could be disrupted for 1-5 days. At each crossing, bed and bank disturbances are small (<15 feet wide). After construction all disturbed areas would be returned to their approximate preconstruction contours and drainage patterns. The temporary Project ROW would be restored and revegetated with native grasses, forbs, conifers, and shrubs, as outlined in the ECRP. After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions. By implementing these measures, lateral and longitudinal connectivity at the site scale would be maintained, although in the short-term, during construction, connectivity may be disrupted. Except for a few days during the construction of the crossing, access to areas necessary for life-histories of aquatic and riparian dependent species would not be obstructed. By restricting stream crossing operations to the ODFW in-stream work window, possible impacts to sensitive life stages of aquatic biota would be minimized. Road decommissioning that occurs within Riparian Reserves (approximately 9.63- acres) would contribute to restoration of aquatic connectivity (see appendix F.4, p. 2-186-191). The residual levels of disturbance are anticipated to be well within the range of natural variability in the High Cascades Province (see appendix F.4, p. 176-181).
Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	Impacts to the stream bed and banks would be minor and limited to the site of construction because the pipeline would be buried, and the actual area of bank and stream bottom disturbance is small at each crossing (<15- feet -wide). This level of disturbance is comparable to a bank failure (see Section 1.4.1) and well within the range of natural variability for watersheds in the High Cascades Province (see Section appendix F.4, p. 176-181). After construction, key habitat components such as LWD and boulders would be restored onsite and the bed and banks would be returned to preconstruction conditions, consistent with the exhibits to the POD (i.e., Wetland and Waterbody Crossing Plan). By implementing these measures, the fluvial integrity of the aquatic system at the site- scale would be maintained. Offsite mitigation measures (see section 2.6.3.6) would substantively improve watershed conditions by decommissioning 29.22 miles of roads (50- acres total of which 12.6- acres are in Riparian Reserves), replanting willows along 0.5 -miles of perennial streams and restoring LWD in 1 mile of Spencer Creek (appendix F.4, p. 2-186-191, 2-73, table 2-74).
Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	Project stream crossings in the Spencer Creek watershed are expected to occur when intermittent stream channels are dry. Minor amounts of sediment would be generated during construction that may be mobilized during the onset of seasonal precipitation in the fall. These impacts are expected to be short -term and limited to the general area of construction (see section 1.4.1). No long-term impacts on water quality are expected because of application of the ECRP including maintenance of effective ground cover (see section 1.4.1) and BMPs during construction (see section 1.4.1.1) Offsite mitigation measures (see appendix F.4, p. 2-186 – 191, table 2-73) address key issues identified in the watershed assessment and are expected to substantially improve watershed conditions.
Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of this sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	The Spencer Creek watershed sediment regime was historically characterized by pulse-type depositions of coarser sediments from streambank erosion following major disturbances such as fires and high-intensity winter storms. More chronic erosion and deposition of fine-grained sediments primarily from roads, and to a lesser degree from land use has replaced these pulse-type disturbances in the current sediment regime in the watershed. The Project construction and operation are not likely to alter this sediment pattern nor is it likely to exacerbate these conditions. Sediment impacts from construction are expected to be like those described in section 1.4.1.2. Proposed mitigation projects including 29.5 miles of road -decommissioning would contribute to reduction of sediments and restoration of aquatic functions at the watershed scale. Any sediment impacts are expected to be well within the range of natural variability given the disturbance history of the Spencer Creek watershed (see appendix F.4, p. 2-176-181).

TABLE 4.7.3.5-10 (continued)

Compliance of the Pacific Connector Pipeline Project with ACS Objectives, Spencer Creek Watershed

ACS Objective	Project Impacts
Maintain and restore instream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.	The Project is unlikely to affect flow patterns in the Spencer Creek watershed because of the dispersed nature of impacts, high infiltration rates and the relatively small proportion of the watershed affected (0.41%) (appendix F.4, p 2-191, table 2-64). Decommissioning roads (29.5 miles) as part of the offsite mitigation plan would contribute substantively the restoration of flow patterns by restoring hydrologic connectivity at stream crossings that are decommissioned (see appendix F.4, p. 2-186 – 191, table 2-73)).
Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.	The Project crosses two small wetland areas and clips the Riparian Reserve of another two forested wetlands. Trench plugs would be installed on each side of these wetlands as needed to block subsurface flows and maintain shallow, unconfined aquifer water table elevations, as required by FERC's *Procedures*. By restricting crossings to the dry season (July 1 to Sept. 15), possible impacts on shallow ground water tables of these wetland areas are expected to be minor and short-term.
Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation; nutrient filtering; and appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of coarse, woody debris sufficient to sustain physical complexity and stability.	The Project impacts on riparian vegetation in the Spencer Creek watershed would be minor. Approximately 9.98 or 0.60% of the Riparian Reserves in the watershed are potentially affected by the Project (table 2-65). Existing herbaceous and brush cover would be maintained in Riparian Reserves to the extent practicable. Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the Project ROW would be returned to disturbed riparian areas. Revegetation of 12.6 acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves (appendix F.4, p. 2-186 – 191, table 2-74)).
Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	The Project impacts on riparian vegetation in the Spencer Creek watershed would be minor. Approximately 9.98 acres or 0.60% of the Riparian Reserves in the watershed are potentially affected by the Project (appendix F.4, table 2-65). Following construction, replanting with native species would facilitate reestablishment of vegetation communities. Large woody debris and boulders from the Project ROW would be returned to disturbed riparian areas. Revegetation on 12.6 acres of Riparian Reserves in roads that would be decommissioned would help to reestablish species composition and structural diversity of plant communities in Riparian Reserves. The Project would waive application of Management Recommendations for Survey and Manage species in the watershed but would not prevent attainment of the ACS objectives because the viability of riparian-dependent survey and manage species would not be not threatened. (see appendix F.5).

Source: Appendix F.4, table 2-77

The Spencer Creek watershed is the easternmost and driest watershed where the ACS applies that is crossed by the Project in the High Cascades Province. It is also a Tier 1 Key Watershed in the NWFP. Stream densities are much lower than watersheds west of the Cascade crest. Precipitation patterns show a strong declining gradient from 40 inches a year on the crest of the Cascades to less than 12 inches where Spencer Creek flows into the Klamath River. The pumice soils in the watershed have high infiltration rates and rarely exhibit overland flows and mass wasting events that influence riparian and aquatic resources in other watersheds crossed by the Project. By locating the Project adjacent to the Clover Creek Road for much of its length, impacts on wetlands and stream channels have been minimized when compared to the impacts of creating a new corridor.

Pacific Connector has modified the Project to respond to the ACS objectives and has incorporated measures consistent with the Riparian Reserve Standards and Guidelines. The assessment demonstrates that short-term impacts would occur to streambanks, and substrates at the site scale. Change in vegetative condition from clearing the Project ROW is a long-term impact that would occur on 8.63 acres of Riparian Reserves. These impacts, however, are well within the range of natural variability given the disturbance processes that function in the watershed (see appendix F.4, p. 2-176-181, table 2-70). Also, because of the linear characteristic of the Project, the Riparian Reserve crossings would be spread out across the landscape.

Off-site mitigation measures, identified by the Forest Service, would supplement on-site minimization, mitigation, and restoration actions. These proposed off-site mitigation measures are responsive to recommendations in the Spencer Creek Watershed Assessment (BLM et al. 1995) and would improve watershed conditions where they are applied (appendix F.4, p. 2-186-191, table 2-73).

Three site-specific amendments of the Winema National Forest LRMP that have a nexus with the ACS are proposed to make provision for the Project (see appendix F.4, p. 2-183-186).

- Proposed amendments WNF-4 and WNF-5 would allow the Project to exceed detrimental soil conditions within the Project ROW. This would not prevent attainment of ACS objectives because soil decompaction and remediation required in Riparian Reserves is expected to effectively moderate detrimental soil conditions. Implementation of measures in the ECRP is expected to effectively control surface erosion and restore native vegetation (see section 4.3.4 of this EIS).
- Proposed amendment of the Winema National Forest LRMP to waive protection measures for Survey and Manage species would not prevent attainment of ACS objectives because the Project does not threaten the persistence of any riparian-dependent species (see appendix F.5).

The Project is otherwise consistent with Standards and Guidelines for activities in Riparian Reserves for the Winema National Forest.

The routing of the Project through NFS lands, coupled with the relatively small area of NFS land affected (0.41 percent of NFS in the fifth-field watershed), makes it highly improbable that the Project impacts could affect watershed conditions. Although there are project-level impacts (e.g., short-term sediment and long-term a change in vegetative condition at stream crossings), these would be minor in scale (see appendix F.4, table 2-77).

No Project-related impacts that would prevent attainment of ACS objectives have been identified. All relevant impacts are within the range of natural variability given the disturbance patterns and fire history of watersheds in the High Cascades Province (see appendix F.4, p. 2-176-181, table 2-70).

4.7.3.6 Resource Values and Conditions on Federal Lands: The Late Successional Reserve (LSR) System on National Forest System Lands

This section summarizes appendix F.3 (LSR Technical Report), which contains the full text of the independent Forest Service analysis. Reviewers who seek additional information should review the applicable section in appendix F.3. Section numbers that refer to sections in the appendix are so noted.

The LSR Network

The NWFP allocated a network of LSRs to conserve species of concern within the existing configuration of land ownership and the location of remaining LSOG forests within the range of the NSO (see appendix F.3 section 1.2).[154] The reserve network is embedded in a matrix of "working" forests and was designed to maintain LSOG forests in a well-distributed pattern across these federal lands (Moeur et al. 2011).

The LSR network is composed primarily of areas of large (mapped) reserves, but also includes smaller areas of "unmapped" reserves that are composed of sites occupied by marbled murrelets or are known northern spotted owl activity centers (KOAC). As presently configured the Pacific Connector pipeline would not cross any "unmapped reserves." The LSR standards and guidelines are designed to guide management activities occurring within these LSRs to protect and enhance the conditions of the LSOG forest ecosystems contained therein (Forest Service and BLM 1994b). The proposed Pacific Connector pipeline route would cross two mapped LSRs (LSR 223 on the Umpqua National Forest, and LSR 227 on the Rogue River National Forest).

LSR Standards and Guidelines

The standards and guidelines for LSRs are contained in Attachment A (pages C-9 through C-21) of the NWFP ROD. They are designed to protect and enhance conditions of LSOG forest ecosystems that serve as habitat for LSOG species. They are written to apply to specific management actions such as silviculture, range management, mining, new developments, etc., and should be interpreted in that context. The standards and guidelines that apply to new developments such as pipelines are addressed on page C-17 of the NWFP standards and guidelines. The standard on page C-17states:

> *Developments of new facilities that may adversely affect Late-Successional Reserves should not be permitted. New development proposals that address public needs or provide significant public benefits, such as powerlines, pipelines, reservoirs, recreation sites, or other public works projects would be reviewed on a case-by-case basis and may be approved when adverse impacts can be minimized and mitigated. These would be planned to have the least possible adverse impacts on Late-Successional Reserves. Developments would be located to avoid degradation of habitat and adverse impacts on identified late-successional species.*

The LSR standards and guidelines provide the framework upon which the proposed LSR mitigation actions and related plan amendments for the Pacific Connector pipeline are evaluated (see section 1.3.3 of appendix F.3). To meet this direction, the Forest Service has provided input to the applicant regarding project design. First, in routing the proposed project, LSRs have been avoided where possible. Second, where impacts to LSRs are unavoidable, on-site "Design Features" or "Project Requirements" have been developed to minimize the impacts. Third, in order to ensure that the objectives would continue to be achievable in these LSRs, land reallocations are being proposed as part of a compensatory mitigation plan. These proposed land reallocations would take non-LSR (i.e., matrix) lands and designate them as LSRs. The reallocations will require amendments of the LRMPs for the Umpqua National Forest and Rogue River National

[154] Originally the NWFP covered federal lands managed by the LM) and Forest Service within the range of the NSO. However, in August 2016, the BLM issued new Resource Management Plans that replaced the management direction for BLM lands. Therefore, the management direction in the NWFP no longer applies to BLM lands.

Forest. Fourth, off-site compensatory mitigation actions have been proposed to aid in off-setting unavoidable adverse impacts.

Project Impacts on LSRs on NFS Lands

The proposed pipeline would cross three national forests (Rogue River, Umpqua, and Winema) for a total of approximately 31 miles. The proposed project would affect mapped LSRs on the Rogue River and Umpqua National Forests. As presently configured, the proposed Pacific Connector project would not cross any LSRs on the Winema National Forest. Table 4.7.3.6-1 and figure 4.7-5 provide an overview of the number of acres that would be directly affected by the Project within LSRs on each affected unit of the Forest Service. The mapped LSR that would be crossed on the Umpqua National Forest is depicted in figure 4.7-5, and the mapped LSR that would be crossed on the Rogue River National Forest is depicted in figure 4.7-5.

TABLE 4.7.3.6-1

Direct Effects (a/) of the Proposed Project on Mapped LSRs (acres)

Forest	Cleared	Modified	Total Direct Effects
Umpqua National Forest	68	17	84
Rogue River National Forest	206	70	276
Total	**274**	**87**	**359**

a/ Direct effects include Pipeline corridor clearing, TEWAs, and UCSAs
Data source: Forest Service, GIS layers

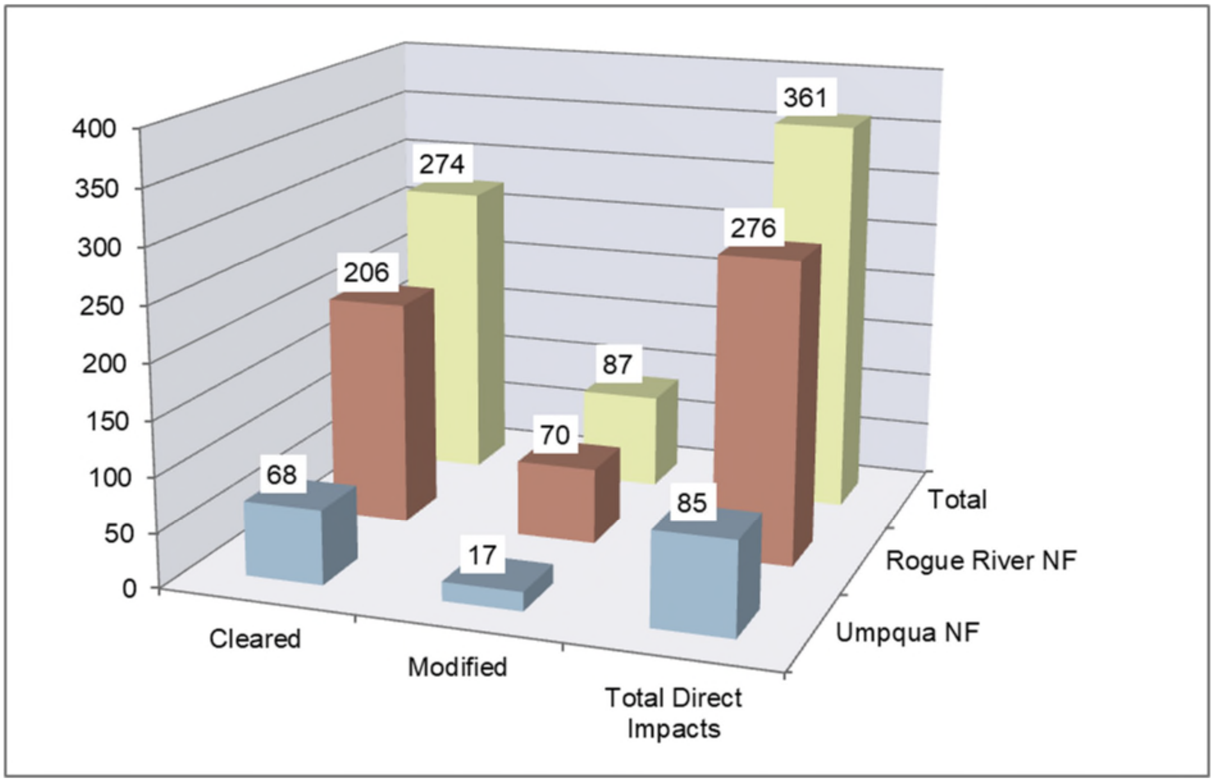


Figure 4.7-5. Direct Effects of the Proposed Project on Mapped LSRs (acres)

Direct effects would occur in the areas that would be cleared (i.e., forest vegetation would be removed) for the pipeline ROW and the TEWAs. Direct effects would also occur on acres that would be "modified" by the pipeline project. These acres include UCSAs that would not be cleared of trees during construction. These areas would be used to store forest slash, stumps, and dead and downed log materials that would be scattered across the ROW after construction, which would be considered temporary habitat modifications.

Indirect effects from construction of the pipeline are also expected within LSRs that have interior forest that the NSO rely on for nesting habitat. The conversion of large tracts of LSOG forest to small, isolated forest patches with large edge areas can create changes in microclimate, vegetation species, and predator-prey dynamics. Such edge effects–the magnitude of changes over distance from the edge to forest interior–would depend on the general orientation to the sun. Two main physical factors affecting and creating an edge microclimate are sun and wind (Forman 1995, Chen et al. 1995, Harper et al. 2005). Together, sun and wind: 1) desiccate leaves by increasing evapotranspiration; 2) influence which plant species survive and thrive along the edge, usually favoring shade-intolerant species; and 3) impact the soil, insects, and other animals along the edge. Compared to the forest interior, areas near edges receive more direct solar radiation during the day, lose more long-wave radiation at night, have lower humidity, and receive less short-wave radiation. However, such effects are dependent on such local conditions as orientation of an edge: the magnitudes of change in humidity with distance from an edge are most extreme with south-facing edges compared to east- and west-facing edges (Chen et al. 1995). These effects would vary along the pipeline route as a function of route orientation and the facing direction of each edge. Because the Pacific Connector pipeline generally trends from northwest to southeast, edge effects would be most pronounced on the southwest-facing edges and weakest along the northeast-facing edges. Fundamental changes in the microclimate (moisture, temperature, solar radiation) of a stand have been recorded greater than 700 feet from the forest edge (Chen et al. 1995).

Using recommendations from the ESA Sub-Task Group and Habitat Quality Subtask Group, indirect effects are considered to extend for 100 meters from the created edge in LSOG forest. In making their recommendation, the sub-task groups considered the study done by Karen A. Harper et al., which looked at edge influence on forest structure in fragmented landscapes (Harper et al. 2005). The study reviewed the effects caused by forest edges on multiple response variables, including: 1) forest processes of tree mortality/damage, recruitment, growth rate, canopy foliage, understory foliage, and seedling mortality, 2) forest structure by canopy trees, canopy cover, snags and logs, understory tree density, herbaceous cover, and shrub cover, and 3) stand composition by species, exotics, individual species, and species diversity. The study found that the mean distance of edge influence on any single response variable did not exceed 300 feet (100 meters). Therefore, indirect effects for the project are estimated to extend for 100 meters beyond the cleared area on each side of the corridor in LSOG forest habitat. There is no corresponding research for edge effects in younger forest stands (less than 80 years old). There is, however, research that indicates indirect effects extend out approximately two times the average tree height (Morrison et al. 2002). Based on this research, an estimate of 30 meters is used in non-LSOG forest habitat. In non-forested areas, no indirect effects are estimated since no new edge would be created. Table 4.7.3.6-2 and figure 4.7-6 provide a summary of the total number of LSR acres that would be directly and indirectly affected on Forest Service lands by the pipeline project.

The construction, operation, and maintenance of the proposed pipeline project would affect LSRs on Forest Service lands in several ways. It would remove and fragment LSOG forest habitat that some vertebrate and invertebrate species depend on. It would directly affect individuals of species listed as threatened under the ESA through removal of suitable nesting, roosting, and foraging habitat for the NSO. The indirect effects discussed above would result in the loss of interior LSOG forest habitat and increased predation (see also section 4.6 of this EIS for additional discussion).

TABLE 4.3.7.6-2

Summary of Total LSR Acres Directly and Indirectly (a/) Affected by the Proposed Project

Forest	Direct Effects	Indirect Effects	Total Effects
Umpqua	84	241	325
Rogue River	276	534	810
Total Forest Service	**360**	**775**	**1,135**

Data source: Forest Service GIS data layers
a/ Direct effects include cleared acres (corridor and TEWAs) and modified acres (UCSAs). Indirect effects include 100 meters on each side of the cleared corridor edge in LSOG, and 30 meters on each side of the cleared corridor edge in non-LSOG.

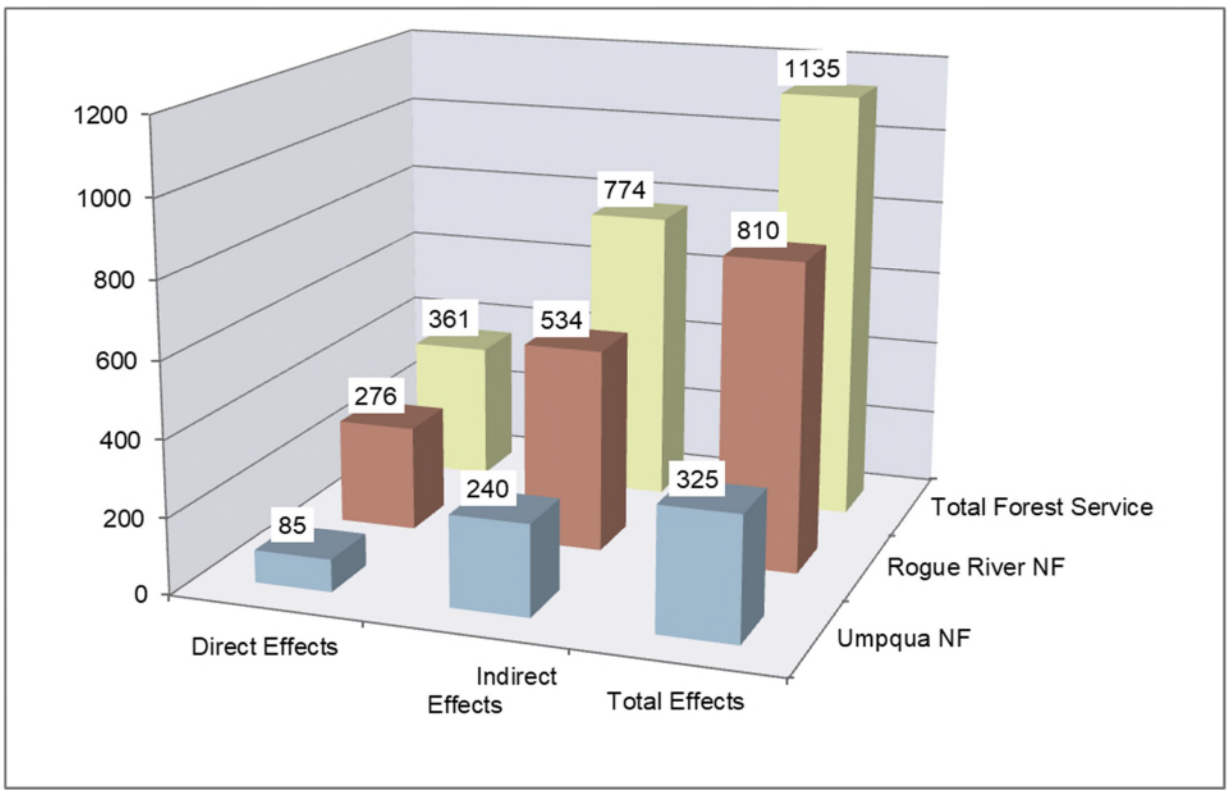


Figure 4.7-6. Summary of Total LSR Acres Directly and Indirectly Affected

The primary mitigation action for the effects of the proposed pipeline on LSRs would add acres to the LSRs. The Forest Service is proposing to accomplish this through reallocation of matrix lands to LSR. Reallocating these acres will require amendments to the Umpqua and Rogue River

National Forest LRMPs.[155] Table 4.7.3.6-3 and figure 4.7-7 display a summary comparison between the LSR acres that would be cleared by the construction of the project and the proposed reallocation of matrix lands to LSR.

TABLE 4.7.3.6-3

Comparison of Total LSR Acres Cleared (a/) by the Project and the Acres of Matrix Reallocated to LSR

	LSR Habitat Affected by Project Construction Clearing			**LSR Mitigation**
Forest	**LSOG Habitat**	**Non-LSOG Habitat**	**Total LSR Clearing**	**Matrix to LSR Reallocations**
Umpqua National Forest	20	48	68	585
Rogue River National Forest	55	151	206	522
Total	**75**	**199**	**274**	**1,107**

Data source: Forest Service GIS data layers
a/ Clearing includes acres in the project corridor and the TEWAs.

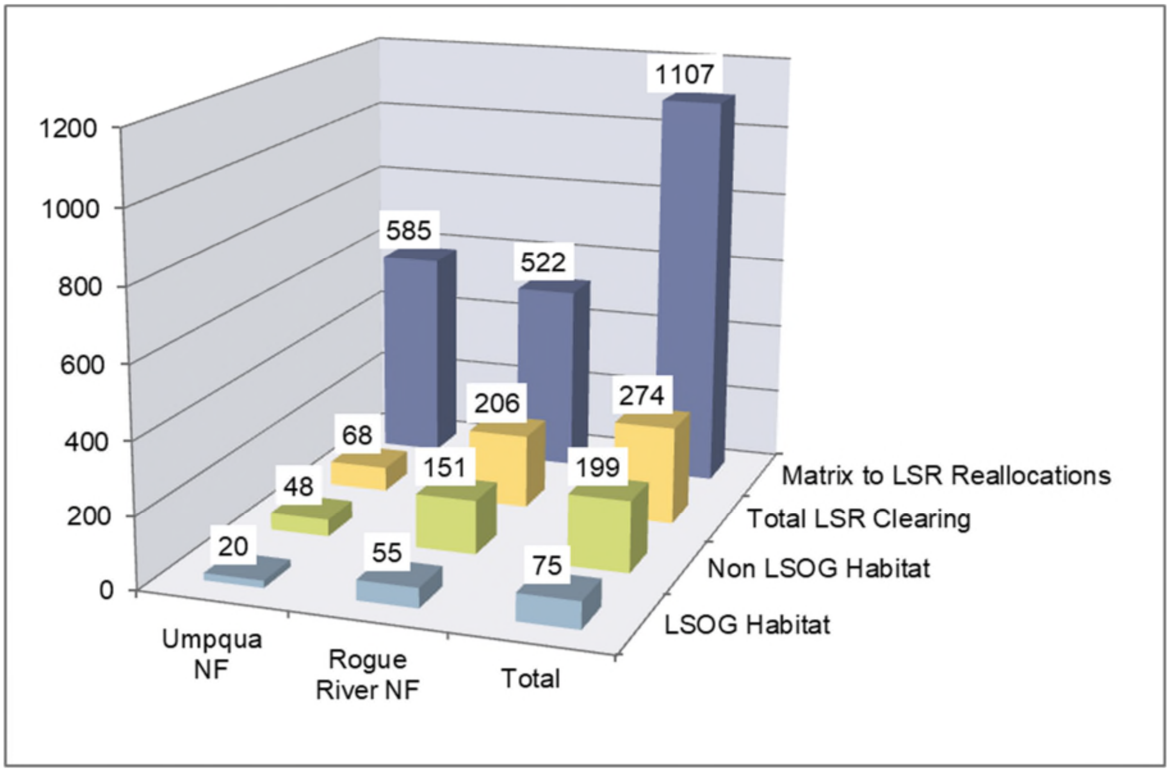


Figure 4.7-7. Comparison of Total LSR Acres Cleared by the Project and Total Acres of Matrix Reallocated to LSR

In addition to the reallocation of matrix lands to LSR, off-site mitigation would also be necessary to ensure that unavoidable adverse impacts are mitigated to meet the requirement that the overall impact would be either neutral or beneficial to the creation and maintenance of late-successional

[155] Evaluations of these proposed amendments and how they relate to the planning requirements in the Forest Service planning rule at 36 CFR 219 (2012 Version) is discussed in Section 4.7 of the DEIS and in appendix F.2.

habitat in LSRs (USDA and USDI Memorandum 2001). A Compensatory Mitigation Plan (CMP) on Forest Service lands has been developed by the agency for the project. A portion of the CMP was developed specifically to compensate for the unavoidable adverse impacts of the project on LSRs, to achieve a neutral or beneficial condition within affected LSRs, and to maintain the long-term integrity of the Forest Service land use plans for LSRs. Under the CMP, unavoidable impacts to LSOG forest habitats within LSRs on Forest Service lands would be compensated for by a set of off-site mitigation projects. These projects are discussed in the sections below (see also appendix F.3 sections 2.1 and 2.2, appendix F.2, and section 4.7.3.4 of this EIS).

Umpqua National Forest LSR 223

In the Umpqua National Forest, the construction of the project would directly affect (acres cleared plus acres modified) approximately 85 acres of LSR 223. A map of the proposed project and LSRs in the Umpqua National Forest is displayed in figure 4.7-8.

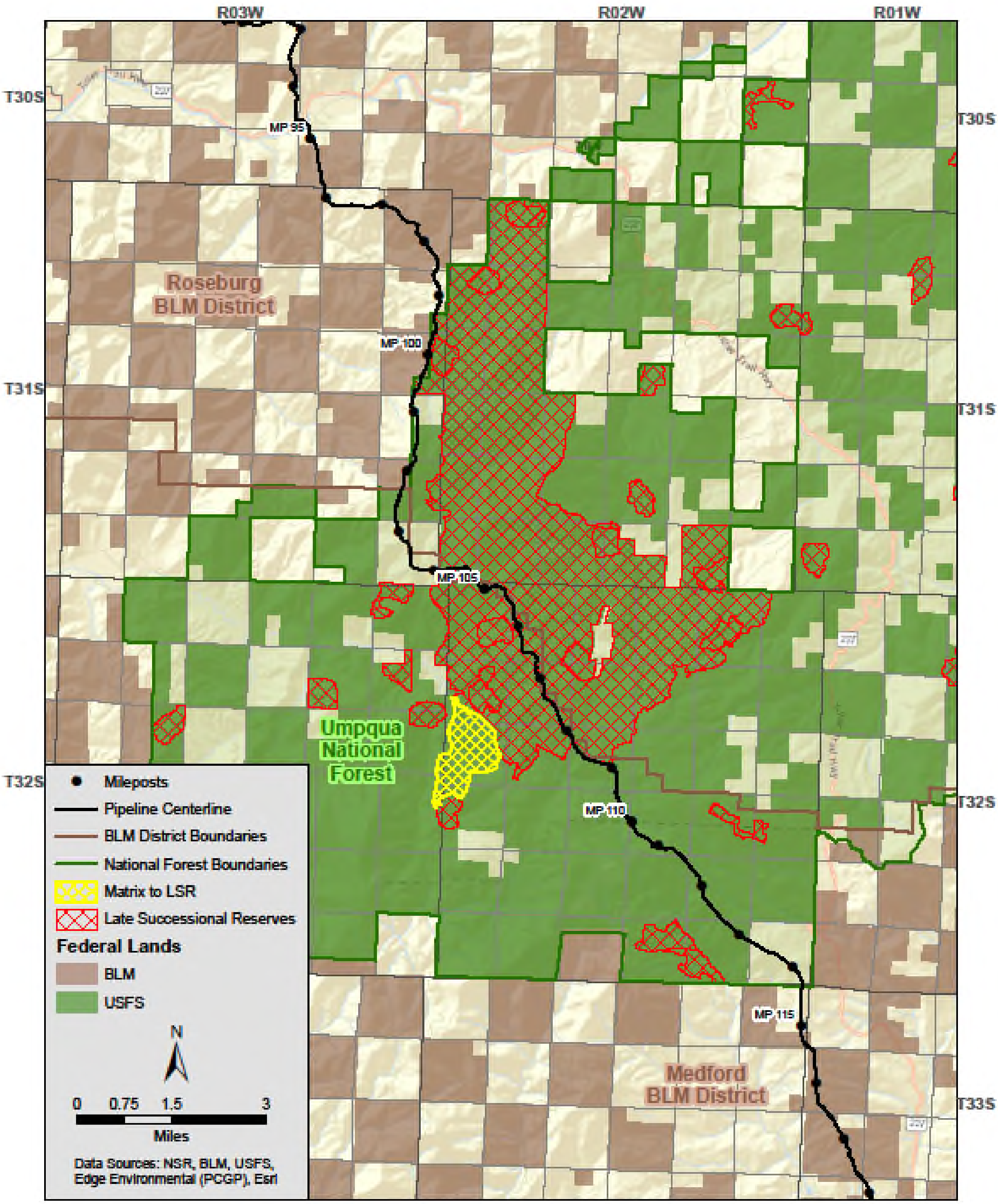


Figure 4.7-8. Map of Proposed Project and LSRs in the Umpqua National Forest

Amendment UNF-4, Reallocation of Matrix Lands to Late Successional Reserves

The Umpqua National Forest LRMP would be amended to change the designation of approximately 585 acres from the matrix land allocation to the LSR land allocation in Sections 7, 18, and 19, T.32 S., R. 2 W., Oregon; and Sections 13 and 24, T. 32 S., R. 3 W., W. M., Oregon (see figure 4.7-8). This change in land allocation is proposed to partially mitigate for the potential adverse impact of the project on LSR 223 in the Umpqua National Forest. This amendment would change future management direction for the lands reallocated from matrix to LSR.

Mitigation Actions

A compensatory mitigation plan has been developed by the Forest Service and submitted to the project applicant to ensure that the goals and objectives of the LRMP related to LSR 223 would be achieved.[156] Mitigation actions include:

- Creation of snags on 190 acres that are below desired snag densities for LSRs.
- Placing coarse woody debris (CWD) on 164 acres in units that are currently below desired levels for CWD.
- Decommissioning 5 miles of roads to reduce fragmentation and develop interior stand habitat over time.
- Thinning approximately 247 acres of overstocked stands to reduce fire risk and accelerate development of LSR characteristics.
- Integrated stand density and fuel break treatments on 898 acres in LSR 233 to restore stand density, species diversity, structural diversity and control the spread and intensity of wildfire within forested stands prone to fire activity.
- Other proposed mitigation actions in LSR 223 include 80 acres of meadow restoration, 301 acres of off-site pine removal, 6 miles of noxious weed treatments, fish passage improvement at two sites, 5 miles of road stormproofing and one water source improvement.

The off-site mitigation actions proposed are consistent with the recommendations in the Late Successional Reserve Assessment (LSRA) for LSR 223. These off-site mitigation actions would accelerate the development of LSOG forest habitat elements to further offset the effects of the project on LSR 223 in the long term. The additional off-site mitigation actions would also increase the effectiveness of the additional LSOG forest habitat added to LSR 223 by improving the quantity, quality, and distribution of high-quality habitat. Figure 4.7-9 displays a map of the proposed mitigation actions.

[156] This mitigation plan has been revised from the previous version based on the changed conditions in LSR 223 as a result of the 2015 Stouts Creek Fire (see Attachment 1 to appendix F.3).

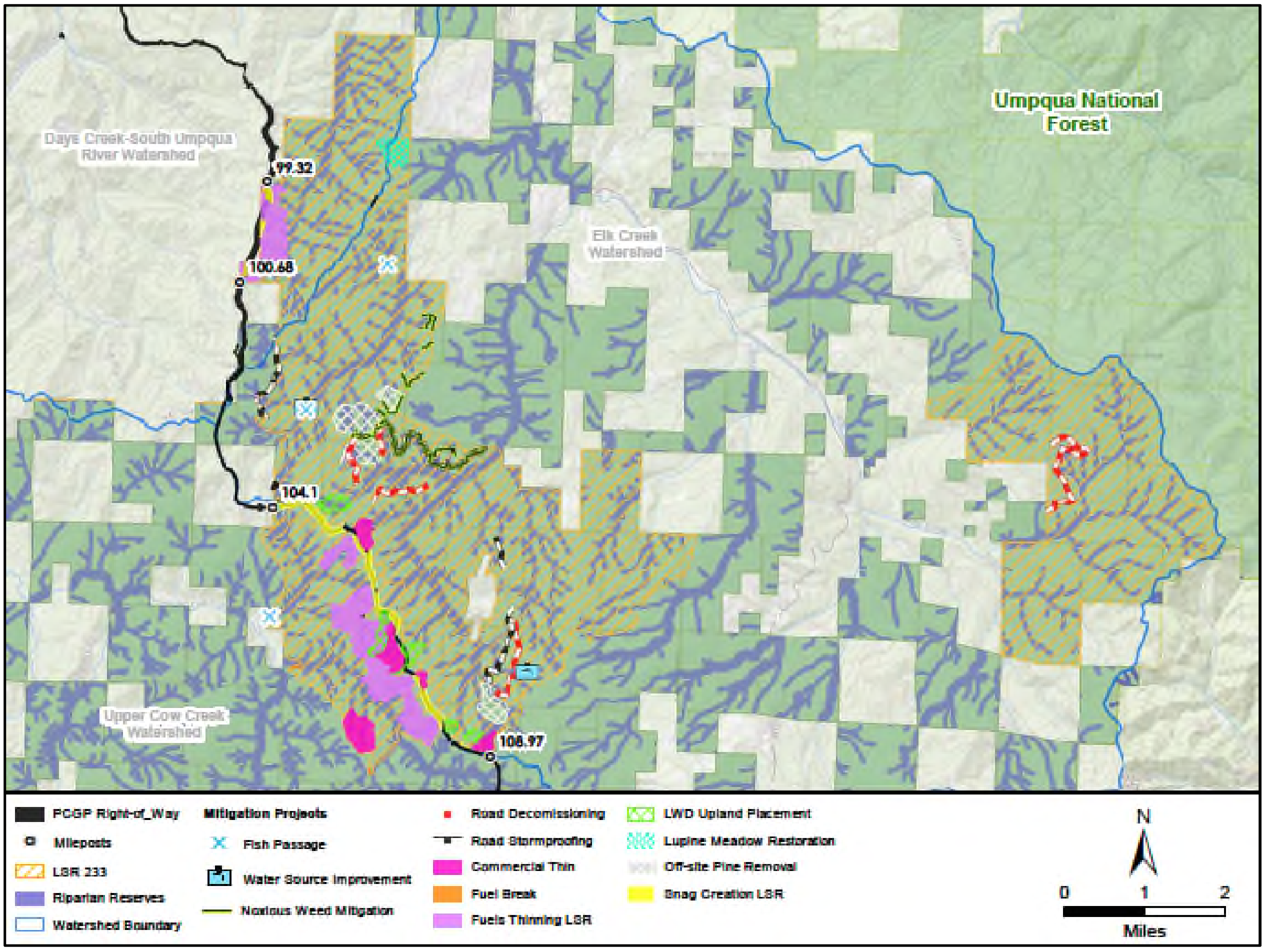


Figure 4.7-9. Proposed Off-Site Mitigation Actions in LSR 223

Assessment of Proposed Amendments and Mitigation Actions Relevant to LSR 223

The Project would clear approximately 68 acres in LSR 223, of which approximately 20 acres are LSOG forest. The area proposed to be reallocated to LSR 223 is approximately 585 acres of matrix lands, of which approximately 296 acres are LSOG forest. This change in land allocation is proposed to partially mitigate for the potential adverse impact of the Project on LSR 223 in the Umpqua National Forest. When acres reallocated from matrix lands to LSR are compared to the acres of LSR that would be cleared by the Project, the proposed amendment would reallocate over eight times more acres to LSR than would be cleared for the Project corridor. A comparison of the total acres affected in LSR 223 and the acres of reallocation are displayed in table 4.7.3.6-4 and figure 4.7-10 below.

TABLE 4.7.3.6-4

Comparison of LSR 223 Acres Affected (a/) by the Project and Acres of Matrix Reallocated to LSR

Umpqua NF LSR 223	Direct Effects: Cleared	Direct Effects: Modified	Indirect Effects	Total Effects	Matrix to LSR Reallocation
LSOG	20	6	166	192	296
Non- LSOG	48	11	74	133	289
Non-Forest	0	0	0	0	0
Total	**68**	**17**	**240**	**325**	**585**

a/ Total effects include cleared acres (corridor and TEWAs), modified acres (UCSAs), and indirect effect acres (100 meters on each side of the cleared corridor edge in LSOG and 30 meters on each side of the cleared corridor edge in non-LSOG).
Data source: USFS GIS Data Layers

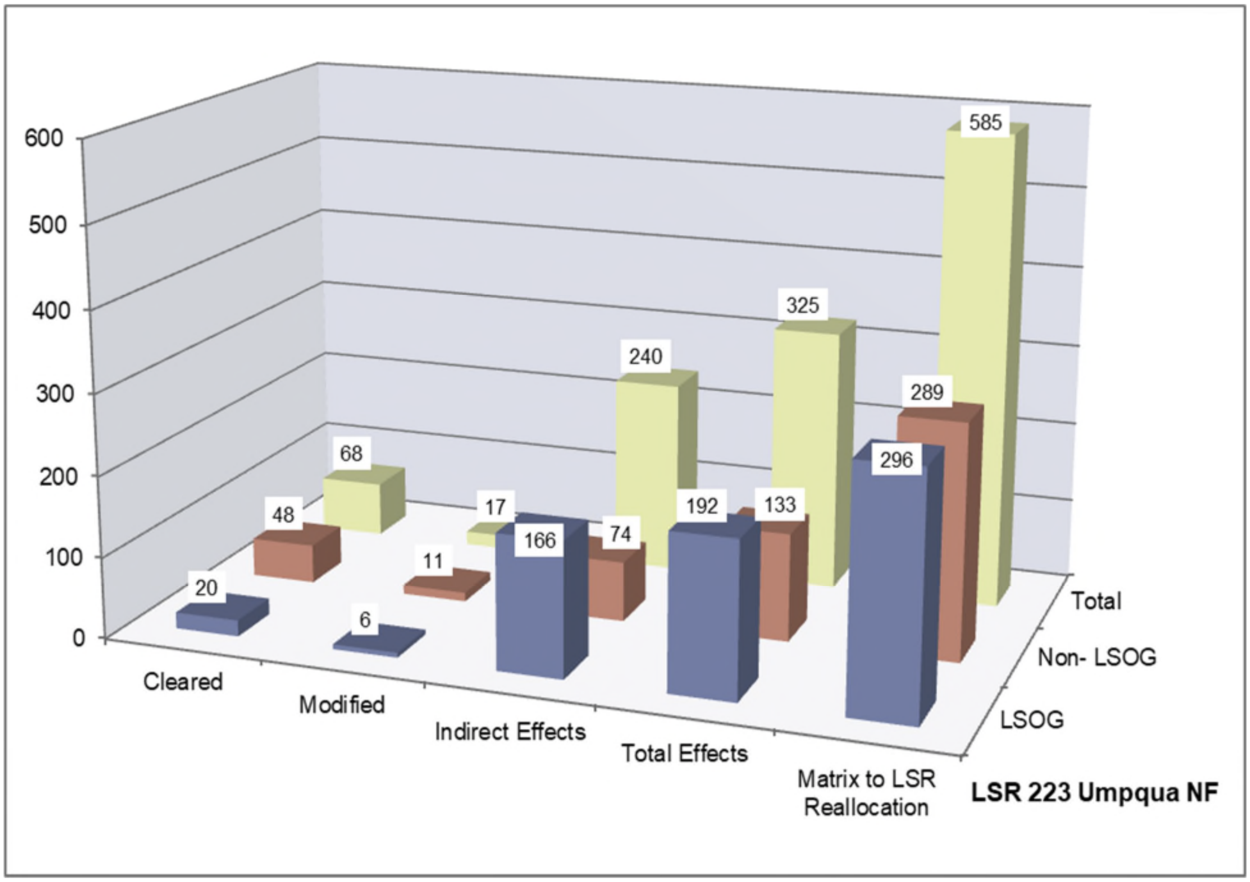


Figure 4.7-10. Comparison of Total LSR 223 Acres Affected by the Project and Acres of Matrix Reallocated to LSR

In addition to the Project impacts on LSR 223 in the Umpqua National Forest there are also potential off-site impacts to LSR 223 from road re-reconstruction that would be necessary to accommodate the trucks that would haul the sections of pipe. These trucks are longer than typical trucks that use forest roads, and some road widening and curve realignment may be necessary to safely allow for this truck traffic. Although this road widening would occur to the extent possible within the existing clearing limits, it is probable that some additional clearing of forest vegetation would be necessary to accommodate the road reconstruction. It is estimated that this would be a maximum of 2.5 acres and would occur along an existing road opening.

Assessment of Functionality of LSR 223 on the Umpqua National Forest and Consistency with LSR Standards and Guidelines

The functionality of LSR 223 relates directly to the goals and objectives for LSRs (see section 1.2 of appendix F.3) and can be measured by the quantity, quality, and distribution of LSOG forest habitat in the LSR and how the proposed project would impact these characteristics.

- Quantity: The overall quantity of LSOG habitat within LSR 223 on the Umpqua National Forest would increase with the proposed LRMP amendment. The project would remove approximately 20 acres of LSOG habitat but the reallocation would add 296 acres of LSOG habitat, for a net increase of 276 acres.

- Quality: The area proposed for reallocation to LSR 223 contains some large blocks of LSOG habitat and it would also be located immediately adjacent to two KOACs, providing further consolidation of LSOG habitat and increased protection of NSO habitat. With the reallocation of matrix to LSR and the consolidating of larger blocks of LSOG habitat, the quality of the LSOG habitat within LSR 223 would be slightly improved. There is also the benefit of the 289 acres of younger (less than 80 years old) stands in the reallocated acres being managed for future LSOG habitat, which would provide the potential for larger blocks of LSOG habitat.

- Distribution: The distribution of LSOG habitat within LSR 223 would remain largely unchanged with the proposed project and the reallocation of matrix to LSR LRMP amendment. To the extent there are minor changes, they would be beneficial due to the location of the proposed reallocation. The reallocation would occur on the southwest edge of the LSR, providing for some additional connectivity with the nearest LSRs to the south and west.

- The off-site mitigation actions would improve the quantity, quality, and distribution of LSOG habitat in LSR 223 by accelerating the development of constituent elements of late-successional habitat, reducing the risk of stand-replacement fire and reducing fragmentation through road decommissioning and stand-density management.

The project design features, the reallocations of matrix to LSR, and the off-site mitigation actions for LSR 223 in the Umpqua National Forest have been designed with the goal of making the overall impact of the Pacific Connector pipeline project either neutral or beneficial to the creation and maintenance of late-successional habitat. These actions combined would maintain or improve the functionality of LSR 223.

Rogue River National Forest LSR 227

The proposed project would cross approximately 13.7 miles of the Rogue River National Forest and, if constructed, would directly affect (corridor plus TEWAs and UCSAs) approximately 276 acres of LSR 227. The proposed project and LSR 227 in the Rogue River National Forest are displayed on figure 4.7-11.

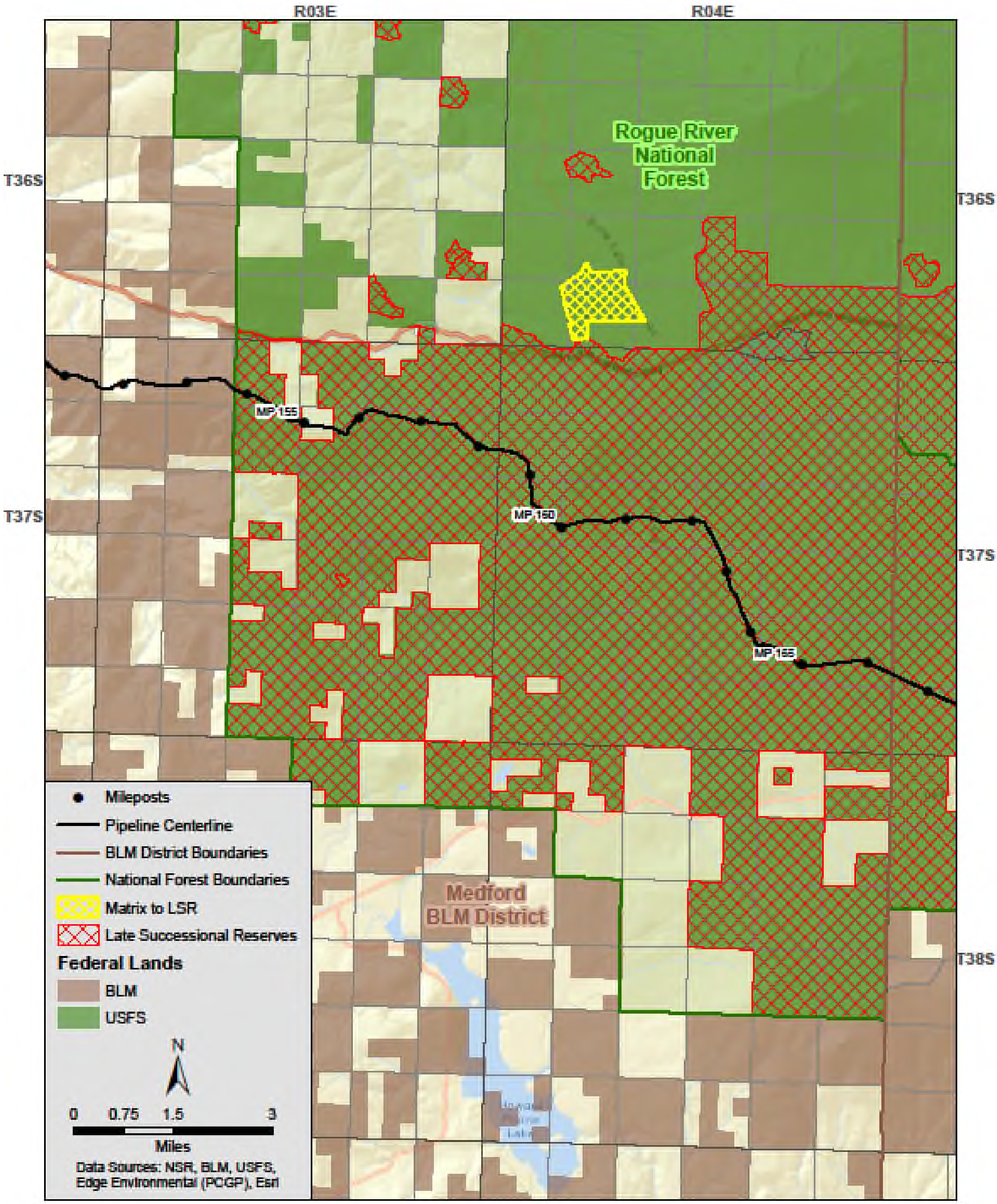


Figure 4.7-11. Map of Proposed Project and LSR in the Rogue River National Forest

Amendment RRNF-7, Reallocation of Matrix Lands to Late Successional Reserves

The Rogue River National Forest LRMP would be amended to change the designation of approximately 522 acres from the matrix land allocation to the LSR land allocation in Section 32, T.36 S., R. 4 E., W. M., Oregon (see figure 4.7-11). This change in land allocation is proposed to partially mitigate for the potential adverse impact of the project on LSR 227 in the Rogue River National Forest. The amendment would change future management direction for the lands reallocated from matrix to LSR.

Mitigation Actions

A compensatory mitigation plan has been developed by the Forest Service and submitted to the project applicant to ensure that the goals and objectives of the LRMP related to LSR 227 would be achieved (see appendix F.3 section 2.2). The lands in the Rogue River National Forest that would be affected by the proposed project are all within LSR 227. The primary objectives for the off-site mitigation actions are to accelerate the development of LSOG forest habitat in LSR 227. Mitigation actions include:

- Creation of snags on 622 acres that are below desired snag densities for LSRs.
- Placing CWD on 511 acres in units that are currently below desired levels for CWD.
- Decommissioning 57 miles of roads to reduce fragmentation and develop interior stand habitat over time.
- Thinning approximately 618 acres of overstocked stands to reduce fire risk and accelerate development of LSR characteristics.
- Other proposed mitigation actions in LSR 227 include placing large woody debris in approximately 1.4 miles of streams to improve fish habitat.

The off-site mitigation actions proposed are consistent with the recommendations in the LSRA for LSR 227. These off-site mitigation actions would accelerate the development of LSOG forest habitat elements to further offset the effects of the project on LSR 227 in the long term. The additional off-site mitigation actions would also increase the effectiveness of the additional LSOG forest habitat added to LSR 227 by improving the quantity, quality, and distribution of high-quality habitat. The proposed mitigation actions are displayed in figure 4.7-12.

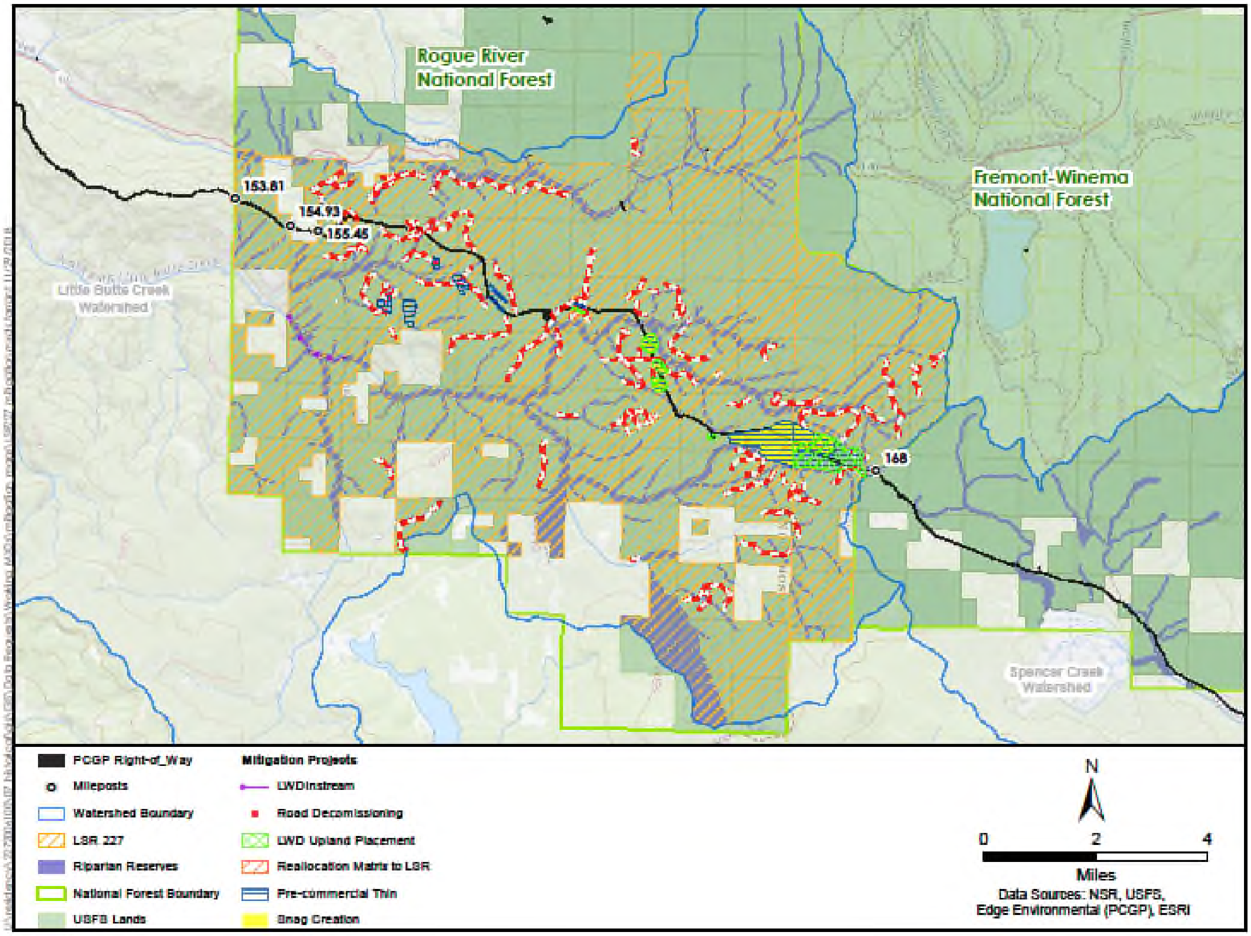


Figure 4.7-12. Proposed Off-Site Mitigation Actions in the Rogue River National Forest

Assessment of Proposed Amendments and Mitigation Actions Relevant to LSR 227

In the Rogue River National Forest, the proposed project would lie entirely within LSR 227. If constructed, the portion of the project on the Rogue River National Forest would be about 13.7 miles long and would clear approximately 206 acres of forest vegetation in LSR 227, of which approximately 55 acres are LSOG forest. The matrix area proposed for reallocation to LSR is approximately 522 acres, of which approximately 237 acres are LSOG forest (see figure 4.7-13). This change in land allocation is proposed to partially mitigate for the potential adverse impact of the project on LSR 227 in the Rogue River National Forest. When acres reallocated from matrix to LSR are compared to the acres of LSR that would be cleared by the project, the proposed amendment would reallocate about 2-1/2 more acres to LSR than would be cleared in the project corridor. When comparing acres of LSOG habitat, the proposed amendment would reallocate over 4 times more acres of LSOG habitat than would be cleared by the project. A comparison of the total acres affected in LSR 227 and the acres that would be reallocated are displayed in table 4.7.3.6-5 and figure 4.7-13 below.

TABLE 4.7.3.6-5

Comparison of Total LSR Acres Affected a/ by the Project and Acres of Matrix Reallocated to LSR

Rogue River National Forest LSR 227	Cleared	Modified	Indirect Effects	Total Effects	Matrix to LSR Reallocation
	Direct Effects				
LSOG	55	21	350	426	237
Non- LSOG	142	49	184	375	284
Non-Forest	9	0	0	9	1
Total	**206**	**70**	**534**	**810**	**522**

a/ Total effects include cleared acres (corridor and TEWAs), modified acres (UCSAs), and indirect effect acres (100 meters on each side of the cleared corridor edge in LSOG and 30 meters on each side of the cleared corridor edge in non-LSOG).
Data source: USFS GIS Data Layers

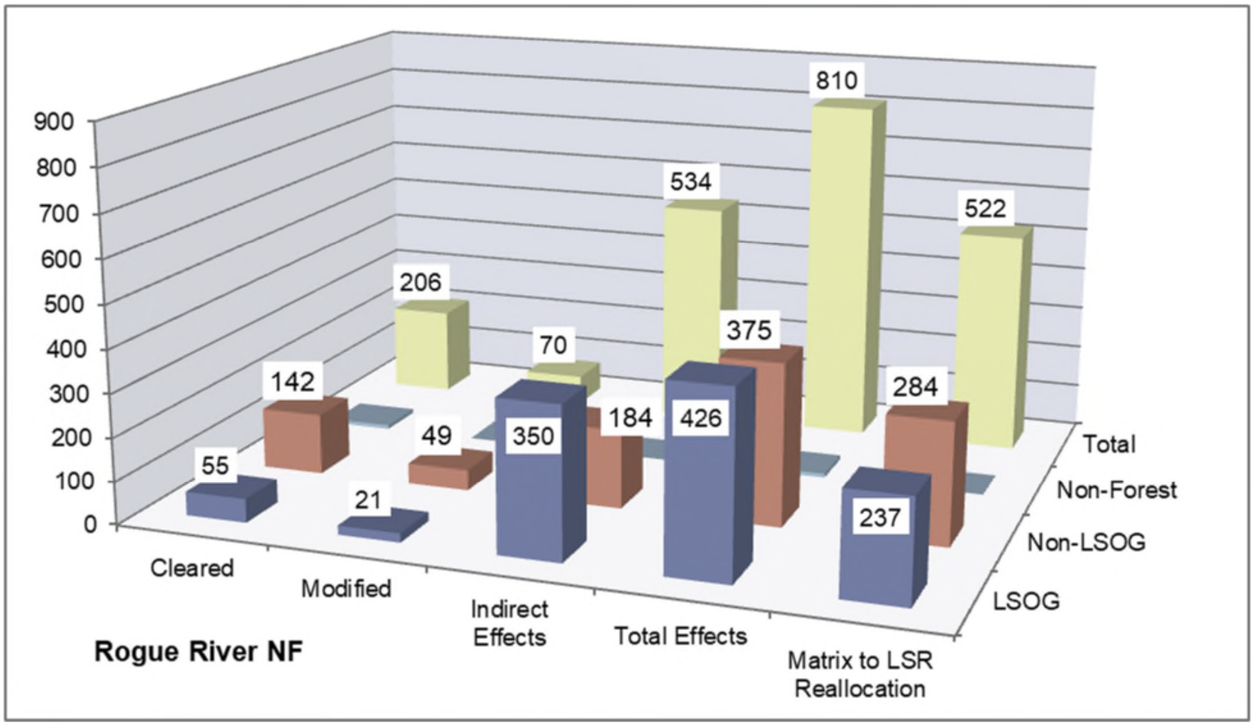


Figure 4.7-13. Comparison of Total LSR Acres Affected by the Project and Acres of Matrix Reallocated to LSR

In addition to the impacts of the pipeline corridor, there are also potential off-site impacts to LSR 227 from road reconstruction that would be necessary to accommodate the trucks that would haul the sections of pipe. These trucks are longer than typical trucks that use forest roads, and some road widening and curve realignment may be necessary to safely allow for this truck traffic. Although this road widening would occur to the extent possible within the existing clearing limits, it is probable that some additional clearing of forest vegetation would be necessary to accommodate the road reconstruction. It is estimated that this would be a maximum of four acres and would occur along an existing road opening.

Assessment of Functionality of LSR 227 on the Rogue River National Forest and Consistency with LSR Standards and Guidelines

The functionality of LSR 227 relates directly to the goals and objectives for LSRs (see section 1.2 of appendix F.3) and can be measured by the quantity, quality, and distribution of LSOG forest habitat in the LSR and how the proposed project would impact these characteristics.

- Quantity: The overall quantity of LSOG habitat within LSR 227 on the Rogue River National Forest would increase with the proposed LRMP amendment. The project would remove approximately 55 acres of LSOG habitat but the reallocation would add 237 acres of LSOG habitat for a net increase of 182 acres.

- Quality: The area proposed for reallocation to LSR 227 contains some large blocks of LSOG habitat. With the reallocation of matrix to LSR and the consolidating of larger blocks of LSOG habitat, the quality of the LSOG habitat within LSR 227 would be slightly improved. There is also the benefit of the 284 acres of younger (less than 80 years old) stands in the reallocated acres being managed for future LSOG habitat that would provide the potential for larger blocks of LSOG habitat.

- Distribution: The distribution of LSOG habitat within LSR 227 would remain largely unchanged with the proposed project and the reallocation of matrix to LSR LRMP amendment. To the extent there are minor changes, they would be beneficial due to the location of the proposed reallocation. The reallocation would occur on the north end of the LSR, providing for some additional connectivity with the nearest LSRs to the north.

- The off-site mitigation would improve the quantity, quality, and distribution of LSOG habitat in LSR 227 by accelerating the development of constituent elements of late-successional habitat, reducing the risk of stand-replacing fire, and reducing fragmentation through road decommissioning and stand-density management.

The Project design features, the reallocation of matrix to LSR, and the off-site mitigation actions for LSR 227 in the Rogue River National Forest have been designed with the goal that the overall impact of the Pacific Connector pipeline project would be either neutral or beneficial to the creation and maintenance of late-successional habitat. These actions combined would maintain or improve the functionality of LSR 227.

4.7.4 Conclusion

Constructing and operating the Project would have both temporary and permanent effects on land use. Some land uses would be permanently converted to industrial use, others (such as affected orchards, vineyards, and forests) would no longer being permitted directly over the pipeline, Other land uses would be converted to more natural conditions than they are currently (as part of the proposed Project-related mitigation sites). Based on the proposed mitigation and minimization measures the Project would not significantly affect land use.

4.8 RECREATION AND VISUAL RESOURCES

4.8.1 Recreation and Public Use Areas

4.8.1.1 Jordan Cove LNG Project

Parks and Other Recreational Use Areas

Land on the North Spit is managed and owned by several public agencies, including the COE, BLM, Forest Service, State of Oregon, and the Port, as well as private entities such as Roseburg Forest Products, D.B. Western, and Southport. The COE manages 245 acres on the Spit, including the North Jetty at the mouth of Coos Bay.

The Jordan Cove LNG Project would be located on the North Spit of Coos Bay, on private land. No recreational activities would be allowed within the facility boundaries. Parks and recreational areas in the general vicinity of the Project site are shown on figure 4.8-1 and discussed in the following sections.

BLM Coos Bay/North Spit Shorelands

The North Spit of Coos Bay is a strip of land between the Pacific Ocean and the waters of Coos Bay. This peninsula area contains both industrial and semi-wild areas. The BLM administers 1,864 acres on the Spit, with 709 acres classified as an Area of Critical Environmental Concern (ACEC) and the remainder designated as Recreation Management Areas (RMAs). BLM (2016a) designated four RMAs within the Coos Bay/North Spit area as part of the Northwestern and Coastal Oregon Record of Decision and Approved Resource Management Plan. The four RMAs are: Bastendorff Beach (a 53-acre Special Recreation Management Area [SRMA]), Coos Head (an approximately 11-acre SRMA), North Spit Boat Ramp (a 5-acre SRMA), and the North Spit Trail System (a 1,505-acre Extensive Recreation Management Area [ERMA]).[157] These SRMA and ERMA areas provide non-motorized and motorized recreation opportunities along the Pacific Coast and in the greater Coos Bay area for use by the local community and regional visitors.

The closest of these RMAs to the Jordan Cove LNG Project is the North Spit Trail System, which is approximately 300 feet from the Trans-Pacific Parkway. The BLM boat launch facility and courtesy dock, which provides access to the Coos Bay estuary and is also part of the SRMA, is approximately 0.16 mile southwest of the LNG terminal site. These four areas include designated roads and trails for OHV use. These roads are also available to hikers and equestrians. The BLM estimated that in a typical year about 2,460 OHVs and approximately 6,150 people traveled on the sand road to the North Jetty. According to the BLM, about 13,100 vehicles visited the boat dock in a single year, and about 420 boats were launched (BLM 2006b). Cross country areas in the Bastendorff Beach, Coos Head, and North Spit Trail System RMAs are available for non-motorized use only.

[157] SRMAs are defined by the BLM as administrative units where recreation opportunities and setting characteristics are recognized for their unique value, importance, and/or distinctiveness, especially as compared to other recreation areas. ERMAs are administrative units that require specific management consideration to address recreation use, demand, and/or related investments (BLM 2016a).

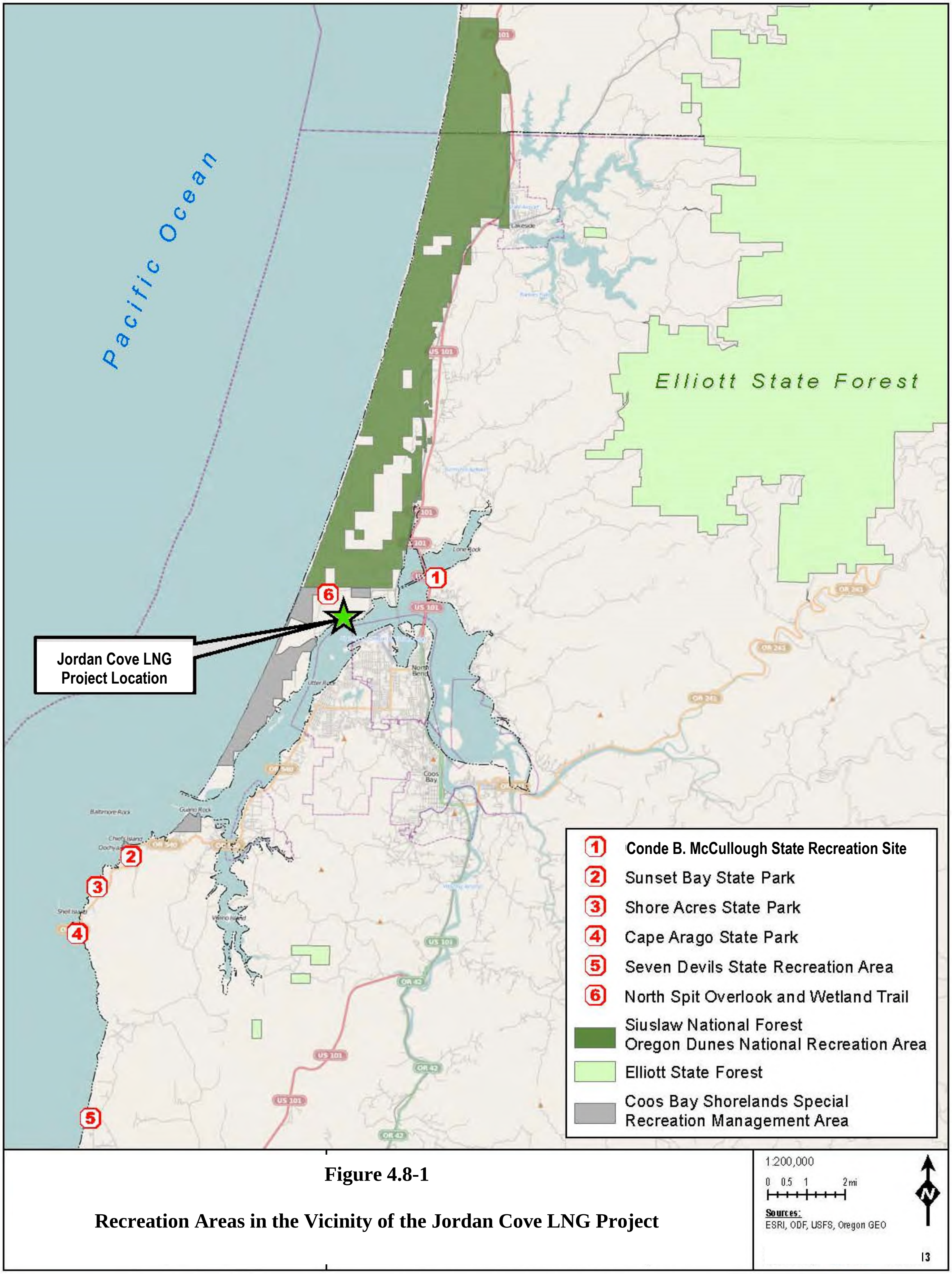


Figure 4.8-1

Recreation Areas in the Vicinity of the Jordan Cove LNG Project

Oregon Dunes National Recreation Area

The Forest Service manages the ODNRA within the Siuslaw National Forest at the north end of the Spit. The ODNRA extends approximately 45 miles along the Oregon Coast from Coos Bay north to Florence. The southern boundary of the ODNRA is about 100 feet north of the Jordan Cove LNG terminal site, across the Trans-Pacific Parkway. The Horsfall Campground is located about 0.5 mile northeast of the LNG terminal site.

The ODNRA contains the largest expanse of coastal sand dunes in North America, as well as a coastal forest and over 30 lakes and ponds. Recreational opportunities at the ODNRA include OHV use, hiking, camping, horseback riding, angling, canoeing, sailing, waterskiing, and swimming. There are approximately 34 miles of designated OHV routes open to all classes of OHVs, and roughly 135 miles of unofficial user-developed routes that are technically closed (Forest Service 2012b). The ODNRA south of Horsfall Road is closed to OHV travel, except along the beach. Day use and overnight camping facilities within the ODNRA are visited by approximately 1.0 to 1.5 million people each year (Forest Service 2009, 2012c). The Forest Service identified 1.6 million visits to the Siuslaw National Forest, including the ODNRA, in 2011, with 23.6 percent of visitors engaging in OHV use, including 18.2 percent of visitors who identified OHV use as their main activity and spent an average of 6.6 hours participating in OHV use per visit (Forest Service 2012c).

National Wildlife Refuges

Two NWRs are located near the North Bank upland wildlife habitat mitigation site (North Bank mitigation site). The 889-acre Bandon Marsh NWR is located adjacent to the North Bank mitigation site, near the mouth of the Coquille River. The lower Coquille River estuary provides important habitat for juvenile and adult anadromous fish species, including coho and Chinook salmon, steelhead, and cutthroat trout (FWS 2018c). The Oregon Islands NWR includes 1,853 rocks, reefs, and islands and extends from Tillamook, Oregon to the Oregon/California border. The refuge also protects two headlands: Coquille Point and Crook Point. Coquille Point, located approximately 5 miles from the North Bank mitigation site, provides a buffer zone between mainland development and the islands, and provides opportunities to watch seabirds and harbor seals, as well as a paved trail and interpretive panels (FWS 2018d).

State of Oregon

Pacific Ocean Beaches

The OPRD controls the Pacific Ocean beaches below the high tide mark on the west side of the Spit, while the ODSL possesses the beach land below mean low tide, including submerged lands (BLM 2005). A survey conducted on behalf of the OPRD found that the 15-mile stretch of beach along the ocean from Ten Mile Creek to the mouth of Coos Bay was visited by an average of 38 people on a weekday, and 60 people on a weekend day (Shelby and Tokarczyk 2002). The main activities of beach visitors in this area include OHV use (54 percent), relaxing (21 percent), walking (16 percent), and recreational activities with dogs (4 percent). Surfing is also a recreational activity in the ocean along the North Spit.

Oregon State Parks and Recreation Areas

Four state parks and two state recreation areas are located within 15 miles of the Project. The closest of these is the Conde B. McCullough State Recreation Site, located approximately 2.4 miles northeast across Highway 101 from the Jordan Cove LNG Project. Located along the southern shore of Haynes Inlet, this narrow shoreline recreation site is largely forested, with a small parking lot near a boat ramp at its eastern end. Only day-use recreation is permitted. The remaining five sites—the William M. Tugman, Sunset Bay, Shore Acres, and Cape Arago State Parks, and the Seven Devils State Recreation Site—are all located more than 8 miles from the Jordan Cove LNG Project. In addition, two state parks are located near the North Bank mitigation site. Bullards Beach State Park is located approximately 0.75 mile west of the North Bank mitigation site. Park facilities include campsites, a horse camp, a hiker/biker camp, and a boat ramp, and also provides access to the historic Coquille River Lighthouse (Oregon State Parks 2018). Face Rock State Scenic Viewpoint is located about 0.2 mile from the North Bank mitigation site. Amenities include picnic tables, restrooms, a viewing scope, and a stairway and trail to the beach.

Oregon State Forests

Elliott State Forest, located in the Coast Range approximately 7.8 miles to the northeast, is the closest state forest to the Jordan Cove LNG Project. Elliott State Forest is a contiguous block of land about 18 miles long (north to south), and about 16 miles wide (west to east) that encompasses approximately 93,000 acres, primarily in Coos and Douglas Counties. Although Elliott State Forest is managed primarily for timber production, recreation uses on the forest include dispersed camping, fishing, OHV use on forest roads and designated trails, horseback riding, hunting, and low amounts of hiking and mountain biking.

North Spit Overlook

The North Spit Overlook and nature trail are located about 0.5 mile west of the Jordan Cove LNG Project, on the north side of the Trans-Pacific Parkway. These facilities are maintained by Weyerhaeuser, a forest products company, to provide the public an opportunity to observe wildlife and birds in the vicinity of its former wastewater lagoon on the North Spit. Typically open to the public for nature studies, birding, walking, and photography, the gate providing access to the overlook and trails has been closed in recent years.

Coos Bay Estuary

Coos Bay estuary spreads nearly 20 square miles, offering many recreational opportunities including boating, fishing, clamming, and crabbing. The Coos Regional Trails Partnership (2004), a loose consortium of federal land management agencies and local economic development entities, developed a brochure that maps Coos Bay's water trails where canoeists and kayakers can enjoy the sloughs, bay islands, and rivers draining into the bay. The water trails closest to the LNG terminal site are approximately one mile northeast in North Slough and Haynes Inlet east of the Central Oregon and Pacific Railroad Bridge that crosses Coos Bay. A separate water trail is identified for Coos Bay east of the Highway 101 bridge. The section of Coos Bay south of the LNG terminal site is not identified as part of the water trail system (Coos Regional Trails Partnership 2004).

Oregon Coast Trail

The Oregon Coast Trail passes within 0.5 mile of the Jordan Cove LNG Project and the meteorological station site, where the trail follows Horsfall Beach Road and joins the Trans-Pacific Parkway. The Oregon Coastal Trail is a 360-mile-long hiking trail that extends south from the Columbia River to the California border. The trail was created by the Oregon Recreation Trails Advisory Council and is managed by the OPRD as part of the state park system. The trail crosses beaches, follows roads, passes through forests, and hugs coastal headlands. The majority of the trail is on the beach, but approximately 1.25 miles north of the Jordan Cove LNG Project, the trail leaves the beach at Horsfall Beach Access Road and becomes an inland trail. After heading east along Horsfall Beach Access Road, the inland trail turns east along the Trans-Pacific Parkway, and then south on U.S. Highway 101 heading into the city of North Bend. The inland trail continues through North Bend on city streets and then continues south to Charleston and then out to Sunset Bay State Park.

Oregon Coast Bike Route

The Oregon Coast Bike Route is a 370-mile-long signed bicycle route that primarily follows U.S. 101 as a shoulder bikeway and passes near the terminal, following U.S. Highway 101 through the Trans-Pacific Parkway/U.S. 101 intersection. In several areas, the route departs from the main highway and follows county roads and city streets. This occurs in North Bend, where bicyclists follow the North Bend Bypass and avoid heavy commercial and truck traffic on U.S. 101 through North Bend and Coos Bay. The bypass passes south of Pony Slough on Virginia Avenue and then turns south on Broadway Street, approximately 1.7 miles south of the Jordan Cove LNG Project. At Newmark Avenue (Cape Arago Highway), the bypass turns west and continues to South Empire Boulevard, where it continues south to Charleston, crossing the South Slough Bridge. Leaving Charleston, the bypass turns south on Seven Devils Road. In Bandon, near the North Bank mitigation site, the route runs along Riverside Drive, Ocean Drive, and Beach Loop Road through historic Old Town.

City of North Bend Parks

There are eight existing parks, one planned park, and a boat ramp in the city of North Bend. Three of these parks and the boat ramp are within 3 miles of the Jordan Cove LNG Project. Simpson Park, located approximately 1.9 miles to the southeast, is mostly forested land for day-use, low intensity recreation. Ferry Road Park, located approximately 1.9 miles to the southeast, across U.S. Highway 101 from Simpson Park and the terminal, is a developed recreation site, with a baseball diamond, a pavilion available for rent from the North Bend Parks Department, and restrooms. Winsor Park, also located approximately 1.9 miles to the southeast, on the east side of U.S. 101, is mostly forested, with an open field for recreational activities. All three parks are located close to the APCO laydown site. The California Street Boat Ramp is located approximately 2.5 miles southeast of the Jordan Cove LNG Project.

City of Coos Bay Parks

Parks operated by the City of Coos Bay Parks Department include John Topits Park, Hollering Place Wayside, Mingus Park, and a series of neighborhood pocket parks. Hollering Place Wayside and Ed Lund Park, one of the neighborhood pocket parks, are the closest of these facilities to the Jordan Cove LNG Project; both are located about 2 miles to the south. Hollering Place Wayside was the location of a pre-European village and also the site of the first European settlement in what would become Coos County. Today, the location offers water views and a place for a picnic. Ed Lund Park includes a children's play area, a large lawn, horseshoe pits, picnic tables and benches, and is the site of many community activities, including the annual Empire Clamboree.

City of Bandon Parks

Three city parks (i.e., Bandon City Park, Kronenberg County Park, and Weber’s Pier) are located approximately 3 miles southwest of the North Bank mitigation site. In addition, private recreation facilities in the vicinity of the North Bank mitigation site include three golf courses north of Bullards Beach State Park, a youth center, and an RV park.

Impacts on Parks and Other Recreational Use Areas

Increased Demand from Construction Workers

The temporary influx of non-local construction workers could potentially increase demand for recreational activities at the parks and other recreational use areas located near the Jordan Cove LNG Project. An estimated average of 802 non-local workers are expected to be employed over the 53-month-long construction phase, with the number of non-local workers expected to peak at 1,568 workers during month 30. Assuming that a portion of the workforce temporarily relocating to the area would be accompanied by family members, temporary increases in population would range from the equivalent of 3.4 percent to 6.6 percent of the combined populations of Coos Bay and North Bend in 2016 (section 4.9). A share of these workers and family members may seek recreational opportunities near the Jordan Cove LNG Project. Demand would primarily be limited to periods when workers are not employed, primarily weekend days, and would be temporary and short term. Given the large amount of public lands in the region and the relatively low levels of current use, this potential short-term increase in demand is not expected to result in significant effects on parks and other recreational areas.

Noise

Construction and operation of the Jordan Cove LNG Project could result in increases in the ambient sound environment for people recreating in the immediate vicinity, including users of the North Spit Overlook, coastal beaches, BLM RMAs, and ODNRA. Noise modeling (discussed in more detail in section 4.12 of this EIS) indicates that expected Project construction noise levels at the closest noise sensitive area (REC 1, which is located about 0.7 mile from the LNG terminal and is representative of the closest areas of federally managed lands on the North Spit) would temporarily result in noise levels increasing from ambient levels of approximately 55 A-weighted decibels (dBA)to 57 dBA.

OHVs that are allowed on the beach and dune trails contribute to the ambient noise levels on the North Spit. The noise limit for OHVs in the ODNRA is 93 dBA at 20 inches from the exhaust outlet (Forest Service 2013). For OHV riders and other people in close proximity, OHV sound levels would exceed the predicted Project's construction and operational noise levels. Distance, topography, coastal winds, and vegetation would help to minimize Project construction and operational noise in the portions of the ODNRA where OHVs are not allowed (between the Trans-Pacific Parkway and Horsfall Beach Access Road).

Recreation Access and Driving for Pleasure:

There may be some conflicts between recreational drivers on the Trans-Pacific Parkway and construction traffic traveling to and from the Jordan Cove LNG Project. Recreational drivers in this context could include recreationists using the Trans-Pacific Parkway to access recreation sites, including the ODNRA, as well as people recreating by driving for pleasure.

Traffic counts conducted in support of the Traffic Impact Analysis prepared on behalf of Jordan Cove (David Evans & Associates, Inc. [DEA] 2017b) counted a total of 232 vehicles passing through the intersection of the Trans-Pacific Parkway and Horsfall Beach Road from 4:30 p.m. to 6:30 p.m. on a Friday afternoon in August 2015. DEA (2017b) estimates that the number of vehicles traveling to and from the Jordan Cove LNG Project would peak in 2021, with 945 workers driving to the site in two staggered shifts each day, and 140 long haul truck trips each day to and from U.S. 101 via the Trans-Pacific Parkway to the site/north laydown yard, and 2 long haul trips each day to and from U.S. 101 via Ferry Road to the south laydown yard. DEA (2017b) assumed that the truck trips would occur throughout the day. Although the number of construction workers employed on-site would be higher in 2022, the number of passenger vehicles traveling to and from the terminal site would decrease with the addition of the temporary workforce housing facility on South Dunes, and external park and ride lots. The addition of construction-related traffic could cause potential delays at key intersections as discussed in section 4.10 during peak hours. Mitigation measures, also discussed in section 4.10, are expected to reduce potential effects, and recreationists could avoid delays by traveling outside of peak commuting hours. Mitigation would likely include staggered work shifts, construction of a dedicated eastbound left-turn lane at the intersection of U.S. 101 at the Trans-Pacific Parkway, and implementation of a temporary signal at the intersection for the duration of construction activities (see section 4.10).

Hunting

Hunting activities are managed by the ODFW. Big game, waterfowl, and fur-bearing animals are hunted in the public areas of the North Spit and within the Siuslaw National Forest during hunting seasons. The influx of Jordan Cove workers to the area could add to the number of people who would hunt on public lands in the region during hunting seasons. However, this potential increase would be temporary and short term. The total construction period would be about 53 months and most construction jobs would last for less than two years. As noted with respect to overall project-related demand for recreation, workers temporarily relocating to the area would have limited time available to hunt, primarily weekend days.

Clamming and Crabbing in Coos Bay

Recreational clamming and crabbing activities occur in Coos Bay near the Jordan Cove LNG Project. Coos Bay was the third most productive clamming estuary in Oregon as of 2008 and an annual average of 15,000 crabbing trips took place between 2008 and 2011 (Ainsworth and Vance 2009; Ainsworth et al. 2012). Sites for clamming include the mud flats on the bay side of the North Spit, the northern reaches of South Slough, in Haynes Inlet and the eastern side of the bay north of the McCullough Bridge. Crabbing takes place from the docks in Charleston and Empire, from boats, and on the bay side of the North Spit.

Dredging in the bay to create the access channel for the Jordan Cove LNG Project could potentially affect recreational clamming and crabbing. Potential effects related to dredging are assessed in section 4.3.2.1 of this EIS, which concludes that dredging of the access channel would only have temporary effects on bay water quality, and increased sedimentation from dredging would be limited in extent. The limited time and extent of dredging siltation is not expected to result in long-term or population wide effects on clams and crabs near the Jordan Cove LNG Project. Further, as mitigation for wetland effects, Jordan Cove would create new eelgrass beds in Coos Bay that could serve as nursery habitat for crabs and Jordan Cove would also create new wetlands at Kentuck Slough.

Wakes from LNG carriers in the Federal Navigation Channel are not expected to cause major shoreline erosion beyond natural waves. Further, due to the relatively low transit speed and the required minimum underkeel clearance distance, propeller wash from LNG carriers is not expected to greatly disturb the channel bottom or affect clam and crab harvest in Coos Bay (see section 4.3.2.1).

Recreational clamming and crabbing that takes place outside the navigation channel would not be directly affected by LNG carrier traffic transiting the waterway to and from the LNG terminal. Effects would be similar to those presently experienced during the passage of other deep-draft ships. However, if crabbing or clamming activities were to occur within the established security zones, those activities may be required to cease, with attending vessels required to temporarily move out of the security zone while the LNG carrier in transit moves by. The requirement for any commercial or recreational boat operating within the security zone near the channel, but not impeding the safe navigation of the LNG carrier in the channel, to move and vacate the security zone area would be up to the Coast Guard on-scene commander and decided on a case-by-case basis. The Coast Guard has informed Jordan Cove that the degree of security zone enforcement would be based on the threat level in effect at the time and the specific perceived threat of any vessel in the security zone. Crab pots outside of the navigation channel should not be affected by LNG carrier traffic in the waterway. Passive equipment, such as crab pots, would be permitted to remain within the security zone while an LNG carrier is present.

Boating and Fishing

Data collected by the Oregon State Marine Board (OSMB) identified approximately 105,000 boat-use days in Coos County in 2013 (Lesser et al. 2014). The data did not identify the share of these trips that originated in Coos Bay, but information collected as part of a similar survey in 2007 indicated that recreational boaters took a total of 31,552 boat trips in Coos Bay for a total of 35,950 activity days. Fishing accounted for 91 percent of these days, sailing for 8 percent, and recreational cruising for 1 percent (OSMB 2008). Sixty-eight percent of the boating activities in Coos Bay in 2007 originated from the Charleston Marina and the Empire ramp, 19 percent at the California Street boat ramp, and 4 percent at the North Spit ramps. Charleston Marina, the Empire ramp, and North Spit ramp are located approximately 7.3 miles, 3.3 miles, and 2.1 miles southwest of the Jordan Cove LNG Project; the California Street boat ramp is about 2.5 miles southeast.

Popular fish species caught by recreational anglers out of Coos Bay include Coho and Chinook salmon. Other recreational catch species include various species of perch, rockfish, flatfish, sturgeon, Pacific herring, and California halibut. Much of the recreational angling for salmon in Coos Bay occurs in late summer and fall. Bank angler access on the North Spit is limited. Boat angling occurs throughout the bay, but angling is limited in some areas at times by exposure to winds.

Jordan Cove proposes to construct the slip and LNG carrier berth structures while the slip is kept isolated from Coos Bay by an earthen berm. The excavation and dredging of the slip would occur in isolation from the bay, with no restrictions placed on recreational boating in the construction site area. Recreational boating would, however, be discouraged around the construction area during the final phase in the slip construction, which would involve removing the earthen berm and connecting the excavated/dredged slip area to the bay. Recreational boating would also be discouraged during excavation of the access channel. Construction would also involve dredging within Coos Bay and would include the excavation of the four submerged areas adjacent to the existing Federal Navigation Channel as part of the Navigation Reliability Improvements. Excavation and dredging activities are expected to occur during the in-water work period from October through February 15. Excavation of the berm and the four submerged areas as part of the

Navigation Reliability Improvements would occur during a single in-water work period. Dredging of the access channel is expected to occur over two in-water work periods.

The Coast Guard and OSMB would provide Notice to Mariners to avoid the affected areas during the construction period. In addition, Jordan Cove would post signs on the shoreline, at the boat ramps and marinas, and on buoys or fixed navigation aids in the bay to notify boaters of the planned construction activity and the duration of the activity. All floating and submerged dredging equipment operating in the bay would be clearly marked with day signals and light signals at night in accordance with the U.S. Inland Rules of the Road. If the signage and notices are not sufficient to prevent recreational boaters from avoiding the construction areas, some form of physical barrier, such as a continuous string of highly visible soft material floats, could be extended across the mouth of the slip or around the construction area. Construction safety inspectors would also be responsible for warning any recreational boaters who enter the construction area.

Potential effects on recreational boaters during construction of the slip, access channel, and the four Navigation Reliability Improvement areas would be temporary and affect a limited area. Coos Bay is extensive (20 square miles or 12,800 acres) and recreational boating opportunities would continue to be available in other portions of the bay during construction, with existing boat ramps remaining open during construction. The construction dredging areas are limited in size and boaters could avoid these areas by moving to the south and east side of the bay.

During construction of the Project, Jordan Cove would have large pieces of equipment brought in via water transport, using the existing Federal Navigation Channel. Jordan Cove anticipates that the terminal would receive approximately 70 water deliveries over a 2-year period. Deliveries would be via a mix of ocean-going vessels and barges. In addition, during construction of the access channel about two barges per day would transport dredged materials from Ingram Yard to the Kentuck project site. The addition of these vessels is not expected to have adverse effects on other bay users, including recreational boaters.

During operation of the Project, recreational boaters would have to avoid LNG carriers in transit within the waterway. Jordan Cove anticipates that up to 120 LNG carriers would visit the LNG terminal each year. Recreational boaters using the bay at the same time that an LNG carrier is in transit within the waterway may encounter delays due to the moving security zone requirements around an LNG carrier, as specified in Jordan Cove's Waterway Suitability Assessment (WSA) and the Coast Guard's Waterway Suitability Report (WSR) and LOR. Jordan Cove estimated that it may take an LNG carrier up to 90 minutes to transit the waterway from the buoy to the terminal at speeds between 4 and 10 knots. Pilots guiding commercial ships in the Federal Navigation Channel currently encounter approximately six recreational boats during the transit into and out of the Port. These numbers are typically lower in winter and on weekdays than during the summer and on weekends. The Coast Guard and OSMB would continue to remind boaters of their obligation not to impede deep draft ships, regardless of the cargo. LNG carriers may take up to 30 minutes to pass resulting in limited potential delays to recreational boaters.

Other Public and Special Use Areas:

The LNG terminal would be approximately 0.9 mile from the Southwest Oregon Regional Airport. Potential effects of the LNG terminal on the airport are addressed in section 4.10.

4.8.1.2 Pacific Connector Pipeline Project

Parks and Recreational Areas or Facilities on Non-Federal Lands

The pipeline route does not cross any non-federal park lands or developed recreational facilities, and construction and operation of the pipeline should not adversely affect park users. However, construction-related activities would temporarily increase traffic on local roads used to access parks, and park users may be able to hear construction noise while workers and equipment move through the area to install the pipeline. In addition, the pipeline route would cross a water trail (i.e., the Haynes Inlet Water Trail) as discussed below. The following sections discuss parks and recreational areas or facilities in the vicinity of the pipeline project.

<u>Oregon State Lands</u>

Oregon Coast Trail

The Oregon Coast Trail is discussed above in section 4.8.1.1. The pipeline route would be within one-quarter mile of the trail where it follows Horsfall Beach road and joins the Trans-Pacific Parkway. Recreational users of the Oregon Coast Trail would be exposed to pipeline construction traffic along the Trans-Pacific Parkway, which is the only access road to the North Spit area and the Jordan Cove Meter Station. Pacific Connector proposes to reduce effects on local traffic by following the measures outlined in its *Transportation Management Plan* (see section 4.10.2). Pipeline construction activities and related traffic could be visible and audible to hikers on the Oregon Coast Trail where it joins with the Trans-Pacific Parkway, but these effects would be temporary, lasting only the duration of pipeline installation in this area. Further, this area is adjacent to a large-scale industrial facility (Roseburg Forest Products), a railroad, and a road. As a result, pipeline construction is not expected to significantly affect trail use or trail user experience.

Coos Bay Estuary

Coos Bay is used for recreational boating, canoeing, kayaking, angling, clamming, and crabbing. As noted above, the Coos Regional Trails Partnership, a consortium of land management agencies and economic development groups, have mapped Coos Bay's water trails for kayakers and other paddlers (Coos Regional Trails Partnership 2004). Portions of one water trail – the Coos Bay Trail – would be crossed by the pipeline alignment. The Coos Bay Trail begins at the California Avenue Boat Ramp, near the south end of the McCullough Bridge (i.e. U.S. Highway 101). The trail heads south through Coos Bay, along the western banks. The pipeline would cross this water trail using trenchless HDD crossing methods at about MP 1.50, with the proposed HDD continuing up into Kentuck Inlet to approximately MP 3.0, where it would end in uplands.

Potential effects on boaters using these areas during or after construction would be limited due to the use of HDD as boating in the vicinity of the HDD path would be allowed to continue during the drilling. HDD operations and pipe stringing would occur in uplands for both the Jordan Cove to North Point HDD, and for the HDD crossing from North Point to Kentuck Inlet. The HDD pipe string would be staged in uplands north of Jordan Cove for the Jordan Cove to North Point HDD, and the pipe string for the North Point to Kentuck Inlet crossing would be staged east of Kentuck Inlet and pulled to the west underneath the bay.

Klamath Wildlife Area

The Klamath Wildlife Area is managed by ODFW to provide habitat for wintering and nesting waterfowl, upland game birds, and a variety of other wildlife. Bald eagles, white pelicans, and ospreys are among the bird species that are present in this area during certain times of the year. The Miller Island Unit, along the Klamath River south of West Klamath, also serves as a recreation spot for fishing, hunting, and boating (ODFW 2017i). The pipeline right-of-way passes within 0.1 mile along the north side of the Miller Island Unit near MP 199.15, but is separated from the Unit by the Klamath River and other industrial areas. Construction in this area would be limited to the ODFW-recommended work period of July 1 through January 31 to avoid affecting wildlife populations supported by the area.

State Parks

There are no Oregon State Parks within 1 mile of the pipeline. Some USGS maps show Camas Mountain State Park near MP 51.7 in Douglas County. However, OPRD records do not show that there is, or historically has been, a state park or any state land ownership at this location (Teal 2006).

County Lands

There are nine county parks located near the pipeline route. Five of these parks are located in Coos County and include three parks accessed by the Coos Bay Wagon Road: Middle Creek Park, Ham Bunch-Cherry Creek Park, and Frona County Park. Middle Creek Park lies approximately 0.5 mile west of the pipeline alignment at about MP 27.5. Middle Creek is an unimproved, day use park. Ham Bunch-Cherry Creek Park, with about eight primitive campsites and fishing on Cherry Creek, is located about 1 mile northwest of the pipeline alignment at MP 28.5. Frona County Park, which offers a primitive group campground and fishing area along the East Fork of the Coquille River, is less than 0.5 mile northwest of the pipeline alignment at MP 29.9 (Coos Bay Net 2006; Coos County Park and Recreation 2006).

The other two parks in Coos County are Rock Prairie County Park and Laverne County Park. Rock Prairie County Park is an unimproved, day use park, located approximately 1.5 miles southwest of the pipeline, near MP 23.26. Laverne County Park is a 350-acre park located approximately 2.5 miles southeast of MP 22. Located on the North Fork Coquille River, Laverne County Park includes 76 campsites (46 RV sites and 30 tent sites), as well as a picnic area, large group area, softball field, playground, and other amenities. Construction is not anticipated to affect park use or associated recreational opportunities.

There are three county parks near the pipeline route in Douglas County: Ben Irving Reservoir, North Myrtle Park, and the Carl C. Hill Wayside. Ben Irving Reservoir, located about 1.5 miles south of the pipeline alignment near the town of Tenmile and State Highway 42 (near MP 55.8), is a large man-made water body used for fishing, boating, and other water related recreation. The day use park has a picnic site and boat launch. The reservoir could be a source of water for pipeline hydrostatic testing (see section 4.3). Project water use would be allowed by the reservoir owner and is not expected to significantly draw down the reservoir or affect boating or other day-use activities. North Myrtle Park is located approximately 1.5 miles north of MP 79 on County Road 15 (North Myrtle Road). This park is a day use park, with a ball field and picnic area. The pipeline would cross the access road to this park. Near Milo, the Carl C. Hill Wayside provides a picnic area and fishing along the South Umpqua River. This day use area is approximately 0.7 mile southwest of the pipeline alignment at MP 94.7, where the pipeline route crosses the South Umpqua River.

In Jackson County, Rogue Elk Country Park provides camping, hiking, and picnicking opportunities. This park is located west on State Highway (SH) 62 (Crater Lake Highway), approximately 2 miles west of the town of Trail. The park, at its closest point, is approximately 0.64 mile from the pipeline. No construction traffic or other related indirect effects are anticipated for park visitors because construction access to the pipeline would be via other roadways.

Although construction-related activities would temporarily increase traffic on local roads used to access the above parks, the five relatively remote county parks (Middle Creek, Ham Bunch-Cherry Creek, Frona, Ben Irving Reservoir, North Myrtle, and Rogue Elk Country) would not be directly affected by construction and operation. The Carl C. Hill Wayside picnic area may experience increased construction traffic and noise due to its proximity to SH 227 and the presence of a large pipe laydown and staging yard. Park visitors would also be able to hear construction activities upriver. The proposed diverted open cut of the South Umpqua River is, however, scheduled to coincide with the low water season of late summer/early fall to minimize effects on boaters and anglers in the area.

Other Non-Federal Public Recreation Areas

Keno Recreation Area

Pacific Power's Keno Recreation Area consists of a developed campground, boat launch, and picnic area along the Keno Reservoir of the Klamath River. Fishing and water sports are common activities at this recreation site near the town of Keno. The pipeline alignment passes less than 0.5 mile north of the reservoir where it would be adjacent to an existing powerline corridor. Recreation and access to the Keno Recreation Area would not be affected by construction and operation activities. While the Keno Reservoir could be a source of water for pipeline hydrostatic testing, this potential use is not expected to significantly draw down the reservoir or affect boating or other day-use activities. Hydrostatic testing is more fully discussed in section 4.3.2.

OHV Controls and Limited Access to the Right-of-Way

Comments received during public scoping expressed concern with the potential for an increase in OHV use where the pipeline right-of-way could create new access points. There was also concern about the effectiveness of control methods proposed by Pacific Connector. The pipeline right-of-way could increase unauthorized OHV, snowmobile, and dispersed motorized access and associated resource access. Pacific Connector's *Recreation Management Plan*[158] describes measures to be employed on both public and private lands to control unauthorized OHV use. Pacific Connector's plan indicates that they would assess the need for OHV control measures primarily where the pipeline right-of-way would intersect roads, OHV trails, or other trails. Various natural and constructed control measures would be installed at appropriate locations in coordination with the appropriate land management agencies or landowner. Potential locations identified by Pacific Connector include the PCT area, the Camel Hump and Obenchain Road areas, Dead Indian Memorial Highway, Forest Road 700, and Clover Creek Road. OHV control measures could include:

- dirt or rock berms, sometimes coupled with erosion control devices;

[158] Appendix S to Pacific Connector's POD filed with the FERC in January 2018.

- strategically placed non-merchantable logs, slash, or tree stumps;
- large rocks or boulders partly buried along the right-of-way;
- signs;
- fencing and locked gates; and
- vegetative screening to disguise the existence of the right-of-way.

Where necessary, OHV control structures would extend out beyond the right-of-way to prevent "drive-around" and would be built at an appropriate height to prevent passage.

Pacific Connector would coordinate with landowners during construction and restoration to finalize site-specific OHV control measures. In addition, following construction, the effectiveness of the site-specific measures would be assessed on a periodic basis, generally in conjunction with revegetation monitoring and in response to identified problems. Pacific Connector would be responsible for monitoring and managing unauthorized OHV use during the full life of the pipeline project and would implement additional measures as necessary.

Federal Parks, Recreation Areas, and Other National Designations

As discussed throughout this EIS, portions of the Pacific Connector pipeline route would cross through parts of three National Forests (Umpqua, Rogue River-Siskiyou, and Fremont-Winema) and four BLM Districts (Coos Bay, Roseburg, Medford, and Lakeview). The proposed route for the Pacific Connector pipeline would not cross any national parks, national monuments, national landmarks, wilderness areas, wildlife preserves, wild and scenic river segments, or reservoirs. The route would, however, cross several federally designated scenic byways, rivers on the national inventory, and national trails, as discussed below. The route would also cross two ERMAs, also discussed below.

National Parks and Monuments

The closest national park to the Pacific Connector pipeline is Crater Lake National Park, located approximately 26 miles northeast of MP 132. The Cascade-Siskiyou National Monument is the closest monument to the pipeline at approximately 10 miles southwest of MP 175. Because of their distance from the pipeline route, no national parks or monuments would be directly affected by the Pacific Connector Pipeline Project. However, indirect effects may include air quality effects on Class I areas (see section 4.12.1), and construction traffic on roads leading to the parks and monuments.

National Scenic Byways

Three National Scenic Byways would be crossed by the Pacific Connector pipeline: the Pacific Coast Scenic Byway (U.S. Highway 101); the Rogue-Umpqua Scenic Byway (State Highway 62); and the Volcanic Legacy Scenic Byway (U.S. Highway 97). Generally, installation of a pipeline across a road may have direct effects through a temporary halt to traffic, and removal of vegetation which may affect visual quality. However, in the case of these three National Scenic Byways, as discussed below, the highways would remain open during pipeline construction and no vegetation would be removed in the vicinity of the crossings.

Following Highway 101 south from Astoria to Brookings, many locations along the Pacific Coast Scenic Byway offer views of the Oregon coast. The pipeline would be installed by conventional construction methods underneath U.S. Highway 101 (at Conde B. McCullough Memorial Bridge) between approximately MPs 1.22 and 1.23 because the highway is elevated at this location. Pipeline construction activities would be staged within existing construction storage yards on both the west and east sides of the highway and would be visible on either side from the highway. There would be no surface disturbance to the highway. Construction access to the staging areas would be via surface streets at Pittum Loop and Chappell Parkway. Temporary short-term traffic interruptions may occur at the intersection of Highway 1 and Ferry Road (approximately 0.23 mile south of construction), when supplies, crews, and heavy equipment traffic are required. Potential effects would be temporary, and once completed, the pipeline would be undetectable to those traveling on U.S. Highway 101, but the right-of-way may be visible in the existing construction storage yard and an old lumber storage yard to the west of Highway 101. Given the current land use of these areas, the right-of-way feature would not be expected to be especially noticeable to those travelling the Pacific Coast Scenic Byway.

Following State Routes 138, 62, and 234, the Rogue-Umpqua Scenic Byway forms a semi-circle route through the Umpqua and Rogue National Forests between the cities of Roseburg and Gold Hill. The pipeline would cross the Rogue-Umpqua Scenic Byway approximately 0.2 mile south of the town of Trail (MP 122.6) on State Highway 62. An HDD would be used to cross under State Highway 62 and the adjacent Rogue River, from MP 122.24 to 122.67; therefore, the pipeline is not expected to affect the Rogue-Umpqua Scenic Byway. A temporary extra work area would be located immediately adjacent to the Scenic Byway, in between the highway and the Rogue River. Temporary short-term traffic interruptions may occur at the intersection of State Highway 62 when supplies, crews, and heavy equipment traffic would be required to service the HDD operations. Pacific Connector would implement traffic control measures while the HDD activities are occurring to ensure safety for the public and construction personnel. The pipeline would not be visible to travelers along the Rogue-Umpqua Scenic Byway following the completion of construction.

The Volcanic Legacy Scenic Byway provides a touring route of south-central Oregon and northeastern California. The Oregon portion of the Volcanic Legacy Scenic Byway begins on U.S. Highway 97, north of Crater Lake, circles Crater Lake, and then continues south on State Routes 62 and 140 through Klamath Falls and into California. The Pacific Connector pipeline would cross the Volcanic Legacy Scenic Byway just south of Klamath Falls (MP 199.6) near where it crosses the Klamath River. Pacific Connector proposes to use an HDD to cross under Highway 97 and the Klamath River between MPs 199 and 200. Effects would be temporary, as travelers on Highway 97 may be able to briefly glimpse pipeline construction activities off in the distance. The HDD under Highway 97 and the Klamath River would be completed within a two-month period. The Pacific Connector Pipeline Project would have no direct effects on the Volcanic Legacy Scenic Byway, and the highway would be kept open to traffic during construction. Following installation, the pipeline would not be visible to travelers using the Volcanic Legacy Scenic Byway and is, therefore, not expected to affect the scenic qualities of this byway.

National Wild and Scenic Rivers and Nationwide Rivers Inventory

Wild and Scenic Rivers

The Rogue River, which the pipeline would cross near the community of Trail, is a designated Wild and Scenic River[159] from the Crater Lake National Park boundary downstream to Prospect, approximately 20 miles north of the pipeline crossing. In addition, an 84-mile section of the Rogue River is designated as Wild and Scenic starting about 7 miles west of the city of Grants Pass and proceeding west toward the town of Gold Beach (NPS 2005). Neither of the designated Wild and Scenic River segments would be crossed or otherwise affected by the pipeline.

Indirect effects could occur if the pipeline crossing were to cause sedimentation that could run downstream and affect water quality of the federally designated Wild and Scenic River portion of the Rogue River. However, the pipeline would cross the Rogue River using an HDD, which would avoid direct effects on this river. Also, while this segment of the Rogue River was found eligible for Wild and Scenic designation by the BLM Medford District (BLM 1995f), its river-related values are only protected on BLM-managed lands (approximately one mile from the pipeline crossing). The pipeline would not cross any protected segments of the Rogue River on BLM-managed lands. The values for which the river was found eligible are not expected to be affected by the pipeline construction and operation.

National Wildlife Refuges, Natural Landmarks, and Wilderness Areas

Sky Lakes Wilderness and Mountain Lakes Wilderness

There are several federally designated Wilderness Areas in the Umpqua, Rogue River, and Fremont-Winema National Forests, but none of them would be crossed by the Pacific Connector pipeline. The pipeline does, however, pass in the general vicinity of two Wilderness Areas: the Sky Lakes Wilderness (113,590 acres), which is located in both the Fremont-Winema and Rogue River National Forests; and the Mountain Lakes Wilderness (23,071 acres), in the Fremont-Winema National Forest. The pipeline would pass approximately 3.7 miles south of the Sky Lakes Wilderness and 1.3 miles south of the Mountain Lakes Wilderness. These wildernesses would not be affected by pipeline construction or operation because of these distances and the intervening forested landscapes.

Round Top Butte National Natural Landmark

Between MPs 134.7 and 137.1 the Pacific Connector pipeline route would pass in close proximity to the east side of the Round Top Butte National Natural Landmark (NNL), which was designated an NNL on June 15, 2011. Geologically, the NNL includes a basaltic butte and volcanic plains. Biologically, the NNL encompasses a unique mixture of grasslands, ponderosa pine, white oak, and buck brush vegetation. The NNL is administered as two parcels: 747 acres managed by the BLM as a Research Natural Area (RNA), and a private preserve managed by The Nature Conservancy.

At its closest point, the pipeline would be about 0.25 mile away from the BLM boundary to the NNL. Where the pipeline would be closest to the NNL boundary, near MP 135.6, it would be located on private land through previously harvested and thinned forest. The pipeline route does

[159] Wild and scenic rivers are designated for preservation under the Wild and Scenic Rivers Act of 1968 (Public Law 90-542), which was enacted by the U.S. Congress to preserve certain rivers with outstanding natural, cultural, and/or recreational values in a free-flowing condition for the enjoyment of present and future generations.

not cross the NNL and would have no direct effects on it. Pacific Connector would minimize the spread of weeds by following its ECRP and its *Integrated Pest Management Plan*.

Klamath Basin National Wildlife Refuges

The Klamath Basin hosts a complex of six NWRs in the Klamath Falls region of Southern Oregon and Northern California. These refuges, managed by the FWS, consist of a variety of habitats including freshwater marshes, lakes, meadows, coniferous forests, sagebrush and juniper grasslands, agricultural lands, and rocky cliffs and slopes. These habitats support diverse and abundant populations of resident and migratory wildlife, with 433 species having been observed on or near the refuges. Each year the refuges serve as a migratory stopover for about 75 percent of the Pacific Flyway waterfowl, with peak fall concentrations of more than 1 million birds. The Pacific Flyway is one of four major migratory routes (Pacific, Central, Mississippi, and Atlantic flyways) used by migratory birds in North America.

The pipeline would pass approximately 3.5 miles north of the Bear Valley NWR, and approximately 3.7 miles north of the Lower Klamath NWR. Between MPs 196 and 199, the pipeline wraps around on the north side of the Klamath River. On the south side of the river, the FWS owns two small 80-acre "out parcels," which are surrounded by State of Oregon lands managed by the ODFW. The two parcels are approximately 0.8 mile to 1.2 miles south of the pipeline. Some USGS topographic maps show old Lower Klamath Refuge boundaries on lands that were withdrawn from consideration in the 1920s (Coles 2006). Pacific Connector confirmed with the FWS in June 2006 that the pipeline would not affect any lands within the Klamath Basin Refuge boundaries.

Construction and operation of the Pacific Connector Pipeline Project should have no direct effects on the Wilderness Areas, Natural Landmarks, and NWRs discussed above because the pipeline would not cross any of these areas.

<u>Inventoried Roadless Areas</u>

The pipeline route and related facilities would not be located in any Inventoried Roadless Areas (IRAs). The nearest IRA is the Brown Mountain IRA, located on the Rogue River National Forest approximately 0.6 mile north of the pipeline route at MP 162.0. On the Fremont-Winema National Forest, the West Boundary IRA is about 2.2 miles northeast of MP 172.25. Construction and operation of the Pacific Connector Pipeline Project would have no direct effects on these IRAs.

<u>National Recreational Areas and Trails</u>

BLM Coos Bay/North Spit RMAs and Forest Service ODNRA

The Pacific Connector pipeline would have no direct effects on the Coos Bay/North Spit RMAs or the ODNRA because it does not cross those areas. From MP 0.00, the pipeline would be installed using an HDD underneath Coos Bay to the southeast, away from the RMAs and ODNRA. During the HDD process, supplies, equipment and crews would need to access the LNG terminal area and the north end of the HDD area. There would be increased traffic volumes on the Trans-Pacific Parkway, which provides access to the North Spit. Travelers may experience increased traffic congestion and short delays, but these effects would be temporary and short term, and access or use of the RMA or ODNRA areas would not be precluded. The *Transportation Management*

Plan prepared by Pacific Connector[160] addresses the potential indirect effects that construction-related traffic may have on recreational users who drive on Highway 101, the Trans-Pacific Parkway, and Horsfall Beach Road to reach the RMAs and ODNRA. This is further discussed in section 4.10.

Recreational users of the Coos Bay/North Spit RMAs and the ODNRA may also be exposed to noise from pipeline construction, as well as from construction of Pacific Connector's Jordan Cove Meter Station. Potential noise effects would be temporary and short-term, and mitigated in part by distance, topography, vegetation, and ambient noise levels from other sources, including non-project related traffic on the Trans-Pacific Parkway, OHVs, and other industries on the North Spit. Noise is more fully discussed in section 4.12.2.

Pacific Crest National Scenic Trail

The Pacific Crest Trail (PCT) is a 2,650-mile-long hiking and equestrian trail stretching from the Canadian border in Washington to the Mexican border in California. With the passage of the National Trails System Act of 1968, as amended, Congress designated the PCT as one of the first scenic trails in the nation (Forest Service 1982). Thousands of hikers, horse riders, cross-country skiers, and snowshoers use the trail each year. Approximately 430 miles of the PCT runs through the Cascade Mountain Range in Oregon. The pipeline route crosses the PCT at approximately MP 167.8.

Trail users can access the trail in several locations near the pipeline route area, including a registered trailhead on the Dead Indian Memorial Highway (County Road 533). This trailhead is about 1.3 miles west of where the pipeline would cross Dead Indian Memorial Highway. The trail can also be accessed using Forest Road 700 or using the Brown Mountain trail accessed by Forest Road 3705.

Installation of the pipeline would affect PCT users for a short duration of time. Pacific Connector proposes to construct the portion of the pipeline across the trail as a "tie-in" to reduce the period when trail users are inconvenienced. Pacific Connector has indicated that it expects that construction of the trail tie-in would be completed within 48 hours or less to minimize effects and the need for trail detours. Pacific Connector has also identified site-specific mitigation measures to reduce potential effects on the PCT in its *Recreation Management Plan*. These measures include the following:

- Provide advance notice of construction to the Forest Service and PCT Association;
- Notify the Forest Service District Ranger 48 hours in advance if any anticipated delays for PCT users would exceed 1 hour;
- Provide at least 7 days advance notice if the PCT needs to be detoured;
- Obtain Forest Service approval and install detailed detour route signs (if needed);
- Plan, if practicable, for PCT disruption outside of the trail's busiest hiking season (mid-July to early August);
- Establish a roughed-in trailhead within 24 hours of crossing completion, with temporary directional signs posted at each end of the crossing;
- Restore the trail to full design standards within 2 weeks of completing the trail crossing (weather permitting);

[160] Appendix Y to Pacific Connector's POD filed with the FERC in January 2018.

- Install standard Nordic ski trail markers as needed post-construction;
- Revegetate the right-of-way using native trees, shrubs, and plants;
- Use a combination of rocks, logs, slash, and gates to deter motorized vehicles and OHVs from gaining access to the PCT, in such a manner as not to adversely affect the area's visual resource qualities, to the extent practicable.

Pacific Connector intends to use a "dog-leg" segment to avoid a perpendicular crossing of the trail and thereby reduce the visibility of the pipeline corridor to trail users (see section 4.8.2.3 for an assessment of visual resources on federal lands). To further reduce potential effects on the PCT and its users, Pacific Connector has "necked down" the construction right-of-way width from the standard 95 feet to 75 feet for approximately 300 feet on either side of the trail.

South Brown Mountain Shelter

The South Brown Mountain Shelter is a small, fully enclosed log cabin about 200 yards off the PCT in Section 32, T.37S, R.5E. The shelter, located in the Rogue River-Siskiyou National Forest near its boundary with the Fremont-Winema National Forest, is used year-round by hikers, cross-country skiers, snowmobilers, and others. The cabin contains a wood stove, primitive storage facilities, and counter spaces. Potable well water is available using a hand pump that is operational from mid-May to late October.

The South Brown Mountain Shelter is approximately 600 feet north of the pipeline route near MP 167.7; and would not be directly affected by construction or operation of the pipeline. Temporary noise from pipeline construction may be audible at the shelter, but visitors would not be able to see the pipeline or related construction activities because of the existing vegetation screening that is located between the shelter and the right-of-way. Distance, topography, and vegetation would reduce pipeline construction noise at the shelter. The effects from pipeline construction noise would be temporary and should not adversely affect users of the shelter.

Brown Mountain Trail

The Brown Mountain Trail is a path for non-motorized users on the Fremont-Winema and Rogue River-Siskiyou National Forests. The trail is linked by two short sections of forest roads and circles Brown Mountain. One access point is near the pipeline at a trailhead on Forest Road 3705, near South Fork Little Butte Creek about a mile north of MP 165.0. In addition to summer recreational activities, cross-country skiing and snowmobiling are popular winter sports along the Brown Mountain multi-use trail system between about MPs 160 and 170. The Brown Mountain Trail and access on Forest Road 3705 are not expected to be affected by pipeline construction or operation.

<u>Other Extensive Recreation Management Areas</u>

Blue Ridge Trail System ERMA.

The Blue Ridge Trail System ERMA is located within the Coos Bay District. Designated for hiking, biking, equestrian, and motorcycle trails, this 1,405-acre ERMA currently supports approximately 12 miles of trails, which connect with a larger network of logging roads that can also be utilized. Timber harvest and management operations occur in this area, with road closures occurring intermittently for logging operations. The pipeline would cross this ERMA from MP 19.92 to MP 22.11 (approximately 2.19 miles) and cross three of the Blue Ridge trails. In addition, Pacific Connector would utilize several existing roads in this ERMA for construction access.

Similar to when logging activities occur in the area, these trail segments would need to be closed during pipeline construction. Construction would also result in increased traffic volumes on existing roads and other users may experience traffic congestion and delays, with access to some trails temporarily affected. Potential construction traffic-related impacts on recreational users are discussed in Pacific Connector's *Transportation Management Plan*. Recreational users may also be exposed to noise during pipeline construction. Potential noise effects would be temporary and short-term, and partially mitigated in some locations by distance, topography, vegetation, and ambient noise levels from other sources, including OHVs. Noise is more fully discussed in section 4.12.2. After construction is complete, Pacific Connector would restore trail segments affected during construction.

In addition, Pacific Connector is proposing to use an existing communications tower located on the top of Blue Ridge, within the ERMA. Pacific Connector would use the tower during operations and Pacific Connector staff and contractors may need to access this existing location intermittently to maintain communications equipment. Impacts to other users are expected to be limited.

Buck Berry Rock ERMA

The Buck Berry Rock ERMA is located within the Medford District. Designated for non-motorized trail systems in a remote setting, this ERMA encompasses 6,504 acres, located north of the community of Trail. This ERMA is approximately 0.5 mile from the pipeline at its closest point, near MP 121 and separated from the proposed route by private lands and SH 227. Construction is not anticipated to have any impacts on this ERMA.

Green Top Mountain ERMA

The Green Top Mountain ERMA consists of 5,316 acres located within the Medford District. Designated for non-motorized trail systems, this ERMA is not located in proximity to any larger communities. This ERMA is approximately 0.3 mile from the Pipeline at its closest point, near MP 138.5. Construction is not anticipated to have any impacts on this ERMA.

Surveyor Mountain ERMA

The Surveyor Mountain ERMA consists of 17,376 acres located within the Lakeview District. This ERMA is a short distance from Klamath Falls and frequented by big game hunters, OHV users, and snowmobilers. From MPs 172 to 178, the pipeline is within one mile of the ERMA, and between MPs 176.1 and 177, the pipeline crosses the ERMA. In this area, the proposed pipeline right-of-way is co-located immediately adjacent to Clover Creek Road (County Road 603), and no new impacts are expected.

Stukel Mountain ERMA

The Stukel Mountain ERMA consists of 9,622 acres located within the Lakeview District. Located close to Klamath Falls, this ERMA attracts OHV users, hikers, and mountain bikers. The Pipeline is approximately 0.4 mile from the ERMA, near MP 212.5, and separated from the ERMA by private lands. Pipeline construction is not expected to have any impacts on this ERMA. Pacific Connector's proposed Stukel Mountain Communication Site is located at an existing communication tower complex on BLM-managed lands within the ERMA. Construction activities at or adjacent to the existing complex would be temporary and short-term lasting a few months with a small crew requiring limited equipment. Communication-related construction and operation activities would be similar to existing activities and operations at the complex with limited impacts on recreation users.

Bryant Mountain ERMA

The Bryant Mountain ERMA consists of 9,093 acres located within the Lakeview District. The Bryant Mountain ERMA has potential for an OHV trail system. The site is close to Klamath Falls and is mostly a contiguous block of BLM land. The Pipeline is approximately 0.4 mile from the ERMA, near MP 228, and separated from the ERMA by private lands. Construction is not anticipated to have any impacts on this ERMA.

<u>Federal Recreational Lakes and Reservoirs</u>

Fish Lake

Fish Lake is located on the Rogue River National Forest near the crest of the Cascades about 2.5 miles away from the pipeline route at about MP 161. The Fish Lake Recreation Area includes Forest Service campgrounds, picnic areas, and a boat ramp, as well as a privately-operated resort with cabins, a trailer park, additional camp sites, food service, and a marina. During the summer the lake supports water related activities, including fishing and boating. During the winter, ice-fishing, cross-country skiing, and snowmobiling are popular in the area. Pacific Connector has identified Fish Lake as a potential source for water that would be used for hydrostatic testing of the pipeline. Water would be potentially withdrawn from two places: one location at the lower end of the lake near the dam; and the other at the upper end of the lake in the vicinity of the Fish Lake Campground and boat ramp. No roads or recreational facilities would be closed because of the hydrostatic test water withdrawals from the lake; however, water trucks would use Forest Service Roads 2800700, 2800706, and 2800800. Use of these roads is addressed in Pacific Connector's *Transportation Management Plan*. Pacific Connector has indicated that after it has selected a construction contractor for the pipeline, it would submit a water withdrawal plan to the Forest Service that would outline measures to minimize effects on recreational users and encumbrances at the lake.

John C. Boyle Reservoir

The John C. Boyle Reservoir is operated by PacifiCorp as part of a FERC-licensed hydropower project. Boat launches and the Topsy Recreation site, operated by the BLM, provide camping, picnicking, fishing, boating and swimming for visitors to this section of the Klamath River approximately 8 miles south of MP 184.31. Recreation and access to the reservoir and recreation site would not be directly affected by construction activities, although construction could cause some temporary delays on Keno Access Road (also known as State Highway 66). Pacific Connector has identified the reservoir as a potential source of water for hydrostatic testing. Use of the reservoir for this purpose would not be expected to significantly or noticeably draw down the reservoir or affect recreational activities. The John C. Boyle Dam is one of four dams on the Klamath River that is planned to be removed as part of the Klamath Economic Restoration Act.

<u>ACECs</u>

North Spit ACEC

The North Spit ACEC is located about 3.5 miles southwest of the Jordan Cove Meter Station, where the pipeline would terminate. The North Spit ACEC would not be directly affected by construction or operation of the Pacific Connector Pipeline Project. Indirect effects could occur as a result of the increased traffic on the Trans-Pacific Parkway that would occur during construction. These potential increases have the potential to cause traffic congestion and short delays but are not expected to preclude access to or use of the ACEC.

Upper Rock Creek ACEC

The BLM's Coos Bay District designated 364 acres in Section 5, T.29S., R.9W., Douglas County, Oregon as the Upper Rock Creek ACEC. The purpose of this ACEC is to maintain, protect, and restore the area's natural systems and botanical values, which include western red cedar and western hemlock, and skunk cabbage, as well as sedge-dominated wetlands. The area also supports the Oregon Natural Heritage Program Coast Range Ecological Cell 108 and provides habitat for marbled murrelet and northern spotted owl. At its closest point, the construction right-of-way is approximately 115 feet south of this ACEC at MP 43.2 and would not directly conflict with the management of the ACEC. Pacific Connector proposes to use North Rock Creek Road, a paved public road located approximately 50 feet from the ACEC, for construction access in this area. Potential effects on wildlife are assessed in section 4.5.1.

4.8.1.3 Environmental Consequences on Federal Lands

Forest Service Potential Wilderness Evaluation

Wilderness Areas, Inventoried Roadless Areas (IRA), and Potential Wilderness Areas (PWA) are discussed together here because they share a set of terminology and interrelated history. A wide range of terms and references have been used by respondents, the courts, and the Forest Service when referring to these topics such as roadless, unroaded, uninventoried roadless, undeveloped areas, and roadless expanse. The terms and definitions as stated below are used in this site-specific analysis. They are based on current law, regulation, agency policy, and the LRMPs, as amended, for the Umpqua, Rogue River, and Winema National Forests.

<u>Wilderness</u>

A Wilderness Area is designated by congressional action under the Wilderness Act of 1964 and other wilderness acts. The Wilderness Act of 1964, Section 2(c) defines wilderness, in part, as:

> *[A]n area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements of human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; …*

Two Wilderness Areas are in proximity to the pipeline alignment: Sky Lakes Wilderness (113,590 acres) is in both the Winema and Rogue River National Forests and its southern tip is approximately 3.7 miles north of the pipeline alignment at MP 162, and Mountain Lakes Wilderness (23,071 acres), in the Winema National Forest, is approximately 1.3 miles north of MP 172.

No Project activities would occur within or adjacent to a wilderness area. There would be no effects on designated wilderness or wilderness characteristics because the closest wilderness (Mountain Lakes) is over a mile away. Because of this distance, project activities would typically not be seen or heard by anyone recreating in the wilderness. The exceptions could be short duration views of smoke during burning activities. Smoke management mitigation measures would minimize the risk of smoke drifting into the wilderness.

Inventoried Roadless Areas

IRAs were identified in the 2001 Roadless Area Conservation Rule in a set of inventoried roadless area maps, contained in Forest Service Roadless Area Conservation Final Environmental Impact Statement, volume 2, dated November 2000, which are held at the National headquarters office of the Forest Service, or any subsequent update or revision of those maps (36 CFR 294.11). These areas were set aside through administrative rulemaking and have provisions, within the context of multiple use management, for the protection of inventoried roadless areas.

The nearest IRA is the Brown Mountain IRA, located on the Rogue River National Forest approximately 0.6 mile north of MP 162. On the Winema National Forest, the West Boundary IRA is about 2.2 miles northeast of MP 172. No activities associated with the Pacific Connector Pipeline Project would occur within or adjacent to an IRA; therefore, there would be no project-related effects on IRAs.

Potential Wilderness Areas

This is not an official inventory. Official inventories of potential wilderness areas are completed during forest planning. This analysis considers PWAs only for purposes of assessing potential effects of the Pacific Connector pipeline activities on wilderness characteristics. PWAs are not a land designation decision (e.g., does not change current land management allocations), they do not imply or impart any particular level of management direction or protection, they are not an evaluation of potential wilderness (Forest Service Handbook [FSH] 1909.12, Chapter 72), and they are not preliminary administrative recommendations for wilderness designation (FSH 1909.12, Chapter 73). The inventory of PWAs does not change the administrative boundary of any IRA or any congressionally designated wilderness. The original designated management area (*e.g.*, Matrix) would remain the land designation even if areas in the project planning area meet the handbook criteria for PWAs. PWAs are evaluated (regarding making recommendations to Congress for inclusion in the National Wilderness Preservation System) during the development or revision of land management plans, in other words at the forest planning level and not at the project planning level.

PWAs qualify for placement on the inventory if they meet the following criteria (FSH 1909.12, Chapter 71):

1. The area contains 5,000 acres or more.
2. Areas contain less than 5,000 acres, but can meet one or more of the following criteria:
    a. Area can be preserved due to physical terrain and natural conditions.
    b. Areas are self-contained ecosystems, such as an island, that can be effectively managed as a separate unit of the National Wilderness Preservation System.
    c. Areas are contiguous to existing wilderness, primitive areas, Administration endorsed wilderness, or potential wilderness in other Federal ownership, regardless of their size.
3. Areas do not contain forest roads (36 CFR 212.1) or other permanently authorized roads, except as permitted in areas east of the 100th meridian.

Areas may meet either criteria 1 and 3, or criteria 2 and 3. If the criteria in section 71.1 of the FSH are met, criteria in section 71.11 of the FSH (criteria for including improvements) must also be met. This analysis used the following project-specific criteria to delineate areas characterized as undeveloped and roadless, yet included improvements:

- Roads (as defined in 36 CFR 212.1) were excluded per FSH 1909.12, section 71.1. Mapped areas were at least 300 feet from NFS roads. This distance was selected because tree harvest is commonly permitted within 300 feet of open forest roads for personal-use firewood. In addition, danger tree removal occurs at various distances from open forest roads depending on tree height, topographic slope, and other factors.

- Timber harvest areas where logging, as evidenced by stumps, and prior skid trails or roads are substantially unrecognizable, or areas where clearcuts have regenerated to the degree that canopy closure is similar to surrounding uncut areas per FSH 1909.12, section 71.11.

No undeveloped areas greater than 5,000 acres would be crossed by the Pacific Connector pipeline route. All of the undeveloped areas crossed by the pipeline are less than 5,000 acres in size, are not contiguous to existing Wilderness or IRAs, and do not meet the PWA criteria for areas less than 5,000 acres. As a result, the Project would not affect any PWAs.

<u>Other Undeveloped Areas</u>

Other undeveloped areas refer to those areas that do not meet inventory criteria as PWAs, and are not an IRA or designated Wilderness area. There are no forest-wide or management area standards and guidelines specific to other undeveloped areas in the Umpqua, Rogue River, and Winema National Forest LRMPs. All lands, including undeveloped areas, are managed consistent with forest-wide standards and guidelines and by designated LRMP management area allocations. Other undeveloped areas are identified because they may contain special resource values that warrant an evaluation differently than other parts of the project area.

There are approximately 3,747 acres of other undeveloped lands not meeting PWA criteria that would be crossed by the pipeline on NFS lands. Approximately 1,792 acres of these areas are within the Umpqua National Forest[161], and approximately 1,955 acres are within the Rogue River National Forest (see appendix F8 for maps and additional information). The portion of the pipeline route within the Winema National Forest is on or adjacent to existing roads and would not impact "other undeveloped areas." Other undeveloped areas may have intrinsic ecological and social values because they do not contain roads (or the roads are no longer system roads) or evidence of past timber harvest. These values can include intrinsic physical and biological resources (e.g., soil, water, wildlife, recreation, fisheries, etc.), and intrinsic social values (e.g., apparent naturalness, solitude, remoteness).

Human influences have had limited impact to long-term ecological processes within these other undeveloped areas. Disturbances by insects and fire have likely been the factors with the most potential to have affected the area. Opportunities for primitive recreation include camping, hiking, hunting, wildlife watching, and photography. Opportunities for a feeling of solitude, the spirit of adventure and awareness, serenity, and self-reliance are limited by the size and shape of the areas,

[161] This area burned in the 2015 Stouts Creek Fire and as a result there are additional alterations in this area from fire suppression efforts. In addition to the changed vegetation conditions the surrounding landscape has also changed as a result of salvage logging on industrial forest lands immediately to the west of this area.

as well as by distance to roads and topographic screening. The size of the area necessary to feel a sense of solitude varies by individual; however, areas that are long and narrow offer less opportunity for solitude due to less distance from noise at their midpoint. Nearby sounds of roads, timber harvest, and other management activities can often be heard and the activities sometimes seen from within these undeveloped areas because they are all within approximately 1 mile or less of the nearest road from their midpoints.

The Pacific Connector Pipeline Project would directly impact approximately 8 acres of other undeveloped areas on the Umpqua National Forest and approximately 22 acres on the Rogue River National Forest. These impacts include the areas cleared by the right-of-way construction, the TEWAs, and the acres used as UCSAs.

For these other undeveloped areas within the pipeline project area where construction and operation would occur the impacts to soil; water quality; air quality; forage; plant and animal communities; habitat for threatened, endangered, and sensitive species; developed recreation; noxious weeds; and cultural resources are essentially the same as disclosed above for recreation and in other sections of chapter 4 of this EIS and are not reiterated here.

The Pacific Connector Pipeline Project would impact the apparent naturalness and solitude within these areas. Pipeline construction would alter the apparent naturalness on approximately 30 acres of these areas. The increase in the number of visible stumps, and the linear nature of the pipeline corridor clearing would be the most apparent visual change resulting from implementation. The linear nature of the cleared corridor would likely adversely affect the visual recreational experience of anyone using these areas for dispersed recreation. This impact would be long term due to a portion of the right-of-way being maintained as a low vegetation area for the life of the pipeline project. Although the pipeline construction and operation would adversely affect visual resources in these areas, they would not be inconsistent with the standards and guidelines for visual quality in the respective LRMPs.

Activities associated with the construction of the pipeline in and adjacent to these other undeveloped areas would reduce the sense of solitude and remoteness during construction activities. Other sights and sounds of ongoing and previously approved activities in areas adjacent to these other undeveloped areas would continue to have short-term effects on opportunities for solitude and remoteness. Overall, there would be little change to the current availability of solitude or primitive recreation within these areas because only a very small portion (approximately 0.8 percent) would be affected by the Pacific Connector Pipeline Project.

BLM Lands with Wilderness Character

In the fall of 2012, the BLM updated its inventory of lands with wilderness character. These updates were part of the Analysis of the Management Situation process associated with the new RMPs for western Oregon that were approved in August of 2016. The inventory covered BLM lands in the Salem, Eugene, Roseburg, Coos Bay, and Medford Districts, as well as the Klamath Falls Resource Area of the Lakeview District. The results of this most recent inventory were compared to the proposed route, and no areas of overlap were discovered. The proposed pipeline would not impact BLM land with wilderness character.

4.8.1.4 Conclusions

Constructing and operating the Jordan Cove LNG Project would not have direct adverse effects on nearby recreational areas, including the ODNRA and BLM RMAs, but may have indirect effects. As described in the preceding sections, temporary indirect impacts during construction would include construction-related noise and short-term delays to recreationists using the Trans-Pacific Parkway to access recreation sites, including the ODNRA. Indirect impacts during operation include short-term delays for recreational boaters required to avoid LNG carriers in transit within the waterway. Constructing and operating the Pacific Connector Pipeline Project would result in impacts on recreation resources as described in the preceding sections. Based on the proposed construction, mitigation, and operation procedures the Project would not significantly affect recreation resources or areas.

4.8.2 Visual Resources

Procedures for describing the existing visual condition of the landscape and assessing the visual effects of the Project are similar to and generally consistent with methodologies developed by the BLM (1986), Forest Service (1973, 1995b), the FHWA (2015), and the COE (Smardon et al. 1988). This section documents the visual assessment conducted for the Jordan Cove LNG Project and the Pacific Connector pipeline, based primarily on the potential visibility of the Project facilities and their expected visual effects on the landscape.

4.8.2.1 Jordan Cove LNG Project

The Jordan Cove LNG Project would be located almost entirely on privately owned, mostly open, industrial-zoned land on the bay side of the North Spit of Coos Bay. Ingram Yard is generally bordered to the north by the Coos Bay Rail Link and the Trans-Pacific Parkway; to the west are open lands of Henderson Marsh, which is owned by the Port; to the east is the existing industrial Roseburg Forest Products wood chip facility; and to the south are the open waters of the Coos Bay estuary. About 3,000 feet northwest of the LNG terminal is the beach and Pacific Ocean. Topography on the westernmost portion of Ingram Yard is relatively flat where fill material has been covered by brush and grasses. Forested sand dune ridges reaching elevations that exceed 100 feet AMSL cover the eastern portion of Ingram Yard.

North of the access and utility corridor is the Coos Bay Rail Link and the Trans-Pacific Parkway, beyond which are federal lands managed by the BLM and Forest Service. Those federal lands contain forested sand dunes. South of the corridor is the existing industrial Roseburg Forest Products facility.

The South Dunes area is relatively flat open lands that were formerly the location of the Menasha-Weyerhaeuser mill complex and a fish hatchery. Most of the buildings of those facilities have been removed, and what remains is a mixture of roads, railroad tracks, parking lots, grasslands, dunes, and wetlands. The South Dunes area is surrounded on the south and east by the open waters of the Coos Bay estuary, including geographic Jordan Cove on the south and Hayes Inlet on the east. To the west is the Roseburg Forest Products facility. To the north is the ODNRA.

The Roseburg Forest Products facility is mostly paved, with roads and railroad tracks, and includes a dock for mooring ships, a 190-foot-tall loading tower, wood chip piles, two large buildings, two water towers, and several small outbuildings.

Beyond 0.5 mile from the Jordan Cove LNG Project, the existing landscape on the North Spit is characterized by a mix of industrial land uses and open space. Industrial facilities on the north side of Coos Bay on the North Spit include the Southport Forest Products lumber mill, approximately 1 mile southwest of the Jordan Cove LNG Project. The International Marine Contractors and the D.B. Western manufacturing plant facilities are also located on the North Spit approximately 2 miles southwest of the Jordan Cove LNG Project (specifically the terminal site). Undeveloped land separates the Project from these facilities. Most of the rest of the North Spit southwest from the Project consists of the open lands and dunes of the BLM RMAs.

Southward, across Coos Bay from the Jordan Cove LNG Project, are the cities of North Bend and Coos Bay. The smaller community of Glasgow is located on the east side of Haynes Inlet and north side of the Coos Bay estuary, about 4,000 feet northeast of South Dunes. The Kentuck project site proposed for wetland mitigation (see section 4.4) is located approximately 1.5 miles southeast of Glasgow and inland from Kentuck Inlet on Upper Coos Bay. The closest residential developments to the terminal site are approximately 1 mile south, on the opposite side of the bay. The Southwest Oregon Regional Airport is directly across Coos Bay, about 1 mile south of the terminal site.

Once constructed, the largest aboveground structures within the Jordan Cove terminal would be the two LNG storage tanks, which would each be approximately 267 feet wide and 180 feet tall. Dredge materials from the Navigation Reliability Improvement Project would be deposited at the APCO site located on the south side of the Bay, between the Coos Bay Railroad Bridge and the Oregon Coast Highway (also known as U.S. Highway 101).

Viewpoint Selection

A visual assessment was conducted to determine the potential effects on visual resources associated with the Jordan Cove LNG Project. Representative viewing points (also referred to as key observation points [KOPs]) were identified within the terminal viewshed (i.e., the area from which facilities at the terminal would be potentially visible). Generally, visual details become apparent to the viewer when they are seen in the foreground, at a distance of one-half mile or less, but may affect viewers when they are present in the middleground (up to 4 miles from the viewer) depending on the extent of landscape modification noticeable and other visual factors. It is anticipated, however, that views of the Project would be partially or fully screened by existing vegetation, topography, or infrastructure for much of the Project viewshed, and from most areas beyond 2 miles away. Therefore, the visual assessment applies to a viewshed for the Jordan Cove LNG Project that extends to a distance of approximately 2 miles from the LNG terminal in all directions, which was defined using aerial and ground photography, local planning documents, computer modeling, and field reconnaissance. Site visits to document existing visual conditions in the terminal area and to identify potentially affected sensitive viewing locations were conducted in April 2006, May 2013, and August 2017.

Representative viewpoints for use in the assessment were selected based on potential visibility of the proposed Jordan Cove LNG Project site from various distances, the sensitivity of viewing locations, and input from land management agencies (primarily the BLM and Forest Service). The viewpoints consist of locations with concentrations of viewers, such as major roadways or housing developments; visually sensitive land uses, such as parks and recreation areas; culturally sensitive locations, such as historic sites; and places designated as having scenic importance, such as highways and overlooks. Figure 4.8-2 indicates the locations of the 11 viewpoints used for visual assessment of the Jordan Cove LNG Project, and the location of the most prominent features there. The viewpoints are identified as follows:

- Viewpoint-1 North Spit Overlook and Wetland Trailhead
- Viewpoint-2 Trans-Pacific Parkway at Jordan Cove Project Site Entrance
- Viewpoint-3 Horsfall Beach Campground and Day Use Area
- Viewpoint-4 U.S. Highway 101 and Trans Pacific Parkway Intersection
- Viewpoint-5 U.S. Highway 101 on the north side of McCullough Bridge
- Viewpoint-6 U.S. Highway 101 at the southern end of McCullough Bridge
- Viewpoint-7 North Bend, intersection of Meade Avenue and Florida Avenue
- Viewpoint-8 North Bend, intersection of Meade Avenue and Vermont Avenue
- Viewpoint-9 North Bend, Open Space near Washington Avenue
- Viewpoint-10 North Bend, Bike Trail south of the Airport
- Viewpoint-11 BLM North Spit Boat Launch Area

Figure 4.8-2

Key Observation Point Locations for the Jordan Cove LNG Project

Visual Simulations

Computer-generated visual simulations were prepared for 9 of the 11 viewpoints. Visual simulations were not prepared for Viewpoint 4 and Viewpoint 7 because the LNG terminal would be, at most, minimally visible from those locations. Figures K-1 through K-11 in appendix K show the existing conditions (or "before" view) for each viewpoint, and a visual simulation (or "after" view) illustrating the expected appearance of built portions of the Project. The visual impact assessment was based on evaluation of the landscape changes that would result from completed construction and during the operation phase of the proposed facilities.

The visual simulations are the result of an objective analytical and computer modeling process and are accurate within the constraints of available site data, such as site topography, the proposed LNG terminal design, and photography obtained in the field. Existing GIS, a digital elevation model, engineering data, and digital aerial photographs provided the basis for developing three-dimensional digital models of the LNG storage tanks using a real-world coordinate system.

Viewpoint Analyses

The visual assessment for the Jordan Cove LNG Project is based on evaluation of the expected visual effects at the individual representative viewpoints. Because the LNG storage tanks would be the most visible feature of the LNG export terminal, the evaluation for each viewpoint focused on the visibility of the storage tanks.

Viewpoint-1 North Spit Overlook and Wetland Trailhead**—**Viewpoint-1 represents views to the southeast experienced by recreational visitors from the North Spit Overlook and Wetland Trailhead, which are located on private land on the northwest side of the Trans-Pacific Highway approximately 0.4 mile west of the LNG terminal site boundary. As shown in the simulation in figure K-1 in appendix K, there would be an unobstructed view of the LNG terminal from this location. Once the forested sand dune is removed, the LNG storage tanks, ground flares, and surrounding concrete perimeter walls would dominate the view.

Viewpoint-2 Trans-Pacific Parkway at Jordan Cove Project Site Entranc**e—**Viewpoint-2 represents views to the southwest for travelers along the Trans Pacific Parkway to the north of the terminal site. The viewpoint is located approximately 0.25 mile northeast of the northern boundary of the LNG terminal site, and approximately 0.5 mile northeast of the LNG storage tanks. As shown in figure K-2 in appendix K, with the forested sand dune removed, parkway travelers at this location would have an unobstructed view of the ground flares, gas processing area and concrete perimeter walls, and a partially screened view of the LNG storage tanks. Similar conditions would occur at other locations along the Trans-Pacific Parkway where views to the south were not obscured by vegetation.

Viewpoint-3 Horsfall Beach Campground and Day Use Area**—**Viewpoint-3 represents views to the south-southeast experienced by visitors to the sand dune public overlook above the Horsfall Beach Campground/Parking/Staging Area in the ODNRA. The Oregon Coast Trail also passes through this location as it transitions from the beach to Horsfall Beach Road. The viewpoint is located approximately 1.25 mile north of the LNG terminal site boundary, and approximately 1.6 miles northwest of the LNG storage tanks. The simulation indicates that views of the proposed facilities would be partially obstructed, and that the domes of the LNG storage tanks, the ground flares, and the surrounding concrete perimeter walls would be partially visible above the existing tree line (figure K-3 in appendix K). Because of their light color, viewers would be most likely to notice the tops of the LNG storage tanks. Along the Oregon Coast Trail, the LNG terminal would likely be partially visible from 0.5 mile to the east of the intersection of Horsfall Beach Road and the Trans-Pacific Parkway.

Viewpoint-4 U.S. Highway 101 and Trans-Pacific Parkway Intersection**—**Viewpoint-4 represents views to the west for travelers along U.S. 101 approximately 2.2 miles east of the LNG terminal site boundary, near the intersection with the Trans-Pacific Parkway and less than 0.5 mile east of the Conde B. McCullough State Recreation Site (figure K-4 in appendix K). The Oregon Coast Trail is also located along the Trans-Pacific Parkway and U.S. Highway 101 south of the Trans-Pacific Parkway Intersection in this area. Looking southwest, the Trans-Pacific Parkway can be seen in the middleground and the 190-foot-high loading tower at the Roseburg Forest Products chip export facility is barely visible above the trees beyond. The LNG terminal site, which would be obstructed by intervening landform and vegetation, would be located behind and to the right of the loading tower. Figure K-4 is an existing view from this viewpoint. A simulation was not completed because the proposed facilities would be obscured by topography and vegetation from this viewpoint. The Trans-Pacific Parkway/U.S. 101 widening would be visible in the foreground. The LNG terminal would likely be partially visible from the Conde B. McCullough State Recreation Site, located 2.4 miles to the northeast of the LNG terminal, but would be mostly obscured by vegetation and intervening topography. The LNG terminal would be visible along U.S. Highway 101 South in this area, but would be partially obscured by vegetation and intervening topography.

Viewpoint-5 U.S. Highway 101 on the north side of McCullough Bridg**e—**Viewpoint-5 represents views to the west as seen by travelers along U.S. 101 on the north side of McCullough Bridge, and is located approximately 2 miles east of the LNG terminal site boundary. The Oregon Coast Trail is also located along this section of U.S. Highway 101.

In the existing view, the forested sand dune located on the LNG terminal site is visible behind the Coos Bay Rail Link Bridge and the Roseburg Forest Products facility (figure K-5 in appendix K). The simulation shows that the forested sand dune would be removed, and that the LNG tanks and concrete perimeter wall would be visible above the treeline. Views of the LNG terminal facilities would be partially obscured by the existing Roseburg Forest Products facilities.

Viewpoint-6 U.S. Highway 101 at the Southern end of McCullough Bridge**—**Viewpoint-6 represents views to the northwest from the south side of McCullough Bridge, approximately 2 miles southeast of the LNG terminal site boundary and approximately 0.1 to 0.3 mile east of the APCO Dredge Disposal Site. Simpson Park, owned by the City of North Bend Parks, is located adjacent to the viewpoint location to the south. As shown in the simulation (figure K-6 in appendix K), the LNG storage tanks would be visible in the background above the APCO Site dredge material deposits, which are visible in the foreground. APCO Site 1 (approximately 0.1 mile west of the viewpoint location) would be approximately 36 feet tall, and APCO Site 2 (approximately 0.3 mile west of the viewpoint location) would be 48 feet tall. Initially, the dredge deposit areas would appear as an exposed sand dune. After vegetation is established, ground cover on the dredge deposit areas would appear visually similar to the surrounding landscape.

Viewpoint-7 North Bend, intersection of Meade Avenue and Florida Avenue**—**Viewpoint-7 represents views to the northwest from urbanized areas within North Bend, approximately 2 miles southeast of the LNG terminal site boundary. The Roseburg Forest Products facility is visible between and over the residential buildings and vegetation, across Pony Slough and Coos Bay (figure K-7 in appendix K). The forested sand dune that currently exists on the LNG terminal site is visible as a dark green line of vegetation behind the Roseburg Forest Products facility in the background. The view of the proposed facilities from this viewpoint was not simulated, because visibility of the facilities would be limited by the vegetation, residences, and other development. The LNG storage tanks would mostly be obstructed by intervening landforms, vegetation, and the existing Roseburg Forest Products facility.

Viewpoint-8 North Bend, intersection of Meade Avenue and Vermont Avenue**—**Viewpoint-8 represents views to the northwest from an urbanized area within North Bend that is higher in elevation compared to Viewpoint-7. The viewpoint is located approximately 2.25 miles southeast of the LNG terminal site boundary. In the existing view, Pony Slough, the Southwest Oregon Regional Airport, the Coos Bay Rail Link, and Coos Bay are visible between the viewpoint location and the proposed terminal location. The forested sand dune that currently exists on the LNG terminal site is visible as the dark green line of vegetation in the distance (figure K-8 in appendix K). As shown in the simulation, the forested sand dune would be removed and the LNG storage tanks, marine slip, concrete perimeter walls, and LNG vessel (when in port) would be visible from this viewpoint.

Viewpoint-9 North Bend, Open Space Near Washington Avenue**—**Viewpoint-9 represents views to the north from an open space in an urbanized area within the western part of North Bend. A single-family development is proposed (but not approved) for this location along Washington Avenue, which is located just south and uphill from the Church of Jesus Christ of Latter-day Saints, approximately 1.4 miles from the LNG terminal site boundary. As shown in figure K-9 in appendix K, the LNG storage tanks, marine slip, and concrete perimeter walls would be visible above the tree line.

Viewpoint-10 North Bend, Bike Trail South of the Airport**—**Viewpoint-10 represents views from Airport Lane and a bike trail that is located south and uphill from of the North Bend Waste Water Treatment Plant and the Southwest Oregon Regional Airport, near the intersection of Colorado Avenue and Arthur Street. The viewpoint is located approximately 1 mile south of the LNG terminal site boundary. In the existing view, treatment plant and airport structures are present in the foreground and the Roseburg Forest Products facility is visible in the middleground, as is the forested dune on the LNG terminal site (figure K-10 in appendix K). The simulation shows that the LNG storage tanks, marine slip and associated sheet pile walls, and LNG vessel (when in port) would be visible and prominent from this viewpoint.

Viewpoint-11 BLM North Spit Boat Launch Area**—**Viewpoint-11 (figure K-11 in appendix K) represents views to the northeast from the interpretive overlook at the BLM North Spit Boat Launch parking lot, and is approximately 0.75 mile southwest of the LNG terminal site boundary. The topography at this site is flat with low-growing vegetation, allowing views of the existing forested sand dune located on the LNG terminal site to the left of the Roseburg Forest Products facility. The simulation shows that the LNG storage tanks, marine slip, concrete perimeter walls, and the LNG carrier (when in port) would be visible in the near middleground.

Visual Impacts

Short-Term Visual Impacts

Construction of the Jordan Cove LNG Project would be noticeable to recreational users on Coos Bay, in portions of the ODNRA, in portions of the North Spit Overlook, and at the boat launch and other locations within the BLM Coos Bay/North Spit RMA. Some residences in both the cities of

North Bend and Coos Bay would also have views across the bay to the terminal, although for other residences such views would be obstructed by terrain, vegetation, or intervening development. Construction activities would also be noticeable to motorists using the Trans-Pacific Parkway and the Pacific Coast Scenic Byway (U.S. Highway 101). Visual effects from construction activities near the terminal site would include dust plumes, exposed surfaces resulting from clearing and grading, and the presence of construction equipment and personnel activity on the LNG terminal site. Wetland restoration activity at the Kentuck project site might be evident to motorists using local roads and rural residences in the immediate vicinity of the site. These visual effects from construction activity would be temporary and limited to the construction period.

Short-term visual effects during construction of the LNG terminal would include the presence of the workforce housing facility within the South Dunes that would include pre-fabricated housing units and basic utility structures, which would visually resemble a small, dense residential community. The workforce housing facility would be dismantled and all structural elements removed from the site following completion of construction activities, and therefore visual effects resulting from the housing facility would be short term.

Long-Term Visual Effects

Based on the visual simulations, the Jordan Cove LNG Project would be visible to the public and would alter the existing visual character and scenic quality of the site. In addition to installation of the LNG tanks and related facilities, another permanent effect includes the removal of portions of a forested dune located on the eastern portion of the terminal site. This dune is a noticeable topographic feature of the existing landscape, and its removal was incorporated in the simulations whenever applicable.

Based on the visual changes indicated by the simulations for the set of representative viewpoints, the Jordan Cove LNG Project would have a moderate to high visual effect on residential communities in Coos Bay and North Bend to the south of the site. This effect would occur because of proposed landform modifications, including removal of the forested sand dune on the LNG terminal site, and the visibility of proposed industrial facilities on a previously undeveloped site. Moderate visual impacts are anticipated for viewers from hillside residences that would have views of the LNG terminal site that are not screened by topography, vegetation, or intervening development. These viewers would see the proposed development in the context of existing residential, commercial, transportation, and industrial uses in North Bend and Coos Bay that would be visible in foreground to middleground distances. Residences located along the shoreline of Coos Bay south of the regional airport (along Maxwell Road, Seagate Avenue, and Fenwick Street, for example) with unobstructed views of the site would experience a stronger visual effects and reduced scenic quality than would hillside residences, because the proposed facilities would primarily be viewed in the context of a shoreline landscape that currently has sparser development and higher scenic quality than the interior urban areas. Lights associated with the LNG terminal site are not anticipated to create a substantial new source of light or glare that would adversely affect daytime views. Nighttime views in the area include lights associated with the airport, the industrial facilities on the North Spit, and other urban uses. The addition of lights associated with the Jordan Cove LNG Project would be a low to moderate incremental impact when viewed in context of the extent and intensity of current lighting in the area.

The Jordan Cove LNG Project would be visible to recreational users on Coos Bay, in portions of the ODNRA, from the North Spit Overlook, and in portions of the BLM Coos Bay/North Spit

RMAs, including the BLM boat launch. Recreational users with views of the Jordan Cove terminal would notice moderate visual contrast in most locations, but high contrast when the Project is viewed in the foreground (within approximately 0.5 mile of the proposed facilities). The reduction of scenic quality in these areas where the Project creates a high contrast in the foreground would reduce the recreation experience from those viewpoints for some viewers who are sensitive to those changes. When viewed from greater distances, the reduction of scenic quality would generally be less pronounced because the Project would be viewed in the context of the surrounding landscape, which is characterized by other industrial, residential, and commercial developments.

The Project would be noticeable to motorists using the Trans-Pacific Parkway and the Pacific Coast Scenic Byway (also known as U.S. Highway 101). Visual effects on travelers on these roadways would be low to moderate. Intervening landforms and vegetation obstructs views toward the LNG terminal site from many locations along U.S. 101 and the Trans-Pacific Parkway. Travelers on these roadways would potentially experience low to moderate visual effects, because these viewers tend to have lower sensitivity and a shorter duration of view, and because the facilities would be viewed in the context of the surrounding landscape.

Wetland restoration would alter the long-term appearance of the 140-acre Kentuck project site. The site is the location of the former Kentuck Golf and Country Club, an 18-hole golf course that opened for play in the mid-1960s and closed in 2009. Aerial imagery indicates the site is no longer actively maintained and has a vegetative cover of grasses and other low-growing species, with trees and shrubs in some areas around the southern periphery and some visible evidence of remnant golf course features. The Kentuck project site is similar in character to adjacent open pasture areas located in the flat valley bottom land along Kentuck Slough, which is a narrow, linear waterway parallel to Kentuck Lane. Over time, most of the open, grassy area of the site would take on the appearance of freshwater and estuarine wetlands, including some areas of open water. The long-term visual effect of the proposed mitigation action would be to create a more natural-appearing landscape at the Kentuck site, and the change would be relatively subtle. Because the Kentuck project site is in a narrow tributary valley, this visual change would only be evident within the immediate local area, primarily including segments of East Bay Road and Kentuck Lane and a small number of rural residences located in the valley. The long-term landscape change at the Kentuck site is likely to be perceived as a minor, positive visual effect.

A related visual element of the LNG terminal would be the introduction of LNG carriers to the viewshed of the Coos Bay area communities. Traveling between 4 and 10 knots per hour, an LNG carrier would cross through the field of view for shoreline viewers in a few minutes. While LNG carriers are very large vessels, they are relatively close in size to cargo ships that currently transit the bay for the purpose of transporting wood products, which average around 600 feet in length. Because ships of this scale are already a regular occurrence in the waterway, the presence of LNG carriers would not be a new type of visual feature on the waterway.

Proposed Mitigation Measures

Jordan Cove has proposed several measures that would mitigate long-term visual effects of the Project. Jordan Cove has taken measures to minimize impacts on wetlands and estuaries in the siting of the Project, thereby retaining some of the visual characteristics of the site. The LNG terminal location was selected to avoid disturbance of Jordan Lake, which would help to minimize visual effects by preserving an existing, distinctive waterbody in the landscape. However, the size and location of the proposed LNG terminal and associated facilities would cause visual effects from many viewpoints that cannot be effectively mitigated.

The exterior of the LNG storage tanks would be constructed of untreated concrete of a light grey color for cryogenic purposes. While a darker color would help reduce the visibility of the tanks from a distance, such treatment is not generally considered feasible, as dark colors absorb heat, which would increase the temperature of the tank exterior and become problematic for LNG storage control. Jordan Cove evaluated various tank profiles and locations to minimize visual effects, and concluded that the proposed size, profile, and location would be the optimum considering other environmental factors, safety, and reliability. The final landscape design for the site would include provisions to contour and stabilize landforms not affected by construction and to provide some level of screening around the facilities. The use of native plants for restoration and stabilization of the landforms would also be incorporated into the final planting design to the extent practical. Building facades would incorporate the architectural design of existing buildings in the area. The final lighting plan would include hooded or cut-off lighting to minimize light spillage onto adjacent areas. Only lighting required for operation and maintenance, site safety and security, and to meet FAA requirements would be used on the LNG storage tanks and, whenever possible, the light would be localized to minimize off-site effects.

4.8.2.2 Pacific Connector Pipeline

Visual resources along the pipeline alignment vary greatly. The natural landscape features include sandy treed dunes, expansive bay views and temperate rain forest in the Coos Bay area, and rolling steep conifer-forested hillsides in the Coast and Cascade ranges and foothills. Open oak savanna, pasturelands, and rolling hills are common in the viewsheds near Roseburg and east of Medford, with views transitioning to dramatic conifer mountain and volcanic landscapes in the Cascade Mountains. Croplands, pasturelands, rolling sagebrush rangeland, and pine-juniper forests punctuated by westerly views of the Cascades compose a unique scenic landscape in the Klamath Basin at the eastern end of the pipeline.

Culturally modified landscapes include farm and rangelands, small towns, and forest management activities including clearcut timber harvesting. Forested viewsheds are characterized by various aged forest stands that are in various stages of harvest, regeneration, or mature forests. Several viewsheds along the western portion of the pipeline route have very low scenic integrity, including hillsides altered by clearcuts and traversed by logging roads. A few forested areas also include existing utility corridors. Where the pipeline crosses NFS lands within the Umpqua, Rogue River-Siskiyou, and Fremont-Winema National Forests, the forested viewsheds are characterized as ranging from low to high scenic integrity, varying with stages of forest maturity and harvest regeneration. Other forest landscapes and views have been modified by recent wildfires, such as the Stouts Creek Fire in the Umpqua National Forest in 2015.

On BLM and NFS lands, visual resources are managed according to visual resource management guidelines. Most of the pipeline alignment would pass through viewsheds which allow moderate change, as evidenced by active timber management activities. These are areas where alterations of the existing landscape would not significantly alter the existing characteristics of the viewshed. In a few locations, the pipeline would cross federally managed public lands that are designated as having high visual resource sensitivity under the agencies' visual management system. These areas are discussed in detail later in this section.

KOP Selection

A visual assessment was conducted to determine the potential effects on visual resources associated with the pipeline. Representative viewpoint points (also referred to as KOPs) were identified within the viewshed for the pipeline, defined as the area from which the pipeline would be potentially visible. The pipeline viewshed extends to a distance of 5 miles on either side of the pipeline. This distance was defined using aerial and ground photography, local planning documents, computer modeling, and field reconnaissance. Site visits were conducted in April 2006 and updated in May 2013 to document visual conditions along the pipeline route and to identify potentially affected sensitive viewing locations along the proposed route. Based on these site visits, it is anticipated that views of much of the pipeline from within the 5-mile viewshed would be partially or fully screened by existing trees, landforms, or intervening development. Figures 4.8-3 to 4.8-5 show the proposed route as it moves through the various BLM VRM classifications and Forest Service visual quality objective (VQO) classes[162] as well as the KOP locations along the route.[163]

A supplemental visual impact assessment was conducted to determine the potential effects on visual resources associated with the pipeline as it crosses the PCT. The viewshed for the PCT at this crossing is quite limited because of the old-growth forest, dense brush and understory trees, and the pedestrian scale of the characteristic landscape. A detailed visual analysis was undertaken for the PCT crossing site. Several site visits were conducted in the spring of 2015 to document existing visual conditions of the PCT at the pipeline crossing. The Forest Service determined that two new KOPs would be required to accurately simulate the expected future visual conditions as seen from the PCT. Forest Service personnel and the visual analysts established two new KOPs in this pedestrian landscape.

For this supplemental analysis, the new KOPs are numbered sequentially as KOP-P8 and KOP-P9, as shown on figure 4.8-5 (MP 155 to 228). The VQO for the affected landscape along the PCT is Foreground Partial Retention, indicating that human activities should remain visually subordinate to the characteristic landscape. Activities may repeat form, line, color, and texture common to the characteristic landscape, but changes in their qualities of size, amount, intensity, direction, pattern, etc. should remain visually subordinate to the characteristic landscape.

A supplemental visual impact assessment was also conducted for the crossing of the Coos Bay Wagon Road corridor in 2013, to support an analysis of the Modified Blue Ridge Route Alternative, which has been incorporated into the Proposed Route. As a result, KOP-P10 was added to the visual resource analysis, as shown on figure 4.8-3.

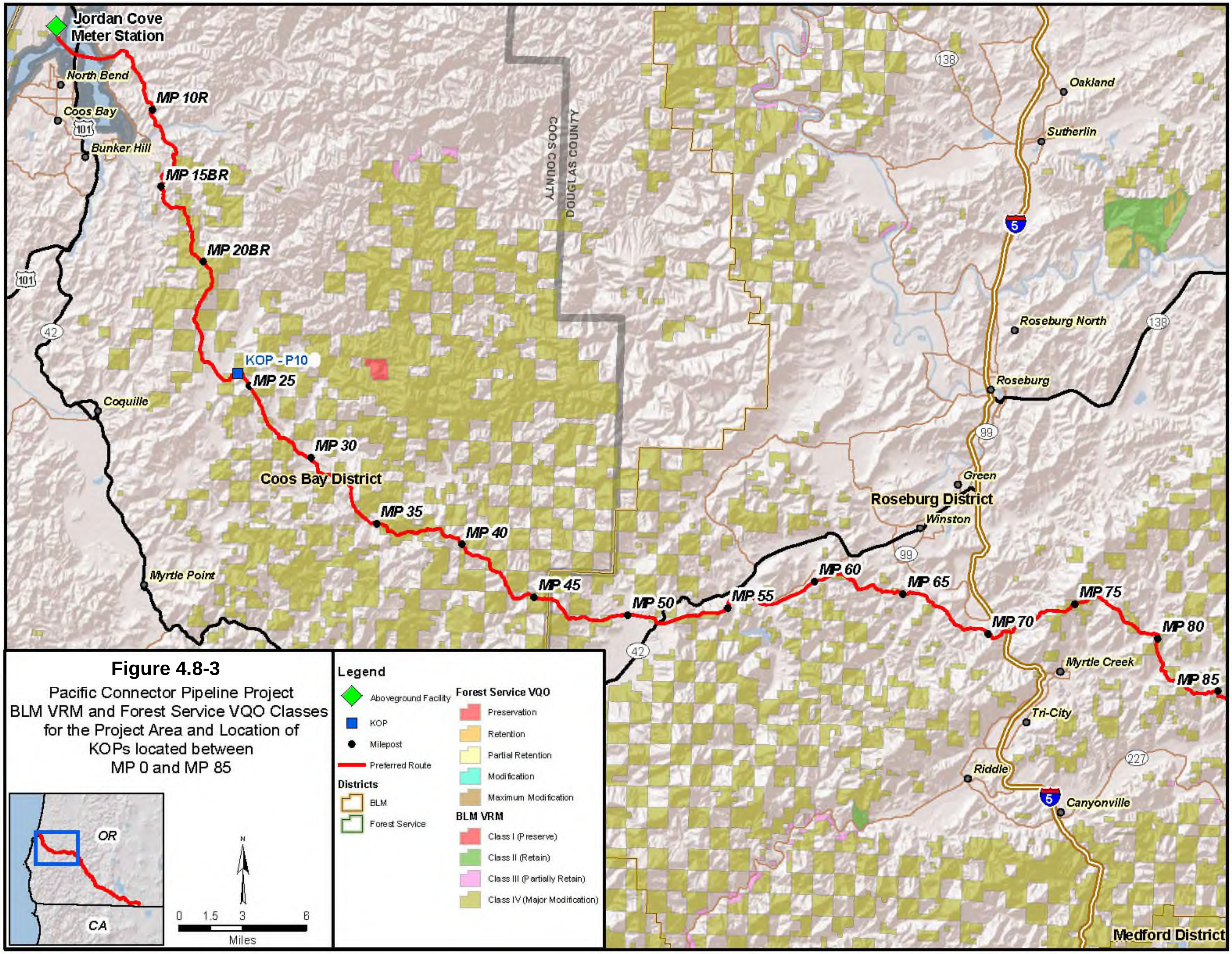
As a result of the original and supplemental visual assessments, the complete list of KOPs for the Pacific Connector Pipeline Project is summarized as follows:

- **KOP-P1 ODNRA**, west of MP 0, Horsfall Beach Campground and Day Use Area

[162] The VRM system has four management classes, with objectives ranging from preserving the existing landscape character (Class I) to providing for management activities that require major modification of the existing landscape character (Class IV). The VQO system has five classes, ranging from Preservation (where most management activities are prohibited) to Maximum Modification (where management activities may dominate the landscape). See Section 4.8.2.3 for additional discussion.

[163] The VRM class boundaries shown on figure 4.8-4 are incorrect near KOP-P2. They are based on GIS data which is being corrected at the time of publication. The VRM class near the Trail Post Office KOP is VRM-II.

- **KOP-P10 Coos Bay Wagon Road**, MP 24.37, Sumner-Fairview Road northwest of Fairview
- **KOP-P2 Trail Post Office**, MP 123.0, Town of Trail adjacent to Highway 62
- **KOP-P3 Highway 140**, MP 145.6 near Little Butte Creek
- **KOP-P4 Big Elk Road** (Forest Road 37), MP 161.4, west of Lake of the Woods
- **KOP-P5 Clover Creek Road**, MP 172.2, north of Buck Lake
- **KOP-P6 Clover Creek Road**, MP 176.8, east of Buck Lake and west of Aspen Lake
- **KOP-P7 Clover Creek Road**, MP 170.1, northwest of Buck lake
- **KOP-P8 Pacific Crest Trail**, MP 167.8, south of Brown Mountain
- **KOP-P9 Pacific Crest Trail**, MP 167.8, south of Brown Mountain



Jordan Cove Meter Station
North Bend
Coos Bay
Bunker Hill
MP 10R
MP 15BR
MP 20BR
KOP - P10
MP 25
Coquille
MP 30
Coos Bay District
MP 35
MP 40
MP 45
MP 50
MP 55
MP 60
MP 65
MP 70
MP 75
MP 80
MP 85
Myrtle Point
COOS COUNTY
DOUGLAS COUNTY
Oakland
Sutherlin
Roseburg North
Roseburg
Green
Roseburg District
Winston
Myrtle Creek
Tri-City
Riddle
Canyonville
Medford District
Figure 4.8-3
Pacific Connector Pipeline Project
BLM VRM and Forest Service VQO Classes
for the Project Area and Location of
KOPs located between
MP 0 and MP 85
OR
CA
0 1.5 3 6
Miles
Legend
Aboveground Facility
KOP
Milepost
Preferred Route
Districts
BLM
Forest Service
Forest Service VQO
Preservation
Retention
Partial Retention
Modification
Maximum Modification
BLM VRM
Class I (Preserve)
Class II (Retain)
Class III (Partially Retain)
Class IV (Major Modification)

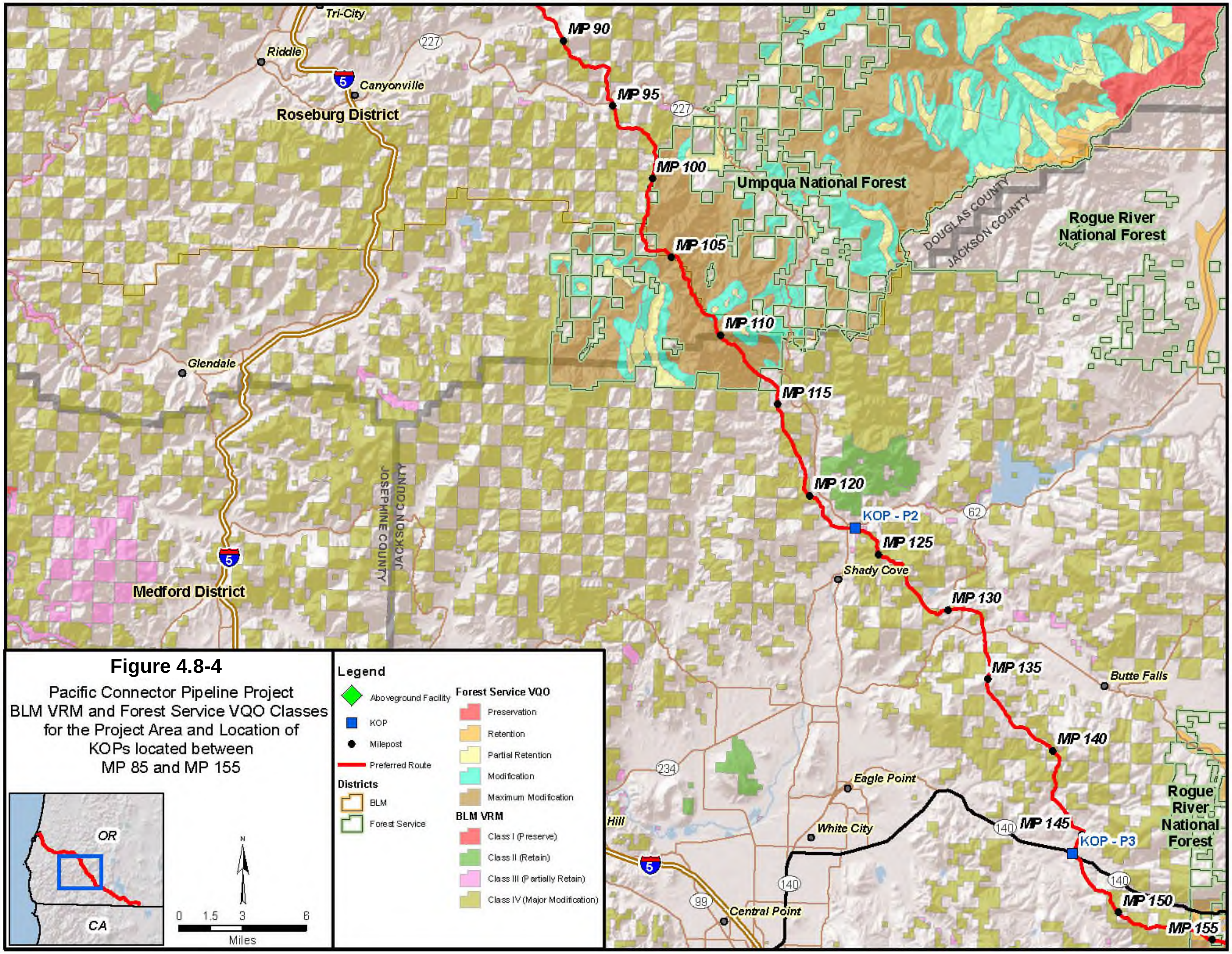


Figure 4.8-4
Pacific Connector Pipeline Project
BLM VRM and Forest Service VQO Classes
for the Project Area and Location of
KOPs located between
MP 85 and MP 155
Legend
Aboveground Facility
KOP
Milepost
Preferred Route
Districts
BLM
Forest Service
Forest Service VQO
Preservation
Retention
Partial Retention
Modification
Maximum Modification
BLM VRM
Class I (Preserve)
Class II (Retain)
Class III (Partially Retain)
Class IV (Major Modification)
0 1.5 3 6
Miles
OR
CA
Tri-City
Riddle
Canyonville
Roseburg District
Umpqua National Forest
Rogue River National Forest
DOUGLAS COUNTY
JACKSON COUNTY
JOSEPHINE COUNTY
Glendale
Medford District
Shady Cove
Butte Falls
Eagle Point
White City
Central Point
Hill
KOP - P2
KOP - P3
MP 90
MP 95
MP 100
MP 105
MP 110
MP 115
MP 120
MP 125
MP 130
MP 135
MP 140
MP 145
MP 150
MP 155

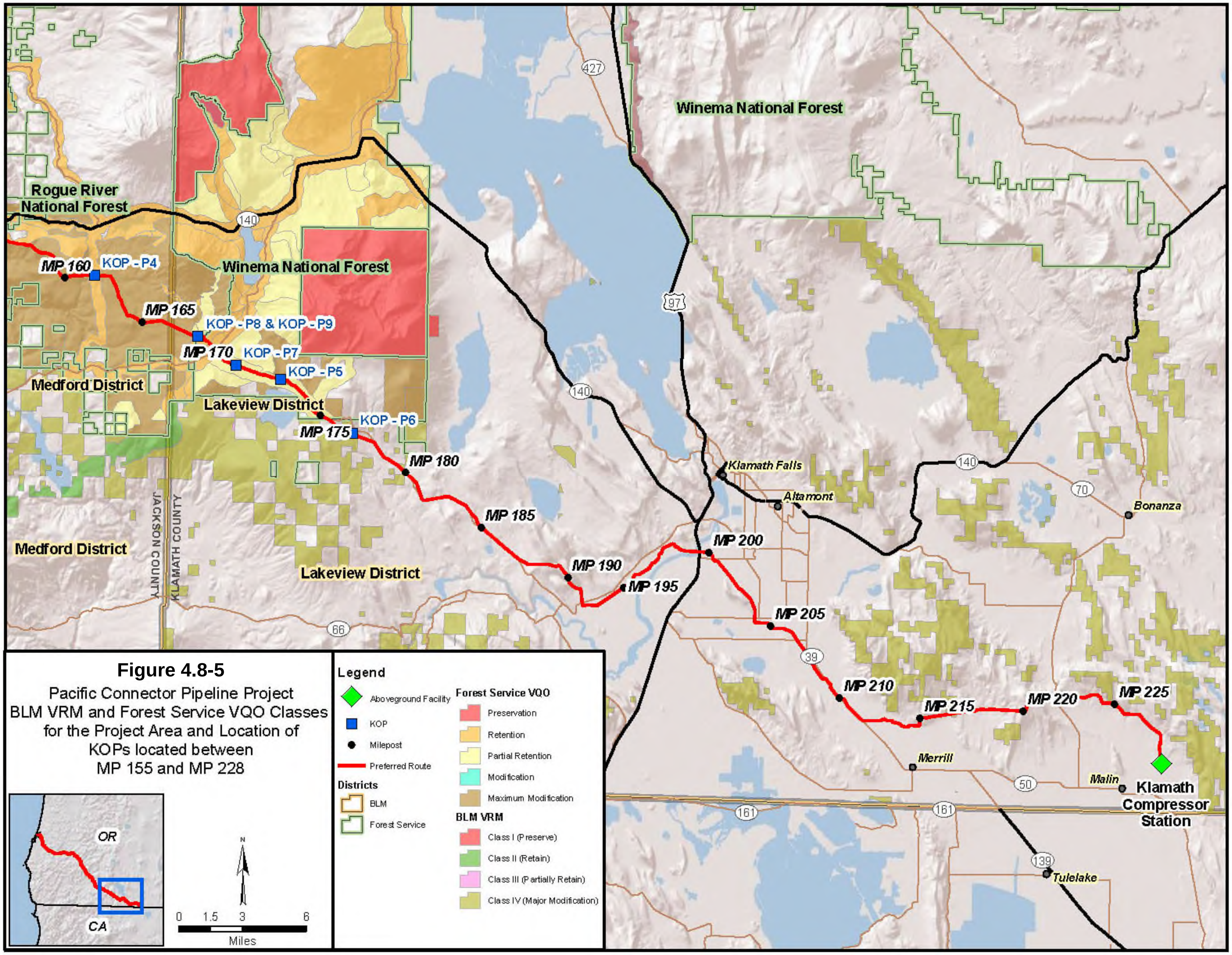


Figure 4.8-5
Pacific Connector Pipeline Project
BLM VRM and Forest Service VQO Classes
for the Project Area and Location of
KOPs located between
MP 155 and MP 228
Legend
Aboveground Facility
KOP
Milepost
Preferred Route
Districts
BLM
Forest Service
Forest Service VQO
Preservation
Retention
Partial Retention
Modification
Maximum Modification
BLM VRM
Class I (Preserve)
Class II (Retain)
Class III (Partially Retain)
Class IV (Major Modification)
0 1.5 3 6
Miles
OR
CA
Rogue River
National Forest
Winema National Forest
Winema National Forest
Medford District
Medford District
Lakeview District
Lakeview District
JACKSON COUNTY
KLAMATH COUNTY
MP 160
MP 165
MP 170
MP 175
MP 180
MP 185
MP 190
MP 195
MP 200
MP 205
MP 210
MP 215
MP 220
MP 225
KOP - P4
KOP - P8 & KOP - P9
KOP - P7
KOP - P5
KOP - P6
Klamath Falls
Altamont
Bonanza
Merrill
Malin
Tulelake
Klamath
Compressor
Station

Visual Simulations

Photographs of existing visual conditions were used in preparing computerized visual simulations for each KOP. Because the appearance of the pipeline right-of-way would change with time, a series of simulations were prepared to illustrate how the pipeline right-of-way would look at different timeframes following construction. The KOP photo sets are presented sequentially in appendix K as follows:

- Existing Conditions: How the landscape appeared at the time site photography was conducted.
- Post-Construction (Year 0): The pipeline is in place and backfilled. Soils have been re-contoured, water bars constructed, and cull logs, root wads, and boulders have been scattered across the right-of-way. Seedlings of native trees (Douglas-fir and ponderosa pine) have been planted among the woody debris and boulders, except for a 30-foot-wide corridor directly above the pipeline.
- Post-Construction, Site Repair, and Replanting (Year 5): Douglas-fir and ponderosa pine saplings are starting to show among the woody debris, boulders, and water bars. Grasses are growing across the entire right-of-way. There are no trees growing in a 30-foot-wide corridor directly above the pipeline.
- Year 25: Young Douglas-fir and ponderosa pine trees are growing throughout the right-of-way, except for the 30-foot-wide corridor directly above the pipeline, and some of the woody debris (cull logs and root wads) is beginning to deteriorate. The boulders and water bars remain, and maintenance has occurred to keep only low-growing shrubs and grasses in the 30-foot-wide corridor centered directly over the pipeline.

KOP Analyses

Pacific Connector, with guidance from the Forest Service and BLM, initially selected nine points from which to assess visual and aesthetic impacts. Five points were selected based on their proximity to federal lands with high scenic qualities and associated visual management objectives. A tenth KOP was added later to reflect potential visual impacts at the pipeline crossing of the former Coos Bay Wagon Road, a feature of historic interest. These KOPs would also serve as monitoring points for mitigation. Each KOP is described below.

KOP-P1 ODNRA

KOP-P1 represents views experienced by recreational users at the ODNRA, Horsfall Beach Campground and Day Use Area. KOP-P1 is geographically similar to Viewpoint-3 at and is located north of pipeline MP 0.00 with views of both the LNG terminal and pipeline construction areas (figure 4.8-2). From KOP-P1, visual effects associated with the pipeline would be subordinate to concurrent construction at the proposed LNG terminal, as well as activities associated with nearby industrial areas, air and sea port traffic, and urban development in the Coos Bay region. Visual effects of the pipeline from this KOP are therefore negligible overall. No further visual impact assessment is necessary at this location due to complete visual screening of the pipeline alignment by intervening topography. For this reason, there is no photograph/simulation set for KOP-P1 in the figures that follow.

KOP-P10 Coos Bay Wagon Road

The pipeline would cross the route of the historic Coos Bay Wagon Road on private lands at MP 24.37, about 15 miles southeast of Coos Bay and 2 miles northwest of the community of Fairview. The Coos Bay Wagon Road was a historic backcountry route built in the 1870s to connect Coos Bay and Roseburg, Oregon for freight transportation. The Wagon Road fell into disuse after OR 42 was built in the Coquille River valley during the early twentieth century. Local roads developed along the original road alignment continue to be used as an alternative travel route. KOP-P10 is located where the pipeline would cross the Wagon Road route, which is now a two-lane paved road identified locally as the Sumner-Fairview Road. The KOP represents foreground/middle ground views of the pipeline that would be experienced by travelers on the former Wagon Road route.

Figure K-12a in appendix K provides the existing view from the just outside the proposed pipeline right-of-way, and figures K-12a through K-12c show visual simulations for different stages of construction and restoration (note that for this KOP the set of simulations also includes a view of conditions at Year 10 as requested by the BLM). In Year 0, clearing associated with the pipeline would be visible to road users for approximately 0.25 mile, or approximately one-eighth of a mile on either side of the pipeline crossing. While the pipeline clearing might be visible from locations beyond this area, it is not likely to dominate views or affect landscape character. By Year 10, the right-of-way might not be noticeable to most road users because planted vegetation would mask the corridor unless the viewer is directly adjacent to the 30-foot permanently cleared area.

KOP-P2 Trail Post Office

KOP-P2 is located on private land at the U.S. Post Office in the town of Trail, near MP 123.0 and is representative of the view from Crater Lake Highway (State Highway 62). Simulations show the views to the southeast where the pipeline route crosses private land southwest of the Rogue River HDD crossing. Approximately halfway up the hill, the pipeline would leave private land and cross BLM land designated as VRM Class IV. Existing vegetation depicted in the view from KOP-P2 at the pipeline right-of-way consists of a dense evergreen forest of Douglas-fir and ponderosa pine. There are patches of scrub-oak and manzanita at the right-of-way, and a bare patch of soil north (left) of the right-of-way (figures K-13a and K-13b in appendix K). After pipeline construction, the removed vegetation and exposed earth within the cleared right-of-way would create a moderate to high level of contrast in the short term, until vegetation is re-established. After vegetation is established, the level of contrast would be low to moderate (figure K-13b and K-13c).

KOP-P3 Highway 140 near Little Butte Creek

KOP-P3 is located at MP 145.6, at the point where the pipeline would cross under State Highway 140 near Little Butte Creek on private lands, and represents views to the southeast experienced by travelers along Highway 140 (figures K-14a and K-14b in appendix K). This KOP provides a middle ground/background view of BLM lands classified as VRM Class IV located approximately 2.5 miles southeast of KOP-P3. The pipeline right-of-way would be visible in the foreground where it is located adjacent to Highway 140, and then in the middleground/background where it would be located on a hill on BLM land. Initially, contrast levels would be moderate to high, depending upon the angle of view. Contrast would be reduced over time as vegetation is re-established within the right-of-way.

KOP-P4 Big Elk Road (Forest Road 37)

KOP-P4 represents views to the north experienced by travelers along Big Elk Road (Forest Road 37) at MP 161.4 This road provides access for snowmobilers, anglers, hikers, and others travelling to Lake of the Woods. The pipeline crossing location is located in the Rogue River-Siskiyou National Forest in an area designated with a VQO of Foreground Retention. The pipeline would cross the road at this location in a perpendicular manner, and viewers would experience both foreground and middleground views of the cleared pipeline right-of-way when they are adjacent to or near the road crossing. Simulations show the moderate long-term visual effects of the permanently cleared 30-foot-wide right-of-way that would be visible to passing motorists (figures K-15a and K-15b in appendix K).

KOP-P5, KOP-P6, and KOP-P7 Clover Creek Road

The pipeline would generally parallel Clover Creek Road for approximately 18.2 miles between MP 169.5 and MP 187.7. The Forest Service VQO for MPs 170 and 175 is Partial Retention. The series of three simulations in figure K-16 shows the typical visual effects that would occur in timbered landscapes along this segment of Clover Creek Road.

Simulations prepared for KOP-P5 represent a long-distance view of the right-of-way near MP 172.2 from the perspective of motorists along Clover Creek Road. The simulations show that clearing associated with the pipeline right-of-way would be visible in the immediate foreground, foreground, and middleground from this perspective (figures K-16a and K-16b in appendix K). Contrast created by the clearing of the right-of-way would be reduced over time after restoration, which would involve recontouring, reseeding, scattering of slash across the right-of-way, and replanting.

KOP-P6 represents a second view from the perspective of motorists on Clover Creek Road, near Spencer Creek at about MP 176.8 along the pipeline route, on BLM lands, looking uphill. In this location, the pipeline right-of-way would be immediately adjacent to the road, as shown in figures K-16a and K-16b for KOP-P5 and figures K-17a and K-17b for KOP-P6. The clearing would create a “widening” effect. Contrast created by the clearing of the right-of-way would be reduced over time after restoration, which would involve recontouring, reseeding, scattering of slash across the right-of-way, and replanting.

KOP-P7 represents a third view from the perspective of motorists along Clover Creek Road. KOP-P7 is located at MP 170.1, facing due east and downhill from a motorists’ perspective. There is an existing partial-cut timber harvest area on the north (left) side of the road. Simulations for KOP-P7 show an additional long-distance view of the pipeline right-of-way from along Clover Creek Road. As shown on the post-construction simulation, woody debris (cull logs, slash, and root wads) would be left on the right-of-way to discourage OHV use, which would create visual contrasts. The Year 25 simulation shows pine reforestation on the right-of-way, and in this view, the permanently cleared and maintained area directly over the pipeline would be partially to completely screened from view of the road. This simulation shows the extent of high visual effects of the pipeline, over time, in the immediate foreground, foreground, and middleground of Clover Creek Road (figures K-18a and K-18b in appendix K).

KOP-P8 and KOP-P9, Pacific Crest Trail

The pipeline would intersect the PCT at approximately MP 167.8, in the Fremont-Winema National Forest. At this location, the old-growth forest has a VQO of Foreground Partial Retention to maintain the aesthetic quality of the forest for PCT users. Because the pedestrian landscape has very limited sight distance, only immediate foreground (0 to 300 feet) views are possible. The visual simulations presented in figures K-19 and K-20 in appendix K show the anticipated visible impacts of the pipeline right-of-way and construction work space immediately following construction as well as 5 and 25 years following implementation.

Because the pipeline would create a linear opening in old-growth forest, hikers and equestrians would now have immediate foreground (0 to 300 feet) and foreground (0 to ½ mile) views. In the Year 0 simulation, the pipeline is in place and the trench is backfilled. The right-of-way clearing was "necked down" from 95 feet to 75 feet wide for a length of 300 feet each side of the PCT (the immediate foreground zone). Within this 600-foot-long zone at the PCT, all large diameter trees that are right along the edge of the cleared right-of-way have been retained. All stumps have been flush-cut rather than removed in this area of right-of-way so that equipment can drive over them. All shrubs have been mowed to 6 inches in height in this 600-foot-long zone, rather than stripping the right-of-way to bare ground. The only bare earth was the 10-foot-wide ditch zone. On-site shrubs and ground cover plants were dug from the 10-foot-wide ditch zone, heeled-in root balls in a safe storage location, and then transplanted back into the trench zone. The entire 75-foot-wide right-of-way was seeded with native grasses and forbs for a length of 300 feet each side of the PCT. In this 600-foot-long zone, trees were planted in masses outside of the 30-foot-wide mowed area and would be irrigated via a holding tank and drip system. Beyond 300 feet from the PCT, the right-of-way expanded back to 95 feet wide, and the entire right-of-way was seeded with native grasses and forbs. Seedlings of Douglas-fir and Shasta red fir were planted in the right-of-way outside the 30-foot-wide mowed zone, and logs were placed in the right-of-way. At Year 5, Douglas-fir and Shasta red fir trees are growing larger, and grasses and forbs are growing across the entire right-of-way. At Year 25, Douglas-fir and Shasta red fir trees are growing larger and some of the logs are beginning to lose their bark. Maintenance has occurred to keep only low-growing shrubs, forbs, and grasses in the 30-foot-wide corridor centered directly over the pipeline.

KOP-P8 represents a hiker's perspective walking northbound on the PCT, looking ahead from the old-growth forest into the 75-foot-wide cleared right-of-way at approximately MP 167.8 and beyond. This vantage point is located between two large trees and is the first opportunity to see the right-of-way clearing, which extends from 67 feet to 142 feet ahead of the camera position. A hiker is shown in the photographs and simulations to represent human scale (figures K-19a and K-19b).

For a typical hiker or equestrian, the duration of view would be short, because it does not take long to walk or ride a few hundred feet along the PCT. The right-of-way would create an opening that would allow more sunlight into this area. The interpretive sign would call attention to the pipeline and explain the changes in the characteristic landscape. As seen from KOP-P8, the overall visual effect would achieve the Foreground Partial Retention VQO.

KOP-P9 is from a hiker's perspective standing in the middle of the 30-foot-wide cleared area over the right-of-way, looking west from a short distance (48 feet) east of the PCT (figures K-20a and K-20b). The pipeline clearing would extend to the west and then make a dogleg to the northwest, thereby reducing the length of the "tunnel effect" of the right-of-way clearing. If the viewer turned around at this location and looked east, a similar dogleg would be limit the visibility of the right-of-way in that direction. Both of these doglegs reduce the extent of right-of-way clearing that would be visible from the PCT. Duration of view from this vantage point would be longer than for KOP-P8 because the viewer has walked off the trail and stopped to survey the landscape. The right-of-way would create a different viewing experience because of its linear form; however, revegetation with trees, grasses, and forbs, plus placement of logs in the right-of-way, would partially retain the surrounding landscape character. Because of the restoration efforts, the pipeline right-of-way would remain visually subordinate to the characteristic landscape. The interpretive sign would call attention to the pipeline and the changes in the characteristic landscape, causing viewers to stop and look more carefully. As seen from KOP-P9, the overall visual effect would achieve the Foreground Partial Retention VQO.

Visual Impacts

Short-Term Visual Impacts

Construction impacts on visual resources would result from the presence of equipment, materials, and workers along the pipeline right-of-way, at TEWAs and staging areas, and along access roads. Visual effects would also result from the alteration of landforms and vegetation along the right-of-way during construction. Excavation for the pipeline would expose sub-grade soils that would contrast with the color of the existing land surface and the forest canopy. Visual contrast in color, line, and texture between the disturbed, vegetated ground and the adjacent vegetation would be most noticeable in the short term (0-5 years after construction) while the right-of-way is in the process of revegetating. Vehicles, heavy equipment, helicopters, pipeline components, and workers would be visible during site clearing, grading, trenching, pipeline transport, welding, laying in, backfilling, and site/right-of-way cleanup and restoration. Construction equipment and activities would be seen by various viewers close to the sites and pipeline corridor, including adjacent and nearby residents, recreationists on trails and roads, motorists on public roadways and, in some cases, pedestrians. Much of the Pacific Connector pipeline route is in remote locations seldom visited by the public, although visitors in such remote areas may be relatively sensitive to changes in visual quality. Where visible, view durations would vary from brief to extended periods. Construction activities would be most visible for those elements of the pipeline in close proximity to residential neighborhoods and adjacent to major travel corridors, including highways and the PCT; however, these effects would be temporary and would be limited to the construction period. Revegetation and restoration efforts, including placement of slash on the right-of-way in forested areas, would serve to mitigate the visual contrast in color, line, and texture.

Amendments to the Rogue River-Siskiyou and Fremont-Winema National Forest LMPs would be necessary to address consistency with specific standards and guidelines related to VQOs. These amendments would acknowledge the short-term visual effects that would occur that would be inconsistent with current management direction. They would allow for an extended period of time for the areas to recover and meet the VQOs in a reasonable amount of time.

Long-Term Visual Impacts

Pipeline

The landscape setting along the pipeline route is varied, ranging from flat valley floors and agricultural fields, to rolling hillsides covered with oak and madrone woodlands, to steep mountainsides and sharp ridgelines covered with mixed conifer forests. On flat terrain in agricultural settings, the right-of-way would be restored following construction and ranchers/farmers would be allowed to grow shallow-rooted crops over the pipeline. Construction work areas would normally be difficult to distinguish from surrounding areas. Therefore, no long-term visual effects would result from installation of the pipeline in agricultural areas.

In the mountainous terrain, many of the existing landscapes that would be traversed by the pipeline have already been affected by timber harvests, including large clear-cuts. Existing scenic integrity in these areas is low, and the introduction of the pipeline should not create long-term visual contrasts in these settings.

The greatest long-term visual effects would occur where the new right-of-way would create new clearings through forestlands not characterized by large-scale timber harvests. The clearing of the right-of-way would create a sharp-edged linear feature across contiguously forested landscape. The appearance of the corridor would be similar to transmission line corridors. Revegetation and restoration, including replacement of slash in the right-of-way, would be initiated following construction and would mitigate the visual contrast in color, line, and texture. Contrast might also be increased where surface rock or stumps would be scattered across the right-of-way or placed in piles at road crossings to create OHV barriers or habitat features. Over time, contrast would decrease as the right-of-way is revegetated, narrows in width because of revegetation, and becomes more similar in texture and color to the surrounding forest lands. After successful restoration, the cleared area around the right-of-way would be reduced to the 30-foot permanently cleared area, further reducing contrast with the surrounding forested area.

The right-of-way might be noticeable to the casual observer depending on the distance, line-of-sight, topographic, and vegetation conditions at the viewpoint as well as the conditions along the Pipeline right-of-way. The corridor would be most apparent when viewed from a location in-line with the right-of-way, and might not be visible when viewed from a perpendicular location due to vegetative screening. Where it crosses ridges, the cleared right-of-way might be visible as a "notch" in the treeline from perpendicular or near-perpendicular viewpoints. Many forested areas crossed by the pipeline are away or visually screened from roads, trails, and populated areas, and therefore are not immediately visible to viewers.

Aboveground Facilities

The aboveground facilities proposed by Pacific Connector would be long-term structural features on the landscape. A detailed description of the aboveground facilities is provided in chapter 2. The MLV sites are all located within the pipeline ROW, and consist of a 50-foot x 75-foot (0.9 acre) site that would be enclosed by a 7-foot-high, chain-link fence. Five of the MLVs would require a 40-foot-tall tower to be installed within the site. Pacific Connector has attempted to locate MLVs adjacent to existing roads to facilitate access and minimize the length of new access roads, and to set block valves back from crossings in sensitive viewsheds. Where not screened by topography or vegetation, the MLV sites would be visible to roadway travelers. On federal lands, all aboveground piping would be painted with a color approved by the managing federal agency in order to meet visual quality objectives and visual screening would be implemented. The MLVs would all be located within the pipeline right-of-way and therefore, with the mitigation measures applied to federal lands, would have low effects on visual quality of the surrounding area. MLV 13 was previously located adjacent to the Dead Indian Memorial Highway, but has been relocated back from Clover Creek Road and accessed from an existing private road to screen the block valve from view.

The Klamath Compressor Station (MP 228.1) would have visual effects on nearby residents and travelers along Malin Loop Road and Morelock Road (figure 4.8-6). The location is on private land in a rural area that is relatively flat and is currently covered by grasses, sage, and juniper. To reduce visual contrast, the buildings at the compressor station would be painted a color selected to blend as well as possible with the surrounding landscape, and portions of the outward facing sides of the station would be landscaped to reduce potential visual effects on area residences. The station would be surrounded by a 7-foot-tall chain-link fence with screening slats. The station would include exterior lighting to be used only when operations personnel are actively performing nighttime work at the station. Pacific Connector has stated that during operation of the station nighttime work or maintenance activities would generally not be scheduled; therefore, these lights would only be used periodically and possibly for short periods during the winter when daylight working hours are shorter. Pacific Connector has not identified specific lighting arrangements, although standard practice is for outside lights at infrastructure facilities such as compressor stations to be shrouded to direct light to the specific work areas within the station.

Pacific Connector anticipates that communications towers would be required at the compressor meter stations, several automated MLVs, and at leased space on existing communication towers (see chapter 2 for location descriptions). The towers at the meter stations, compressor station, and automated MLVs would be located within the fenced facility sites. The Communication Facilities Plan[164] describes the construction, modification, operation, and maintenance of communication facilities on lands managed by the BLM and the Forest Service.

The proposed communication facilities are not expected to significantly alter or impair the visual setting. Pacific Connector would co-locate communications towers with existing facilities whenever possible, if leased space is available within existing facility sites at the time of construction. If construction of new facilities is required, Pacific Connector would seek to obtain an approximate 100-foot by 100-foot (0.23 acre) area for each of the new tower installations in the immediate vicinity of the existing communication tower facilities. A variance would be needed to allow installation of any new tower under such conditions. Because additional towers are anticipated to be co-located with existing tower facilities, they are not expected to impair the existing visual setting.

Proposed Mitigation Measures

Pacific Connector produced an *Aesthetics Management Plan*[165] that outlined measures to reduce visual impacts along its pipeline route. Generally, these measures include:

- reducing the width of the right-of-way and elimination of TEWAs at sites with high visual sensitivity;
- strategic alignment of the right-of-way where it crosses roads or trails to reduce the visible extent of the corridor (for example, crossing roads or trails at right angles);
- strategic placement of construction debris (slash, stumps, and boulders) in visually sensitive areas;

[164] Appendix D of Pacific Connector's POD filed with the FERC in January 2018.
[165] Appendix A to Pacific Connector's POD filed with the FERC in January 2018.

- place natural barriers where the right-of-way opening is adjacent to trails and roads to prevent potential unauthorized OHV use;
- clear additional timber outside the right-of-way in selected locations to scallop and feather the edges of the clearing, to reduce the hard line of forested lands adjacent to the right-of-way;
- revegetation of the right-of-way after pipeline installation, including planting trees in TEWAs that were cleared of forest or woods and strategic placement of trees to help reduce contrast between the cleared right-of-way and surrounding forest lands;
- planting rows or clusters of trees and shrubs across the right-of-way (outside of the 30-foor permanently cleared corridor) to provide visual screens at specific sensitive trail or road crossings, using native species whenever possible; and
- painting aboveground facilities in color schemes that would blend into the background landscape.

It should be noted that some visual mitigation measures are not shown in the visual simulations. These include opportunities for revegetation with large-sized trees (tree-spade efforts), forest edge scalloping, and/or feathering treatments to decrease stand density contrasts at the right-of-way edges. Therefore, these simulations represent a worst-case scenario at each KOP.

4.8.2.3 Environmental Consequences on Federal Lands

Visual Resources on Federal Lands

Regulatory Setting and Visual/Scenic Management Systems

The responsibility of protecting visual resources on lands owned or under the jurisdiction of the federal government is established by FLPMA, which places emphasis on the protection of scenic resources on public land, and the Forestland and Rangeland Renewable Resources Planning Act (1974) which empowers the Forest Service to manage scenery resources. The National Forest Management Act (1976) required the completion of Forest Plans that established VQOs for the National Forests.

NFS Lands

The Forest Service seeks to manage NFS lands to attain the highest possible quality of landscape aesthetics and scenery commensurate with other appropriate public uses, costs, and benefits. Scenic integrity is defined as "*a measure of the degree to which a landscape is visually perceived to be* "*complete.*" The highest scenic integrity ratings are given to those landscapes that have little or no deviation from the character valued by constituents for its aesthetic appeal. Scenic integrity is used to describe an existing situation, standard for management, or desired future condition" (Forest Service 1995b).

National Forests use a Visual Management System (VMS) to manage visual resources on NFS lands and to analyze visual effects of proposed projects. The VMS has a rating system known as VQO to establish standards for scenery resource management. The VMS was outlined in FSH 462, published in 1974. Since then, scenery management on NFS lands has been updated by Handbook 701, which introduced the Landscape Aesthetics, Scenery Management System (SMS). The SMS utilizes a rating system similar to VMS to evaluate project impacts on visual quality. The SMS is based on the relative scenic quality of each portion of the landscape and its sensitivity based on the visibility from, and uses in, the surrounding areas. The SMS uses Scenic Integrity Objectives to establish the desired conditions for management of an area.

Under the former VMS system, management prescriptions and related VQOs were developed for all NFS lands. VQOs for each national forest crossed by the pipeline are identified in their respective LRMPs. VQOs are management standards that identify five degrees of alteration to the natural landscape based on a landscape's diversity of natural features and the public's concern for scenic quality. Because the aforementioned forest plans have not been amended to use the SMS, both VMS and SMS are used in this EIS section. A crosswalk between the two systems is described in *Landscape Aesthetics: a Handbook for Scenery Management* (Forest Service 1995b), and summarized in table 4.8.2.3-1.

BLM Lands

The BLM has a Visual Resource Management (VRM) system that is comparable to the Forest Service VMS. Based on a matrix of three factors (scenic quality, sensitivity level, and distance), BLM lands are placed into one of four visual resource inventory classes (table 4.8.2.3-2). These classes represent the relative value of the visual resources, Class I (Preserve Character) and Class II (Retain Character) being the most restrictive, Class III (Partially Retain Character) relatively less restrictive, and Class IV (Major Modification of Character) being least respective. The class objectives describe the different degrees of modification, or contrast, allowed to the basic visual elements of the landscape in each class. VRM management classes are then established through the RMP process and adjusted as necessary to reflect the resource allocation decisions made in RMPs.

The Pacific Connector pipeline route would cross 46.9 miles of BLM lands that are classified as VRM Class IV in the 2016 Southwestern Oregon and Northwestern and Coastal Oregon ROD/RMPs. VRM Class IV areas allow high levels of change from projects to the characteristic landscape. Management activities may dominate the view and will be the major focus of viewer attention. The construction, operation, and maintenance of the pipeline would be consistent with the objectives of this class.

TABLE 4.8.2.3-1

Forest Service Crosswalk Between Visual Quality Objectives, Scenic Integrity Objectives, and Scenic Integrity Levels a/

Visual Management System (VMS) 1973 Direction **Visual Quality Objective (VQO)**	**Scenery Management System (SMS) 1995 Direction** **Scenic Integrity Objective (SIO)**	**Definition of Scenic Integrity Levels**
Preservation	Very High	*Unaltered*: Valued landscape character "is" intact with only minute if any visual deviations. The existing landscape character is expressed at the highest possible level.
Retention	High SIO	*Appears unaltered*: Landscapes where the valued landscape character "appears" intact. Visual deviations (human-made structures or activities) may be present but must repeat the form, line, color, texture, and pattern common to the landscape character so completely and at such a scale that they are not evident.
Partial Retention	Moderate SIO	*Appears slightly altered*: Noticeable deviations must remain visually subordinate to the landscape character being viewed.
Modification	Low SIO	*Appears Moderately Altered*: Visual deviations (human-made structures or activities) begin to dominate the valued landscape character being viewed but they borrow valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed but compatible or complimentary to the character within.
Maximum Modification	Very Low SIO	*Appears Heavily Altered*: Visual deviations (human-made structures or activities) may strongly dominate the valued landscape character. They may not borrow from valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles within or outside the landscape being viewed. However deviations must be shaped and blended with the natural terrain (landforms) so that elements such as unnatural edges, roads, landings, and structures do not dominate the composition.
For Inventory and Scenic Effect Prediction Purposes Only		
Unacceptable Modification UM	Unacceptably Low	*Extremely altered*: Landscapes where the valued landscape character being viewed appears extremely altered. Visual deviations (human-made structures or activities) are extremely dominant and borrow little if any form, line, color, texture pattern or scale from the landscape character. Landscapes of this level of integrity need rehabilitation. This level should only be used to inventory existing integrity. It must not be used as a management objective.

a/ Scenic Integrity Objectives establish desired conditions for management (equivalent to purpose of Visual Quality Objectives under former VMS); Scenic Integrity Levels describe the current condition of the scenic resource.

TABLE 4.8.2.3-2

BLM Visual Resource Management Classes

VRM Class	Definition
Class I Preserve Landscape Character	Manage Visual Resource Management Class I areas in accordance with natural ecological changes. Prohibit activities that would lower the Visual Resources Inventory class of Visual Resource Management Class I areas. The level of change to the characteristic landscape will be very low and will not attract attention. Changes will repeat the basic elements of form, line, color, texture, and scale found in the predominant natural features of the characteristic landscape.
Class II Retain Landscape Character	Manage Visual Resource Management Class II areas for low levels of change to the characteristic landscape. Management activities will be seen but will not attract the attention of the casual observer. Changes will repeat the basic elements of form, line, color, texture, and scale found in the predominant natural features of the characteristic landscape.
Class III Partially Retain Landscape Character	Manage Visual Resource Management Class II areas for low levels of change to the characteristic landscape. Management activities will be seen but will not attract the attention of the casual observer. Changes will repeat the basic elements of form, line, color, texture, and scale found in the predominant natural features of the characteristic landscape.
Class IV Major Modification of Landscape Character	Visual Resource Management Class IV includes all lands that are not designated as Visual Resource Management Classes I, II, or III. Manage Visual Resource Management Class IV areas for high levels of change to the characteristic landscape. Management activities may dominate the view and will be the major focus of viewer attention.

Sensitive Viewsheds on Federal Lands

The federal land managing agencies identified areas they consider possessing sensitive viewsheds along the pipeline route and, as appropriate, developed site-specific amendments to LMPs to ensure compliance with the LMPs if the Project were authorized. Pacific Connector outlined measures it would implement to reduce visual impacts at those areas in its *Aesthetic Management Plan for Federal Lands* (Appendix A to the POD). Table 4.8.2.3-3 lists the sensitive viewsheds on federal land, their visual objective classes, and proposed mitigation measures.

TABLE 4.8.2.3-3

Sensitive Viewsheds on Federal Lands and Proposed Mitigation Measures

MPs	Viewshed Area	Agency/Unit	Visual Class or Objective	Sensitivity Level	Mitigation Methods a/
161.07-161.64	Big Elk Road (FS Road 37) – South Fork Little Butte Valley	Forest Service – Rogue River National Forest	VQO – Foreground Retention	High	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 13
167.49-167.93	PCT	Forest Service – Rogue River National Forest	VQO – Foreground Partial Retention	High	1, 2, 3, 4, 5, 6, 10, 13
156.3 to 156.8 and 157.2 to 157.5	Little Butte Creek	Forest Service – Rogue River National Forest	Middleground Partial Retention	Moderate	1, 2, 6, 12, 13
168.40-169.00	Dead Indian Memorial Highway	Forest Service – Winema National Forest	VQO – Foreground Retention	High	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
169.00-174.40 176.15-176.45; 176.60-177.04	Clover Creek Road	Forest Service – Winema National Forest	VQO - Foreground Partial Retention	Moderate-High	1, 2, 3, 4, 5, 6, 7, 8, 10

a/ 1 – Mulch right-of-way and use colorant of dark brownish green for hydro-mulch;
2 – Scallop and feather edges of the right-of-way by removing or cutting some tall trees as directed by land manager;
3 – Transplant trees 15-20 feet tall in clusters spaced 660 feet apart;
4 – Transplant trees in clusters in TEWAs and combine with partly buried boulders;
5 – Bury root wads and boulders in foreground along right-of-way;
6 – Reduce soil compaction according to the ECRP;
7 - Plant 1-2 gallon-sized shrubs and protect them with plant guards;
8 – Construct a berm with boulders to discourage OHV access;
9 – Screen corridor from viewer by leaving trees near roadway and transplanting trees 15-20 feet tall in foreground;
10 – Plant deciduous trees and shrubs such as willow, ceanothus, ribes, huckleberry and chinquapin;
11 – Recontour cut bank to discourage OHV access;
12 – Fund Forest Service tree thinning activities
13 – Necking-down, or narrowing, construction corridor.
b/ This VRM class is inconsistent with figure 4.8-16. The VRM Class shown here is correct.

Visual Resources Specific to Consistency with Federal LMPs

BLM Lands

BLM lands crossed by the Pacific Connector Pipeline Project are VRM Class IV where high levels of change in the landscape character are permitted. The Pacific Connector Pipeline would meet the VRM Class IV standards on all BLM lands.

NFS Lands

Umpqua National Forest

The VQO for all lands crossed by the Pacific Connector Pipeline Project on the Umpqua National Forest is Maximum Modification. The pipeline would be within the VQO standards of Maximum Modification upon completion of corridor restoration and revegetation.

Rogue River National Forest

The Pacific Connector pipeline would meet the VQOs of the Rogue River National Forest LRMP with the following three exceptions:

(1). At the crossing of the Big Elk Road at Pacific Connector pipeline MP 161.4 in Section 16, T. 37 S., R. 4 E., W. M., Oregon.

This location has a VQO of Foreground Retention (Management Strategy 6, Rogue River National Forest LRMP, page 4-72). Standards and guidelines for Foreground Retention where the Pacific Connector pipeline route crosses the Big Elk Road require that VQOs be met within one year after completion of the Project and that management activities not be visually evident. The pipeline project would not meet that standard at that location. Amendment RRNF-2 of the Rogue River National Forest LRMP is proposed at this location to make provision for the Pacific Connector pipeline. This proposed amendment would change the VQO at this location to Foreground Partial Retention (Management Strategy 7, LRMP page 4-86) and allow 10 to 15 years for the amended VQOs to be attained. The Big Elk Road in the vicinity of the Pacific Connector pipeline crossing would be affected by this proposed amendment. This is a site-specific amendment that would apply only to the Pacific Connector pipeline. It does not change VQOs for any other project.

Temporal and Spatial Boundaries of Impacts

This proposed change would affect about 5 acres in the year of construction and approximately 2 acres after 10 years. The 5 acres represents the 75-foot-wide construction right-of-way as seen from Big Elk Road. The 2 acres represents the area seen from Big Elk Road associated with the 30-foot-wide operational permanent easement for the pipeline that would be kept clear of tall trees (more than 15 feet tall) 10 years after right-of-way restoration and revegetation. This would not achieve the Forest Plan goals and objectives of a natural appearing forest at that location one year after construction. Drivers passing the corridor would be able to see it for approximately 15 to 20 seconds. This change would affect only recreation and VQOs in the vicinity of the Big Elk Road–Pacific Connector pipeline intersection. No other LRMP goals and objectives would be affected by this change.

(2). At the crossing of the PCT at Pacific Connector pipeline MP 168 in Section 32, T. 37 S., R. 5 E., W. M., Oregon

This location has a VQO of Foreground Partial Retention (Management Strategy 7, Rogue River National Forest LRMP page 4–86). Standards and guidelines for Foreground Partial Retention require that VQOs be met within three years of completion of the Project, and that activities be visually subordinate to the landscape. The Pacific Connector pipeline would not meet that standard at that location. Amendment RRNF-3 is proposed at this location to change the VQO to Modification (USDA Forest Service Agricultural Handbook 478) and to allow five years for amended VQOs to be attained. The PCT in the vicinity of the Pacific Connector pipeline crossing would be affected by this proposed amendment. This is a site-specific amendment that would apply only to the Pacific Connector pipeline. It does not change VQOs for any other project.

Temporal and Spatial Boundaries of Impacts

This proposed change would affect approximately 5 acres of seen area in the year of construction. The 5 acres would encompass the 75-foot-wide pipeline construction right-of-way seen from the PCT. Vegetation growth and mitigation measures would reduce the seen area to approximately 2 acres after five years. This would not achieve the Forest Plan goals and objectives of a natural appearing forest at that location within 3 years after construction. Hikers and horseback riders passing the corridor would be able to see it for approximately 1 to 3 minutes. This change would affect only recreation and VQOs in the vicinity of the PCT–Pacific Connector pipeline intersection.

(3). Along the ridgetop south of State Highway 140 between Pacific Connector pipeline MPs 156.3 to 156.8 and 157.2 to 157.5 in Sections 11 and 12, T. 37 S., R. 3 E., W. M., Oregon

This location has a VQO of Middleground Partial Retention. Standards and guidelines for Middleground Partial Retention (Management Strategy 9, Rogue River National Forest LRMP Page 4– 112) require that VQOs for a given location be achieved within 3 years of completion of the Project. The Pacific Connector pipeline would not meet this standard at that location. Amendment RRNF-4 of the Rogue River National Forest LRMP is proposed at this location to make provision for the pipeline project. This proposed amendment would allow 10 to 15 years to meet the Middleground Partial Retention standard at this location. Approximately 0.8 mile or 9 acres of the Pacific Connector right-of-way in the Middleground Partial Retention VQO visible at distances of 0.8 to 5 miles from State Highway 140 would be affected by this proposed amendment. This is a site-specific amendment that would apply only to the Pacific Connector pipeline. It does not change VQOs for any other project.

Temporal and Spatial Boundaries of Impacts

This proposed change would affect approximately 9 acres or about 0.8 mile of the pipeline corridor as seen from Highway 140 in the year of construction. For the next 10 to 15 years, the pipeline corridor would remain visually dominant to the surrounding landscape but would become less evident each year. Vegetation growth and mitigation measures would allow the area to meet the assigned VQO of Middleground Partial Retention after 10 to 15 years.

This proposed amendment would not change VQOs, but instead allow more time to meet the VQO of Middleground Partial Retention as seen from Highway 140. To the degree that travelers look up as they are headed west on Highway 140, this location would be visible from a distance of 0.8 to 5 miles for a few minutes. Duration would depend on travel speed but would likely be less than 10 minutes, and would likely not be continuous because of the height of roadside trees and line of sight from the highway. This location would not be visible from other key observation points or travel routes such as the Big Elk Road.

Winema National Forest

The Pacific Connector pipeline would meet the VQO of the Winema National Forest LRMP with the following exceptions:

(1). Where the Pacific Connector right-of-way crosses the Dead Indian Memorial Highway at approximately pipeline MP 168.8 in Section 33, T. 37 S., R. 5 E., W. M., Oregon

This location has visual standard of Foreground Retention. Standards and guidelines for Scenic Management, foreground retention (Winema National Forest [WNF] LRMP 4–103, Management Area 3A, Foreground Retention) requires visual standards for a given location be achieved within one year of completion of the Project. The Pacific Connector pipeline would not meet that standard at that location. Amendment WNF-2 is proposed to allow 10 to 15 years to meet the specified visual standard at this location. This is a site-specific amendment that would apply only to the Pacific Connector pipeline in the vicinity of the Dead Indian Memorial Highway and would not change future management direction for any other project.

Temporal and Spatial Boundaries of Impacts

This proposed amendment would affect about 3 acres of Management Area 3A initially, but over a period of 10 to 15 years, the affected area would decrease to around one-quarter of an acre because of the growth of vegetation at the highway crossing. Installing the pipeline across Dead Indian Memorial Highway would create a corridor that would be visible for about 10 to 15 seconds for travelers along the highway. The area affected by pipeline construction at the crossing would be much less than one percent of Management Area 3A. This is a project-specific amendment that would affect only and recreational experiences in a limited area. This proposed amendment would not change visual standards, but instead allows more time to meet the visual standards of foreground retention as seen the Dead Indian Memorial Highway.

(2). Where the Pacific Connector right-of-way is adjacent to the Clover Creek Road from approximately pipeline MP 170 to 175 in Sections 2, 3, 4, 11, and 12, T. 38 S., R. 5 E., and Sections 7 and 18, T. 38 S., R. 6 E., W. M., Oregon

This location has a visual standard of Foreground, Partial Retention. Standards and guidelines for Foreground Partial Retention (LRMP, page 4–107, Management Area 3B) require that visual standards be met within three years of completion of a project. The Pacific Connector pipeline cannot meet that standard at that location in three years after construction. Amendment WNF-3 is proposed to allow 10 to 15 years to meet the standard of Foreground, Partial Retention at this location. This is a site-specific amendment that would apply only to the Pacific Connector pipeline in the vicinity of the Clover Creek Road and would not change future management direction for any other project.

Temporal and Spatial Boundaries of Impacts

The Winema National Forest LRMP would be amended to allow 10 to 15 years to meet the VQO for Scenic Management, Foreground Partial Retention from MPs 170 to 175. This change would potentially affect approximately 50 acres and 6 miles of corridor as seen from the Clover Creek Road. This is a site-specific amendment that would apply only to the Pacific Connector pipeline in the vicinity of Clover Creek Road and would not change future management direction for any other project. Over a period of 10 to 15 years, the affected area would decrease to about 29 acres because of changes in vegetation. Initially, the affected area would be visually evident for the entire 5 miles on NFS lands adjacent to the Clover Creek road. Over time, this would become less visually evident because of the ingrowth of vegetation and mitigation measures adopted by the Pacific Connector pipeline. At an average speed of 40 mph, the 5-mile-long area affected by this amendment would be visible for approximately 10 to 12 minutes.

4.8.2.4 Conclusion

Constructing and operating the Jordan Cove LNG Project would result in substantial short-term and long-term changes to the existing landscape within the viewshed of the Project. As described in the preceding sections, the LNG tanks and related facilities at the terminal would be visible from a range of viewpoints within the surrounding area and the visual effects were assessed to be low to high dependent on the user and viewpoint location. Jordan Cove attempted to optimize design factors for the LNG tanks and has adopted various measures to mitigate for the visibility of the Project facilities, including use of landform contouring and stabilization, vegetative screening, architectural treatments, and use of hooded lighting. However, based on the size and location of the proposed LNG facilities we conclude that the Jordan Cove LNG portion of the Project would significantly affect visual resources for some views and viewing locations.

Constructing and operating the Pacific Connector Pipeline Project would result in short-term and long-term visual effects as described in the preceding sections. However, Pacific Connector's proposed procedures and mitigation measures are expected to result in reduction of the long-term visual contrast in color, as well as line and texture created by clearing of the pipeline right-of-way. Measures such as structure co-location, painting, landscaping, and screening are expected to limit the visual effects of the associated aboveground Project facilities. Based on the proposed construction, operation, and minimization measures, the Project, excluding the LNG facility, would not significantly affect visual resources.

4.9 SOCIOECONOMICS

This section addresses the potential effects of Project construction and operation on the following components of the social and economic environment: population, housing, the local economy and employment, infrastructure and public services, recreation and tourism, other commercial activities, and environmental justice. The following discussion is divided into two main sections that address the Jordan Cove LNG Project and Pacific Connector Pipeline Project separately. Both projects would involve construction and operation activities in Coos County. Potential impacts to Coos County are discussed separately by Project, with the combined impacts of both Projects discussed in section 4.9.2.

4.9.1 Jordan Cove LNG Project

4.9.1.1 Population

The closest cities to the Jordan Cove LNG Project are North Bend and Coos Bay. These two cities had estimated 2017 populations of 9,800 and 16,615, respectively (see table 4.9.1.1-1). The total estimated population of Coos County in 2017 was 63,310.

TABLE 4.9.1.1-1

Population by State, County, and Community

State/County/Community	2000	2010	2017	2010 to 2017 Net Change	2010 to 2017 Percent Change
Oregon	3,421,399	3,831,074	4,141,100	310,026	8.1%
Coos County	62,779	63,043	63,310	267	0.4%
City of Coos Bay	15,374	15,967	16,615	648	4.1%
City of North Bend	9,544	9,695	9,800	105	1.1%

Source: Portland State University 2012, 2017a, 2017b

As described previously, Jordan Cove estimates that construction of the Jordan Cove LNG Project and associated facilities would take place over a roughly 5-year period. Following an initial 9-month period of site clearing, construction of the Jordan Cove LNG Project would occur over a 53-month construction period. Jordan Cove's estimated construction workforce would average 1,023 workers over the 53-month construction period, with projected employment expected to peak in month 30 with an estimated 1,996 workers employed on site (ECONorthwest 2017a). Construction would require workers in highly skilled crafts, such as pipefitters, ironworkers, electricians, carpenters, and management staff, including safety specialists. Jordan Cove anticipates that the workers hired will already have these skills, having gained experience in other related industries, including the oil and gas and power industries.

Jordan Cove estimates that an average of 221 workers would commute daily from their normal place of residence to the Project site, leaving an estimated average of 802 workers temporarily relocating to the Project vicinity. A portion of this workforce would be accompanied by family members, resulting in the total estimated addition of an average of 901 people (workers and family members) to the Project vicinity. The addition of 901 people would be equivalent to approximately 3.4 percent of the combined populations in the cities of Coos Bay and North Bend in 2017 (26,415), and approximately 1.4 percent of the total county population (63,310) (table 4.9.1.1-1).

At the peak of construction, an estimated total of 1,752 people would temporarily relocate to the Project vicinity (ECONorthwest 2017a). This temporary increase would be equivalent to about 6.6 percent of the combined populations of Coos Bay and North Bend and 2.8 percent of the county total (table 4.9.1.1-1). These estimated peak population increases would be temporary and short term. Very few, if any, of the temporary construction workers relocating to the Project area are expected to stay permanently. Impacts associated with construction-related population increases are discussed throughout this section.

In the first full year of operations, Jordan Cove would directly employ 200 workers in Oregon, 180 at the Jordan Cove LNG Project and 20 at the company office in Portland. Unlike construction, once the Project is operating, the employees would live permanently near their workplaces. Workers would either be hired locally or permanently relocate to the area. ECONorthwest (2017a) estimated that about 40 percent of the operating workforce at the Jordan Cove LNG Project would be hired locally, with the remaining 60 percent relocating to Coos County from out-of-state or elsewhere in Oregon. Assuming an average household size of 2.74, this would result in the addition of 296 new residents, which would be equivalent to about 1.1 percent of the combined populations in the cities of Coos Bay and North Bend in 2017.

Crime

We received several comments on the Project that expressed concern that the temporary influx of construction workers and the development of "man-camps" would result in increases in crime, drug and alcohol use, prostitution, human trafficking, and domestic violence, as well as other criminal activities. Local tribal members also expressed concern about the potential for increased crime to disproportionally affect Native Americans and suggested that staff consider natural resource development impacts on crime in North Dakota and Wyoming. Based on this concern and to assess the Project's potential impact on crime rates, we reviewed existing published literature that considers the link between crime and natural resource development, as well as (based on historical patterns) the potential for disproportionate impacts on tribal communities. Most of the research into the link between natural resource development and crime focuses on "boomtowns," where large-scale resource development, especially oil and gas extraction, has resulted in rapid population growth that has weakened existing social ties in the affected communities (O'Connor 2017). Some might consider the introduction of a workforce to construct the Project as analogous to a "boomtown"; however, the number of individuals that are expected to temporarily migrate to the Project area would, as described above, result in a minor increase in the local population.

Based on official crime statistics and interviews with law enforcement officers, studies in North Dakota and Wyoming found that the crimes that increased the most during boom periods included traffic-related crimes (e.g., driving under the influence), felony and simple assault, disorderly conduct, drug-related crimes, thefts, burglaries, and domestic violence (Archbold 2015; Archbold et al. 2014; Jacquet 2005; Jayasundara et al. 2016). Police officers in North Dakota attributed the increase in domestic violence calls to housing shortages and cramped living quarters and stated that violent crimes in their jurisdictions were not increasing to the extent that local, regional, and national media outlets reported (Archbold 2015). Some articles (Harvard 2015; Adler and Hillstrom 2015; Gillette 2016; Briody 2017; Deer and Nagle 2017; Nienaber 2017) have focused on the Bakken Oil Field in North Dakota, near the Fort Berthold Indian Reservation. These articles focus on links between semi-permanent worker camps and negative impacts on female Native

American populations. The influx of large numbers of well-paid male oil workers at the North Dakota camps coincided with increases in sex trafficking, rape, and physical violence.

Other studies found inconclusive links between crime and increased oil and gas activity or only minor increases in crime (Ruddell et al. 2014; Kowalski and Zajac 2012; Luthra et al. 2007; Price et al. 2014). A recent study in North Dakota found few significant relationships linking increased drilling to increases in crime and concluded that the impact of drilling is localized, with different counties experiencing different levels and types of crime-related impacts (O'Connor 2017).

The experiences of oil- and gas-related boomtowns in North Dakota and Wyoming have limited applicability when considering the potential for increased crime in the Project area. As discussed above, temporary construction-related increases in population would range from about 3.4 percent (average) to 6.6 percent (peak) of the combined populations in the cities of Coos Bay and North Bend in 2017. These numbers would, however, be higher when pipeline construction workers employed in Coos County are added to the total (see section 4.9.2.1). This population increase would be temporary, and we conclude that attempts to estimate related increases in crime would be speculative, but were they to occur such increases would likely be commensurate with the relative increases in population.

4.9.1.2 Housing

In 2015, Coos County had an estimated total of 30,482 housing units[166], with a rental vacancy rate of 6.7 percent and 660 housing units available for rent. In addition, an estimated 1,462 units were identified for seasonal, recreational, or occasional use. In the cities of North Bend and Coos Bay, an estimated 124 and 172 housing units, respectively, were available for rent, with an additional 26 and 230 units identified for seasonal, recreational, or occasional use (U.S. Census Bureau 2017a, 2017b).

A housing analysis and action plan completed for Coos County in 2018 (czbLLC 2018) found limited affordable housing units available for rent or purchase in Coos County, with very little new construction over the past decade and existing units being converted to vacation and seasonal use. The study identified a deficit of affordable rental units for almost all income groups, including low-income households. In addition, the study noted that anecdotal examples exist of newcomers being unable to find quality housing at a reasonable price (czbLLC 2018).

ECONorthwest (2017b) identified 23 hotels and motels in Coos County, with a combined total of 1,442 rooms. More than half of these rooms (776 or 54 percent) were located in the cities of Coos Bay and North Bend, with a further 34 percent (496 rooms) located in Bandon, about 30 miles south of the site. There were also at least 26 smaller lodging establishments (less than 15 rooms) in Coos County, with an estimated total of 214 rooms (ECONorthwest 2017b). The number of rooms available for rent by construction workers would vary by season. Average occupancy data for Coos County compiled from January 2011 through July 2017 indicate that average monthly occupancy rates range from about 38 percent in January to 78 percent in July and 80 percent in August (ECONorthwest 2017a). Applying these percentages to the estimated total supply of hotel, motel, and inn rooms in Coos County (1,656) suggests that on average 1,025 rooms would likely

[166] The Census Bureau defines a housing unit as a house, apartment, mobile home or trailer, group of rooms, or single room occupied or intended to be occupied as separate living quarters. Data are 5-year estimates (2011 to 2015) from the U.S. Census American Community Survey. Estimates are annual totals based on 5 years of data (U.S. Census Bureau 2017a, 2017b).

be available for rent in January, with 330 rooms potentially available in August. It should also be noted that occupancy rates vary during the week, and tend to be higher during weekends.

Jordan Cove identified 39 recreational vehicle (RV) parks and campgrounds in Coos County, with a combined total of approximately 2,206 managed spaces (ECONorthwest 2017b). In addition to these identified designated camping facilities, camping is also allowed outside of designated facilities on some public land. This "dispersed camping," as it is known, is common throughout Coos County. As with hotels, demand for RV spaces is highly seasonal and the highest demand is usually on weekends.

As described previously, Jordan Cove proposes to build a workforce housing facility at the South Dunes site to address concern that demand for rental housing by construction workers will have a negative impact on the availability and cost of rental housing for local residents. Units would be added in phases beginning with approximately 200 units in the fall of year 2, and peaking at up to 700 units (depending on demand) in early year 3, with the number of units on-site gradually reduced starting in the latter half of year 4.

Potential housing options for relocating workers include rental housing (houses, apartments, and mobile homes), hotels and motels, and RV parks and campgrounds, as discussed above. In addition, construction workers commonly rent extra bedrooms in existing owner- or renter-occupied homes. Finally, workers would also have the option to stay in the Workforce Housing Facility.

ECONorthwest (2017a) estimated that during an average month 147 workers would seek rental housing, 337 workers would seek hotel and motel rooms, RV or campground spaces, or individual room rentals; with 311 workers expected to reside at the workforce housing facility. During peak construction, they estimated that 274 workers would seek rental housing, 588 workers would seek hotel and motel rooms, RV or campground spaces, or individual room rentals; and 693 workers would be expected to reside at the workforce housing facility.[167]

For rental housing, the estimated average demand for 147 units and peak demand for 274 units would be equivalent to approximately 22 percent and 42 percent of the total 660 units estimated to be available for rent in Coos County. However, as noted above, potential shortages of rental housing have been identified in Coos County (czbLLC 2018). Average and peak demand for other types of housing units (337 and 588 units, respectively) would exceed the estimated available supply of hotel and motel rooms in Coos County in August (330 rooms). However, a share of this demand would also likely be met by RV and campground spaces and individual room rentals in existing owner- or renter-occupied housing. Construction-related demand would result in lower vacancy rates and upward pressure on rental/room rates. Other visitors seeking temporary accommodation near the terminal site may be temporarily displaced during peak season, especially on summer weekends. These estimates also assume, as described above, that about one-third of the workers temporarily relocating to the area would be housed at the workforce housing facility, thereby reducing demand for other types of housing in the Project vicinity. Construction workers associated with the Pacific Connector pipeline would also be seeking temporary housing in Coos

[167] These estimates developed on behalf of Jordan Cove are "likely housing choices based on information provided by contractors, union PLA documents, comparable Oregon projects, JCEP, and estimates by ECONorthwest" (ECONorthwest 2017a, p. 16). In addition to the above, they assumed that a handful of non-local construction workers (7 to 13) would seek to purchase housing.

County. The combined impact of housing demand from LNG terminal and pipeline workers is discussed below in section 4.9.2.2.

In 2024, the first full year of operations, Jordan Cove would directly employ 180 workers in Coos County. ECONorthwest (2017a) estimated that about 40 percent of the operating workforce (72 workers) at the LNG terminal would be hired locally, with the remaining 60 percent (108 workers) relocating to Coos County from out-of-state or elsewhere in Oregon. Many of the relocating workers would likely buy homes, while others would choose to rent. Estimates from the U.S. Census Bureau's American Community Survey indicate that Coos County's existing housing for sale (480 units) and for rent (660 units) currently exceeds this potential demand (U.S. Census Bureau 2017b). However, as noted above, the 2018 Coos County housing analysis and action plan identified potential shortages of rental housing, as well as anecdotal evidence of newcomers to the area being unable to find quality housing at a reasonable price (czbLLC 2018).

4.9.1.3 Property Values

Numerous stakeholders expressed concern about the Project's impact on property values. The nearest residences to the Jordan Cove LNG Project are located across the bay in the cities of North Bend and Coos Bay, more than a mile from the site. The proposed terminal site is located near other industrial uses and the Southwest Oregon Regional Airport. Real estate property values are dependent on a number of factors, including, but not limited to, location, lot size, property condition, proximity to public services and infrastructure, and market trends. Staff has repeatedly attempted to address property value concerns; however, due to the lack of independently prepared, peer-reviewed studies regarding natural gas export terminal facility impacts on property values, we are not able to determine what, if any, impact the Project would have on property values. A property's value is ultimately determined by the amount a purchaser is willing to pay, and we are not aware of any conclusive evidence linking natural gas terminal infrastructure to a decrease in property value.

Studies that assess the impact of LNG export terminals on property values are limited. However, a study conducted by the Argonne National Laboratory (Clark and Nieves 1994) examined the economic impacts of eight types of "noxious" facilities on local wages and property values. The study examined the effects of 262 facilities, 11 of which were LNG facilities. The study concluded that the presence of five of the eight types of "noxious" facilities has a significant negative effect on property values and a positive effect on wages. However, the study concluded that the presence of an LNG facility did not have a significant positive or negative effect on either wages or property values (Clark and Nieves 1994).

More recently, Davis (2011) assessed the impact of 92 large power plants that opened in the U.S. between 1993 and 2000. Using the hedonic price method, Davis estimated impacts to housing values and rents within 2 miles of each new facility and found "modest declines" of 4 to 7 percent, with somewhat larger decreases within 1 mile.

For Jordan Cove, ECONorthwest (2006) reviewed property values within 1 mile of existing LNG "peak storage" facilities in Newport and Portland, Oregon. Using data from the Lincoln County Tax Assessors Office, ECONorthwest found that property values around the Newport LNG plant were not depressed and 25 homes within 0.5 mile and overlooking the facility had above average market values. They also argue that the presence of many other industrial and commercial properties around the Portland LNG facility, including the second-largest industrial employer in the city, suggest that the presence of this facility has not discouraged other businesses from locating in the area (ECONorthwest 2006).

4.9.1.4 Economy and Employment

Coos County had a total estimated civilian labor force of 26,521 in 2016 (Oregon Employment Department 2017). The average annual unemployment rate in Coos County in 2016 was higher than the statewide average, 6.5 percent versus 4.9 percent. State and local government and retail trade were the two largest sectors in the county in 2015 based on employment (U.S. Bureau of Economic Analysis 2016a). The median household income in Coos County in 2015 was $38,934 (U.S. Census Bureau 2016).

Jordan Cove estimates that construction of the Jordan Cove LNG Project would cost about $7.3 billion over the 53-month construction period, with an estimated $2.99 billion expected to be spent in Oregon (ECONorthwest 2017c).

Using IMPLAN economic modeling software, ECONorthwest (2017c) estimated the total (direct, indirect, and induced) regional economic impacts of Project construction (table 4.9.1.4-1). Direct impacts are those that happen at the initial source of the economic activity, in this case the project construction sites. Indirect impacts are generated by the expenditures on goods and services by suppliers who provide goods and services to the construction project. Indirect effects are often referred to as "supply-chain" impacts because they involve interactions among businesses. Induced impacts are generated by the spending of households associated either directly or indirectly with the Project. Workers employed during construction, for example, will use their income to purchase groceries and other household goods and services. Workers at businesses that supply the facility during construction or operation will do the same. Induced effects are sometimes referred to as "consumption-driven" impacts. Spending associated with the Project produces multiplier spending effects for other sectors of the state economy as businesses respond to supply-chain and consumption-driven demands for goods and services.

TABLE 4.9.1.4-1

Regional Economic Impacts of Construction of the Jordan Cove Project in Oregon

Impact Type	Output b/	Value Added b/	Labor Income b/	FTE Jobs b/	Average Number of Jobs per Year c/
Total Direct Impacts	$7,300	na	$1,235	4,527	1,023
Local Impacts (State of Oregon) a/					
Direct	$2,990	$1,027	$967	3,531	798
Indirect	$1,743	$992	$776	14,107	3,194
Induced	$1,725	$982	$571	13,435	3,042
Total d/	**$6,458**	**$3,001**	**$2,314**	**31,073**	**7,034**

Notes:
FTE – full-time equivalent; na – not applicable
a/ Local impacts in this context are impacts that would occur within the state of Oregon. Direct impacts are the share of the total direct impacts expected to occur in Oregon.
b/ Impacts are presented for the entire 53-month construction period. Output, value added, and labor income are expressed in millions of dollars.
c/ Average number of jobs per year based on 53 months of construction.
d/ Totals may not sum due to rounding.
Source: ECONorthwest 2017c

Total impacts are estimated in terms of economic output, value added, labor income, FTE jobs, and average jobs per year. Economic output represents the dollar value of goods and services produced, and serves as a broad measure of economic activity. Value added represents the net contribution of industries to the local economy and consists of revenues less intermediate inputs. Labor income is the sum of employee compensation and proprietary (self-employed) income. FTE jobs represent employment for 2,080 hours per year; FTE jobs do not necessarily translate into the number of affected workers. Two jobs that last 6 months each, for example, count as one FTE job.

As stated in section 4.9.1.1, Jordan Cove estimated that they would employ an annual average of 1,023 workers over the 53-month-long construction period, with a peak of 1,996 employees during month 30. Total direct employment over the 53-month construction period was estimated to be equivalent to 4,527 FTE jobs, with the equivalent of 3,531 FTE jobs expected to be filled by Oregon workers. Construction of the Jordan Cove LNG Project would be a union project, with Jordan Cove requiring the major contractor to sign a project labor agreement with the key signatory unions to the National Construction Agreement. Union locals believe they can supply the majority of skilled crafts workers from within Oregon. ECONorthwest (2017a), in an analysis prepared on behalf of Jordan Cove, assumed that almost four-fifths of all construction workers, managers, and staff for the Jordan Cove LNG Project would come from Oregon. In addition, ECONorthwest (2017a) estimated that Project construction would support a total of 14,107 indirect and 13,435 induced FTE jobs in Oregon over the life of the Project (table 4.9.1.4-1).

During the first full year of operations, Jordan Cove would directly employ 200 workers in Oregon, 180 for the LNG terminal, and 20 for the company office in Portland, with total labor compensation (including benefits and payroll taxes) expected to exceed $44.8 million. This direct employment in conjunction with facility expenditures on Oregon sourced goods and services would support additional economic activity in Coos County and elsewhere in Oregon. Using expenditure data provided by Jordan Cove, ECONorthwest (2017d) estimated that annual Project operation would support total (direct, indirect, and induced) employment of 1,602 FTE jobs in Oregon in 2024, with total associated labor compensation of approximately $132.3 million. Viewed in 2017 dollars, total compensation would be about $111.3 million or $69,477 per FTE job (ECONorthwest 2017d). Indirect and induced impact estimates developed by ECONorthwest (2017c, 2017d) are based on the share of construction and operation expenditures that Jordan Cove estimates would occur in Oregon. Changes in actual levels of in-state spending would result in changes to the indirect and induced impact estimates.

No commercial enterprises would be displaced by the Project, and construction and operation of the terminal would not result in the loss of local business revenues or taxes.

4.9.1.5 Tax Revenues

Total revenues for Coos County were approximately $52.3 million in fiscal year 2016. Tax revenues accounted for $10.5 million of this total, with 96 percent of tax revenues generated by property taxes (Coos County 2017). Other sources of revenue included intergovernmental transfers (state and federal funds); licenses, fees, and permits; charges for services; and timber sales on county forestlands (table 4.9.2.5-1). The LNG terminal would contribute to the fiscal health of local communities through a local Community Enhancement Plan (CEP) in Coos County. Construction and operation of the Jordan Cove LNG Project would also generate state and local tax revenues, including revenues from payroll taxes.

4.9.1.6 Public Services

Law Enforcement and Fire Protection

Coos County is served by one sheriff's office, seven police departments, and 17 fire departments. To minimize potential impacts, Jordan Cove would reimburse Coos County to cover any costs associated with public safety during construction and operation. Jordan Cove has also committed to building and funding the SORSC within the Jordan Cove LNG Project site. In addition, a continuously manned Jordan Cove Fire Station would be located on-site and Jordan Cove would be responsible for funding additional security measures to protect LNG carrier marine traffic.

Jordan Cove would also be responsible for funding additional security measures outlined in the Coast Guard's WSR and LSR to protect LNG carrier marine traffic to and from the terminal within the waterway; this would include escort boats operated by the County Sheriff's department.

Medical Facilities

Coos County is served by three hospitals. The Southern Coos Hospital is designated a critical access hospital as well as a full-service, general acute care hospital. It is ranked as a Level 4 Trauma Center (Southern Coos Hospital & Health Center 2017). The Coquille Valley Hospital in Coquille is ranked as a Level 4 Trauma Center (Coquille Valley Hospital 2017). The Bay Area Hospital in the city of Coos Bay is the closest to the Jordan Cove LNG Project site, approximately 6 miles away. This facility is rated a Level 3 Trauma Center (Bay Area Hospital 2017). In addition, North Bend Medical Center is a regional health care cooperative with five locations and more than 70 providers in the Coos Bay area (North Bend Medical Center 2017).

During construction, Jordan Cove would provide on-site medical facilities and personnel to provide care for the project workforce both at the site and at the Workforce Housing Facility. Care would include first aid, emergency response, and treatment of common illnesses. Potential construction injuries requiring treatment could range from scrapes and bruises through broken bones and injured limbs, concussion, and wounds requiring stitches, with injured parties requiring off-site treatment for more severe injuries should they occur.

During plant operation, Jordan Cove would have a licensed nurse practitioner on staff with offices located in the Operations Building. The primary functions for the nurse practitioner would be to assess routine employee needs, manage employee wellness programs to reduce the need for emergency visits, and handle triage of any job-related injuries that might occur within the Project site. Additionally, to address public concern, Jordan Cove signed an MOU with the State of Oregon that requires it to equip the Bay Area Hospital according to State policies for all hospitals in treating burns.[168] Other potential injuries that might occur are expected to be similar to those already treated at the hospital and by the North Bend Medical Center.

Schools

Coos County has six school districts, with total enrollment of 10,051 in the 2016-17 school year (Oregon Department of Education 2017). The Coos Bay School District operates five schools, serving about 3,100 students (Oregon Department of Education 2017). The North Bend School

[168] Memorandum of Understanding and Agreement No. 14-008 By and Between Jordan Cove Energy Project and the State of Oregon for LNG Emergency Preparedness. Filed July 1, 2014, in FERC Docket No. CP13-483.

District operates four schools serving about 4,400 students (Oregon Department of Education 2017). In addition, there are four private schools in North Bend serving approximately 250 students (ECONorthwest 2017a). The Bandon School District #54 has three schools, serving about 697 students (Bandon School District 2018).

As described previously, numerous non-local workers are expected to temporarily relocate to the Project area during construction, but very few are expected to be accompanied by family members. ECONorthwest (2017a) estimated that 57 households would temporarily relocate to the Project area during Project construction. Assuming an average household size of approximately 2.74 persons, including 0.55 school-aged children, would result in the addition of an estimated 31 students to Coos County schools. This addition would be equivalent to 0.3 percent of total county enrollment in 2016-17, or 0.4 percent of the combined enrollment in the Coos Bay and North Bend School Districts.

Assuming the same average household size as above, Project operation would result in the potential addition of 59 students to Coos County schools. This addition would be equivalent to 0.6 percent of total county enrollment in 2016-17, or 0.8 percent of the combined enrollment in the Coos Bay and North Bend School Districts.

Utilities

Constructing and operating the terminal facilities would require connection to and use of public electric, water, waste disposal, and communications systems/utilities. Jordan Cove has indicated that there is sufficient electric power on the North Spit to serve existing customers and meet Project needs during construction. Liquefaction operations would be powered directly by gas-fired combustion turbines and would not require externally sourced electric power from the grid. The SORSC and low load remote instrumentation would be connected to the local grid.

Solid waste generated during Jordan Cove LNG Project's construction would be collected on-site and items that cannot be reused or recycled would be hauled to licensed landfills by authorized waste haulers and disposal companies. Sanitary waste would either be collected and taken off-site for disposal by a licensed contractor, or treated prior to discharge to the IWWP, and any solid waste would be disposed of off-site by a licensed contractor. All waste generated by the workforce housing facility would be handled in a similar manner.

During operation of the terminal, sanitary waste water would be treated on-site and effluent sent to the IWWP. Solid waste would either be recycled or hauled from the site and disposed of by private licensed waste disposal companies without the need for city or county resources.

4.9.1.7 Recreation and Tourism

Recreation and Tourism

Approximately 1 million people visited Coos County in 2016, staying on average 2.6 nights (Dean Runyan Associates 2017). An estimated 43 percent of these nights were spent in hotels or motels, which accounted for approximately 70 percent of visitor spending. Travel-related spending in Coos County in 2016 totaled about $265.3 million, and supported an estimated 3,280 jobs (approximately 10.2 percent of total county employment), $76.6 million in earnings, and an estimated $9 million in local and state tax revenue.

Commenters during public scoping expressed concern that the Project could negatively affect the local economy by harming the recreation and tourism sectors. Potential effects on tourism could also occur during the summer when construction workers would likely compete with visitors to Coos County for accommodations. Potential combined demand for hotel and motel rooms, RV or campground spaces, and individual room rentals would exceed the estimated available supply of hotel and motel rooms in Coos County in August, even with the workers camp in place. However, as discussed in section 4.9.1.2, a share of this demand would also likely be met by RV and campground spaces and individual room rentals in existing owner- or renter-occupied housing. Construction-related demand would result in lower vacancy rates and upward pressure on rental/room rates. Other visitors seeking temporary accommodation near the terminal site may be temporarily displaced during peak season, especially on summer weekends. This could result in reduced demand for some recreation outfitter/guide services, as potential clients seek recreation opportunities elsewhere.

4.9.1.8 Other Commercial Activities

Commercial Fishing

Coos Bay was the third most important port in Oregon in terms of commercial fish harvested in 2015, accounting for about 10 percent of the total catch by volume. Pacific shrimp constituted almost two-thirds (64 percent; 13.3 million pounds) of the Coos Bay catch in volume and one-half (48 percent) of its catch in value. The other major catches by volume were groundfish (3.2 million pounds), albacore tuna (1.2 million pounds), and sardine (1.4 million pounds) (The Research Group 2016). An estimated total of $54.7 million in total personal income was generated by the fishing industry in the Coos Bay area in 2014, including income from both landed fish and revenue returned from distant water fisheries (The Research Group 2015).

Almost 200 commercial fishing vessels operate in Coos Bay on average per month from March to October, with just over 100 based in Coos Bay for the entire year (ECONorthwest 2017b). The actual number of commercial fishing vessels traveling through Coos Bay might be greater due to some transient travel to deliver products, buy ice, or seek other services. A fisherman's market cooperative and a small commercial fishing fleet are located in Charleston (located a few miles south of the Project area near the mouth of the bay). The Charleston Marina provides infrastructure and services to locally-based and visiting commercial fishing vessels (Oregon International Port of Coos Bay 2018a).

As described previously, numerous cargo ships (vessels and barges) would deliver materials to the terminal site during construction and, once in operation, the site would be called upon by up to 120 LNG carriers per year. Fishing boats would avoid cargo ships and barges similar to how they currently deal with commercial deep-draft ship and barge traffic into and out of the Port. Coos Bay pilots have indicated they typically encounter about two commercial fishing boats when they guide deep-draft commercial ships through the navigation channel (ECONorthwest 2017b).

During LNG carrier transit in the waterway to the terminal, fishermen would be required to move out of the security zone, which would result in delays in transit. The LNG marine traffic would overlap with the portion of the navigation channel used by the ocean-going fishing fleet from Charleston for about 2 miles. There may be slight delays resulting from meeting situations between an LNG carrier and a commercial fishing vessel, because of the security and safety zones or other conditions imposed by the Coast Guard. Jordan Cove has indicated that the impact on boats at any point in the channel would last about 20 to 30 minutes, the same as when other deep-draft vessels use the channel.

Commercial Ship Traffic

According to the Oregon International Port of Coos Bay (2018b), the Port is a major deep-draft coastal harbor moving more than 1.5 million tons of cargo each year. In 2017, 47 deep-draft vessels and 34 tugs and barges docked at Coos Bay port facilities.

The existing Coos Bay channel is wide enough to accommodate only one deep-draft ship in one direction. The Coast Guard, as part of its Waterway Suitability Report (WSR) and LOR, requires Jordan Cove to develop a Transit Management Plan to outline how conflicts with other commercial vessels would be avoided.

Ships associated with the construction and operation of the terminal could be affected by or affect other commercial ship traffic. Because the navigation channel can only accommodate one deep-draft transit, Project-related vessels may need to wait for the channel to clear. Conversely, other commercial ship traffic may need to wait for Project-related vessels to clear the channel, resulting in delays in transit. These potential impacts would be temporary and similar to those associated with existing deep-draft vessels calling at the Port.

Other Industries

There are several industrial enterprises located in proximity to the terminal site including the Southwest Regional Airport, Roseburg Forest Products, the Southport Lumber Company (Southport Lumber), and D.B. Western. The Southwest Oregon Regional Airport is addressed in section 4.10. Jordan Cove would temporarily lease land from Roseburg Forest Products for a staging area (i.e., a “laydown area”) during construction of the Jordan Cove LNG Project. Also, two warehouses located on the Roseburg Forest Products site would be removed during site preparation.

Southport Lumber operates a sawmill about a mile southwest of the terminal site. This facility includes a barge slip at about NCM 6.3 and a rail spur. The D.B. Western factory and berth is located at NCM 5.6, about 2 miles south of the terminal site. Based on the distances to the terminal site, impacts on these facilities are not expected. However, access to these facilities, as well as the Roseburg Forest Products facility, by road and water could be affected by Project-related vehicle traffic on the Trans-Pacific Parkway and vessel traffic in the navigation channel. Project-related effects on the Trans-Pacific Parkway and related mitigation plans are further discussed in section 4.10. Mitigation would likely include staggered work shifts, construction of a dedicated eastbound left-turn lane at the intersection of U.S. 101 at the Trans-Pacific Parkway, and implementation of a temporary signal at the intersection for the duration of construction activities (see section 4.10). Impacts on commercial ship traffic are discussed in the preceding section.

4.9.1.9 Environmental Justice

EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires federal agencies to consider if impacts on human health or the environment (including social and economic aspects) would be disproportionately high and adverse for minority and low-income populations and appreciably exceed impacts on the general population or other comparison group.

As described below and consistent with our understanding of EO 12898, we reviewed the Project to determine if resulting impacts would be disproportionately high and adverse for minority and low-income populations and appreciably exceed impacts on the general population or other comparison group. Our area of analysis for the LNG terminal consisted of a 3-mile radius centered on the LNG terminal site. Our comparison groups for this analysis consisted of the general population in Coos County and the State of Oregon.

In comments provided on the draft resource reports prepared for this Project, the EPA requested that the FERC conduct appropriate public outreach to ensure that the public and Native American tribes are informed about the Project and the possible impacts on their communities and trust resources. The EPA also stated that it considers children, the disabled, the elderly, and those with limited English proficiency to be potential environmental justice communities due to their unique vulnerabilities. In several different filings with the FERC, the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (Coos Tribe) stated that the Jordan Cove LNG Project would be within their ancestral lands. The Coos Tribes indicated that this EIS should address adverse environmental and cultural impacts on low-income and minority populations, and consider protection of cultural resources of importance to the tribes. Cultural resources are discussed further in section 4.11.

Review Methodology

Based on guidelines provided by the CEQ (1997) and EPA (1998), we used a three-step approach to conduct our review. These steps were:

1. Determine the presence of minority and/or low-income populations.
2. Determine if the Project would result in high and adverse human health or environmental effects.
3. Determine if high and adverse human health or environmental effects would fall disproportionately on minority and/or low-income populations.

Environmental Justice and Vulnerable Populations

Guidelines provided by the CEQ (1997a) and EPA (1998) indicate that a minority community may be defined as one where the minority population comprises more than 50 percent of the total population or comprises a meaningfully greater share of total population than the share in the general population. Minority communities may consist of a group of individuals living in geographic proximity to one another, or a geographically dispersed set of individuals who experience common conditions of environmental effect. Further, a minority population exists if there is “more than one minority group present and the minority percentage, as calculated by aggregating all minority persons, meets one of the above-stated thresholds” (CEQ 1997a, p. 26).

Minority populations identified by the U.S. Census include Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, and Other Race, which are considered races, and as well as persons of Hispanic or Latino origin, which is considered an ethnicity.

The CEQ and EPA guidelines indicate that low income populations should be identified based on the annual statistical poverty thresholds established by the U.S. Census Bureau. Like minority populations, low income communities may consist of individuals living in geographic proximity to one another, or a geographically dispersed set of individuals who would be similarly affected by the proposed action or program.

We used the EPA's Environmental Justice Mapping and Screening Tool (EJSCREEN) to assess the potential presence of environmental justice communities in the vicinity of the Jordan Cove LNG Project site. In accordance with EO 12898, EJSCREEN provides information on low income and minority populations. The tool also provides summary information for four other factors: less than high school education; linguistic isolation; individuals under age 5; and individuals over age 64, which are considered potential indicators of vulnerable populations. Data for the six demographic variables assessed in EJSCREEN are presented in table 4.9.1.9-1. Review of EJSCREEN indicated that there are no residents within 1 mile of the Jordan Cove LNG Project site.

TABLE 4.9.1.9-1

Demographic Indicators

Selected Variables a/	**North Bend**	**Coos Bay**	**3-Mile Radius**	**Coos County**	**Oregon**	**United States**
Total Population	16,062	9,583	12,156	62,775	3,939,233	316,515,021
Percent of Total						
Minority Population	19	18	19	14	23	38
Low Income Population	37	46	43	44	36	34
Linguistically Isolated Population	1	1	0	1	3	5
Population with Less Than High School Education	7	12	10	11	10	13
Population under Age 5	6	6	6	5	6	6
Population over Age 64	19	21	17	23	15	14

a/ Data are originally from the American Community Survey 2011-2015 five-year estimates compiled by the U.S. Census Bureau.
Source: EPA 2018b

The data presented in table 4.9.1.9-1 indicate that the minority share of the population in the cities of North Bend and Coos Bay and within 3 miles of the site is higher than the Coos County average. Minority shares in all four areas are, however, lower than the statewide average. The data also indicate that the share of the population considered low income by EJSCREEN in the city of Coos Bay, within 3 miles of the site, and in Coos County is higher than the statewide average. The data also indicate that the share of the population over age 64 is higher than the state average in North Bend, Coos Bay, within 3 miles of the site, and in Coos County as a whole.

Coos County has a higher percentage of Native Americans (2.5 percent) than the state of Oregon (0.9 percent) as a whole. This is also the case with the cities of Coos Bay and North Bend, where Native Americans constitute 2.5 percent and 1.9 percent of the total population, respectively (U.S. Census Bureau 2018).

Larger and more populated geographic areas may have the effect of "masking" or "diluting" the presence of concentrations of minority and/or low income populations (CEQ 1997a; EPA 1998). Data were, therefore, also reviewed at the census tract level to identify the potential existence of minority and/or low-income communities within a 3-mile radius of the LNG terminal site (figure 4.9-1). A total of 10 census tracts are fully or partially located within 3 miles of the LNG terminal site. Data were reviewed at the census tract level for the minority and low-income variables identified in table 4.9.1.9-1 using EJSCREEN. The resulting shares of the population were compared to two benchmark areas – Coos County and the state of Oregon – to identify potential environmental justice and/or vulnerable populations within 3 miles of the LNG terminal site.

Four of the 10 census tracts (03, 04, 05.04, 07) had minority populations that were higher than the county share (14 percent). The minority share for these four census tracts ranged from 17 percent to 26 percent, substantially lower than the 50 percent measure identified in CEQ (1997a) and EPA (1998) guidelines, and less than the state average (23 percent) in all but one case.

The share of the population considered low income by EJSCREEN is higher than the state average (36 percent) in Coos County (44 percent) (table 4.9.1.9-1). The low income share of the population was higher than the county average in one of the 10 census tracts (05.04), and higher than the state average in 6 of the 10 census tracts. The low income share in the six census tracts ranged from 37 percent to 55 percent.

The share of total population with less than a high school education was higher than the state average in 5 of the 10 census tracts. Almost all of the census tracts (9 out of 10) had larger shares of their population over age 64 than the state average, while two tracts also had larger shares of total population below age 5. The share of the population identified as linguistically isolated was below the state average in all 10 census tracts.

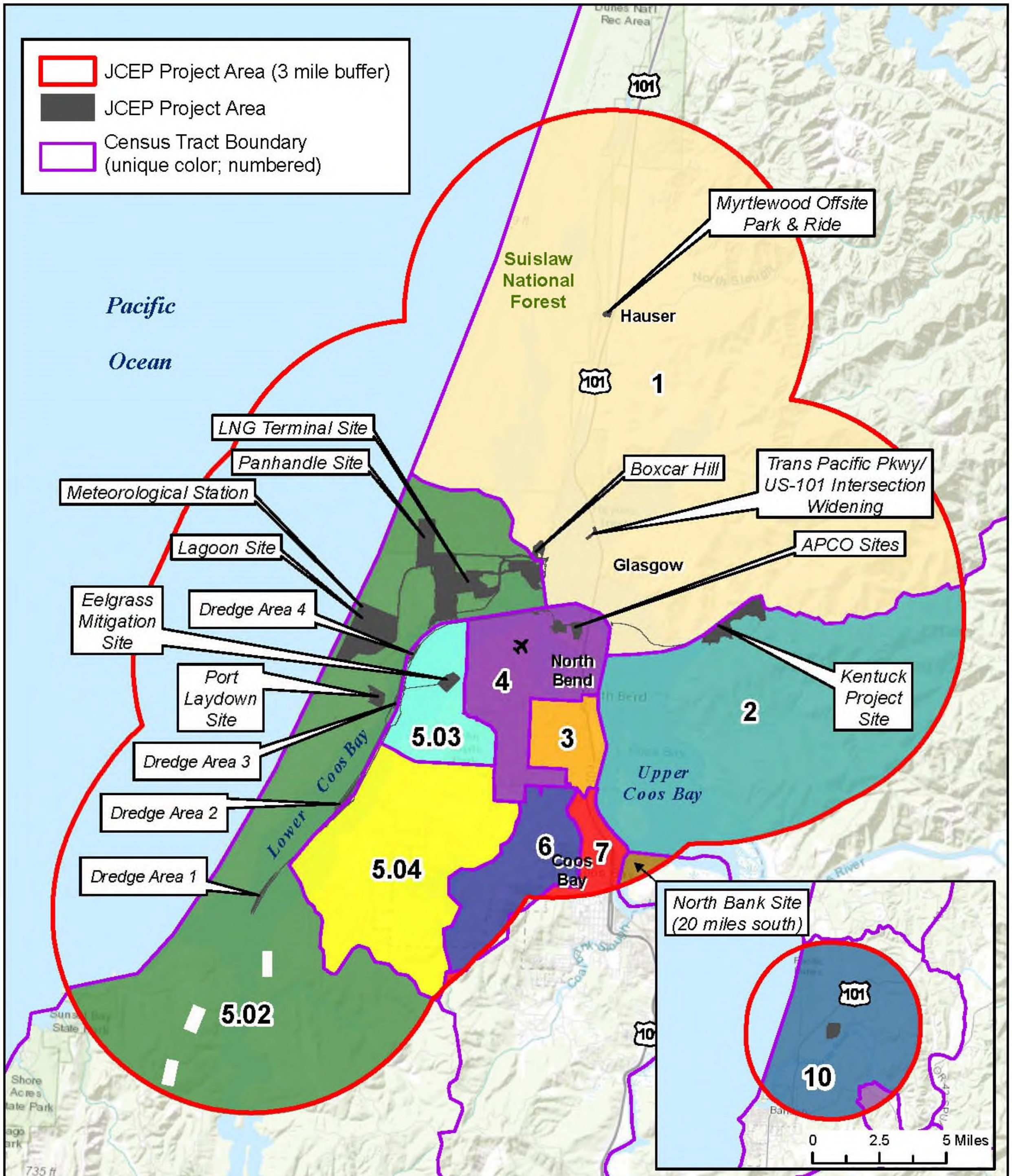


Figure 4.9-1

2010 Census Tracts in the Jordan Cove Project Area

High and Adverse Impacts

The impacts of constructing and operating the Project on the natural and human environments are identified and discussed throughout the environmental analysis section of this document. As described in the numerous environmental resource-specific discussions, we conclude that with two exception, the Project would not significantly impact the environment or have high and adverse effects on human health or the environment. Constructing and operating the LNG terminal would result in a significant impact on the visual character of Coos Bay. Additionally, the combined demand for housing from LNG terminal and pipeline workers would result in a significant impact on housing in Coos County.

Disproportionate Impacts on Environmental Justice Populations

Low-income communities are present in the vicinity of the LNG terminal site. However, none of the potential low-income populations are located within 1 mile of the LNG terminal site (there are no residents within 1 mile of the site) and the potential for these populations to be disproportionately affected relative to other populations within 3 miles of the site is low. Increased demand for rental housing would affect the market as a whole, but would likely be more acutely felt by low-income households who are spending a large share of their income on housing.

Tribal populations are a minority population with the potential to be disproportionately affected by construction and operation of the terminal as a result of their unique relationship with the surrounding environment. Government-to-government consultations between the FERC and Indian tribes are still ongoing and are discussed in detail in section 4.11 of this EIS. Issues raised by the tribes are summarized in section 4.11.1.3 and explicitly recognized in the related environmental analysis sections of this document. An assessment of the potential effects of the Project on tribal uses of those resources or the tribal members themselves has been requested by FERC staff to be presented in a forthcoming ethnographic study (see section 4.11.3.1).

4.9.2 Pacific Connector Pipeline Project

4.9.2.1 Population

Population data for the four counties that would be crossed by the pipeline are summarized in table 4.9.2.1-1. The pipeline route mainly passes through sparsely populated rural areas, with population densities in 2017 ranging from 11.4 people per square mile in Klamath County to 77.9 people per square mile in Jackson County. Estimated population in the affected counties in 2017 ranged from 63,310 in Coos County to 216,900 in Jackson County.

TABLE 4.9.2.1-1

Population by State and County

State/County	Population 2000	Population 2010	Population 2017	Percent Change in Population 2010-2017	Persons per Square Mile 2017
Oregon	**3,421,399**	**3,831,074**	**4,141,100**	**8.1%**	**43.1**
Coos County	62,779	63,043	63,310	0.4%	39.7
Douglas County	100,399	107,667	111,180	3.3%	22.1
Jackson County	181,269	203,206	216,900	6.7%	77.9
Klamath County	63,775	66,380	67,690	2.0%	11.4
Total a/	**408,222**	**440,296**	**459,080**	**4.3%**	**29.9**

a/ This row is the sum of the four counties that would be crossed by the pipeline.
Sources: Portland State University 2012, 2017a; U.S. Census Bureau 2017c

As described previously, Pacific Connector estimates that construction of the pipeline would occur over a 4-year period, with an average monthly workforce of 885 people over this period. The construction workforce is expected to peak at approximately 4,242 workers in June of Year 3, dropping to 4,027 the following month. The construction workforce would be distributed over seven construction spreads.

Based on Pacific Connector's initial estimates, monthly employment for pipeline construction is assumed to average 241 workers in Coos County, 194 workers in Douglas County, 361 workers in Jackson County, and 89 workers in Klamath County. ECONorthwest (2017a) assumed that approximately 64 percent of the average pipeline workforce would temporarily relocate to the affected counties for the duration of their employment, with about 5 percent of the total expected to be accompanied by their families. Assuming an average household size of 2.74 persons, estimated temporary increases in population would range from 0.1 percent (Douglas, Jackson, and Klamath Counties) to 0.3 percent (Coos County) of their respective county populations in 2017.

Peak construction workforces would include an estimated 1,002 workers in Coos County, 1,350 workers in Douglas County, 1,524 workers in Jackson County, and 366 workers in Klamath County. ECONorthwest (2017a) assumed that approximately 78 percent of the peak workforce would temporarily relocate to the affected counties, with 1 to 2 percent of workers expected to be accompanied by their families. Assuming an average household size of 2.74 persons, estimated temporary increases in population would range from 0.4 percent (Klamath County) to 1.3 percent (Coos County) of their respective county populations in 2017. These estimated population increases and associated impacts would be temporary and short term, with very few if any of the temporary construction workers relocating to the project area expected to stay permanently. Impacts associated with construction-related population increases are discussed throughout this section.

Construction of the Pacific Connector pipeline in Coos County would coincide with Jordan Cove LNG Project construction. Based on the above analyses, the combined temporary increase in population (workers and family members) associated with both projects would average 1,076 workers over the life of the Project. Assuming LNG terminal and pipeline construction activities in Coos County begin at the same time, construction workforces could potentially peak at the same time, resulting in a temporary combined increase in population of approximately 2,555 workers. These potential additions would be equivalent to approximately 1.7 percent (average) and 4.0 percent (peak) of the total estimated population in Coos County in 2017.

Operating the pipeline would require an estimated permanent staff of 15 employees, consisting of six operations technicians in Coos Bay, Coos County, five employees in the Medford pipeline office in Jackson County, and four employees at the compressor station near Malin in Klamath County. Employees are expected to live within driving distance of their work location and are not expected to affect population levels or trends in the counties along the pipeline route.

Crime

We received several comments on the Project expressing concern that a temporary influx of construction workers would result in increases in crime, drug and alcohol use, prostitution, human trafficking, domestic violence, and other criminal activities. Potential increases in crime related to an influx of construction workers is discussed in section 4.9.1.1. As discussed in section 4.9.1.1, increases in crime, were they to occur, would likely be commensurate with the relatively small increases in population (discussed above).

4.9.2.2 Housing

In 2015, the four counties that would be crossed by the pipeline had an estimated total of 204,107 housing units, with almost half of this total (91,782 units) located in Jackson County. An estimated 3,927 of these units were identified as vacant and available for rent. Available rental units ranged from 660 in Coos County to 1,436 in Jackson County. In addition, an estimated 7,138 units were identified for seasonal, recreational, or occasional use, ranging from 1,164 units in Douglas County to 2,335 units in Klamath County. ECONorthwest (2017b) also identified an estimated total of 9,640 hotel, motel, and small inn rooms in the four counties, along with 9,237 sites in managed RV parks and campgrounds (table 4.9.2.2-1).

TABLE 4.9.2.2-1

Housing

Geographic Area	Housing Units 2011-2015 a/				Hotels and Motels b/		Managed RV Parks and Campgrounds Number of Sites
	Total Housing Units	Rental Vacancy Rate	Units Available for Rent	For Seasonal, Recreational, or Occasional Use c/	Number of Facilities	Number of Rooms	
Coos County	30,482	6.7%	660	1,462	49	1,656	2,206
Douglas County	49,018	5.5%	834	1,164	40	1,990	2,800
Jackson County	91,782	4.3%	1,436	2,177	91	4,457	2,498
Klamath County	32,825	9.4%	997	2,335	37	1,537	1,733
Project Area Total	**204,107**	**5.7%**	**3,927**	**7,138**	**217**	**9,640**	**9,237**

a/ Data are 5-year estimates from the U.S. Census American Community Survey. Estimates are annual totals based on 5 years of data.
b/ Hotel and motels include commercial hotels, inns, and motels, as well as smaller inns and bed and breakfast establishments (B&Bs), with data obtained from STR, Inc. (commercial hotels, inns, and motels) and internet searches (smaller inns and B&Bs) (ECONorthwest 2017b).
c/ Housing units for seasonal, recreational, or occasional use are generally considered to be vacation homes. They are not included in the estimated number of housing units available for rent.
Source: ECONorthwest 2017b, U.S. Census Bureau 2017a, 2017b

Hotel and motel occupancy rates in the Project area follow a seasonal trend, with occupancy rates tending to be higher in the summer (June through September) and lower in the winter (November through February). During peak tourist season (July and August), average hotel and motel occupancy rates are around 80 percent in Coos, Jackson, and Klamath Counties and close to 75 percent in Douglas County (ECONorthwest 2017b). Occupancy rates for RV parks in the pipeline project area are not published, but tend to be more seasonal than those of hotels and motels, largely because RV parks tend to cater to tourists and RV driving is difficult during the rainy season and winter months (ECONorthwest 2017b).

Estimated average and peak housing demand by non-local construction workers is shown by housing type and county in table 4.9.2.2-2. Estimated average and peak demand is compared with estimated supply by housing type and county in table 4.9.2.2-3. Viewed as a portion of available rental housing, peak demand for rental housing would range from 6 percent (Klamath County) to 24 percent (Coos County) and 25 percent (Douglas County) of estimated available units. As discussed in section 4.9.2.1, the 2018 Coos County housing analysis and action plan identified a shortage of affordable rental housing (czbLLC 2018). Similarly, despite Census estimates that almost 1,000 housing units in Klamath County are currently available for rent, a recent newspaper editorial indicated that Klamath Falls and Klamath County are also facing a housing shortage (H&N View 2019).

TABLE 4.9.2.2-2

Estimated Housing Demand by Pacific Connector Construction Workers

	Rental Housing (Apartments, Houses, Mobile Homes) a/,b/		Hotels and Motels, RV and Campground Spaces, and Individual Room Rentals a/	
Geographic Area	**Average**	**Peak**	**Average**	**Peak**
Coos County	59	157	92	624
Douglas County	48	207	74	845
Jackson County	88	239	138	949
Klamath County	22	57	34	228

a/ Estimated demand by housing type is based on ratios estimated by ECONorthwest (2017a) adjusted to account for subsequent changes in Pacific Connector's construction schedule and workforce estimates.
b/ Assumes that 10 percent of individual workers would share a rental unit with another construction worker.

TABLE 4.9.2.2-3

Estimated Housing Demand by Pacific Connector Construction Workers as a Share of Estimated Supply

	Rental Housing (Apartments, Houses, Mobile Homes)		Hotels and Motels and RV and Campground Spaces a/b/	
Geographic Area	**Average**	**Peak**	**Average**	**Peak**
Coos County	9%	24%	2%	16%
Douglas County	6%	25%	2%	18%
Jackson County	6%	17%	2%	14%
Klamath County	2%	6%	1%	7%

a/ Percentages represent estimated demand as a share of the total estimated supply of hotel and motel rooms and RV sites, not the share that would normally be available for rent. Percentages do not include special living situations, such as bedrooms in single-family homes that home owners may rent to construction workers

Peak demand for hotels and motels, RV and campground spaces, and individual room rentals would range from about 7 percent of the total supply of hotel and motel rooms and RV spaces in Klamath County to 18 percent of the total in Douglas County. Total supply in this context refers to the total number of units and is not adjusted to account for seasonal occupancy rates. During peak season (July and August), peak demand would exceed the normally available supply of hotel and motel rooms in Coos (330 rooms), Douglas (511 rooms), and Jackson (833 rooms) Counties. A share of this demand would, however, also likely be met by RV and campground spaces and individual room rentals in existing owner- or renter-occupied housing.

During peak tourist season (July to September), short-term accommodations in some communities, especially those in Coos, Douglas, and Jackson Counties, would experience lower vacancy rates and upward pressure on rental rates. The availability of short-term housing, especially at hotels, motels, and RV parks, could become limited in the immediate pipeline vicinity, and workers and others seeking temporary accommodation in those areas may pay higher rents or have to commute farther than desired. Additionally, during peak construction worker demand, tourists would likely be displaced, particularly during summer weekends. Visitors seeking outdoor recreational opportunities do, however, have a wide range of destination choices in southern Oregon and would be likely to recreate elsewhere in the region if they were interrupted by pipeline construction at a particular location.

These potential issues would be exacerbated in Coos County, where the Pacific Connector Pipeline Project construction would coincide with Jordan Cove LNG Project construction, resulting in higher levels of demand for temporary housing. The following discussion addresses the combined demand from both projects and assumes that housing demand would peak for both projects during the same month. Combined, estimated average and peak demand for hotel and motel rooms, RV or campground spaces, or individual room rentals would be for 429 and 1,212 units, respectively, equivalent to 11 percent and 31 percent of the total supply of hotel and motel rooms and RV spaces in Coos County. These peak levels of demand would exceed the share of hotel and motel rooms and RV spaces that are usually vacant and available for rent during the summer, resulting in increased competition for temporary housing among workers, as well as the potential displacement of tourists and other visitors who would be unable to find temporary accommodation in Coos County.

For rental housing, the combined estimated average and peak demand would be for 207 and 432 units, respectively, equivalent to approximately 31 percent and 65 percent of the total 660 units estimated to be available for rent in Coos County. As noted in section 4.9.2.1, potential shortages of rental housing have been identified in Coos County (czbLLC 2018). Increased demand from Project-related construction workers would likely reduce vacancy rates and place upward pressure on rental rates, resulting in the potential displacement of other existing or potential residents seeking rental accommodation.

Operation of the pipeline would require 15 permanent employees and would have no noticeable effect on the local housing markets.

4.9.2.3 Property Values

We received numerous comments concerning the potential effect of the pipeline on property values. These comments included concerns that the pipeline would negatively affect sales prices and result in an inability to sell one's property. Concern was also expressed that a decrease in property values would result in reduced property tax revenues for the affected counties.

A number of studies have sought to determine whether the presence of a pipeline affects property values using a range of statistical techniques including paired sales and other sales comparisons, linear regression and hedonic price modeling, and descriptive statistics. These studies include two national case studies conducted by the Interstate Natural Gas Association of America (Allen, Williford & Seale, Inc. 2001; Integra Reality Resources 2016), two case studies that evaluated the effects of the South Mist Pipeline Extension in Clackamas and Washington Counties, Oregon (Fruits 2008; Palmer 2008), and studies from Arizona and Nevada (Diskin et al. 2011; Wilde et al. 2014). These studies suggest that natural gas pipelines dos not necessarily negatively affect the value of that property. The effect a pipeline may have on a property's value depends on many factors, including the size of the tract, the values of adjacent properties, the presence of other utilities, the current value of the land, and the current land use. Subjective valuation is generally not considered in appraisals, but may affect individual decisions when a property is offered for sale. Purchase decisions are often based on the purchaser's plans for the property, such as occupancy, use for agriculture, future residential development, or commercial/industrial development. If the presence of a pipeline interferes with a purchaser's plans, the potential buyer may decide against acquiring the property. However, each potential purchaser has different criteria and differing capabilities to purchase land. Therefore, based on our review of available studies and our understanding of property valuation, we conclude that the likelihood of the pipeline resulting in a long-term decline in property values and a related decrease in property tax revenues is low.

4.9.2.4 Economy and Employment

The four counties that would be crossed by the pipeline had a total combined estimated labor force of 203,614 in 2016. Labor force estimates by county ranged from 26,521 in Coos County to 101,776 in Jackson County (table 4.9.2.4-1). Annual unemployment rates in 2016 ranged from 5.8 percent in Jackson County to 6.5 percent in Coos and Klamath Counties and were higher than the state average (4.9 percent) in all four counties. Table 4.9.2.4-1 also presents average per capita income and median household income by county, and identifies the two largest economic sectors based on total employment data compiled by the U.S. Bureau of Economic Analysis (2016a). Average per capita income in 2015 (the most recent year available) was lower than the state average ($43,783) in all of the affected counties. Median household income was also below the state median ($54,074) in 2015 in all four counties.

TABLE 4.9.2.4-1

Employment and Labor Statistics for the Pacific Connector Pipeline Project Area

State/ County	Civilian Labor Force 2016 a/	Unemployment Rate (%) 2016 a/	Per Capita Income ($) 2015	Median Household Income ($) 2015	Two Largest Economic Sectors 2015 (By Percent of Employment) b/
Oregon	2,055,114	4.9	$43,783	$54,074	Health Care and Social Assistance (12%); Retail (11%)
Coos	26,521	6.5	$38,475	$38,934	State and Local Government (16%); Retail Trade (12%)
Douglas	45,891	6.4	$35,977	$41,696	Health Care and Social Assistance (12%); Retail (12%)
Jackson	101,776	5.8	$40,698	$44,855	Health Care and Social Assistance (15%); Retail Trade (13%)
Klamath	29,426	6.5	$35,216	$42,384	State and Local Government (13%); Health Care and Social Assistance (13%)

a/ Labor force and unemployment data are annual averages.
b/ Employment by economic sector is summarized in more detail in table 4.9.2.4-2.
Sources: Oregon Employment Department 2017; U.S. Bureau of Economic Analysis 2016a, 2016b; U.S. Census Bureau 2016, 2017c

All four counties were identified as distressed on Business Oregon's Temporary Distressed List for January 2017 (Business Oregon 2017). A county is considered distressed by Business Oregon based on an index calculated from four composite factors (unemployment rates, per capita personal income, changes in covered payroll by worker, and changes in employment). Twenty-three of Oregon's 36 counties were identified as distressed in January 2017.

Similar to the analysis prepared for the Jordan Cove LNG Project (see section 4.9.1.4, above), ECONorthwest (2017c) used IMPLAN to estimate the total (direct, indirect, and induced) regional economic impacts of pipeline construction and operation. Pacific Connector estimates that constructing the pipeline and related facilities would cost about $2.46 billion, with an estimated $1.4 billion expected to be spent in Oregon (ECONorthwest 2017c). ECONorthwest (2017c) estimated that total direct employment over the 24-month construction period would be equivalent to 2,854 FTE jobs, with the equivalent of 1,712 FTE jobs expected to be filled by Oregon workers. [169] Total direct labor income during pipeline construction would be approximately $926 million; with $544 million of this total expected to be paid to Oregon workers (table 4.9.2.4-2).

Constructing the Project would also support an estimated total of 4,102 indirect and 6,344 induced FTE jobs, with an estimated average of 2,051 indirect and 3,172 induced FTE jobs supported each year. In addition, Project construction would support total (direct, indirect, and induced) output, value added, and labor income of $2.8 billion, $1.3 billion, and $1.1 billion, respectively (table 4.9.2.4-2).

TABLE 4.9.2.4-2

Regional Economic Impacts of Construction of the Pacific Connector Pipeline Project in Oregon

Impact Type	Output b/	Value Added b/	Labor Income b/	FTE Jobs b/
Total Direct Impacts	$2,460	na	$926	2,854
Local Impacts (State of Oregon) a/				
Direct	$1,400	$578	$544	1,712
Indirect	$591	$313	$241	4,102
Induced	$820	$467	$272	6,344
Total d/	$2,811	$1,359	$1,056	12,159

Notes:
na – not applicable.
a/ Local impacts in this context are impacts that would occur within the state of Oregon. Direct impacts are the share of the total direct impacts expected to occur in Oregon.
b/ Impacts are presented for the entire construction period. Output, value added, and labor income are expressed in millions of dollars.
c/ Pacific Connector revised its construction workforce estimates in a November 2018 filing with the FERC, increasing the length of the construction period and the total number of FTE workers. These changes would likely result in an increase in direct impacts in Oregon, with smaller potential increases in indirect and induced impacts.
d/ Totals may not sum due to rounding.
Source: ECONorthwest 2017c

In the first full year of operations, Pacific Connector would directly employ 15 workers in Oregon, with total labor compensation (including benefits and payroll taxes) of approximately $3.1 million. This direct employment in conjunction with facility expenditures on Oregon sourced goods and services would support additional economic activity in Coos, Douglas, Jackson, and Klamath Counties and elsewhere in Oregon. Annual Project operation is estimated to support total (direct, indirect, and induced) employment of 180 FTE jobs in Oregon in 2024, with total associated labor compensation of approximately $11.3 million. Viewed in 2017 dollars, total compensation would be about $9.5 million or $53,200 per FTE job (ECONorthwest 2017d).

As noted with respect to the Jordan Cove LNG Project, indirect and induced impact estimates developed by ECONorthwest (2017c, 2017d) are based on the share of construction expenditures that Pacific Connector estimates would occur in Oregon. Changes in actual levels of in-state spending would result in changes to the indirect and induced impact estimates.

[169] Pacific Connector revised its construction workforce estimates in a November 2018 filing with the FERC, increasing the length of the construction period and the total number of FTE workers. These changes would likely result in an increase in direct impacts in Oregon, with smaller potential increases in indirect and induced impacts.

4.9.2.5 Tax Revenues

The Pacific Connector pipeline would generate federal, state, and local tax revenues during both the construction and operation phases of the Project. Federal tax revenues would be generated from federal income tax on Project-related earnings. There is no sales and use tax in Oregon, but state tax revenues would be generated through income and lodging taxes. Local tax revenues would be generated from property taxes.

Federal lands generate revenues for local counties through 25 percent fund/Secure Rural Schools payments and Payment in Lieu of Taxes (PILT) payments. Secure Rural Schools payments are discussed below in section 4.9.3.2. The PILT program is designed to compensate local governments for lost property tax revenue associated with federal lands. Annual PILT payments to the four affected counties in Fiscal Year 2018 ranged from $649,640 in Coos County to $1,864,853 in Jackson County (U.S. Department of the Interior 2018).

Total revenues for the four counties that would be crossed by the pipeline in fiscal year 2016 ranged from $44.0 million in Klamath County to $149.3 million in Jackson County (table 4.9.2.5-1). The intergovernmental revenue category identified in table 4.9.2.5-1 includes payments from the federal and state governments to the counties. These revenues include PILT payments, which help local governments maintain public services such as firefighting and police protection, public schools and roads, and search-and-rescue operations.

TABLE 4.9.2.5-1

Revenues for the Counties Crossed by the Pacific Connector Pipeline, FY 2016

Revenue Type	Coos County	Douglas County	Jackson County	Klamath County
Property Taxes	$10,150,562	$9,628,905	$41,248,304	$12,527,141
Other Taxes	$373,677	NR	NR	$1,470,964
Intergovernmental Revenues a/	$29,188,456	$40,276,259	$82,404,563	$23,682,220
Licenses, Fees, and Permits	$4,311,496	$1,571,451	$4,257,881	$1,499,150
Charges for Services	$2,132,755	$10,899,007	$18,775,415	$3,877,796
Timber Sales	$5,081,975	NR	NR	NR
Interest on Investments	$239,689	$1,762,954	$2,417,455	$729,486
Other Revenue	$849,807	$5,056,629	$168,413	$206,158
Total	**$52,328,417**	**$69,195,205**	**$149,272,031**	**$43,992,915**

NR – not reported
Sources: Coos County 2017; Douglas County 2016; Jackson County 2016; Klamath County 2016

During construction, Pacific Connector estimates that the pipeline would generate approximately $91 million in federal income tax based on an estimated construction payroll of $537 million and an average federal income tax rate of 17 percent. The estimated construction payroll would also generate approximately $40.1 million in state income tax, assuming an average state income tax rate of 9 percent. Temporary workers associated with pipeline construction would generate approximately $374,000 in state lodging taxes, as well as an estimated $1.9 million in local lodging taxes that would be distributed across the four counties. Pacific Connector also estimates that personal property taxes on approximately $728 million worth of equipment and materials either purchased in or brought into Oregon would generate about $10.9 million in tax revenues.

During operation, Pacific Connector estimates that the pipeline would generate approximately $518,000 in annual federal taxes based on estimated labor income during the first year of operation, as well as an estimated $233,000 in annual state income taxes. Pacific Connector would also pay property taxes based on the value of the installed pipeline and associated aboveground facilities and the number of pipeline miles in each county. ECONorthwest estimated pipeline property taxes based on 2016 tax rates and the number of pipeline miles in all taxing jurisdictions crossed by the pipeline. Over the initial 20 years of operations, the pipeline is expected to generate approximately $4.7 million in average annual property taxes in Coos and Douglas Counties and approximately $5.3 million in average annual property taxes in Jackson and Klamath Counties (ECONorthwest 2017d). Property tax payments would vary over time due to pipeline depreciation and changing tax rates.

The Pacific Connector pipeline would not involve federal land disposal, acquisition, or exchange and is, therefore, not expected to affect existing PILT or 25 percent fund/Secure Rural Schools payments to the affected counties.

4.9.2.6 Local Infrastructure and Public Services

Law Enforcement and Fire Protection

The pipeline route crosses four counties, each with its own Sheriff's office, employing a combined total of almost 400 officers. In addition, 23 municipalities have their own police departments, with a combined total of more than 350 officers. There are more than 30 municipal fire departments and approximately 40 RFPDs in the four counties that would be crossed by the pipeline, with a combined total of approximately 1,750 firefighters. As discussed in section 4.9.2.1, estimated temporary increases in population during peak construction would range from 0.4 percent of the existing total in Klamath County to 1.3 percent in Coos County. This relatively minor and short-term influx of non-local workers and their families during the peak construction period is not expected to adversely affect existing law enforcement or fire-fighting capabilities.

The USDOT is mandated to provide pipeline safety, and the USDOT pipeline standards are published in 49 CFR Parts 190-199. Part 192 of 49 CFR specifically addresses natural gas pipeline safety issues. Part 192 requires that each operator must establish and maintain liaison with appropriate fire, police, and public officials to learn the resources and responsibilities of each organization that may respond to a natural gas pipeline emergency and to coordinate mutual assistance. The operator must also establish a continuing education program to enable customers, the public, government officials, and those engaged in excavation activities to recognize a gas pipeline emergency and report it to appropriate public officials. Pacific Connector would provide the appropriate training to local emergency service personnel before the pipeline is placed in service. No additional specialized local fire protection equipment is expected be required to handle pipeline emergencies. Pipeline safety is discussed further in section 4.13 of this EIS.

Pacific Connector has developed an *Emergency Response Plan Concept Paper*, a *Fire Prevention and Suppression Plan*, and a *Safety and Security Plan.*[170] Pacific Connector would be responsible for the cost of implementing these plans. Pacific Connector does not anticipate that

[170] Pacific Connector's Overburden and Excess Material Disposal Plan and a Sanitation and Waste Management Plan are included as Appendices Q and W, respectively, in its POD filed with the FERC on January 23, 2018.

implementation of these plans would require additional medical or other public service personnel (including additional police or fire fighting capabilities).

Pacific Connector has indicated that in the event of a pipeline accident, the party deemed responsible for the accident would ultimately be responsible for paying all costs for emergency response, containment, damages, remediation, and repairs for the public and private property affected. In the event of an accident, Pacific Connector would provide emergency support to completely respond to the accident.

Medical Facilities

There are nine hospitals in the four counties that would be crossed by the Pacific Connector pipeline, with a combined total of almost 900 beds (table 4.9.2.6-2). These include four Level III Trauma System Hospitals that can receive helicopter transport and three level IV Trauma Hospitals (table 4.9.2.6-1).

TABLE 4.9.2.6-1

Hospitals in the Counties Crossed by the Pacific Connector Pipeline

County	Hospital	Town	Trauma Level a/	Staffed Beds	Occupancy Rate 2016
Coos	Bay Area Hospital	Coos Bay	III	129	50.1
Coos	Coquille Valley Hospital	Coquille	IV	17	36.1
Coos	Southern Coos Hospital and Health Center	Bandon	IV	19	6.7
Douglas	Lower Umpqua Hospital	Reedsport	NA	16	18.0
Douglas	Mercy Medical Center	Roseburg	III	129	60.1
Jackson	Asante Ashland Community Hospital	Ashland	IV	37	33.9
Jackson	Providence Medford Medical Center	Medford	III	138	54.5
Jackson	Asante Rogue Medical Center	Medford	III	307	74.5
Klamath	Sky Lakes Medical Center	Klamath Falls	NA	100	52.8

a/ Trauma hospitals differ from other hospitals in that they guarantee the immediate availability of surgeons, anesthesiologists, physician specialists, nurses, ancillary services, and resuscitation life-support equipment 24 hours a day and are dedicated to the care of trauma patients. Trauma facilities in Oregon are designated as Level I, II, III, or IV, with Level I and II centers offering the highest level of care (Oregon Health Authority 2018).
Source: Oregon Association of Hospitals and Health Systems 2018

As discussed above, estimated temporary increases in population during peak construction are expected to be short-term and range from 0.4 percent of the existing total in Klamath County to 1.3 percent in Coos County. If construction employment for the terminal and pipeline were to peak in Coos County at the same time, the combined temporary increase in population would be equivalent to about 4.0 percent of the existing total. Existing medical facilities are expected to be adequate to handle issues resulting from the temporary influx of non-local employees working on pipeline construction. Therefore, we conclude that constructing and operating the pipeline is not expected to have significant adverse effects on emergency services or regional hospitals.

Schools

There are 33 school districts within the four counties that would be crossed by the Pacific Connector pipeline, with a total combined enrollment of almost 64,000 students. Enrollment by county in the 2016-2017 school year ranged from about 9,500 students in Klamath County to almost 30,000 students in Jackson County.

As discussed in section 4.9.2.1, Pacific Connector anticipates that approximately 5 percent of the average workforce relocating to the potentially affected counties would be accompanied by family members, with just 1 to 2 percent of the peak non-local workforce expected to be accompanied by family. Assuming an average household size of approximately 2.74 persons, including 0.55 school-aged children, the temporary relocation of these households would result in the addition of 2 (Klamath County) to 10 students (Jackson County) to county schools. These additions would be equivalent to 0.1 percent of current enrollment or less for all counties and are not expected to noticeably affect existing school facilities and programs. Construction of the pipeline would coincide with terminal construction, resulting in a combined (pipeline and terminal) addition of an estimated 38 students to Coos County schools, which would be equivalent to about 0.4 percent of total county enrollment in 2016-2017.

Operation of the pipeline would require an estimated permanent staff of 15 employees, consisting of 6 operations technicians in Coos Bay (Coos County), 5 employees in Medford (Jackson County), and 4 employees near Malin (Klamath County). Assuming that these employees would all be hired from elsewhere, their permanent relocation along with their families to the area would not be expected to noticeably affect enrollment in local public schools.

Utilities

All four counties crossed by the Pacific Connector pipeline route have existing public utilities already in place, including water, sewers and sanitation, electricity, natural gas and propane, telephone, and cable. Some of those services are provided by county governments or municipalities, and some by private companies.

Construction of the pipeline would have only minor, temporary effects on local community utilities, services, and infrastructure. Pacific Connector would need to hook up to local utilities, including electric power and telephone lines, at its compressor station, three meter station locations, and new communications towers and buildings. Pacific Connector would also use electric power and telephone lines at its contractor yards, where existing power and telephone lines are available. Other than water required for pipeline hydrostatic testing and dust control during construction, Pacific Connector has stated that its Project would not require public water or sewer services. The pipeline would not require wastewater treatment or the construction or expansion of wastewater facilities and existing stormwater drainage systems.

Pacific Connector developed an *Overburden and Excess Material Disposal Plan* and a S*anitation and Waste Management Plan* as part of its POD.[171] During construction, trash and food waste would be collected on a daily basis and removed from the pipeline ROW. Excess rocks, overburden, large slash, and timber would be removed to established disposal areas. Following construction, all construction-related debris, including mats, skids, rope, and excess padding, would be removed by qualified solid waste disposal companies to appropriate licensed landfills or recycling facilities.

[171] Pacific Connector's *Overburden and Excess Material Disposal Plan* and a S*anitation and Waste Management Plan* are included as Appendices Q and W, respectively, in its POD filed with the FERC on January 23, 2018.

4.9.2.7 Recreation and Tourism

Recreation

A recent report by the Outdoor Industry Association (2017) estimated that outdoor recreation and related expenditures in Oregon generated an estimated $16.4 billion in consumer spending and $749 million in state and local tax revenues, supporting 172,000 jobs and $5.1 billion in wages and salaries (Outdoor Industry Association 2017). This included money spent on gear, vehicles, trips, and travel-related expenses.

Concern was expressed by commenters that the proposed pipeline crossing of the Rogue River would affect recreation-related businesses in the nearby community of Trail in Jackson County. The Rogue River is well known for its salmon and steelhead fishery, and this section of the river is popular for recreational floating using rafts and inflatable kayaks. Visitors spend money on outfitter and guide services, bait, and equipment rentals, as well as lodging, restaurants, transportation, and other local goods and services. Pacific Connector proposes to cross the Rogue River using HDD technology, which would avoid direct effects on the river and its fisheries (see chapter 2 and section 4.3) and reduce potential direct effects on recreationists.

Concern was expressed during public scoping that the pipeline would have negative effects on the communities of Shady Cove and Trail by disrupting traffic along SH 62, which parallels the Rogue River and connects these communities to Crater Lake. Viewed as a share of current traffic, the average expected increase in vehicles would range from 1.1 percent to 2.4 percent of estimated totals, with the peak estimated increase ranging from 2.4 percent to 5.0 percent (table 4.9.2.7-1). Pacific Connector developed a Transportation Management Plan to reduce conflicts between construction traffic and recreational users of local roads (see Appendix Y to Pacific Connector's POD filed with the FERC on January 23, 2018). Transportation issues related to pipeline construction are more fully addressed in section 4.10.2.

TABLE 4.9.2.7-1

Estimated Construction Traffic Impacts on SH62 near Shady Cove and Trail

SH 62 Location Description	Milepost	2015 AADT	Estimated Increase in AADT	
			Average a/	Peak b/
1.83 miles north of SH 234	15.46	7,900	1.1%	2.4%
0.05 mile south of Brophy Way	18.35	5,500	1.6%	3.4%
0.03 mile north of Indian Creek Road in Shady Cove	19.81	6,200	1.4%	3.0%
0.02 mile north of Rogue River Drive in Shady Cove	20.11	6,400	1.4%	2.9%
Northern city limits of Shady Cove	21.10	4,200	2.1%	4.4%
0.05 mile south of Tiller-Trail Highway (SH 227)	22.37	3,700	2.4%	5.0%

a/ Based on an estimated average of 89 construction-related vehicle round trips per day.
b/ Based on an estimated peak of 187 construction-related vehicle round trips per day.
AADT – average annual daily traffic
Source: Oregon Department of Transportation 2017.

Tourism

Travel spending in the four potentially affected counties in 2016 was approximately $1,187 million, ranging from $141 million in Klamath County to $548 million in Jackson County (table 4.9.2.7-2). Travel spending generated earnings of approximately $334 million and supported approximately 13,760 jobs in the four-county area in 2016. Travel-related employment as a share of total county employment ranged from 4.5 percent (Jackson County) to 10.2 percent (Coos County) (Dean Runyan Associates 2017).

TABLE 4.9.2.7-2

Travel Spending, Earnings, and Employment, 2016

State/County	Travel Spending ($ million)	Earnings ($ million)	Employment	
			Jobs	Percent of County Total (2016) a/
Oregon	11,300	3,100	109,500	Na
Coos	265.3	76.6	3,280	10.2
Douglas	233.2	68.1	3,130	6.1
Jackson	547.9	142.8	5,440	4.5
Klamath	141.0	46.4	1,910	6.3
Project Area Total	**1,187.4**	**333.9**	**13,760**	**Na**

a/ This percentage represents travel-related employment for 2016 as a percent of total employment.
Source: Dean Runyan Associates 2017

As discussed in section 4.9.2.2, during periods of peak demand by pipeline workers and tourists (July to September), short-term housing accommodations in some communities, especially those in Coos, Douglas, and Jackson Counties, would experience lower vacancy rates and upward pressure on rental rates. At peak demand for lodging by construction workers has the potential to temporarily displace tourists at some locations, particularly during weekends of the summer season. As noted in section 4.9.2.2, visitors seeking outdoor recreational opportunities have a wide range of destination choices in southern Oregon and would be likely to recreate elsewhere in the region if they were interrupted by pipeline construction at a particular location. However, this temporary displacement could result in reduced demand for some recreation outfitter/guide services, as potential clients seek recreation opportunities elsewhere.

4.9.2.8 Other Commercial Activities

Commercial Fishing

Commercial and recreational fisheries are discussed in section 4.5 of this EIS and section 4.9.1.8 discusses the commercial fishing industry in Coos Bay. There are no commercial fisheries for vertebrate fish species in the Coos Bay estuary.

Fish are not harvested commercially in the rivers and streams crossed by the pipeline. However, fish such as salmon and steelhead that spawn in affected rivers are commercially harvested in coastal areas off Oregon, Washington, and California, as well as British Columbia and Alaska. A 2009 study estimated that Rogue River salmon commercially harvested off the Northwest coast support annual economic benefits of approximately $1.36 million (ECONorthwest 2009). Constructing the pipeline would affect waterbodies that provide habitat for aquatic resources that are commercially harvested. However, short-term construction-related effects on streams and rivers are not expected to adversely affect the spawning of fish that are commercially harvested from the ocean; as effects such as sedimentation and turbidity would be reduced through the use of erosion control devices. Potential effects resulting from the pipeline crossing waterbodies and mitigation of those effects are discussed in section 4.3, and effects on aquatic resources in stream habitats are evaluated in section 4.5 of this EIS.

Commercial Oyster Farms

Commercial oyster beds are located in South Slough, Haynes Inlet, and Upper Coos Bay, including two commercial oyster operations in the northern portion of Coos Bay near the pipeline crossing: Clausen Oysters and Coos Bay/North Bend Oyster Company. Both companies lease land from the Port of Coos Bay and Coos County and cultivate non-native Pacific and Kumamoto oysters and native Olympia oysters (DeKrey 2017). A study conducted for Pacific Connector estimated that Clausen Oysters had an annual yield of 10 to 13 million oysters, with the potential for gross wholesale revenues of about $2.25 million annually. The same study estimated that Coos Bay/North Bend Oyster Company had an annual yield of 7 to 8 million oysters, with the potential for gross wholesale revenues of about $1.25 million annually. Annual operational costs for both companies were estimated to be approximately 50 percent of gross sales (HDR 2015).

The pipeline would be installed via HDD beneath an active oyster lease area operated by Clausen Oysters. The use of an HDD would generally result avoid impacts on Haynes Inlet and this oyster lease area. Appendix I.2 to Resource Report 2 (i.e., the *Drilling Fluid Contingency Plan*) outlines the measures that would be used during construction to avoid and minimize potential disturbance to oyster populations during construction. However, commercial oyster beds could be affected by an inadvertent release of HDD drilling fluids in the immediate vicinity. Contingency plans would be implemented that would reduce the chance of a frac-out spill being substantial and also result in timely clean up, if needed. This is discussed further in section 4.5 of this EIS.

Other Industries

The pipeline would cross mostly rural areas, avoiding densely populated or urban areas, and not result in the displacement of any businesses. Constructing and operating the pipeline would, however, temporarily and permanently affect forested and agricultural lands and associated businesses. The pipeline would cross about 82.8 miles of mature forested lands and 58.8 miles of recently harvested forested lands. Land ownership of forested lands includes privately-owned timberland, state lands, NFS lands, and BLM lands. Approximately 1,050 MMBF of timber was harvested in the four affected counties in 2016, with an annual average harvest from 2011 to 2016 of 1,047 MMBF (Oregon Department of Forestry 2017). During Project scoping, private timber companies expressed concern about impacts on their operations. The Seneca Jones Timber Company identified a number of concerns, including potential competition between Pacific Connector and private timber companies for the use of ridge tops for access and equipment placement; possible restrictions related to forest yarding or the hauling of heavy equipment over the installed pipeline; and potential increases in the cost of local aggregate materials. Timber harvesting and the mitigation of effects related to the pipeline are discussed in more detail in section 4.7.

Pacific Connector has indicated that it will require a total of approximately 650,00 cubic yards of aggregate to construct the pipeline and associated facilities spread over 2 years, with an estimated 325,000 cubic yards required each year. Using information from DOGAMI, Pacific Connector estimates that this annual demand would be equivalent to approximately 8 percent of the suitable aggregate produced in the four potentially affected counties. In their assessment, they assume that half of the total aggregate (8 million cubic yards) produced in the four counties would be suitable for use in pipeline construction. Therefore, we conclude that pipeline construction is unlikely to result in a measurable decrease in the availability of aggregate or a substantial price increase.

Pipeline construction would affect agricultural land. The majority of the potentially affected land is pasture and cropland used for livestock forage and to grow hay, alfalfa, and food crops. A very small portion of the construction ROW would cross land in orchards, groves, vineyards, and nurseries. Following construction, a smaller area of agricultural land would be retained within permanent easements or acquired for pipeline operation. This area would include the permanent pipeline corridor, surface facilities, and maintenance ROW. The vast majority of these lands could be restored and returned to their original condition and use after the pipeline is installed. Therefore, although impacts could last for several years, most potential effects on agricultural operations would be temporary and short-term in nature. One exception is deep-rooted crops, such as orchards and vineyards, which could not be planted directly over the pipeline. Owners of orchards crossed by the pipeline would lose a percentage of their trees and potential future income. Potential impacts on agriculture are discussed further in section 4.7.

For both temporary and permanent effects, Pacific Connector would negotiate with landowners and provide compensation for timber/crop losses or land taken out of use as a result of pipeline construction.

4.9.2.9 Environmental Justice

Review Methodology

The methodology used for the terminal environmental justice assessment is summarized in section 4.9.1.9. The same methodology was used for the following pipeline assessment.

Environmental Justice and Vulnerable Populations

The Pacific Connector pipeline would cross a mostly rural region. The population in all four counties is predominantly White, with persons of Hispanic or Latino origin making up the largest share of the non-White population in all four counties, and statewide (table 4.9.2.9-1).

TABLE 4.9.2.9-1

Race and Ethnicity in Counties Crossed by the Pacific Connector Pipeline a/

Geographic Area	Total	Percent of Total						
		White b/	Hispanic or Latino	Black or African American b/	American Indian and Alaska Native b/	Asian b/	Other Race b/, c/	Two or more races b/
Coos County	62,775	85.8	5.9	0.6	2.5	1.2	0.4	3.5
Douglas County	107,194	88.8	5.2	0.3	1.3	0.8	0.1	3.5
Jackson County	208,363	82.4	11.8	0.6	0.6	1.0	0.4	3.3
Klamath County	65,972	79.7	11.6	0.8	3.1	1.1	0.3	3.5
Oregon	3,939,233	77.2	12.3	1.8	0.9	3.9	0.5	3.3

a/ Data are American Community Survey 2011-2015 five-year estimates compiled by the U.S. Census Bureau.
b/ Non-Hispanic only. The federal government considers race and Hispanic/Latino origin to be two separate and distinct concepts. People identifying Hispanic or Latino origin may be of any race. The data summarized in this table present Hispanic/Latino as a separate category.
c/ The "Other Race" category presented here includes census respondents identifying as "Native Hawaiian and Other Pacific Islander" or "Some Other Race."
Source: U.S. Census Bureau 2018

Data for the six demographic variables assessed in EJSCREEN are presented by county in table 4.9.2.9-2. These variables include low-income and minority populations, along with four other indicators considered by EJSCREEN to be potential indicators of vulnerable populations. These data indicate that the share of the population considered low income by EJSCREEN is higher than the statewide average in all four counties. The data also indicate that the share of the population over age 64 exceeds the state average in all four counties (table 4.9.2.9-2).

TABLE 4.9.2.9-2

Demographic Indicators

Selected Variables a/	Coos County	Douglas County	Jackson County	Klamath County	Oregon
Total Population a/	62,775	107,194	208,363	65,972	3,939,233
Percent of Total					
Minority Population	14	11	18	20	23
Low Income Population	44	43	42	44	36
Linguistically Isolated Population	1	1	1	1	3
Population with Less Than High School Education	11	11	11	12	10
Population under Age 5	5	5	6	6	6
Population over Age 64	23	23	19	19	15

a/ Data are originally from the American Community Survey 2011-2015 five-year estimates compiled by the U.S. Census Bureau.
Source: EPA 2018b

Data were also reviewed using EJSCREEN for the 34 census block groups that would be crossed by the pipeline. The share of the population considered minority by EJSCREEN is lower than the state average (23 percent) in all four counties, ranging from 11 percent to 20 percent (table 4.9.2.9-2). None of the census block groups in Coos, Douglas, or Jackson Counties had minority populations that exceeded the state average. Five census block groups in Klamath County had minority populations that exceeded the state average, including one where the minority population was more than 50 percent of the total. The share of the population considered low income by EJSCREEN is higher than the state average (36 percent) in all four counties, ranging from 42 percent to 44 percent (table 4.9.2.9-2). Slightly more than half (19 out of 34) of the census block groups that would be crossed by the pipeline had low income populations that exceeded the state share.

The share of the population considered linguistically isolated by EJSCREEN is lower than the state average (3 percent) in all four counties (1 percent in each) (table 4.9.2.9-2). Two census block groups, both in Klamath County, had linguistically isolated populations that exceeded the state average, with linguistically isolated populations of 8 and 11 percent versus the statewide average of 3 percent. The share of the population with less than high school education was slightly higher than the state average (10 percent) in all four counties, ranging from 11 percent to 12 percent (table 4.9.2.9-2), with the shares in 14 of the 34 census block groups also exceeding the state average. The populations in the census block groups crossed by the Pacific Connector pipeline tend to be older than the state average, as suggested by the county averages (table 4.9.2.9-2), with the share of the population over 64 exceeding the state average in 27 census block groups. Only 7 of the census block groups crossed by the pipeline route had populations below age 5 that exceeded the state average.

High and Adverse Impacts

The impacts of constructing and operating the Project on the natural and human environments are identified and discussed throughout the environmental analysis section of this document. As described in the numerous environmental resource-specific discussions, we conclude that the

Project would not significantly impact the environment or have high and adverse effects on human health or the environment. As discussed elsewhere in this section, the combined impact of housing demand from LNG terminal and pipeline workers does, however, have the potential to cause short-term housing impacts in Coos County.

Disproportionate Impacts on Environmental Justice Populations

The Pacific Connector pipeline route mostly crosses rural regions with low population densities, and avoids towns and cities. Pacific Connector has indicated that they sought to find the shortest, buildable route between Coos Bay and Malin, Oregon, where the pipeline would terminate. Along the way, the pipeline route mostly follows ridges through the mountains. Unlike discrete facilities whose impacts are generally concentrated in one location, a pipeline establishes or expands a narrow corridor often over long distances passing near communities with a mosaic of social and economic characteristics. The preceding review suggests the presence of potential environmental justice or vulnerable populations in several of the census block groups that would be crossed by the Pacific Connector pipeline. Construction and operation of the pipeline are not expected to result in high and adverse human health or environmental effects on any nearby communities and the likelihood that these potential environmental justice and vulnerable populations will be disproportionately affected relative to other populations in the census tracts crossed by the pipeline is low.

As noted in section 4.9.1.9, government-to-government consultations between the FERC and Indian tribes are still ongoing and FERC staff has requested an assessment of the potential effects of the Project on tribal uses of those resources or the tribal members to be presented in a forthcoming ethnographic study (see section 4.11.3.1).

4.9.3 Environmental Consequences on Federal Lands

Potential socioeconomic effects of the pipeline on federal lands would be primarily related to timber harvesting, recreation, and transportation. These are discussed in sections 4.7, 4.8, and 4.10, respectively.

4.9.3.1 Financial Efficiency Analysis

The Forest Service directs that projects involving timber sales include a financial efficiency analysis that compares the anticipated costs and revenues that are part of Forest Service monetary transactions (Forest Service 2002). Pacific Connector prepared a financial efficiency analysis that assesses the net present value of costs and benefits that would accrue to the federal government as a result of construction and operation of the pipeline project. This analysis was prepared in general accordance with direction contained within the Forest Service Handbook.

The analysis is limited to those costs and revenues that would result from the direct use of federal assets (land, timber, and roads) and can be directly quantified based on existing fee schedules. The analysis does not include government administrative revenues that would be generated from the fees charged to process the project application and monitor the ROW. In addition, the analysis does not include non-market economic costs or benefits that are not part of federal monetary transactions.

Costs and benefits were projected over a 50-year time period, where appropriate, and discounted using a real discount rate of 4 percent. The analysis identifies two sources of direct government revenue: (1) Pacific Connector's payment for timber that would need to be cut, and (2) Pacific Connector's rental payments for construction access and the pipeline ROW. The analysis also identifies three sources of government costs: (1) the value of lost timber productivity along the new ROW, (2) the value of non-merchantable trees that would need to be cut prematurely (lost timber growth), and (3) the incremental cost of future maintenance for existing roads that Pacific Connector may upgrade above their existing federal maintenance level (Levy 2008). The present values of these projected revenues and costs are summarized in table 4.9.3.1-1. The projected net present value of the Pacific Connector Pipeline Project based on this analysis is $7.77 million in 2015 dollars (table 4.9.3.1-1).

TABLE 4.9.3.1-1

Financial Efficiency Analysis of the Pacific Connector Pipeline Project

Category	Timing	Present Value in 2015 (2010$ millions)
Revenues		
Timber Revenue a/	2021 to 2022	5.25
Temporary Use Permit and Right-of-Way Revenue b/	2021 to 2073	2.67
Costs		
Lost Timber Productivity c/	2021	-0.004
Lost Timber Growth d/	2021	-0.058
Incremental Road Maintenance e/	2023 to 2073	-0.083
Net Present Value		7.77

a/ Timber revenue was calculated based on the pond value of the estimated timber volume, less the costs of logging and hauling the timber to the mill, slash disposal, and road work. Timber volumes and other values used in this estimate are based on preliminary estimates prepared by Pacific Connector.
b/ This analysis assumes that Temporary Use Permits would be required for construction for 2 years and the ROW would be required for 50 years. Revenues are estimated based on the federal 2020-2023 Linear ROW Rental Schedule values per acre for the affected counties. The analysis assumes that Pacific Connector would make a one-time payment, rather than make annual payments over the life of the project.
c/ Lost timber productivity was estimated based on the soil expectation value of the lands that would be permanently lost to timber production and is based on an average soil expectation value of $14.30 per acre.
d/ Lost timber growth accounts for the value of non-merchantable trees that would be cleared in the ROW. This value is based on the projected value of these trees at merchantable age. Premature harvest of these trees represents foregone revenue for the federal government and is, therefore, counted as a cost here.
e/ Non-design improvements, such as turn-outs, widening, or blading/grading, to existing roads on NFS and BLM lands would likely be necessary as part of this project and may change the maintenance level of the existing road (by, for example, adding base and gravel to an existing road surface of native materials) and, as a result, impose an incremental maintenance cost on the government. This analysis assumes that all roads on federal lands used by Pacific Connector for construction access would be upgraded from native materials to gravel and, therefore, result in costs at the upper end of the range of possible outcomes. Incremental cost increases are assumed to be $343 per mile per year.
Source: Levy 2008

This analysis does not, however, as noted above, account for other costs and benefits that are not assigned monetary values by the federal government. Other potential impacts (not valued) to federal lands include impacts on recreation, the PCT, grazing, LSRs, and Riparian Reserves (Levy 2008). While no monetary value is assigned to these potential impacts, they are considered in detail elsewhere in this document.

4.9.3.2 Secure Rural Schools and Community Self-Determination Act

Prior to 2000, in states with national forests and certain BLM lands, 25 percent of the returns to the U.S. Treasury from revenue-producing activities, such as timber sales, were returned to each state for distribution back to counties having acreage within a national forest. Those payments were called the "25 percent fund payments" and were dedicated by law to roads and schools. In October 2000, the *Secure Rural Schools and Community Self Determination Act of 2000* was enacted to stabilize federal payments to states in response to declining federal receipts. The legislation was authorized for implementation for fiscal years 2001 through 2006, and has subsequently been reauthorized, most recently in May 2018 (Forest Service 2018). As mentioned above, the Pacific Connector pipeline would not involve federal land disposal, acquisition, or exchange and is, therefore, not expected to affect existing 25 percent fund/Secure Rural Schools payments to the affected counties.

4.9.3.3 Mitigation of Impacts on Federal Lands

No mitigation of impacts on federal lands specifically related to socioeconomics is currently being considered.

4.9.4 Conclusion

Construction and operation of the Project would result in impacts on socioeconomic resources as described in the preceding sections. Temporary impacts during construction would include increased demand for law enforcement and fire protection, and medical services. These potential construction-related impacts would be temporary and short term. In addition, constructing the Project would provide direct employment for local workers, support jobs and income elsewhere in the local and state economies, and generate tax revenues for local, state, and federal agencies. However, when the combined effects of the Jordan Cove LNG Project and Pacific Connector Pipeline Project are taken into consideration collectively, construction of the Project has the potential to cause significant affects to short-term housing in Coos County. These impacts could include potential displacement of existing and potential residents, as well as tourists and other visitors. Tourists and other visitors could also be displaced during peak construction in Douglas and Jackson counties as Project-related demand for hotel and motel rooms would likely exceed the normally available supply. With the applicant's proposed construction and operations procedures and mitigation measures in place, construction and operation of the LNG terminal and pipeline facilities are not expected to result in significant impacts on socioeconomic resources or services, with the exception of housing availability.

4.10 TRANSPORTATION

4.10.1 Jordan Cove LNG Project

4.10.1.1 Marine Traffic

Marine traffic in Coos Bay includes deep-draft cargo ships that call at the Port; tugs and barges; and commercial and private fishing and recreational boats. In 2015, 42 deep-draft cargo ships called at the Port, down from about 200 calls per year in the mid-1990s. Nearly 200 commercial fishing vessels operate in Coos Bay from March to October, with just over 100 based in Coos Bay year-round. There is also some transient travel from other commercial vessels through Coos Bay delivering products, buying ice, or seeking other services. Barges, commercial fishing boats, and recreational boats are all shallow-draft vessels that can move out of the navigation channel to avoid deep-draft cargo ships when necessary.

All deep-draft cargo ships servicing Coos Bay use the existing navigation channel. They enter and exit the Port under the control of a Coos Bay Pilot. According to ECONorthwest (2017b), the Coos Bay Pilots Association typically encounters an average of six recreational boats and two commercial fishing boats during the transit of each deep-draft vessel through the Federal Navigation Channel.

The LNG terminal would receive approximately 70 water deliveries over a 2-year period. Deliveries would be via a mix of ocean-going vessels and barges. During construction, Jordan Cove would also use barges to transport dredge materials from the LNG terminal access channel and slip for fill at the Kentuck project site, resulting in an estimated 225 barge deliveries over a 4- to 5-month period. The addition of these vessels, about 25 trips per month, would not adversely impact other bay users, such as other commercial ship traffic, fishing vessels, or recreational boaters. Transits would be scheduled with the pilots and follow normal procedures in use for commercial vessel traffic. Jordan Cove would consult with the Coast Guard regarding other requirements for construction equipment ships and barges (see appendix B).

As described in chapter 2, Jordan Cove anticipates that LNG carriers would call on the terminal up to 120 times per year. Travel time from the offshore buoy at the beginning of the navigation channel to the terminal is estimated to be about 90 minutes at typical speeds of 4 to 10 knots. Coos Bay pilots would not pilot an LNG carrier through the Federal Navigation Channel under severe weather conditions, or when the volume of other ship traffic in the channel is so heavy that transit to the LNG terminal could be unsafe.

The Federal Navigation Channel can accommodate only one-way deep-draft vessel traffic (i.e., only one vessel at a time, see chapter 2). An LNG carrier would be unable to use the channel when another deep-draft commercial ship is in transit in Coos Bay, and would instead be held either at the buoy outside the bay or in the marine slip at the Jordan Cove LNG terminal until the other deep-draft ship has completed its transit.

Impacts on fishing and recreational boats in Coos Bay resulting from Project-related ship traffic would be similar to those from current deep-draft cargo ship traffic in the Federal Navigation Channel. In general, as a deep-draft vessel enters the channel, other boats move out of its way, and boats in the ocean near the mouth of the channel defer entering the channel until the larger ships have passed. The escort boats accompanying each LNG carrier would facilitate moving other boats out of the way in a timely manner. As they currently do for other commercial cargo ship traffic, the Coast Guard and OSMB would remind recreational boaters of their obligation to not impede deep-draft vessels transiting in the Federal Navigation Channel. Interactions between deep-draft cargo ships and other boats rarely occur in Coos Bay. The likelihood of a collision between an LNG carrier and another boat would be extremely low because of the mitigation measures imposed by the Coast Guard's WSR, including the implementation of a TMP, and a security zone around LNG carriers in the waterway (typically around 500 yards in size). While an LNG carrier is moored at berth at the terminal, a security zone would be established around the slip. This security zone would not extend as far as the Federal Navigation Channel and would not affect vessels transiting through the channel.

The addition of approximately 70 water deliveries via a mix of ocean-going vessels and barges during the two-year construction period and 120 LNG carriers per year transiting to and from the Jordan Cove LNG terminal during its operation would increase the total number of deep-draft vessels calling at Coos Bay. This increase in marine traffic combined with current deep-draft vessel traffic would be less than historic ship traffic through the channel. Therefore, based on this historic capacity, current traffic practices in the bay, and the implementation of Coast Guard shipping measures, we conclude that some marine traffic might be temporarily inconvenienced, but the passage of LNG carriers and other Project-related marine traffic through the channel would not significantly affect other boats in Coos Bay.

4.10.1.2 Motor Vehicle Traffic

As described in chapter 2, the construction work force would use public roads and highways (U.S. Highway 101 and the Trans-Pacific Parkway) to deliver supplies and access LNG terminal site workspaces.

On behalf of Jordan Cove, DEA prepared a *Traffic Impact Analysis* for the Jordan Cove LNG Project (DEA 2017b) based on a Project study area established by ODOT, Coos County, and the City of North Bend.[172] The 14 intersections that comprise the study area are governed by operational targets or standards established by the applicable jurisdiction (City of North Bend, Coos County, and/or ODOT). The existing conditions (August 2017) analysis performed by DEA found that all study area intersections met the applicable mobility targets during both midweek AM and PM analysis hours. All intersections but one also met the applicable LOS mobility targets during both Friday PM and midday Saturday analysis hours.[173] The exception, the westbound left turn from Ferry Road to U.S. 101, was identified as operating at level of service (LOS) E and, therefore, exceeding the applicable "LOS D" mobility target established by the City of North Bend).[174]

The DEA analysis assessed impacts for four analysis hours, which coincide with peak workforce shift changes. The DEA construction phase analysis assumed two work shifts, with start times staggered by one hour, with only one shift occurring during peak analysis hours. The analysis,

[172] This report was filed as part of Jordan Cove's response to FERC's January 3, 2018 Environmental Information Request.
[173] LOS is measured as a function of control delay at intersections, with six established targets ranging from LOS A, where there is little or no delay, to LOS F, where there is delay of more than 50 seconds at unsignalized intersection, or more than 80 seconds at signalized intersections.
[174] Project construction and operation would not add any traffic to the westbound left turn from Ferry Road to U.S. 101 and, therefore, this intersection is not discussed further.

therefore, looked at only half the proposed workforce, with the other half of the workforce assumed to travel outside of peak analysis hours. The use of two staggered work shifts is intended to reduce construction impacts and assumed to be in place in all the construction-related analyses.

The DEA study analyzed impacts for two construction phases—(1) just before the proposed workforce housing and Park and Ride (PnR) lots are active; and (2) when the construction workforce would be at its peak with the proposed housing and PnR lots also at peak usage—and the first year of operations.

For the first construction phase, the study found that the intersection of U.S. 101 at the Trans-Pacific Parkway would fail to meet operational targets during the midweek PM and Friday PM analysis hours if no mitigation were provided, with construction-related traffic resulting in significant vehicle queuing and delays. To address this failure, Jordan Cove would construct a dedicated eastbound left-turn lane (approximately 600 feet in length) and implement a temporary signal at the intersection for the duration of construction activities.

This intersection would also fail to meet operational targets during the second construction phase evaluated in the DEA study. In addition, U.S. 101 at Hauser Depot Road was predicted to fail to meet operational targets during the midweek PM and Friday PM analysis hours, with estimated traffic volumes exceeding intersection capacity resulting in traffic congestion and delays. Jordan Cove would mitigate this impact by implementing manual flagging of the intersection during the PM hours when the construction workforce would be leaving the Myrtlewood Off-site Park and Ride lot.

The DEA analysis of the first year of operation found that all intersections meet the applicable mobility targets.[175]

In summary, the DEA (2017b) study indicates that Project-generated trips during peak construction would result in operational impacts at two study area intersections if no other mitigation were provided. In addition to staggered work shifts (assumed in the analysis), the *Traffic Impact Analysis* recommended the following strategies and mitigation measures:

- U.S. 101 at Trans-Pacific Parkway – construct a dedicated eastbound left-turn lane and employ temporary signalization of the intersection.
- Hauser Depot Road at U.S. 101 – employ manual flagging at the intersection during the PM hours when the workforce is leaving the Myrtlewood Off-site Park and Ride lot.
- Use PnR lots to bus workers not residing at the North Spit housing facility to the Project site.

The Traffic Impact Analysis recommends that Jordan Cove enter into development agreements with ODOT, Coos County, and the City of North Bend to allow the various entities to work through different scenarios should they occur during construction. Such development agreements would provide the framework to allow for timely identification and development of response actions or

[175] The one exception would be the westbound turn from Ferry Road to U.S. 101, which currently fails to meet operational targets. As noted above, operation of the project would not add any traffic to this intersection.

mitigation for unforeseen scenarios that develop during construction. We concur with these findings. Therefore, **we recommend that:**

- **<u>Prior to construction</u>, Jordan Cove should file documentation that it has entered into development agreements with ODOT, Coos County, and the City of North Bend, as recommended in the *Traffic Impact Analysis* report.**

During construction of the LNG terminal slip, excavated material would be transported by truck to upland sites. The excavated material truck haul route would be on Jordan Cove or Roseburg Forest Products owned land and would not cross the Trans-Pacific Parkway. The haul trucks and other equipment using the haul road would consist of large off-road vehicles common for large civil infrastructure or mining projects. The only potential conflict would be with Roseburg chip truck traffic, when the Jordan Cove excavated material trucks cross Jordan Cove Road. This potential impact would be mitigated by construction of a temporary traffic overpass that would segregate traffic traveling to and from the Roseburg Forest Products facility from large, off-road haul trucks and equipment.

4.10.1.3 Railroad Traffic

The existing Coos Bay rail line would be used for the delivery of sheet piling. Over the first year 16 deliveries of sheet piling would occur. However, Jordan Cove has indicated that pending further analysis, additional use of the rail line may be necessary. All rail shipments would be off-loaded at an existing rail spur at the Roseburg Forest Products yard, which runs into the construction laydown area. No new rail construction is anticipated for the purpose of transporting materials and equipment to the site. Rail deliveries would be coordinated with Roseburg Forest Products and Coos Bay Rail Link to minimize impacts on their operations.

4.10.1.4 Air Traffic

The Southwest Oregon Regional Airport is located in the city of North Bend, directly across Coos Bay and less than 1 mile from the LNG terminal site. The airport is owned and operated by the Coos County Airport District and provides commercial passenger services to the region. The Coast Guard also has five helicopters based at the airport. The number of fixed wing aircraft based at the Southwest Oregon Regional Airport has ranged from 51 to 68 for the past 20 years, with 51 aircraft based at the airport in 2010.

Commercial passenger service to and from the airport is currently provided by United Airlines, with one flight daily to and from San Francisco, four days a week. United Airlines also provides seasonal twice-a-week roundtrip flights to and from Denver. Federal Express and Ameriflight operate cargo services out of the airport.

During operation of the Jordan Cove LNG Project, LNG carriers in the Federal Navigation Channel would cross he airport approach pathway. Jordan Cove has indicated that aircraft would be delayed by about 13 minutes for each passing vessel, consisting of a 10-minute advance notice period, and 3 minutes of actual time during which airspace would be potentially obstructed. LNG carrier transit times could also be adjusted to avoid conflict with air traffic, if the need arises.

Comments during public scoping requested that the EIS evaluate the potential impact of thermal plumes from the Jordan Cove LNG terminal on airport operations. Jordan Cove commissioned a thermal plume study for the previously proposed LNG terminal in 2013 (TRC Environmental

Corporation 2013) which showed that the combustion turbines that were part of the previously proposed South Dunes Power Plant were identified as the main potential source of thermal plumes from the terminal. The South Dunes Power Plant is not part of the current proposal and therefore the LNG terminal would not general thermal plumes.

Title 49 CFR §193.2155 of the USDOT's regulations requires that an LNG storage tank be at least 1 mile from the end of an airport runway, or 0.3 mile from the nearest point on a runway, whichever is longer. This issue is discussed further in section 5.1.13, Reliability and Safety.

4.10.2 Pacific Connector Pipeline Project

4.10.2.1 Access Roads

Pacific Connector would use a variety of vehicles including standard pick-up trucks, earth-moving equipment, tractor trailers, and pipe-stringing (and other materials/equipment) trucks to construct the pipeline. These vehicles would traverse Project-area roadways and access workspaces via existing and new construction access roads. Equipment and materials would be transported from various laydown areas and storage yards to the pipeline right-of-way and associated construction workspaces. Most construction equipment would remain on the right-of-way during construction.

As described previously, existing roads, including federal and state highways, as well as local, private, and BLM and Forest Service roads, would be used to access workspaces and move construction equipment, materials, and personnel (see table D-2 in appendix D).

Major state and federal highways that would be affected by the pipeline include:

- U.S. Highway 101 (MP 1.2) and State Highway 42 (MP 51.5) in Coos County;
- I-5 (MP 71.2) and State Highway 227 (MP 94.7) in Douglas County;
- State Highway 62 (MP 122.6), Butte Falls Highway (132.5), and State Highway 140 (MP 145.6) in Jackson County; and
- State Highway 66 (MP 191.5), U.S. Highway 97 (MP 199.6), and State Highway 39 (MP 208.8) in Klamath County.

The pipeline would be installed in Coos Bay under U.S. Highway 101. State Highways 42, 140, 66, and 39 would be crossed with conventional road bores. Pacific Connector proposes to use direct pipe technology to cross under I-5. State Highway 62 and U.S. 97 would be crossed with HDDs. Highway 227 and the Butte Falls Highway would be crossed with open cuts. Smaller roads would also typically be crossed with open cuts.

Constructing the pipeline would temporarily impact Project-area roads and their users. Temporary impacts include increased road traffic, traffic delays, and road wear. To facilitate construction of the pipeline, some existing roads would be improved. Improvements would generally occur on smaller roads and would include widening, base improvement (gravel), and the installation of pullout/passing spaces. Minor improvements (i.e., filling potholes, grading to remove ruts, and/or limbing to remove overgrowth) would be needed in some areas to accommodate oversized and heavy construction equipment. In other cases, roadway improvements would require reconstruction to make the roads usable for access to the construction right-of-way. Pipeline-stringing trucks would haul 40- to 80-foot lengths (joints) of pipe, which would often require travel outside an existing road footprint. Widening access roads would be necessary to accommodate the potential for the stringing trucks to "walk" outside of the existing road footprint. In some circumstances, it may also be necessary for oncoming traffic to pull off of the existing road footprint to pass.

To reduce impacts on affected roads and users, Pacific Connector would implement the measures described in its TMP.[176] These measures include:

- Obtain all necessary permits from ODOT, BLM, Forest Service, and the counties to cross and/or use roads, and implement all permit stipulations.
- Notify landowners or managers 7 days in advance of planned road work. In cases where there are unforeseen changes to the schedule, provide a minimum 48-hour notice.
- Use flaggers, signs, lights, barriers, and other common traffic control measures.
- Maintain at least one lane of traffic with detours around the construction by plating over the open portion of the trench or by other suitable methods. Where road closures are necessary, limit closures to 24 hours, post signs in advance, provide access for emergency vehicles, and evaluate alternate access for local residents.
- Keep roads free of mud and other debris that may be deposited by construction equipment. Ensure track-driven equipment crosses roads on tires or construction pads to minimize road damage. Repair any roadways damaged by construction activities.

In addition to its use of public roads, Pacific Connector would construct 10 new TARs and 15 new PARs (table 4.10.2.1-1). Eight of the TARs and 12 of the PARs would be located on non-federal land . After the pipeline is installed, unless specifically requested by the landowner, the TARs would be removed, and the land restored to its original use. Most of the new PARs would be located within Pacific Connector's permanent pipeline easement and would provide access during construction as well as for operations and maintenance activities while the Pacific Connector pipeline is in service.

TABLE 4.10.2.1-1

Proposed New Temporary and Permanent Construction Access Roads

Access Road (TAR/PAR-MP)	Width (feet)	Length (feet) a/	Jurisdiction	County
TAR-27.06	20	1,500	BLM	Coos
TAR-29.92	16	2,249	Private	Coos
TAR-88.69	20	416	Private	Douglas
TAR-94.81	20	114	Private	Douglas
TAR-101.70	25	1,517	Private/NFS	Jackson
TAR-141.10	25	471	Private	Jackson
TAR-143.19	20	146	Private	Jackson
TAR-145.60	20	391	Private	Klamath
TAR-208.72	20	281	Private	Klamath
TAR-215.72	14	728	Private	Klamath
Total TAR		**7,813**		
PAR-15.07	25	258	Private	Coos
PAR-29.48	25	85	Private	Coos
PAR-48.58	25	222	BLM	Douglas
PAR-59.58	25	195	Private	Douglas
PAR-71.46	25	692	Private	Douglas
PAR-80.03	25	92	BLM	Douglas
PAR-94.66	25	501	Private	Douglas
PAR-113.66	25	73	Private	Jackson
PAR-122.18	25	181	Private	Jackson

[176] Pacific Connector filed its TMP as Appendix Y to its POD filed with the FERC on January 23, 2018.

TABLE 4.10.2.1-1 (continued)

Proposed New Temporary and Permanent Construction Access Roads

Access Road (TAR/PAR-MP)	Width (feet)	Length (feet) a/	Jurisdiction	County
PAR-132.46	25	271	Private	Jackson
PAR-150.70	25	282	BLM	Jackson
PAR-169.48	25	342	Private	Klamath
PAR-187.46	25	438	Private	Klamath
PAR-196.53	25	106	Private	Klamath
PAR-211.58	25	72	Private	Klamath
Total PAR		**3,810**		

TAR = Temporary Access Road; PAR = Permanent Access Road; MP = milepost
a/ All or portions of the PARs are located within the permanent pipeline easement. Estimated total disturbance from TAR = 3.8 acres, total disturbance from PAR = 2.2 acres.

4.10.2.2 Additional Traffic on Local Roads

Pacific Connector assumes that approximately 80 percent of workers would travel each morning to a construction yard, and then make the return trip in the evening. These workers would then be transported from the contractor yard to and from construction workspaces on crew buses. The remaining 20 percent of the workforce would drive their own vehicles to construction workspaces using local roads and highways, with 30 percent of this total expected to carpool with approximately two workers per vehicle. The 20 percent of the workforce using their own vehicles would make two to three daily trips from the contractor yards to various construction locations.

Pacific Connector estimates that between three and four pipe-stringing trucks would make approximately two roundtrips per day between the pipe storage yards and pipeline work sites for the duration of project construction. Three water trucks and three dump trucks would make up to six roundtrips per day to deliver materials and equipment to the right-of-way and control fugitive dust. Another five fuel/lube/maintenance trucks and five equipment trucks would make approximately one roundtrip per day between the storage yards and work sites. Based on these assumptions, average heavy truck traffic during mainline construction is estimated to include 53 vehicle round trips per day along each construction spread. The routes taken by these vehicles would vary depending on the location of construction activities.

Based on these assumptions, construction-related peak vehicle round trips per day would range from 461 to 1,657, including crew buses and heavy vehicle trips (table 4.10.2.2-1).[177]

[177] These estimates are based on five construction spreads as initially identified by Pacific Connector. Pacific Connector has since indicated that they would use eight construction spreads. Increases in the number of spreads would reduce the number of workers traveling to any one location.

TABLE 4.10.2.2-1

Estimated Peak Vehicle Round Trips per Day by Pipeline Spread

Vehicle Type/Journey	Spread a/,b/				
	1	**2**	**3**	**4**	**5**
Personal vehicles from place of residence to work sites c/	413	589	284	171	150
Personal vehicles from place of residence to contractor yards	661	942	455	274	239
Worker vans and trucks from contractor yards to work sites d/	52	74	36	21	19
Heavy Vehicle Trips e/	53	53	53	53	53
Total Traffic f/	**1,179**	**1,657**	**828**	**520**	**461**

a/ The spreads initially identified by Pacific Connector are as follows:
Spread 1: Coos Bay (Coos County) to Camas Valley (Douglas County)
Spread 2: Camas Valley to Milo (Douglas County)
Spread 3: Milo (Douglas County) to Shady Cove (Jackson County)
Spread 4: Shady Cove (Jackson County) to Keno (Klamath County)
Spread 5: Keno to Malin (Klamath County)
b/ Pacific Connector has indicated they now plan to use eight construction spreads, which would reduce the number of workers traveling to any one location.
c/ Personal vehicles are assumed to make between two and three trips per day between work sites and contractor yards.
d/ Worker vans are assumed to be 15-passenger crew vans.
e/ Heavy vehicle traffic includes pipe-stringing, water, dump, material, and fuel/lube/maintenance trucks making between one and six trips per day between work sites and contractor yards.
f/ Totals may not sum due to rounding.

Other trips not included in the estimates in table 4.10.2.2-1 include workers building the aboveground facilities, inspectors, and surveyors traveling to and from various work sites.

4.10.2.2 Operations

Operating the pipeline would require a permanent staff of about 15 employees. Project-related traffic during operations would be minimal, occurring on a sporadic rather than regular basis, and would have negligible effects on traffic volumes on roads in the Project area.

4.10.2.3 Off-Highway Vehicles

Commenters raised concerns during public scoping that the pipeline right-of-way could be used to increase unauthorized OHV, snowmobile, and dispersed motorized access to adjacent lands. OHV use is discussed in section 4.8, Recreation and Visual Resources.

4.10.3 Environmental Consequences on Federal Lands

4.10.3.1 Roads Crossed

The pipeline would cross multiple roads on BLM and NFS lands. Some roads would be crossed at more than one location. The pipeline would be placed within the right-of-way of a number of roads. Open cuts would be used to cross all of the roads on BLM and NFS lands.

4.10.3.2 Roads Used for Access

Pipeline construction would require the use of many miles of existing roads on federal lands, or existing private roads on which federal land-managing agencies hold an easement. The BLM and NFS roads are of varying conditions, and some roads would require improvements to surfacing, brushing, drainage maintenance, and other work to accommodate oversized and heavy construction equipment. In most cases, the potentially affected roads are single-lane forest roads designed and built primarily for the removal of timber using conventional log trucks. Pacific Connector's pipe-stringing trucks would be hauling 40- to 80-foot-long sections of pipe to the right-of-way. These vehicles would be approximately 100 feet long. Because of the size of these and other vehicles that would use these access roads, some minor improvements (straightening, widening, cut and fill, and/or culvert improvements) may be required. In some circumstances, it may also be necessary to construct turnouts for oncoming traffic to "pull out" of the existing road footprint for passing purposes. All road maintenance, reconstruction, and improvements undertaken by Pacific Connector and their contractors would conform to BLM and Forest Service requirements. No maintenance or improvements would be allowed on any road not authorized for use and approved for improvements.

Pacific Connector would construct one new TAR on BLM land. This road would be approximately 0.3-mile-long and would disturb less than approximately 1 acre of land. One TAR would be constructed on NFS lands. This road would also be approximately 0.3 mile long and disturb less than approximately 1 acre of land (table 4.10.2.1-1). These roads would provide access during construction and would be restored to preconstruction conditions following completion of construction; which would result in a short-term impact.

Pacific Connector would construct three new PARs on BLM land, totaling about 600 feet (see table 4.10.2.1-1). Construction of these new roads would permanently impact approximately one-third of an acre. These roads would provide access during construction and for operations and maintenance activities while the Project is in service. No new PARs would be built on NFS land.

Construction activities at proposed federal road crossings would also affect public access, as well as use by permittees, contractors, and cost share users. Pacific Connector's TMP identifies the roads on federal lands that would be used during Project-related timber extraction activities, and pipeline construction and operations, and specifies the standards that would be utilized where improvements on federal roads are necessary.

As discussed in section 4.10.2.3, Pacific Connector's TMP outlines measures Pacific Connector would implement to maintain public access on roads used for construction access or crossed by the construction right-of-way during pipeline construction.

4.10.3.3 OHV Use on Federal Lands

Federal land managers have raised concerns that the pipeline right-of-way could be used to increase unauthorized OHV, snowmobile, and dispersed motorized access to federal lands. Locations where unauthorized access could be exacerbated by the pipeline right-of-way include the area around the PCT; the Camel Hump area; the Obenchain area; along the Clover Creek Road (on NFS land); and various points on BLM lands. In the Obenchain area, four-wheel-drive vehicles have caused extensive resource damage. The Camel Hump and Obenchain areas are located within the Jackson Access and Cooperative Travel Management Area, which encompasses both private and BLM lands, and is generally closed to motorized use from mid-October through April. In the area along the Clover Creek Road, the pipeline would closely parallel the road for 18 miles (on public and private lands); thus, the pipeline right-of-way could potentially turn into an OHV thoroughfare without appropriate barriers and mitigation.

OHV controls were addressed in Pacific Connector's *Recreational Management Plan*. The general measures Pacific Connector would use to limit OHV access to its right-of-way on federal lands would be the same as those discussed for non-federal lands above.

4.10.4 Conclusion

Constructing and operating the Project would not significantly affect marine, railroad, or air traffic. With the proposed mitigation measures mentioned in previous sections in place, the Project would also not significantly affect motor vehicle traffic.

4.11 CULTURAL RESOURCES

Cultural resources are locations of human activity, occupation, or use. According to the FERC's Office of Energy Projects' "Guidelines for Reporting on Cultural Resources Investigations for National Gas Projects," cultural resources include any prehistoric or historic archaeological site, district, object, cultural feature, building or structure, cultural landscape, or Traditional Cultural Property (TCP). Generally, cultural resources are considered to be historic properties[178] under the NHPA if they are at least 50 years old and meet the criteria for listing on the NRHP (36 CFR Part 60.4). Adverse effects to historic properties are typically considered significant impacts under NEPA; however those impacts may be mitigated to less-than-significant levels. It should be noted that consulted Indian tribes have pointed out that their definition of cultural resources is more expansive than that above and may include natural resources or features. As discussed in subsection 4.11.1.3 below, while resources and issues of concern to Indian tribes that do not meet the above definition of cultural resources are described in this section, the reader is referred to the corresponding section of this EIS for a more detailed discussion.

The regulations for implementing Section 106 of the NHPA, at 36 CFR 800.9, encourages the integration of the Section 106 compliance process with the NEPA process; and we have done this in this section below of the EIS. This section is broken into several subsections. The subsections mirror the Section 106 compliance process. The steps of the process, as outlined in 36 CFR 800 are: 1) consultations; 2) identification of historic properties; 3) assessment of effects; and, 4) the resolution of adverse effects. Our first subsection below is a summary of consultations initiated by the FERC staff, and communications the applicants had with various consulting parties, including other federal agencies, SHPO, and interested Indian tribes. Next, we define the APE, and summarize the results of literature reviews and site file searches, and the results of cultural resources inventories conducted by the applicants' consultants. Then we discuss the Unanticipated Discovery Plan (UDP) produced by the applicants for this Project, and reviews by consulting parties. Lastly, we reach conclusions about the status of our compliance with the NHPA. Appendix L includes a cultural context for the Projects, a brief summary of archaeological research in southern Oregon, detailed listings of consultations with SHPO and Indian Tribes, and detailed listings of identified cultural resources in the APEs of the Project, anticipated impacts on those resources, and proposed methods to address those effects.

Section 101(d)(6) of the NHPA states that properties of traditional religious and cultural importance to Indian tribes may be determined eligible for the NRHP. In carrying out our responsibilities under Section 106 of the NHPA, the FERC staff consulted with Indian tribes that may attach religious and cultural importance to properties in the APE. On behalf of all the federal cooperating agencies, as the lead federal agency, the FERC staff conducted government-to-government consultations with Indian tribes that may be interested in the Projects, and may have concerns about potential impacts on cultural resources and historic properties, including traditional religious and cultural properties. Consultations with Indian tribes are detailed below.

[178] Historic properties include any prehistoric or historic district, site, building, structure, or object, and properties of traditional religious or cultural importance to Indian tribes listed on or eligible for listing on the NRHP, as defined in 36 CFR 800.16(l).

Section 106 of the NHPA requires the FERC to take into account the effect of its undertakings[179] (including authorizations under Sections 3 and 7 of the NGA) on historic properties and afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment. Jordan Cove and Pacific Connector, as non-federal applicants, are assisting the FERC in meeting its obligations under Section 106 by providing data, analyses, and recommendations in accordance with 36 CFR 800.2(a)(3) and the FERC's regulations at 18 CFR 380.12(f). The FERC remains responsible for all findings and determinations under the NHPA.

As the lead federal agency for the Project, the FERC will address compliance with Section 106 on behalf of all the federal cooperating agencies in this EIS.[180] However, the federal land-managing agencies still have separate obligations regarding cultural resource management under other federal laws and regulations, including, but not limited to, the Antiquities Act of 1906, Section 110 of the NHPA, Archaeological and Historic Preservation Act of 1974, Archaeological Resources Protection Act of 1979, FLPMA, and the Native American Graves Protection and Repatriation Act.

4.11.1 Consultations

To identify historic properties potentially affected by the Projects and in accordance with Section 106, FERC, on behalf of all of the federal cooperating agencies, consulted with the Oregon SHPO,[181] interested Indian tribes, and other consulting parties prior to making our determinations of NRHP eligibility and Project effects. We also consulted with the SHPO, interested Indian tribes, and other consulting parties to determine the resolution of adverse effects on historic properties that cannot be avoided. All correspondence related to these consultations can be found in the Commission's administrative record. A detailed listing of communications and comments received from Indian tribes are included in appendix L. Our consultations are ongoing and will be updated in the final EIS.

Consultations began with the issuance of the NOI on June 9, 2017. The NOI was sent to a wide range of stakeholders, including other federal agencies such as the ACHP, U.S. Department of the Interior Bureau of Indian Affairs (BIA), BLM, COE, Forest Service, Reclamation, and NPS; state and local government agencies, such as the Oregon SHPO; affected landowners; regional environmental groups and non-governmental organizations; and Indian tribes that may have an interest in the project area. The NOI contained Section 106-specific text initiating consultations with the SHPO and soliciting their views and those of other government agencies, interested Indian tribes, and the public on the Project's potential effects on historic properties.

[179] "Undertaking means a project activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; those requiring a Federal permit, license or approval; and those subject to state or local regulation administered pursuant to a delegation or approval by a Federal agency," as defined in 36 CFR 800.16(y). The Projects are undertakings.

[180] Pursuant to 36 CFR 800.2(a)(2), the EPAct, and the May 2002 Interagency Agreement on Early Coordination of Required Environmental and Historic Preservation Reviews.

[181] In all cases, the SHPO refers to the staff of the Oregon State Historic Preservation Office within the Oregon State Parks and Recreation Department, including the State Archaeologist.

4.11.1.1 Consultations with the SHPO

Throughout the planning process, the FERC staff have consulted with and the applicants have communicated with the Oregon SHPO regarding the Projects. While not specific to the current application, FERC consultations and applicant communications regarding previous versions of the Projects occurred between 2006 and 2015 and informed our current consultations. Those efforts were summarized in the relevant FEISs prepared for Docket Nos. CP07-441-000, CP07-444-000, CP13-483-000, and CP13-492-000. Consultations between the FERC and the SHPO after September 2015, related to Docket Nos. CP17-494-000 and CP17-495-000, are summarized in table L-1 in appendix L. Communications between the SHPO and the applicants after September 2015 are summarized in tables L-2 and L-3 in appendix L.

4.11.1.2 Consultations with Indian Tribes

The unique and distinctive political relationship between the United States government and Indian tribes is defined by treaties, statutes, executive orders, judicial decisions, and agreements. These have resulted in differentiating tribes from other entities that deal with, or are affected by, the federal government. This relationship has given rise to a special federal trust responsibility, involving the legal obligations of the United States government toward Indian tribes and the application of fiduciary standards of due care with respect to Indian lands, tribal trust resources, and the exercise of tribal rights. Indian tribes are defined in 36 CFR 800.16(m), as: "an Indian tribe, band, nation, or other organized group or community, including a Native village, Regional Corporation, or Village Corporation, as those terms are defined in Section 3 of the Alaska Native Claims Settlement Act (43 U.S.C. 1602), which is recognized as eligible for the special programs and services provided by the United States to Indians because of their special status as Indians."

The FERC acknowledges that it has trust responsibilities to Indian tribes, and so, on July 23, 2003, it issued a "Policy Statement on Consultations with Indian Tribes in Commission Proceedings" in Order 635. That policy statement included the following key objectives:

- The Commission will endeavor to work with Indian tribes on a government-to-government basis, and will seek to address the effects of proposed projects on tribal rights and resources though consultations; and
- The Commission will ensure that Tribal resources and interests are considered whenever the Commission's actions or decisions have the potential to adversely affect Indian tribes or Indian trust resources.

The FERC contacted Indian tribes that may attach religious or cultural significance to sites in the region or may be interested in potential Project impacts on cultural resources. We identified Indian tribes that historically used or occupied the Project area through basic ethnohistorical sources, such as the *Handbook of North American Indians* (Suttles 1990), communications with the SHPO and the Oregon Legislative Commission on Indian Services, information provided by the applicants, and scoping responses to our June 9, 2017 NOI, including letters from interested Indian tribes.

Indian tribes identified in the region are: the Burns Paiute Tribe, Confederated Tribes of the Lower Umpqua, Coos, and Siuslaw Indians (CTCLUSI), Coquille Indian Tribe (CIT), Cow Creek Band of Umpqua Tribe of Indians (Cow Creek Tribe), Fort Bidwell Paiute Tribe, Confederated Tribes of the Grand Ronde Community of Oregon (Grand Ronde Tribes), Hoopa Valley Tribe, Karuk

Tribe, Klamath Tribes, Modoc Tribe of Oklahoma, Pit River Tribe, Confederated Tribes of Siletz Indians (Siletz Tribes), Tolowa Dee-ni' Nation (formerly Smith River Rancheria), and Yurok Tribe.

A context that identifies Indian tribes that historically used or occupied the area affected by the Project, as well as details of the FERC consultations and the applicants' communications with Indian tribes, can be found in appendix L.

FERC Staff Consultations with Indian Tribes

Similar to consultations with SHPO, government-to-government consultations between the FERC and Indian tribes related to previous versions of the Projects occurred between 2006 and 2015 and were documented in the FEISs produced for Docket Nos. CP07-441-000, CP07-444-000, CP13-483-000, and CP13-492-000.

Consultations between the FERC and Indian tribes after September 2015, related to Docket Nos. CP17-494-000 and CP17-495-000, are listed in table L-4 in appendix L. Consultations between FERC staff and Indian tribes are still ongoing. Tribal consultation efforts were initiated with an e-mail sent on May 9, 2017 to tribes inviting them to participate in a telephone conference call about the Projects. This was followed by the NOI issued by the FERC on June 9, 2017, requesting comments about the Projects. On April 5, 2018, the FERC staff sent out letters to individual Indian tribes. In response to those letters, the CTCLUSI, Coquille Tribe, Grand Ronde Tribes, Karuk Tribe, and Yurok Tribe requested meetings with the FERC staff. Additional meetings and telephone conference calls have occurred between the FERC staff and some of the above tribes to discuss specific concerns about the Projects (see table L-4 in appendix L).

Comments from Native American Individuals

Besides government-to-government consultations between the FERC staff and leaders of interested Indian tribes, various other tribal members and individual Native Americans commented about the Projects during scoping and in response to our notice of applications. Communications between Native American individuals and organizations and the FERC under Docket Nos. CP17-494-00 and CP17-495-000 are listed in table L-5 in appendix L. Of these communications, 26 were letters from Native American individuals submitted as motions to intervene.

In addition to the above letters, several individuals identifying themselves as Native Americans spoke at our public scoping sessions for the Projects. Gary Jackson, who identified himself as a member of the Cow Creek Tribe, spoke at the public scoping session held on June 28, 2017 in Roseburg. Dale Ann Frye Sherman Yaqui and Margaret Robbins, who identified themselves as members of the Yurok Tribe, spoke at the public scoping session held on June 29, 2017 in Klamath Falls. Also at the Klamath Falls session, Monique Sonoquie identified herself as Chumash and Apache residing at the Yurok reservation in California; Mirinda Hart identified herself as Wylocki-Wintu from the Round Valley Confederation of Tribes in California; Anna Powell identified herself as a member of the Hoopa Valley Tribe in California; and Della Sanchez and Taylor Tupper identified themselves as members of the Klamath Tribes. Concerns voiced during the scoping meetings were similar to those identified in the letters from tribal members and Native American individuals listed in table L-5 in appendix L.

Applicants' Communications with Indian Tribes

Jordan Cove and Pacific Connector have also conducted their own, separate Native American contact programs, as part of their investigation efforts. Communications between the applicants and Native Americans informed their current efforts. Those were discussed in the FEISs produced for previous iterations of the Projects under Docket Nos. CP07-441-000, CP07-444-000, CP13-483-000, and CP13-492-000. Current contacts between the applicants and Indian tribes since September 2015 and regarding the current application are listed in tables L-6 and L-7 in appendix L of this EIS.[182] Tribes were provided the opportunity to review research designs and reports. They also participated in cultural resources investigations and monitored surveys and subsurface testing. The applicants have executed a Cultural Resources Protection Agreement (CRPA) with the CTCLUSI.

4.11.1.3 Issues Raised by Indian Tribes

This section summarizes the comments received from consulted Indian tribes. Tribes raised a wide variety of topics, not necessarily limited to historic properties considered under Section 106. In general, issues of concern, outside of the NHPA process, raised by Indian tribes included:

- Indian trust assets;
- traditional lifeways;
- water quality;
- aquatic species/fisheries;
- wildlife;
- forestry and wildfires;
- air quality and climate change;
- aesthetics;
- geologic hazards and general safety of the Project;
- environmental justice and socioeconomics; and
- cumulative impacts of the Project.

We summarize tribal concerns raised in consultations with the FERC, below, by individual tribe. However, where a tribal concern for a resource not considered under Section 106 was discussed, the reader is referred to the corresponding section of this EIS for a more detailed description of those resources, and where applicable, the impacts of the Project on those resources under NEPA.

Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians

In several different filings with the FERC, the CTCLUSI indicated that they consider the geographic area of Coos Bay to be a Traditional Cultural Property (TCP), "Q'alay ta Kukwis schichdii me." The Tribe has issued two resolutions (Resolution No. 2006-097 and Resolution No. 2015-049) mentioning the TCP. The CTCLUSI also began the process of nominating the TCP to the NRHP. The nomination has been approved by the Oregon State Advisory Committee on Historic Preservation and forwarded to the SHPO. It is anticipated to be accepted or denied NRHP-listing by the NPS in June 2019. There are no federal laws that would prevent a project from crossing a TCP. However, there are regulations (36 CFR 800) and an NPS bulletin (Parker and King 1998) that provide guidance about evaluation of significance, assessing impacts, and mitigating effects on TCPs.

[182] These communications were documented in Jordan Cove's and Pacific Connector's September 2017 applications to the FERC and their subsequent responses to staff's multiple environmental information request since January 2018.

The CTCLUSI are concerned that Project-related activities at the terminal (Ingram Yard) and South Dunes area, such as drilling, grading, dredging, and vibro-compaction, may impact buried village sites and Indian graves documented in the Tribes' database of cultural resources. In its January 29, 2018 letter to the FERC staff, the CTCLUSI stated that a pre-contact shell midden deposit was found deeply buried in Coos Bay during geotechnical testing for improvements to the Navigation Channel. Survey reports submitted to the FERC by the applicants, including a September 12, 2018 summary memo by Archaeological Investigations Northwest, Inc. (AINW; Hulse 2018) describing the results of a cultural resources survey conducted for the Coos Bay marine waterway modifications, did not identify any deeply buried shell middens in Coos Bay, as described by CTCLUSI. Jordan Cove's consultants have recommended monitoring of construction by professional archaeologists and Tribal representatives. Any cultural resources or human remains uncovered during monitoring would be handled according to the Project's UDP. In addition, Jordan Cove has executed a CRPA with the CTCLUSI that provides for Tribal monitoring of construction activities.

As articulated in its July 10, 2017 letter to the FERC, the CTCLUSI are concerned that traditional activities of its members in the Project area, including the gathering of traditional plants, harvesting of shell fish, fishing, and hunting, may be restricted by the proposed projects. It should be noted that Jordan Cove's proposed upland facilities would be located on private lands where access to the public has already been limited since the Luse family sold its ranch on the North Spit in 1883 (Beckham 2015).[183]

Jordan Cove agreed to hire a professional ethnographer to conduct research to more clearly document religious and cultural properties important to the CTCLUSI that may be located within the APE, including the TCP reported by the CTCLUSI in the Jordan Cove area. A draft ethnographic study was filed with the FERC on April 4, 2018 (Deur 2018); however, the FERC staff has requested revisions to the document. The revised ethnographic study is expected to address what natural resources are important to the Tribes, such as traditionally gathered plants, fisheries, and hunted species that may still exist in the Project area. The CTCLUSI indicated that they are funding their own independent ethnographic study of the Coos Bay area. However, more recently, Jordan Cove has convened a Native American Working Group, and offered individual tribes financial support for them to produce their own ethnographic studies of the Project area.

In the EIS, we address effects on upland vegetation and timber in section 4.4, terrestrial wildlife in section 4.5.1, and aquatic resources in section 4.5.2. Since the U.S. government never executed a treaty with the CTCLUSI, the Tribes do not have treaty-protected or special fishing or hunting privileges on ceded lands.

The CTCLUSI also expressed concerns about crime, sexual exploitation of women, and negative impacts on the native communities of the Coos Bay area as a result of the operation of a "man-camp" (South Dunes Temporary Workers Housing Complex) during terminal construction; similar to the impacts of man-camps of the Bakken oil fields of North Dakota (see Harvard 2015; Adler

[183] William Luse, the son of H.H. Luse, who established a sawmill at Empire in 1855, was once married to a Coos woman, and was involved in the Indian community at Jordan Cove. The Luses acquired the properties of the Henderson, Barnett, Crawford, and Jordan families, which included Coos members. The lands were consolidated into a large ranch on the North Spit. As long as the Luses owned this land, Indian occupation of the North Spit would have been allowed, but this changed once the property was sold to the Oregon Southern Improvement Company.

and Hillstrom 2015; Gillette 2016; Briody 2017; Deer and Nagle 2017; Nienaber 2017; Finn et al. 2016). We discuss this issue in section 4.9, Socioeconomics, of this EIS.

In its July 10, 2017 letter to the FERC, the CTCLUSI requested to be a cooperating agency in the preparation of our EIS. However, on October 25, 2017, the CTCLUSI filed a motion to intervene in the proceeding. It is Commission policy that intervenors cannot also be cooperating agencies. As such, the CTCLUSI's request to be a cooperating agency cannot be granted.

Also in its July 10, 2017 letter, the CTCLUSI requested a meeting between FERC staff and the Tribal Council as part of our government-to-government consultations. Tribal leaders met directly with the Chair of the Commission at FERC headquarters in Washington, D.C., and representatives of the CTCLUSI met face-to-face with Commission staff in Oregon on March 22 and June 28, 2017, and July 17, 2018. We consider those meetings, our NOI, our letters to the CTCLUSI, and letters from the Tribes to the Commission to constitute government-to-government consultations.

The CTCLUSI believe that the Project may have negative impacts on Coos Bay's tourism and fishing industries. Effects on fisheries are discussed in section 4.5.2 of the EIS, and we discuss the tourism industry in section 4.9.

The CTCLUSI are also concerned about potential safety risks that may be caused by earthquakes related to seismic movements along the CSZ, and that an earthquake-triggered tsunami could hit the North Spit. The CSZ is discussed in section 4.2, and there is a tsunami impact assessment in section 4.1 of the EIS.

The CTCLUSI would like an assessment of potential health impacts on Tribal members and the general community of Coos Bay. This includes Project-related impacts on water quality and air quality. Jordan Cove will arrange for on-site medical professionals to provide basic care for terminal construction workers, reducing the potential influx of patients to the local medical facilities. Further, Jordan Cove signed a MOU with the State of Oregon that requires Jordan Cove to equip the Bay Area Hospital according to state policies for all hospitals in treating burns. The EIS addresses water quality effects in sections 4.3.1 and 4.3.2, while air quality effects are discussed in section 4.12.1.

The CTCLUSI raise concerns about the clearing of forest, and the potential for Project-caused wildfires. Effects on forested lands and the potential for wildfires are discussed in in section 4.4.

In a letter to the FERC dated January 22, 2018, the CTCLUSI stated that Jordan Cove was not providing advance notification of geotechnical investigations in a timely manner and did not provide the Tribes with detailed work plans. Jordan Cove responded to these issues in a letter to the FERC dated January 25, 2018, detailing the geotechnical investigation work plan and notifications provided to the Tribes. In addition, the CRPA contains procedures for notifications to the CTCLUSI concerning future geotechnical investigations proposed by Jordan Cove.

According to their January 29, 2018 letter to the FERC, the CTCLUSI would like to be engaged in the discussion of impacts on the Projects' viewshed. This section discusses indirect impacts on cultural resources through visual and audible intrusions. Section 4.8.2 of the EIS includes a visual assessment. The Tribes also requested that the cumulative impact assessment in the EIS include the Channel Modification Project; which it does.

Coquille Indian Tribe

On November 8, 2017, the Coquille Tribe requested to be a cooperator in the production of this EIS. We accepted that request in a letter to the Tribe dated April 4, 2018. On July 16, 2018, the FERC staff met in-person with the Coquille Tribe at Coos Bay.

The Coquille Tribe requested that this EIS address potential indirect impacts on Indian trust assets, such as the Coquille Forest. Although Jordan Cove has stated that there are no Indian trust assets "directly adjacent to the APE," the pipeline route is in close proximity to three parcels of the Coquille Forest which are held in trust by the BIA and managed by the Coquille Tribe. There should be no direct impacts on lands held in trust by the Coquille Tribe. The proposed pipeline right-of-way would be as close as 65 feet upslope of the three parcels of the Coquille Forest. Indirect impacts on the Coquille Forest would be similar to other forested lands, which are discussed in section 4.4 of this EIS.

In a February 26, 2019 e-mail to FERC staff, the Coquille Tribe provided a list of important traditional-cultural plant and animal species. The Tribe noted that plant species provided much of the sustenance, shelter, and safety for their ancestors. Some of the most important traditional cultural plant species that are found on the Coquille Forest and other Tribal lands include: trees, including their bark and wood (Port Orford cedar, western red cedar, Sitka spruce, big leaf maple, myrtle, red alder, madrone, Pacific yew); the wood, buts, and berries of shrubs (elderberry, willows, hazel, vine maple, rhododendron, azalea, manzanita, ocean spray, Labrador tea, huckleberry, salal, thimbleberry, salmonberry, Oregon grape); the roots and fibers of flowers and vines (yarrow, camas, tiger lily, columbine, various Lomatium and Brodiaeas, iris, trailing blackberry, yurba buena, beargrass), various wet meadow/riparian species (cattail, tule, various sedges and ferns, skunk cabbage, various mosses); and marine/estuary species (eelgrass, giant kelp bull kelp, sea lettuce, surfgrass). The upland vegetation in the Project area and wetlands are discussed in sections 4.4 and 4.3 of this EIS, respectively. Some traditionally used plants are also considered special status species, and are discussed in section 4.6.

The Coquille Tribe noted that animals (including fish and birds) provided food and raw materials for shelter, technologies, economies, and ceremonial purposes. The Tribe provided a list of some of the animal species that are culturally important to them: terrestrial mammals (deer, elk, coyote, cougar, bear, bobcat, raccoon, beaver, squirrel), marine/estuary species (Lamprey, all available salmon species, shellfish, crab, sea mammals, rockfish, lingcod, sculpin, halibut, flounder, perch, herring, greenling, candlefish, snails, mussels, barnacles, chiton, sea urchin, abalone, dentalium, other seasonally available estuary species); and birds (eagles, hawks, owls, cormorant, kingfisher, herons, osprey, flicker, woodpeckers [particularly pileated], grebe, cormorant, crows and ravens, and colorful neo-tropical species). Wildlife and aquatic species are discussed in section 4.5 of this EIS. As with the culturally significant plant species listed above, some traditionally important animals are also considered special status species and are discussed in section 4.6.

Cow Creek Band of Umpqua Tribe of Indians

In a letter to the FERC dated October 20, 2017, the Cow Creek Tribe stated that the Pacific Connector pipeline route would cross about 122 miles of the Tribe's aboriginal territory or ceded lands. The Tribe is concerned about potential Project-related impacts on cultural resources, and is also concerned about river and stream crossings and impacts on water quality and aquatic resources.

As of September 2018, Pacific Connector has identified 79 archaeological sites along the pipeline route within the historic aboriginal territory or ceded lands of the Cow Creek Tribe, from about MP 42 to MP 168. The FERC has determined that 59 of those sites are listed or eligible for the NRHP or are unevaluated; the remaining 20 sites were found not eligible for listing on the NRHP. The Cow Creek Tribe has reviewed previously filed cultural resources inventory and evaluation reports, and treatment plans. The Tribe also monitored previous archaeological investigations in their territory. There is additional cultural resource work to be done for the Projects, including additional investigatory work and consultations. However, we expect that Pacific Connector should execute an agreement with the Cow Creek Tribe, similar to the CRPA with the CTCLUSI described above, to continue Tribal monitoring of future archaeological investigations. In addition, the FERC will require Pacific Connector to provide future reports of cultural resources investigations, and new treatment plans, to the Cow Creek Tribe for review.

Proposed waterbody crossings of the Pacific Connector pipeline route are listed by milepost in table H-3 of appendix H of this EIS. This EIS addresses impacts on waterbodies in section 4.3.2 and impacts on aquatic species in section 4.5.2. The 1853 treaty with the Cow Creek Tribe did not specify the reservation of fishing, hunting, or gathering rights for Indians in lands ceded by the Tribe.

Confederated Tribes of the Grand Ronde Community

In its motion to intervene, filed with the FERC on November 15, 2017, the Grand Ronde Tribes stated that they have maintained a deep connection to the resources and sacred places of their treaty homelands. The Tribes are interested in protecting, enhancing, and restoring tribal culture and natural resources affected by the Projects. Salmon and lamprey have particular cultural significance to the Tribes. In addition, the Grand Ronde Tribes have concerns about other aquatic resources, including ESA federally listed bull trout, and Oregon Conservation Strategy species rainbow trout, cutthroat trout, and Umpqua chub. Birds of concern include federally listed marbled murrelet and northern spotted owl, and state-sensitive common nighthawk, flammulated owl, great gray owl, Lewis's woodpecker, purple martin, white-headed woodpecker, and yellow breasted chat. Other upland mammals that hold the Tribes' attention include American marten, fisher, California myotis, fringed myotis, hoary bat, red tree vole, ringtail, and Sierra Nevada red fox. Reptiles of interest include the federally listed Oregon spotted frog, and state-listed Del Norte salamander, northern red-legged frog, southern torrent salamander, California mountain kingsnake, and western pond turtle.

This EIS discusses aquatic species in section 4.5.2, upland wildlife in section 4.5.1, and ESA protected and other special status species in section 4.6. The FERC will additionally produce a BA that addresses impacts on federally listed species protected under the ESA, and submit this BA to the FWS and NMFS. The 1853 treaty with the Rogue River Tribes and 1854 treaty with the Upper Umpqua Tribes did not specify the reservation of fishing, hunting, or gathering rights for Indians on lands ceded by the Tribes.

The Grand Ronde Tribes stated that their ancestors once occupied the region between MPs 50 and 175 along the Pacific Connector pipeline route. As of 2015, Pacific Connector's consultants recorded 81 archaeological sites along that segment of the proposed pipeline route. Of those, 42 sites were either found to be eligible for the NRHP or are unevaluated; the remaining 39 sites were found not eligible for listing on the NRHP. In a January 16, 2018 letter to the FERC commenting on Pacific Connector's Resource Report 4, the Grand Ronde Tribes requested a reassessment of isolated finds, which do not "accurately reflect the historic land use of the landscape, but is a consequence of many years of cultural resource surveys being undertaken in a piecemeal fashion." In addition, the Grand Ronde Tribes suggested revisions to Pacific Connector's UDP. Pacific Connector has provided the Grand Ronde Tribes with copies of cultural resources investigations reports for their review.

In its May 4, 2018 letter to the FERC, the Grand Ronde Tribes re-asserted their deep connections with the resources and sacred places of their ancestral homelands in southern Oregon, including Usual and Accustomed areas ceded by treaties with the U.S. government. The Tribes requested a study be done to identify sacred places, gathering places, locations of burials, and other places of cultural significance to the Tribes. In response to an earlier request from the FERC staff, the applicants filed with the FERC on April 4, 2018 a draft ethnographic study (Deur 2018). However, in a May 4, 2018 environmental information request to Pacific Connector, the FERC staff asked that the document be revised. The revised ethnographic study is expected to address natural resources that are important to the Tribes, such as traditionally gathered plants, fisheries, and hunted species that may still exist in the Project area. However, more recently, Pacific Connector has convened a Native American Working Group, and offered individual tribes financial support for them to produce their own ethnographic studies.

On July 20, 2018, the FERC staff held a telephone conference call with representatives of the Grand Ronde Tribes. That call discussed the FERC's NEPA process, and our process for complying with the NHPA.

On September 19, 2018 the Grand Ronde Tribes provided the FERC staff with a comment letter regarding the cultural resource studies completed to date and the Tribal Working Group proposed by the applicants. The Tribes noted they were, to date, yet to receive complete materials documenting cultural resource surveys from the applicant for the Tribes' review. Concerns were expressed for a lack of consideration of historic properties of religious and cultural significance to Indian tribes. The Grand Ronde Tribes have apprehensions about the proposal for the Tribal Working Group.

In a letter to the FERC dated October 5, 2018, the Grand Ronde Tribes requested an in-person government-to-government meeting with the FERC staff at their Tribal headquarters. We have been unable to schedule such a meeting to date due to travel considerations and ex parte rules, but continue efforts to establish a meeting with the Tribes.

Karuk Tribe

The Karuk Tribe, in comments to the FERC dated July 5, 2017, raised concerns about potential Project-related impacts on water quality and the salmon fishery in the Klamath River. Since the U.S. government never executed a treaty with the Karuk Tribe, and did not set aside an officially designated reservation for the Tribe, the Karuk Tribe does not have special fishing or hunting privileges on ceded lands that are federally protected as treaty rights.

The Karuk Tribe believes that the Pacific Connector pipeline may contribute sediment to and increase the water temperature of streams crossed. We address impacts on waterbodies in section 4.3.2 of this EIS. Likewise, this EIS discusses aquatic resources in section 4.5.2.

The Karuk Tribe also claims that in the case of a break of the Pacific Connector pipeline, waterbodies would be polluted. However, the pipeline would transport natural gas in gaseous form (not liquid) and, in the unlikely event of an incident and release, natural gas, which is lighter than air, would dissipate into the atmosphere and would not contaminate waterbodies. The Karuk Tribe believes that the Jordan Cove export terminal would include a 420-megawatt power plant. This is not so, as the current proposal has eliminated the power plant.

In their May 3, 2018 letter to the FERC, the Karuk Tribe requested a meeting with staff to discuss the Projects. Again, the Tribe mentioned its concerns about the pipeline crossing of the Klamath River, and its potential impacts on the salmon fishery and the lifeways of the Tribe. The FERC staff met in-person with representatives of the Karuk Tribe in Happy Camp, California, on July 18, 2018.

Klamath Tribes

The Klamath Tribes provided comments about the Project to the FERC in filings on June 7 and 26, September 1, and October 20, 2017, and May 3, 2018. The Klamath Tribes assert that the Pacific Connector pipeline route would cross ceded lands that contain cultural resources of importance to the Tribes, and that former villages and graves may be impacted by construction of the pipeline.

As of 2015, Pacific Connector's consultants have identified 10 pre-contact archaeological sites along the pipeline route in Klamath County. Eight of those sites were evaluated as eligible for the NRHP or are unevaluated. It should be noted that members of the Klamath Tribes participated in Pacific Connector's cultural resources surveys. Pacific Connector has provided the Klamath Tribes with copies of all previous cultural resource reports, for their review. If the Projects are authorized by the FERC, and any unanticipated sites or human remains are found during construction, Pacific Connector would follow the procedures outlined in its UDP, that was previously reviewed by the Klamath Tribes.

The Klamath Tribes requested the opportunity to assist in the drafting of a revision of Pacific Connector's Historic Property Management Plan (HPMP). A draft HPMP was filed with the FERC by Pacific Connector on October 5, 2018; it is unclear if the applicants made that document available to the Klamath Tribes for their review.

The Klamath Tribes are also concerned about water quality, the pipeline route crossings of the Rogue and Klamath River, and the potential for the Projects to impact fish species that are important to the Tribes. The 1864 treaty with the Klamath Tribes stated that the Tribes hold "…*the exclusive right of taking fish in the streams and lakes, included in said reservation, and of gathering edible roots, seeds, and berries within its limits*…." However, the Pacific Connector pipeline route does not cross the Klamath Reservation. Pacific Connector proposes to cross under the Rogue River and Klamath River using HDDs, to avoid impacts on those rivers and their associated fisheries. The pipeline would also cross 17 streams or creeks that form part of the Klamath River headwaters in Klamath County. Pacific Connector would use dry methods (flumes or dams) to cross other streams. Erosion controls that would be implemented at stream crossings would limit turbidity and sedimentation. These stream crossing would not result in significant long-term impacts on the fishery resources associated with the Klamath River system. See sections

4.3.2 and 4.5.2 in this EIS for more details about impacts on waterbodies and aquatic resources, respectively, and proposed mitigation measures.

The Klamath Tribes raised concerns about impacts on regional air quality, and the Project's potential contributions to global warming. Air quality is discussed in section 4.12.1 of this EIS.

The Klamath Tribes are also concerned about the potential for the Projects' facilities to be impacted by earthquakes and landslides. Section 4.1 of this EIS discusses geological hazards, including measures that would be implemented to reduce impacts from earthquakes and landslides.

The issue of "man camps" and tribal community safety in those settings has also been raised by the Klamath Tribes. There are no proposed worker housing camps along the Pacific Connector pipeline route. Instead, workers would be dispersed along spreads and find housing in RV camps, rental houses and apartments, and hotels, as discussed in the socioeconomic section of this EIS.

The Klamath Tribes cite EO 12898 as requiring the study of impacts of the Projects on Environmental Justice communities, including Indian Tribes. Although the FERC is an independent regulatory agency excluded from compliance with Executive Orders, in order to address this tribal and general public concern, we analyze in section 4.9 of this EIS whether the Projects would have disproportional environmental impacts on minority and low-income populations.

Tolowa Dee-Ni' Nation

The Tolowa Dee-Ni' Nation, in its letter dated December 6, 2018 to the FERC, described the Nation's "strong opposition [to] and concern" regarding the proposed Project. The Nation noted they cannot support the Project based on the proximity of the pipeline to the headwaters of the Rogue River and the perceived potential for pipeline leaks to impact the waters of the river. As noted elsewhere in this section, the pipeline would transport natural gas in gaseous form which, in the event of a release, would dissipate into the atmosphere and would not contaminate waterbodies. The pipeline would cross under the Rogue River with an HDD, and Pacific Connector would use dry methods to cross other headwater streams. Those techniques, as explained in section 4.3 of this EIS, would reduce impacts on waterbodies and their associated fisheries.

Yurok Tribe

The Yurok Tribe, in its letter dated July 6, 2017 to the FERC, and in its motion to intervene filed October 26, 2017, stated that Pacific Connector's proposed crossing of the Klamath River could have potential impacts on tribal trust fish species, including ESA-listed coho salmon, Chinook salmon, steelhead, green sturgeon, and Pacific lamprey. Disruption of fish habitat may have negative impacts on the Yurok Tribal economy that depends in part on a commercial salmon fishery. In addition, the Tribe states that the Klamath Riverscape is a district listed on the Yurok Tribe Register of Historic Properties. Pacific Connector's consultants should review the Klamath Riverscape to determine what effects, if any, the Projects would have on it.

When the Klamath Reservation in California was created in 1855 for the Yurok and Hupa people, their rights to fish in the rivers running through the reservation were federally protected. In a 1993 opinion issued by the Solicitor for the U.S. Department of the Interior, it was stated that the entitlement of the Yurok and Hoopa Valley Tribes was limited to 50 percent of the harvest of Klamath-Trinity Basin salmon (Leshy 1993). The Pacific Connector pipeline route does not cross through the Klamath-Trinity Basin of California. The pipeline route would cross the Klamath River in Klamath County, Oregon, within the traditional territory of the Klamath Tribes, where Pacific Connector would use an HDD. The HDD would limit impacts on the Klamath River and its fishery resources.

Impacts on federally listed aquatic species are discussed in section 4.6 of this EIS, together with proposed mitigation measures. The FERC will produce a BA and EFH Assessment that will be reviewed by the NMFS and FWS.

In their May 4, 2018 letter to the FERC, the Yurok Tribe requested a meeting with staff to discuss the Projects. On July 18, 2018, the FERC staff met in-person with representatives of the Yurok Tribe in Klamath, California.

4.11.1.4 Communications with Other Agencies

The BLM, Forest Service, Reclamation, COE, EPA, FWS, and NMFS are federal cooperating agencies in the production of this EIS, and consulting parties with regard to the Section 106 compliance process. The federal land-managing agencies previously provided the FERC with their opinions on NRHP eligibility and pipeline effects for sites on federal land. Comments related to cultural resources received by the FERC from other federal agencies between 2012 and 2015 for Docket Nos. CP13-483-000 and CP13-492-000 are discussed in section 4.11.1.3 of our September 2015 FEIS for those projects. Communications between the FERC and other federal agencies related to cultural resources issues for Docket Nos. CP17-494-000 and CP17-494-000 are discussed below.

In response to our June 9, 2017 NOI for these Projects, the EPA filed comments, dated July 10, 2017. One of its comments was that the EIS should discuss compliance with the NHPA, including consultations with the SHPO. In addition, the document should discuss Project-related impacts on tribal, cultural, or other treaty resources. We address EPA's issues in this section.

The ACHP wrote a letter to the FERC dated January 25, 2018, in response to the January 22, 2018 letter from the CTCLUSI to the FERC about geotechnical testing. The ACHP stated that, in general, their agency has "interpreted geotechnical testing as part of project planning for undertakings and not, in and of itself, subject to review by federal agencies under Section 106." They requested that the FERC respond to the Tribes and clarify the purpose of the geotechnical investigations and the place of those investigations in the FERC's Section 106 compliance process. The FERC staff agrees with the ACHP position that geotechnical investigations are considered part of the pre-planning process and not subject to Section 106 compliance. It is FERC practice that pre-construction geotechnical investigations be conducted without FERC review or approval and are not considered to be cultural resource studies or part of the Section 106 process (see FERC 2017). As such, the applicants do not need permission from the FERC to conduct pre-planning geotechnical work, and these activities do not constitute part of the FERC's undertaking. However, the applicants may need permits from other federal agencies, such as the COE, for those activities.

Jordan Cove's Communications with Other Agencies

Jordan Cove sent email communications to the COE, SHPO, ODEQ, and ODE on May 19 and November 16, 2017, providing a context for the geotechnical work proposed at the APCO site and about sampling at Kentuck Slough, respectively. Project Activity Updates were also provided to the same agencies via email on September 3, 2017 for September 2017; October 2, 2017 for activities scheduled in October; October 13 and 27 and November 9, 2017 for activities in November; December 1, 2017 for activities scheduled for December 2017; and December 14 and 20, 2017 for activities scheduled for January and February 2018. Details of these communications can be found in appendix L.

Pacific Connector's Communications with Other Agencies

Communications between Pacific Connector and federal agencies between 2006 and 2009 were summarized in section 4.10.1.3 of our May 2009 FEIS produced for Docket Nos. CP07-441-000 and CP07-444-000. Communications between Pacific Connector and federal agencies between May 2009 and September 2015 were listed in table 4.11.1.3-2 of our September 2015 FEIS for Docket Nos. CP13-483-000 and CP13-492-000.

On February 24, 2017, Pacific Connector sent an email to the BLM requesting a review of the list of cultural resource sites located along the pipeline route on BLM lands. On February 29, 2017, the Forest Service called Historical Research Associates, Inc. (HRA) to discuss heritage properties on NFS lands that may be affected by the Pacific Connector Project. On May 26, 2017, Pacific Connector sent an email to the COE, ODE, and ODEQ regarding geotechnical testing to support the proposed HDD under Coos Bay. We detail Pacific Connector's communications since 2015 with other federal and state agencies in appendix L.

4.11.2 Area of Potential Effect

As stated in our NOI, we define the direct APE as all areas subject to ground disturbance, including the construction right-of-way, temporary extra work spaces, contractor/pipe storage yards, disposal areas, aboveground facilities, and new or to-be-improved access roads. An indirect APE was also established by the applicants for each project based on each viewshed.

4.11.2.1 Jordan Cove LNG Project

In the case of the Jordan Cove Project, the direct APE includes the footprint of all potential ground-disturbing actions. Specifically, this includes the South Dunes Site, Ingram Yard, Access and Utility Corridor, Meteorological Station, Industrial Wastewater Pipeline, Trans-Pacific Parkway/U.S. 101 Intersection, the planned mitigation sites (Kentuck, Eelgrass, Lagoon, Panhandle, and North Bank), Boxcar Hill laydown and parking area, Roseburg Forest Products and Port laydown sites, APCO Sites 1 and 2, Myrtlewood Off-site Park and Ride, and hydraulic dredge pipelines in Coos Bay. We agree with the definition of the direct APE, provided in Jordan Cove's application to the FERC. The Jordan Cove Project facilities are described in more detail in chapter 2 of this EIS.

The indirect APE is defined to include all areas potentially subjected to the introduction of visual, atmospheric, or audible elements that diminish the integrity of a historic property's significant historic features. Jordan Cove's consultants conducted a windshield survey for a 2-mile radius around the proposed LNG terminal. The existing Boxcar Hill Campground and RV Park was noted in this area. Also found in the indirect APE was a house in the Shorewood area at the northern mouth of Haynes Inlet, the Hilltop House restaurant and Bay Bridge Motel on the north side of the McCullough Bridge, and residential neighborhoods in the City of North Bend (Bowden et al. 2017). The consultants concluded that no historic properties would have a view of the aboveground components of the LNG terminal. As such, the indirect APE was recommended to be the same as the direct APE. We agree with this definition. Section 4.8.2 of this EIS includes a visual impact assessment of the LNG terminal facilities. Section 4.12.2 of this EIS discusses noise impacts related to the construction and operation of the terminal.

The direct APE, which is the same as the indirect APE for the Jordan Cove Project, is depicted in Figure 1-1 of the 2017 survey report (Bowden et al. 2017) filed with Jordan Cove's application to the FERC.

4.11.2.2 Pacific Connector Pipeline Project

Pacific Connector defined the direct APE as all geographic areas that will potentially experience ground disturbances from the construction, operation, and maintenance of the pipeline. The construction right-of-way for the pipeline represents the majority of the direct APE and encompasses the temporary construction right-of-way, permanent easement, TEWAs, USCAs, and MLVs. Areas where elements of the Project extend outside the pipeline corridor generally consist of contractor and pipe storage yards, rock source and disposal sites, hydrostatic discharge sites, new and improved access roads, cathodic protection, and aboveground facilities, including communication towers. We agree with this definition of the direct APE. The Pacific Connector Project facilities are described in more detail in chapter 2 of this EIS.

Pacific Connector defined the indirect APE to include all geographic areas that would potentially experience visual intrusions or changes as a result of the construction, operation, and maintenance of the pipeline. The pipeline will not produce sufficient noise or odors to warrant consideration of audible or atmospheric/olfactory indirect effects in establishing the indirect APE. Section 4.12.2 of this EIS discusses noise impacts related to the construction and operation of Pacific Connector's facilities. Since the pipeline will be buried, the aboveground components of the project will be related to the associated aboveground facilities and the permanent easement itself, which will be maintained as a 50-foot-wide cleared corridor on the landscape. To identify the indirect APE, Pacific Connector's consultants reviewed the pipeline route for instances where the cleared easement may be noticeably visible, considering 1) current heavily vegetated landscapes with adjacent significant topographical differences and 2) landscapes that are relatively unencumbered by modern intrusions. This analysis determined that locations where the indirect effects APE diverges from the direct APE are limited to locations where the permanent easement traverses a steep, heavily vegetated area, then turns sharply so that the permanent easement could be seen directly from a location outside of the direct APE. The SHPO, in a letter to Pacific Connector's consultants dated January 22, 2016, concurred with the methodology for defining the indirect APE. We agree. Section 4.8.2 of this EIS includes a visual impact assessment of the proposed pipeline right-of-way.

Appendix A of the 2017 pipeline addendum survey report (Derr et al. 2017), filed with Pacific Connector's application with the FERC, contains maps that depict the direct and indirect APEs.

4.11.3 Results of Investigations

Archaeological, historical, and ethnographic contexts of the Project area can be found in the numerous survey reports completed for the Project since 2005. A brief historical summary of archaeological studies in the region can be found in appendix L. Studies conducted specifically for the Projects are described and listed below.

4.11.3.1 Ethnographic Studies

On April 4, 2018, the applicants filed a first draft Ethnographic Report (Deur 2018). The FERC staff and several interested Indian tribes reviewed that draft, and the FERC staff, in environmental information requests dated May 4 and October 23, 2018, requested that the applicants revise the ethnographic report. In a filing on November 2, 2018, the applicants declined to revise the ethnographic report, claiming that it is not required for purposes of compliance with Section 106 of the NHPA. This is not true. The regulations for implementing Section 106 at 36 CFR 800.2(c)(2)(ii) require consultations with Indian tribes to identify sites of religious and cultural importance to tribes, in keeping with Section 101(d)(6) of the NHPA. Further, section 6.1 (8) of the FERC staff's guidelines (FERC 2017) directs applicants to produce and file an "ethnographic analysis to identify any living Native American groups or other groups with ties to the project area to identify properties of traditional, religious, or cultural importance to Tribes and other groups." In addition, several interested Indian tribes requested the additional data we asked for in the revision request. In order to meet our obligations under Sections 101 and 106 of the NHPA, **we recommend that**:

- **<u>Prior to construction of facilities and/or use of any staging, storage, temporary work areas, or new or to-be-improved access roads</u>, Jordan Cove and Pacific Connector should file with the Secretary a revised Ethnographic Report describing sites of religious and cultural significance to Indian Tribes and other tribal information as outlined in the FERC staff's October 23, 2018 environmental information request #14, for the review of interested Indian tribes and the FERC staff, and for written approval by the Director of OEP.**

4.11.3.2 Jordan Cove LNG Project

Since 2005 surveys have been conducted for Jordan Cove to identify cultural resources within the LNG terminal direct APE. Table 4.11.3.2-1 lists the surveys that cover Jordan Cove's proposed facilities. More detailed summary descriptions of the surveys are included in appendix L of this EIS.

TABLE 4.11.3.2-1

Cultural Resources Surveys of Jordan Cove's Proposed LNG Terminal Facilities

Facility or Use Area a/	Survey Reports	Inventory Status
Access Channel (Coos Bay)	Byram 2006a, Rose et al. 2014, Punke, et al. 2018, Punke 2018	Survey Complete
Marine Slip (Ingram Yard) including LNG Vessel Berth, Tug Berth, and Emergency Lay Berth	Stubbs 1975, Barner 1978, Simmons 1983, Byram 2006a, Byram 2006b, Rose et al. 2014, Byram and Shindruk 2014; Punke et al. 2018, Punke 2018	Requires Additional Geoarchaeological Deep Testing of High Probability Area
Rock Apron (Ingram Yard & Coos Bay)	Hulse 2018	Survey Complete

TABLE 4.11.3.1-1 (continued)

Cultural Resources Surveys of Jordan Cove's Proposed LNG Terminal Facilities

Facility or Use Area a/	Survey Reports	Inventory Status
Material Offloading Berth (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Punke et al. 2018, Punke 2018	Survey Complete
Haul Road (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Punke et al. 2018, Punke 2018	Survey Complete
LNG Loading Platform and Transfer Pipeline (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Punke et al. 2018, Punke 2018	Survey Complete
LNG Storage Tanks (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Liquefaction Processing Area (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Refrigerant Storage Area (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Gas Processing Area (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Utilities (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Flare Area (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Secondary Terminal Entrance (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Punke et al. 2018, Punke 2018	Survey Complete
Laydown Area (Ingram Yard)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Fire Station and Ancillary Buildings at west end of Access and Utility Corridor (north of Roseburg Forest Products)	Byram 2006a, Byram 2006b, Punke et al. 2018, Punke 2018	Survey Complete
Access and Utility Corridor (north of Roseburg Forest Products)	Barner 1977, Simmon 1984, Byram 2006a, Byram 2006b, Byram 2008, Byram and Shindruk 2012, Punke et al. 2018, Punke 2018	Survey Complete
Laydown Areas (Roseburg Forest Products)	Byram 2006a, Byram 2006b, Rose and Davis 2013	Survey Complete
Temporary Dredge Slurry and Water Return Pipelines (Roseburg Forest Products & South Dunes)	Byram 2006a, Byram 2006b, Byram 2008; Bowden et al. 2009	Survey Complete
Truck Haul Route (Ingram Yard and Roseburg Forest Products)	Simmons 1983, Byram 2006a, Byram 2006b, Macfarlane and Skinner 2013, Punke et al. 2018, Punke 2018	Survey Complete
Laydown Area (South Dunes) and Temporary Workforce Housing Complex (South Dunes)	Stubbs 1975, Barner 1978, Byram and Purdy 2007, Byram and Shindruk 2012, Olander et al. 2009, Bowden et al. 2009, Ragsdale et al. 2013, Bowden et al. 2017; Punke 2018	Survey Complete
SORSC (South Dunes)	Byram and Purdy 2007, Bowden et al. 2017	Survey Complete
Administration Building (South Dunes)	Byram and Purdy 2007, Bowden et al. 2017	Survey Complete
Industrial Wastewater Pipeline Replacement and new Water Line (Trans-Pacific Parkway)	Simmons 1984, Lange 1984, Langer 1986, Byram 2009, Byram and Shindruk 2012, Byram and Rose 2013, Rose and Johnson 2014	Survey Complete
Port Laydown Site (North Spit – south of Southport facility)	Darby 2005, Byram and Purdy 2008	Survey Complete
Box Car Hill Laydown Area (North Spit – east side of Causeway)	Langer 1986, Byram 2009, Derr et al. 2017	Partially surveyed/Requires additional survey
Meteorological Station and Access Road (Lagoon)	Goodwin 2014	Survey Complete

TABLE 4.11.3.1-1 (continued)

Cultural Resources Surveys of Jordan Cove's Proposed LNG Terminal Facilities

Facility or Use Area a/	Survey Reports	Inventory Status
Channel Improvement Areas 1-4 (Coos Bay)	AINW 2017; Hulse 2018	Survey Complete
Temporary Dredge Line from Channel Improvement Areas to APCO sites (Coos Bay)	AINW 2017; Hulse 2018	Survey Complete
Temporary Dredge Line to Eel Grass Mitigation Site (Coos Bay)	Bowden et al. 2017	Survey Complete
Eel Grass Mitigation Site (Coos Bay – north of airport)	Byram 2013; Bowden 2018	Survey Complete
Temporary Dredge Line to Kentuck Slough Mitigation Area (Coos Bay)	Bowden et al. 2017	Partially surveyed/Requires additional survey
Trans-Pacific Parkway Causeway and U.S. Highway 101 Intersection Improvements (north of McCullough Bridge)	Simmons 1984, Byram 2006a, Byram 2009, Byram 2013, Goodwin 2014	Survey Complete
APCO Sites 1 and 2 (North Point of North Bend)	Byram 2017, Bowden et al. 2017; Punke and Bowden 2018	Survey Complete
Kentuck Slough Wetland Mitigation Area (Kentuck Slough)	Bowden et al. 2009, Byram and Walker 2010, Ragsdale et al 2013, Bowden et al. 2017, Derr et al. 2017; Bowden 2018	Partially surveyed/Requires additional survey
Myrtlewood RV Park Off-Site Parking Lot (Hauser)	Bowden et al. 2017	Survey Complete
Lagoon Habitat Mitigation Site	N/A	Unsurveyed
Panhandle Habitat Mitigation Site	N/A	Unsurveyed
North Bank Habitat Mitigation Site	N/A	Unsurveyed

a/ Facilities derived from Table 1.4-1 and Figure 1.1-1 of Resource Report 1 attached to Jordan Cove's application to the FERC, and Table 4.2-2 filed November 2, 2018.

Areas that still require additional survey include the dredge slurry lines in Coos Bay; the Boxcar Hill Laydown and Parking Area; and the Lagoon, Panhandle, and North Bank habitat mitigation sites.

Geoarchaeological deep testing and shovel probing have been conducted in Ingram Yard, the Access and Utility Corridor, and the South Dunes area (Punke et al. 2018; Punke 2018a and 2018b), as well as at both APCO sites (Punke and Bowden 2018). A possible piece of archaeological bone material was found in a shovel probe at the South Dunes area. No other archaeological evidence was uncovered by the geoarchaeological studies. However, buried surfaces suitable for human habitation were identified beneath the fill layers at tested areas and may include unrecorded archaeological resources. The geoarchaeological studies identified "high probability areas." Additional geoarchaeological deep testing has been recommended in the high probability area within Ingram Yard, which is yet to be completed. Jordan Cove has indicated that supplemental shovel and auger testing is ongoing and will be provided in a new, comprehensive survey report to be submitted in late 2018 or early 2019. Additionally, Jordan Cove's consultants recommended that archaeological monitoring of construction activities within the high probability areas at the terminal site and the APCO sites be conducted (Punke 2018a and 2018b; Punke and Bowden 2018).

Appendix L summarizes the identified and reported resources that are within or adjacent to the direct APE. We concur with all SHPO determinations of NRHP eligibility and effects. For those resources where SHPO concurrence has not yet been requested (pending additional investigations) or is pending SHPO response, the recommended NRHP eligibilities and effects are preliminarily used for this analysis.

To date, no historic properties have been identified within the APE for the Jordan Cove LNG terminal. One NRHP-listed resource, McCullough Bridge, is avoided by the Project. Jordan Cove's consultants have recommended that construction be monitored by qualified professional archaeologists in the vicinity of sites 35CS221 and 35CS227 at the Ingram Yard and South Dune area respectively; and at site BAC-2014-1 near the intersection of Highway 101 with the North Spit Causeway. Jordan Cove's consultants also recommended that sites 35CS324, 35CS325, 35CS326, 35CS327, and 35CS328, near the Kentuck project site be avoided or tested to assess their NRHP eligibility. In a November 2, 2018 filing, Jordan Cove indicated it would conduct phase II testing in 2019 to determine the NRHP eligibility of site 35CS227. Additionally, the reported site leads require additional testing and/or monitoring during construction. Similarly, the TCP, *Q'alay ta Kukwis schichdii me*, requires further consultation.

4.11.3.3 Pacific Connector Pipeline Project

Pacific Connector hired cultural resources management consultants HRA to coordinate its cultural resources investigations and has conducted surveys of the APE since 2006, as applicable to the various past iterations of the Project. Table 4.11.3.3-1 lists the surveys, including those that cover Jordan Cove's proposed facilities.

TABLE 4.11.3.3-1

Cultural Resources Surveys Conducted for the Pacific Connector Project

Title	Reference	Type	Subsurface Detail	Project Component(s) Surveyed
Pacific Connector Gas Pipeline Project Cultural Resources Survey, Coos, Douglas, Jackson, and Klamath Counties, Oregon	Bowden et al. 2009	Pedestrian and subsurface	Shovel probe, test units	Portions of pipeline corridor and some TEWAs (including co-located aboveground facilities), UCSAs, quarries, laydown areas, and access roads outside the pipeline corridor.
Pacific Connector Gas Pipeline Project Cultural Resources Investigations, Coos, Douglas, Jackson, and Klamath Counties, Oregon, Final Phase II Evaluations	Bowden et al. 2010	Subsurface	Test units	Portions of pipeline corridor.
Pacific Connector Gas Pipeline Project Cultural Resources Survey, Coos, Douglas, Jackson, and Klamath Counties, Oregon, Survey Report Addendum for December 2009 FERC Data Request	Knutson et al. 2010	Pedestrian, intertidal/boat	–	Portions of pipeline corridor and some laydown areas outside the pipeline corridor.
Pacific Connector Gas Pipeline Project Cultural Resources Survey, Coos, Douglas, Jackson, and Klamath Counties, Oregon: 2013 Cultural Resources Addendum	Bowden et al. 2013	Pedestrian and subsurface	Shovel probe	Portions of pipeline corridor, Klamath Falls Compressor Station, and some TEWAs outside the pipeline corridor.

TABLE 4.11.3.3-1 (continued)

Cultural Resources Surveys Conducted for the Pacific Connector Project

Title	Reference	Type	Subsurface Detail	Project Component(s) Surveyed
Pacific Connector Gas Pipeline Project Cultural Resources Survey: 2013 Cultural Resources Addendum #2	Ragsdale et al, 2013	Pedestrian and subsurface	Shovel probe, deep testing, test units	Portions of pipeline corridor, some TEWAs.
Pacific Connector Gas Pipeline Project Cultural Resources Survey: Phase II Evaluation of Site 35DO1284	Willis et al. 2013	Subsurface	Test units	Portion of pipeline corridor and one TEWA in pipeline corridor.
Pacific Connector Gas Pipeline Project Cultural Resources Survey, Coos, Douglas, Jackson, and Klamath Counties, Oregon. 2014-2015 Cultural Resources Addendum	Derr et al. 2015	Pedestrian and subsurface	Shovel probes, deep testing	Portions of pipeline corridor, some TEWAs, and one laydown area.
Pacific Connector Gas Pipeline Project Cultural Resources Survey, Coos, Douglas, Jackson, and Klamath Counties, Oregon. 2017 Cultural Resources Addendum.	Derr et al. 2017	Pedestrian, intertidal/boat, windshield, and subsurface	Test units	Portions of pipeline corridor and some TEWAs and access roads outside the pipeline corridor.
Pacific Connector Gas Pipeline Project Cultural Resources Survey, Coos County, Oregon: 2018 Cultural Resource Addendum 1	Derr et al. 2018	Pedestrian and subsurface	Shovel probes	Portion of pipeline corridor and some TEWAs and access roads outside the pipeline corridor.

As of April 2018, Pacific Connector indicated that approximately 221 miles of the direct APE for the pipeline route (96 percent) was covered by cultural resources surveys. A total of 1,557 work spaces (97 percent) have been surveyed. Surveys has been completed for 26 pipe yards and 16 rock source and disposal sites. All 35 hydrostatic test water discharge sites have been surveyed. About 498 miles (85 percent) of roads has been surveyed.

Access to unsurveyed portions of the 229-mile-long proposed pipeline corridor has either been denied or is pending. The pipeline crossings of Coos Bay/North Point, North Point/Kentuck Slough, Coos River, South Umpqua/I-5, Rogue River, and Klamath River are considered to have potential for buried cultural resources that could be impacted by the proposed HDD technology at these locations. Geoarchaeological deep testing has been conducted at the Klamath River crossing (Derr et al. 2015). Additional deep testing is planned to be conducted at the remaining above HDD crossings when access is obtained.

Survey of work spaces is also partially complete. Forty-one TEWAs (2.6 percent of the total number of TEWAs) remain to be surveyed. One UCSA (0.3 percent of the total number of UCSAs) requires survey.

A total of 17 pipe yards and rock source and disposal sites (34 percent) remain to be surveyed. One hundred and forty-eight access roads, totaling about 81 miles (15 percent) of proposed access roads, need to be surveyed. Lastly, three TARs (30 percent) require survey.

With the exception of the Klamath Compressor Station and new communication towers, all of the proposed aboveground facilities are within the pipeline corridor and/or are co-located with other facilities. Those aboveground facilities within sections of the pipeline corridor that have not yet been surveyed are MLV #2 and MLV #9. This area is 8 percent of the total area of MLVs not co-located with other aboveground facilities. Additionally, the Harness Mountain Communication Tower has not been surveyed. This area is less than 7 percent of the total area of communication towers not co-located with other facilities. Pacific Connector plans to survey this area once specific construction plans are finalized and access to the area is granted. The Klamath Compressor Station was surveyed as part of a previous iteration of the application (Bowden et al. 2013), however the design of the station has changed in the current application (CP17-494 and CP17-495; filed September 21, 2017). As such, a portion of this Project component requires survey. Pacific Connector planned to survey the additional acreage in 2017; however, the results have not yet been submitted to the FERC.

Of the 18 locations identified by Pacific Connector's consultants as having potential to convey indirect effects from viewshed changes related to the pipeline, only five appeared to contain potentially historic features based on a desktop analysis. Only these five areas in the indirect APE were recommended for survey. Surveys have not yet been conducted at the following five locations in the indirect APE: 1) east of Haynes Inlet (MP 5.5R); 2) west side of Kentuck Slough (MP 6.3R); 3) 13674 Sitkum Lane, Myrtle Point (MP 29.5); 4) near Dora Cemetery (MP 29.5): and 5) 2378 Upper Camas Road, Camas Valley (MP 49.5). Other areas of the indirect APE either have no potential to affect historic-period resources because no potential historic properties appear to be present, or historic-period resources are entrenched within a modern viewshed and significant impacts are therefore not expected.

The inventories for the Pacific Connector Project identified 158 archaeological and historic architectural sites (see appendix L); 120 sites are along the proposed pipeline route, and 38 sites are along access roads, within TEWA or UCSA, rock source or disposal areas, or yards. Thirty-seven of these sites are located on federal lands (one is on private and federal lands). In addition to the identified sites, 129 isolated finds were also recorded. Two of these require additional investigations (HRA-724i and HRA-727i). After consulting with the SHPO, we determined that the remaining 127 isolated finds are not eligible for the NRHP and require no further work.

Of the 125 sites on non-federal land (including one site that is on private and federal land), 26 have been evaluated as not eligible for the NRHP and require no further work. The Oregon SHPO has concurred with these recommendations and we agree (see appendix L). Seventy-nine sites are outside the APE or can be avoided. Six sites were previously recorded by other investigators and not relocated by Pacific Connector's consultants. The remaining sites are either NRHP-eligible or unevaluated.

Avoidance plans can be found in the draft HPMP filed with the FERC on October 5, 2018. The HPMP is subject to revision based on ongoing consultations between Pacific Connector, tribes, SHPO, and cooperating agencies. However, not all unevaluated, potentially NRHP-eligible, and NRHP-listed sites that can be avoided by the Project have avoidance plans; therefore, the draft HPMP still needs further revision.

Forty-three sites are unevaluated and cannot be avoided, so they need additional investigations, either survey or testing. The unevaluated sites requiring additional work are listed in in appendix L.

Twenty sites, listed in appendix L, have been determined to be eligible for or listed on the NRHP and cannot be avoided. Data recovery excavations are recommended as mitigation for these sites.

In most cases, the applicants prepared treatment plans for these sites, which were reviewed and accepted by appropriate interested Indian tribes, federal land management agencies, the Oregon SHPO, and the FERC staff.

4.11.3.4 Federal Lands

The Jordan Cove LNG Project would not directly affect any federal lands. The proposed Pacific Connector pipeline route, however, would cross federal lands administered by the BLM, Forest Service, and Reclamation. In total, 38 sites were identified on federal lands or are otherwise managed by one of these federal agencies. Thirty-three of the sites are on BLM lands (three of which extend onto private lands and therefore have dual land ownership), four are on NFS lands, and one is managed by Reclamation. We have included a table in appendix L listing all sites on federal lands.

Of the 33 sites on BLM lands, 10 are not eligible for the NRHP and require no further work. Ten of the 33 sites are treated as NRHP-eligible or are unevaluated and can be avoided. Eight of the sites on BLM lands require additional work, either additional survey or testing, prior to their evaluation for eligibility to the NRHP. Five BLM sites (35DO1104, 35DO1105, 35DO1106, 35DO1110, and 35DO1117) have been determined eligible for the NRHP and cannot be avoided by the Project. Pacific Connector's consultants have recommended that data recovery investigations be conducted to mitigate adverse effects at the unavoidable eligible sites.

Two of the four sites on NFS lands were evaluated as not eligible for the NRHP and require no further work. One Forest Service site (35DO1426) is unevaluated, but can be avoided. The remaining site (35DO1107) on NFS lands is eligible for the NRHP and cannot be avoided. Pacific Connector produced a treatment plan to mitigate adverse effects at 35DO1107, which the Forest Service found acceptable.

The Klamath Project, managed by Reclamation, is eligible for the NRHP. The Pacific Connector pipeline route would cross 16 features associated with the Klamath Project. Pacific Connector proposes to bore under the Klamath Project canals. However, neither Reclamation nor the SHPO have commented to date on this method of reducing impacts on the canals.

4.11.4 Unanticipated Discovery Plans

Jordan Cove included a draft UDP (August 2017) as Appendix B.4 in Resource Report 4 of its September 2017 application to the FERC in Docket No. CP17-495-000. Jordan Cove has stated that it developed its UDP in communications with certain Indian tribes (see appendix L). The Oregon SHPO, as well as the CTCLUSI, Coquille Tribe, Grand Ronde Tribes, and Klamath Tribes, provided Jordan Cove with comments on the plan, and Jordan Cove indicated that it would address those comments. A revised and final version of the UDP has not yet been submitted to the FERC.

Pacific Connector included a copy of its August 2017 draft UDP as Appendix B.4 of Resource Report 4, attached to its September 2017 application to the FERC and as an appendix to the draft HPMP submitted in October 2018 in response to a request by the FERC staff. Pacific Connector has indicated that the CTCLUSI, Coquille Tribe, and the Klamath Tribes commented on the draft UDP. Review of the draft UDP by the SHPO has not yet been completed. As such, a revised and final version of the UDP based on tribal and SHPO review has not yet been submitted to the FERC.

We cannot find the UDPs acceptable until we see final versions that address comments from Indian tribes and the SHPO.

4.11.5 Compliance with the NHPA

We have not yet completed the process of complying with Sections 101 and 106 of the NHPA. Additional consultations, investigations, and/or plans remain necessary.

For the Jordan Cove LNG Project, the planned Lagoon, Panhandle, and North Bank habitat mitigation sites still require surveys. Jordan Cove's consultants recommended that construction be monitored by qualified professional archaeologists in the vicinity of sites 35CS221 and 35CS227 at the Ingram Yard and South Dune area, respectively; and at site BAC-2014-1 near the intersection of Highway 101 with the North Spit Causeway. In a November 2, 2018 filing, Jordan Cove indicated it would conduct phase II testing at site 35CS227 in 2019. Jordan Cove's consultants also recommended that sites 35CS324, 35CS325, 35CS326, 35CS327, and 35CS328, which may be impacted by the dredge slurry line in Coos Bay to the Kentuck project site, should be avoided or tested to assess their NRHP eligibility.

For the Pacific Connector Pipeline Project, about 23 miles (totaling 793 acres) of proposed pipeline route, 41 TEWAs (totaling about 28 acres), 17 pipe yards rock source and disposal sites (totaling about 211 acres), and 148 access roads (totaling about 81 miles) remain to be inventoried. Where access has been denied, Pacific Connector would need a Certificate from the Commission in order to use eminent domain to conduct remaining surveys and other investigations. Forty-three sites are unevaluated and cannot be avoided, so they may be impacted by the Pacific Connector Pipeline Project. Those sites need additional investigations, either survey or testing.

The ethnographic study of the Projects and the identification of traditional cultural resources is also incomplete. We have recommended that the applicants file a revised Ethnographic Report.

Twenty historic properties may be affected by the Pacific Connector Pipeline Project. Those sites require treatment to mitigate impacts. To resolve adverse effects at affected historic properties, the FERC will produce a MOA for the current undertaking, to be circulated among the consulting parties. The MOA would stipulate that the treatment plans should be implemented; with the written permission of the FERC and federal land-managing agencies, as applicable. It would also allow for phased surveys and testing investigations, in areas were access was previously denied. However, the MOA cannot be drafted until after the Commission authorizes the Projects. If the Commission should deny the Projects, no adverse effects on historic properties would occur.

To ensure that the Commission's responsibilities under the NHPA and its implementing regulations are met, **we recommend that:**

- **Jordan Cove and Pacific Connector should <u>not begin construction of facilities and/or use</u> any staging, storage, or temporary work areas and new or to-be-improved access roads <u>until</u>:**
  - **a. Jordan Cove and Pacific Connector each file with the Secretary:**
    1. **remaining cultural resources inventory reports for areas not previously surveyed;**

2. **site evaluations and monitoring reports, as necessary;**
3. **final HPMP with avoidance plans;**
4. **final UDP; and**
5. **comments on the cultural resources reports and plans from the SHPO, applicable federal land managing agencies, and interested Indian tribes.**

b. **FERC affords the ACHP an opportunity to comment on the undertaking; and**

c. **FERC staff reviews and the Director of OEP approves all cultural resources reports and plans and notifies Jordan Cove and Pacific Connector in writing that treatment plans may be implemented and/or construction may proceed.**

All materials filed with the Commission containing location, character, and ownership information about cultural resources must have the cover and any relevant pages therein clearly labeled in bold lettering: "CUI//PRIV - DO NOT RELEASE."

4.11.6 Conclusion

We have not yet completed the process of complying with Sections 101 and 106 of the NHPA. Additional cultural resource inventories, evaluations, and associated reports are to be completed, as are a final ethnographic study, HPMP, and UDP. Consultations with tribes, SHPO, and applicable federal land-managing agencies have also not been concluded. As such, the Project would result in an adverse effect under Section 106 of the NHPA and a significant impact under NEPA. However, should the Project be approved by the Commission, an MOA would be developed with the goal of resolving adverse effects under Section 106. It is expected that the resolution of adverse effects through an MOA and implementation of treatment plans would mitigate impacts at affected historic properties to a less-than-significant finding under NEPA.

4.12 AIR QUALITY AND NOISE

4.12.1 Air Quality

Construction and operation of the proposed Projects would affect local and regional air quality. The term "air quality" refers to relative concentrations of pollutants in the ambient air. The subsections below summarize applicable federal and state air quality regulations and describe well-established air quality concepts that are applied to characterize air quality and to determine the significance of increases in air pollution. This includes metrics for specific air pollutants known as ambient air quality standards (AAQS), regional designations to manage air quality known as Air Quality Control Regions (AQCRs), and efforts to monitor ambient air concentrations.

Air quality impacts are spatially dependent, and therefore this section is divided into subsections as follows:

- Impacts in the Coos Bay area associated with the Jordan Cove LNG Project and marine vessels on the waterway are discussed in section 4.12.1.3.
- Impacts associated with the Pacific Connector pipeline—for which the key air pollution sources are emissions from construction and operation of the compressor station in Klamath County—are discussed in section 4.12.1.4.
- Environmental consequences on federal lands are summarized in section 4.12.1.5.

4.12.1.1 Regulatory Setting

Regulatory requirements for air quality—aside from the requirement that the overall project not contribute to a degradation in air quality that results in an exceedance of the national ambient air quality standards (NAAQS)—depend upon the equipment that is proposed to be constructed and the associated emissions. Sources of air pollution at the Jordan Cove LNG Project and in the associated waterway include the following:

- five direct-drive combined cycle combustion turbines, each rated at 524.1 million Btu per hour (MMBtu/hr), to power refrigeration compressors;
- one thermal oxidizer, rated at 110 MMBtu/hr for the gas conditioning system;
- one auxiliary boiler rated at 296.2 MMBtu/hr;
- one enclosed marine flare rated at 0.74 MMBtu/hr;
- one multipoint ground flare rated at 2.13 MMBtu/hr;
- two diesel black-start engines each rated at 4,376 hp;
- two backup engines each rated at 1,073 hp;
- three fire water pump engines each rated at 700 hp;
- two 160,000 cubic meters (m^3) capacity LNG storage tanks;
- fugitive emission sources (valves, flanges, and other equipment); and
- LNG carriers and support vessels.

Regulatory requirements for air quality applicable to the Pacific Connector Pipeline Project depend in part upon the equipment that is proposed to be installed at the compressor station and the associated emissions. Sources of air pollution at the compressor station would include:

- three General Electric PGT25/DLE 1.5 natural gas–fired combustion turbines, each with a maximum site rating of 28,290 hp, and a maximum heat input rate of 194.7 MMBtu/hr at 0°F (the air permit would limit operation to only two turbines at a time; the third is solely for reliability to maintain maximum throughput for the pipeline at times when one of the two operating units is offline for maintenance);
- one 6.28 MMBtu/hr gas-fired hot water boiler;
- one 1,090 kilowatt (kW) natural gas–fired spark-ignition standby generator, limited to no more than 100 hours per year of operation; and
- ancillary activities (fugitive venting, blowdowns, and condensate tank).

Air emission sources for the Jordan Cove LNG Project and the Pacific Connector Pipeline Project are regulated at the federal and state level. Applicable federal and state air quality regulations are summarized below.

Federal and International Air Quality Requirements

Applicable and potentially applicable federal air quality regulations include:

- New Source Review (NSR)/Prevention of Significant Deterioration (PSD) preconstruction permit requirements;
- General Conformity;
- Title V Operating Permit requirements;
- New Source Performance Standards;
- National Emissions Standards for Hazardous Air Pollutants (HAP);
- Chemical Accident Prevention; and
- Mobile Source Regulations.

<u>NSR/PSD Preconstruction Permit Requirements</u>

The federal NSR preconstruction permit program is administered by ODEQ under OAR 340-224 and includes two components: Nonattainment NSR (NNSR), which applies to "major" stationary sources located in nonattainment areas, and PSD, which applies to "major" stationary sources located in attainment or unclassifiable areas. Because existing air quality is classified as "attainment" or "unclassifiable" for all NAAQS pollutants, only PSD regulations are applicable to the Jordan Cove LNG Project. The Project as originally designed was considered a "major" PSD source, and a PSD permit application was submitted to ODEQ in March 2013. However, the current Project design no longer includes the previously proposed South Dunes Power Plant facility, and as a result it no longer qualifies as a major PSD source. A Type B state-only NSR application was submitted to ODEQ in September 2017.

Criteria pollutant emissions from the Pacific Connector Pipeline Project compressor station would be well below major source thresholds. Although GHGs are above previously identified major source thresholds, the Supreme Court made a ruling on June 23, 2014 (*Utility Air Regulatory Group [UARG] v. EPA [No. 12-1146])* that effectively disallowed the triggering of NSR/PSD based on the significance of GHG emissions alone. Therefore, the Pacific Connector Pipeline Project is not expected to trigger NSR/PSD.

General Conformity

For proposed activities that are not covered by NSR/PSD permits—such as construction activities—General Conformity requirements can apply in areas designated as "nonattainment" or "maintenance" with respect to the NAAQS. However, as there are no such areas within the vicinity of the Jordan Cove LNG Project or along construction routes, these requirements do not apply.

Approximately 325 feet of the Pacific Connector pipeline in construction spread 5, between MPs 199 and 200, would be located within the particulate matter with a diameter of less than 10 microns (PM_{10}) maintenance area. Federal regulations at 40 CFR 93 Subpart B require a General Conformity analysis for PM_{10} maintenance areas when emissions of PM_{10} exceed 100 tons per year (TPY). Estimated emissions for this 325-foot length of construction in the PM_{10} maintenance area are presented in table 4.12.1.1-1 and are far below the General Conformity applicability threshold; therefore, the General Conformity requirements do not apply to the Pacific Connector Pipeline Project.

TABLE 4.12.1.1-1

Estimated Construction PM_{10} Emissions in Klamath Falls PM_{10} Maintenance Area (tons) from the Pacific Connector Pipeline Project

Pollutant	PM_{10}
Total Spread 5 nonroad engine emissions (42.5 miles)	2.48
Total Spread 5 fugitive dust emissions (42.5 miles)	26.573
Total Spread 5 PM_{10} emissions	29.053
PM_{10} maintenance area total emissions (300 feet)	**0.039**

Title V Operating Permit

Facilities that have the potential to emit at least 100 TPY of any criteria pollutant, 10 TPY of any individual HAP, or 25 TPY of any combination of HAPs are required to obtain Title V Operating Permits, which are implemented by ODEQ under OAR 340-218. Because the Jordan Cove LNG Project's emissions of oxides of nitrogen (NO_x), carbon monoxide (CO), PM_{10}, and particulate matter with a diameter of less than 2.5 microns ($PM_{2.5}$) would each exceed that threshold for criteria pollutants, it will be required to apply for a Title V Operating Permit. For new sources (such as the ones proposed here), applications for these permits are due one year after the source commences operation. Oregon requires Title V facilities to obtain a Standard ACDP permit prior to construction; see the discussion of state air permitting requirements below.

Facilities that trigger PSD permitting, such as this one, are required to obtain Title V Operating Permits, which are implemented by ODEQ under OAR 340-218. The Pacific Connector Pipeline Project would therefore be required to apply for a Title V Operating Permit. For new sources (such as the ones proposed here), applications for these permits are due one year after the source commences operation.

The Title V Operating Permit will help ensure that the facility continues to comply with all applicable air regulations after it is built. These permits require periodic monitoring to ensure compliance with the permit, annual certification of compliance with all applicable air pollution regulatory requirements, and public comment on permit issuance/renewal and on significant modifications to the permit.

New Source Performance Standards

All new sources of air pollution in specific source categories are required to comply with applicable New Source Performance Standards (NSPS) regulations (40 CFR 60), which establish maximum emission limits for criteria pollutants (and their precursors) and also incorporate monitoring, reporting, and recordkeeping requirements. NSPS regulations that are applicable to the Project are discussed below.

The natural gas–fired turbines at the Jordan Cove LNG Project are subject to NSPS Subpart KKKK, which limits emissions of NO_x from the turbines.

The auxiliary boiler is subject to NSPS Subpart Db, which applies to steam-generating units rated at greater than 100 MMBtu/hr heat input. The auxiliary boiler would be subject to the Subpart Db emission limit for NO_x but would be exempt from the Subpart Db emission limits for sulfur dioxide (SO_2) and particulate matter because it would burn only natural gas.

The two diesel black-start generators, two diesel backup generators, and three diesel fire pump engines are subject to NSPS Subpart IIII, which requires that new or modified stationary engines meet the same emissions standards that manufacturers of comparable nonroad engines are required to comply with. Jordan Cove has proposed to install engines that meet EPA Tier 2 emission standards for the diesel generators, and EPA Tier 3 emission standards for the diesel fire pump engines.

New large storage tanks containing liquids that can emit significant amounts of volatile organic compounds (VOCs) - i.e., where the equilibrium partial pressure exerted by the VOC exceeds 3.5 kilopascals (kPa) - are subject to NSPS Subpart Kb. However, the two largest constituents in LNG that exert partial pressure are methane and ethane (both of which are negligibly photochemically reactive and therefore exempt from the definition of VOC). The remaining VOC constituents in LNG, such as butane, propane, and heavier compounds, have an equilibrium partial pressure of less than 3.5 kPa at the storage temperature, and therefore the LNG storage tanks are not subject to NSPS Subpart Kb.

Certain equipment at crude oil and natural gas production facilities can be subject to NSPS Subpart OOOOa. However, Jordan Cove has determined that none of its proposed facilities or equipment would qualify as affected sources under Subpart OOOOa.

With respect to the Pacific Connector Pipeline Project, the gas-fired combustion turbines located at the Klamath Compressor Station would be new and subject to NSPS Subpart KKKK (and are therefore specifically exempted from NSPS Subpart GG for stationary combustion turbines, as per 40 CFR 60.4305(b)). They would be required to meet an NO_x emission standard of 25 parts per million (ppm) by volume, dry basis, corrected to 15 percent oxygen (ppmvd @ 15 percent O_2) or approximately 1.2 pounds NO_x per megawatt hour generated.

The potential spark-ignition emergency generator at the compressor station would be manufactured after June 12, 2006, and therefore would be subject to NSPS Subpart JJJJ, which requires that NO_x emissions be no higher than 2.0 grams per horsepower per hour (g/hp-hr) = 160 ppmvd @ 15% O_2 and that CO emissions be no higher than 4.0 g/hp-hr = 540 ppmvd @ 15% O_2.

New large storage tanks containing liquids that can emit significant amounts of VOCs—i.e., where the equilibrium partial pressure exerted by the VOC exceeds 3.5 kPa—are subject to NSPS Subpart Kb. While the design of the Klamath Compressor Station has not been finalized, a condensate storage tank is likely to be installed. The potential applicability of NSPS Subpart Kb will be determined once the final storage tank specifications are known.

Certain equipment at crude oil and natural gas production facilities can be subject to NSPS Subpart OOOOa. The fugitive emissions at the Klamath Compressor Station would qualify as an "affected facility" under Subpart OOOOa, and the centrifugal compressors may be subject as well if they are equipped with wet seals. If any pneumatic controllers are installed, they may also be subject to Subpart OOOOa if they have a natural gas bleed rate of greater than 6 standard cubic feet per hour. Storage tanks may be subject to Subpart OOOOa if they have potential VOC emissions of 6 TPY or more; however, the condensate storage tank is unlikely to have potential emissions meeting this threshold. The extent to which NSPS Subpart OOOOa is applicable will be determined once the design of the Klamath Compressor Station is finalized.

National Emissions Standards for Hazardous Air Pollutants

New and existing sources of air pollution are required to comply with applicable National Emissions Standards for Hazardous Air Pollutants (NESHAP), many of which are also incorporated by reference into Oregon's regulations at OAR 340-244-0220. NESHAPs exist for the following source types included at the Jordan Cove LNG Project terminal:

- Stationary Combustion Turbines (40 CFR 63, Subpart YYYY); Stationary Reciprocating Internal Combustion Engines (40 CFR 63, Subpart ZZZZ); and
- Industrial, Commercial, and Institutional Boilers at Area Sources (40 CFR 63, Subpart JJJJJJ).

For natural gas–fired turbines, the requirements of Subpart YYYY were stayed per 40 CFR 63.6095(d), and therefore, there are no applicable requirements. For the engines, compliance with NSPS Subpart IIII satisfies the requirements of 40 CFR 63 Subpart ZZZZ, and therefore, there are no additional applicable requirements. For the auxiliary boiler, the requirements of Subpart JJJJJJ do not apply because it would burn only natural gas.

NESHAPs exist for the following source types included at the Pacific Connector compressor station:

- Stationary Combustion Turbines (40 CFR 63, Subpart YYYY); and
- Stationary Reciprocating Internal Combustion Engines (40 CFR 63, Subpart ZZZZ).

For natural gas–fired turbines, the requirements of Subpart YYYY were stayed per 40 CFR 63.6095(d), and therefore there are no applicable requirements. For the engines, compliance with NSPS Subpart JJJJ satisfies the requirements of 40 CFR 63 Subpart ZZZZ, and therefore there are no additional applicable requirements.

Chemical Accident Prevention Provisions

LNG facilities are subject to safety regulations developed by the USDOT (49 CFR 193) and the U.S. Department of Homeland Security (33 CFR 127). The EPA's Chemical Accident Prevention Provisions (40 CFR 68, which were developed in accordance with Section 112(r) of the Clean Air

Act (CAA) and referenced by Oregon regulations at OAR 340-244-0230) can also apply to owners or operators of stationary sources producing, processing, handling, or storing toxic or flammable substances. However, the EPA's General Counsel has clarified that Section 112(r) and the associated regulations do not apply to LNG stored at terminals because the material is either being transported or stored incident to transportation (EPA 2006).

Aside from LNG, which would be stored incident to transportation, the Project would not be storing hazardous or flammable substances in excess of any thresholds identified in 40 CFR 68, and therefore, those regulations do not apply. However, with regard to the storage of any small quantities of hazardous substances that are not being transported or stored incident to transportation, the 112(r)(1) general duty clause does apply:

> *The owners and operators of stationary sources producing, processing, handling or storing [hazardous] substances have a general duty in the same manner and to the same extent as section 654, title 29 of the United States Code, to identify hazards which may result from [accidental] releases using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur.*

Mobile Source Regulations

International Maritime Organization (IMO) Standards for Ships – The IMO has officially designated waters off North American coasts as "Emission Control Areas" (ECAs) under Annex VI, which means that stringent international emission standards will apply to ships operating in these areas. Effective in 2015, the sulfur content in marine fuels used in these waters is required to contain no more than 0.1 percent sulfur (or else vessels can install control equipment to reduce emissions from fuels with higher sulfur contents to equivalent levels). In November 2011, IMO's Marine Environment Protection Committee adopted amendments that exempted boiler-propelled vessels "that were not originally designed for continued operation on marine distillate fuel or natural gas" (such as LNG carriers) from the fuel sulfur requirements until at least 2020 (IMO 2011). However, Jordan Cove has indicated that they would require vessels calling on the LNG terminal to meet the fuel sulfur requirements. In addition, diesel engines installed on vessels manufactured in 2016 or later are required to control NO_x emissions to levels that are approximately 80 percent lower than currently allowable levels ("Tier 1") when operating in ECAs (which in most cases will mean that NO_x control equipment will need to be installed). The IMO regulations also include requirements pertaining to emissions from shipboard incinerators.

EPA Requirements for Marine Diesel Engines – All marine diesels larger than 37 kW that have been manufactured in the United States since January 1, 2004, are required to meet federal emissions standards identified in 40 CFR 94 or 40 CFR 1042; the newest engines are subject to the most stringent requirements ("Tier 4"). Although most engines on existing LNG carriers were not manufactured in the United States, some of the newer engines installed on tugs and other local support vessels may be subject to these regulations, and the Project's emissions calculations reflect the use of "Tier 4" diesel engines in the tugboats.

EPA Requirements for Land-Based Engines and Vehicles – The EPA has promulgated extensive regulations reducing emissions from new on-road vehicles and construction equipment, which has resulted in substantial emissions reductions over time in spite of increased equipment/vehicle populations and usage.

EPA Regulations on Fuels – Any diesel oil or gasoline sold in the United States that is used in or intended for use in marine engines or land-based engines is subject to federal regulations (40 CFR 80). Non-road, locomotive, and marine diesel sold in the United States must have a sulfur content no greater than 15 ppm (0.0015 percent) by weight. Although these requirements do not apply to diesel fuel (or boiler fuel) obtained by LNG carriers outside the United States, diesel fuel used by tugboats, support vessels, and construction equipment would need to meet these criteria. Gasoline is required to have a sulfur content of no more than 80 ppm per gallon, or more than 30 ppm on average for any given refinery or importer.

State Air Quality Requirements

In addition to the rules identified above, ODEQ has state-specific air quality requirements. Those that would be directly applicable to the Jordan Cove LNG Project and/or the Pacific Connector Pipeline Project, and those that may potentially be applicable are discussed below.

Oregon Construction Permit

Oregon requires that facilities subject to Title V Operating Permits obtain a Standard ACDP in accordance with OAR 340-216 prior to construction. As part of this permit, Plant Site Emission Limits are required to be obtained for all regulated pollutants, as per OAR 340-222-0020, and an air quality impact analysis must be conducted in accordance with OAR 340-216. Since the Jordan Cove LNG Project terminal is subject to the Title V Operating Permit regulations, an ACDP is required. Oregon also requires that facilities subject to NSPS regulations with emissions greater than 10 TPY obtain an ACDP, including Plant Site Emission Limits and an air quality impact analysis. The Pacific Connector Pipeline Project is subject to this requirement.

A Standard ACDP identifies all applicable requirements, identifies plant site emission limits (PSELs), and includes testing, recordkeeping, and reporting requirements sufficient to determine compliance with the PSEL. A Type B state-only NSR application for a Standard ACDP was submitted to ODEQ in September 2017.

Air Quality Impact Analysis

Oregon's ACDP regulations cross-reference air quality analysis regulations in OAR 340-225-0050(1) and (2) and OAR 340-225-0060. These regulations are therefore applicable. With respect to the requirement for projects to demonstrate compliance with the NAAQS and PSD increments, ODEQ allows projects to show that their own impacts are below significant impact levels. Projects that cannot demonstrate impacts less than the significant impact levels must show that (a) modeled impacts from the proposed source and other PSD increment-consuming sources are less than PSD increments, and (b) those impacts plus background concentrations are less than the NAAQS. The Project's ACDP permit application demonstrates that the applicable requirements of these regulations are met. More details about the air quality impact analysis are provided under the "Operational Air Impacts and Mitigation" subheadings below.

General Emission Standards

Under OAR 340-226, sources that are not already subject to NSPS requirements (as identified above) or other new source standard and have the potential to emit at least 1 TPY of any criteria pollutant must meet the requirements for Typically Achievable Control Technologies (TACT). Emission limits that meet TACT would be typical of the emission rates achieved by other recently installed emission units of a similar type and size. The use of dry low emission technology and good combustion practices in the Pacific Connector compressor turbines would meet or exceed TACT for gas-fired turbines of this size.

Visible Emission and Nuisance Requirements

State visible emissions and nuisance abatement regulations are codified in OAR 340-208. Both construction and operation phases of the Projects would be subject to visible emission limits stated in terms of opacity. Either Project may not emit contaminants causing opacity to equal or exceed 20 percent in any period or periods aggregating more than 3 minutes in any hour. In addition, no person may create an observable deposition of particulate matter on another person's property (OAR 340-208-540).

This regulation prohibits nuisances and requires that reasonable precautions be taken to minimize fugitive dust emissions in Special Control Areas (which include areas within 3 miles of the corporate limits of any city having a population of 4,000 or more). The LNG Project site is within three miles of North Bend, Oregon, which has a population of approximately 10,000.

Given that visible emissions from the combustion of gaseous fuels are typically far below 20 percent opacity and that the only fugitive dust emissions are likely to be those associated with construction, the Jordan Cove LNG Project is anticipated to meet these regulations.

4.12.1.2 Existing Conditions

Climate

Jordan Cove LNG Project

Climatic conditions, such as ambient temperature, cloud cover, and wind, can significantly change how emissions of pollutants impact local air quality. The State of Oregon is divided into nine climate zones as established by the National Climatic Data Center (NCDC). The Jordan Cove LNG Project and the waterway used by the LNG marine traffic lies in the southern part of Zone 1–The Oregon Coast. The climate of the Project area is characterized by wet winters, relatively dry summers, and mild temperatures year-round. Terrain features include the coastal plain, which extends from less than a mile to a few tens of miles in width, numerous coastal valleys, and the Coast Range, whose peaks range from 2,000 to 5,500 feet above sea level. The National Weather Service (NWS) maintains a climate station at the Southwest Oregon Regional Airport in Coos County, located across Coos Bay approximately 1 mile south of the Project site. Climate data from this station should be representative of conditions in the area of the Jordan Cove LNG Project.

The heaviest precipitation in this zone occurs mainly during the winter months when moist air masses move off the Pacific Ocean onto land. Normal annual precipitation (as measured at the Southwest Oregon Regional Airport) is approximately 65 inches, with normal annual snowfall of approximately 1 inch. The highest monthly precipitation values occur during the months of November, December, and January.

The mean maximum temperature in North Bend/Coos Bay is approximately 60°F, the mean minimum temperature is approximately 46°F, and the mean temperature is approximately 53°F. Temperatures of 90°F or higher occur less than once per year, on average, and freezing temperatures are infrequent, with killing frosts being even less frequent. The growing season (period between minimum temperature occurrences of 28°F) averages approximately 303 days.

Strong winds occur occasionally, usually in advance of winter storms. These winds can exceed hurricane force and have been known to cause significant damage to structures and vegetation. Such events, however, are typically short-lived, and last less than one day. Partly cloudy skies are prevalent during the summer. Winter skies are likely to be cloudy. As a result of the persistent cloudiness, total solar radiation is relatively low in this zone.

Pacific Connector Pipeline Project

As identified above, the State of Oregon is divided into nine climate zones as established by the NCDC. The pipeline runs from Zone 1 (the Oregon Coast; as described in section 4.12.1.1) through Zone 3 (Oregon Southwestern Valleys) to Zone 7 (the South Central Oregon climate region; NCDC 1994). The primary source of air pollutants associated with Project operation is the proposed Klamath Compressor Station, which lies in Zone 7. The region surrounding the Klamath Compressor Station receives an annual average of 14.2 inches of precipitation per year.[184] Average daily temperature is 50.4°F from the same station and reporting period. The prevailing wind direction is from the west at an average daily speed of 6.3 miles per hour (mph).[185]

The air temperature extreme in Klamath Falls ranges from -10°F to 100°F. For the period 1997 to 2008, an air temperature below 0°F was recorded on average 1.3 days per year (Western Regional Climatic Center [WRCC] 2012). Hourly meteorological data for Klamath Falls were obtained from the NCDC for the most recent five-year period (2008 to 2012) (NCDC 2013). During the 2008–2012 period, ambient air temperature at or below 0°F occurred for 84 hours for an average of approximately 17 hours (0.7 day) per year.

Existing Air Quality

Existing air quality is typically characterized relative to EPA's NAAQS, which exist for seven pollutants:

- oxides of sulfur (measured as SO_2)
- CO
- oxides of nitrogen (measured as nitrogen dioxide, NO_2)
- ozone
- PM_{10}
- $PM_{2.5}$
- lead and its compounds (measured as lead)

[184] Based on data from the Western Regional Climatic Center at the Klamath Falls 2 SSW weather station for the period January 1981 through December 2010.
[185] As recorded at the Klamath Falls Airport Weather Station, from November 1997 to December 2008.

These pollutants are referred to as "criteria pollutants" because EPA is required to periodically identify air quality criteria which reflect the latest scientific knowledge (including knowledge regarding the health impacts on children, asthmatics, and the elderly), and revise the NAAQS accordingly. The CAA requires EPA to set both primary NAAQS (which are established to be protective of human health, allowing an adequate margin of safety) and secondary NAAQS (established to be protective of public welfare, which includes effects on wildlife, crops, vegetation, and buildings). Emissions of other non-criteria pollutants are also regulated by EPA and state/local environmental agencies, even though NAAQS are not developed for them.

The EPA, and state and local agencies, have established a network of ambient air quality monitoring stations to measure concentrations of criteria pollutants across the United States. All areas of the United States are classified as being "attainment," "unclassified," or "nonattainment" with respect to the NAAQS. "Nonattainment" areas, where criteria pollutant concentrations exceed the NAAQS, are required to develop plans to meet the standards by specified deadlines, and after meeting the standards are classified as "maintenance areas" (a subcategory of attainment areas, for areas previously designated as nonattainment). Coos County is part of the Southwest Oregon Interstate AQCR and is designated as "attainment" (criteria pollutant concentrations are below the NAAQS) or "unclassifiable" for all of the NAAQS. The NAAQS and the ambient concentrations of criteria pollutants at the nearest ambient air monitoring stations are shown in table 4.12.1.2-1. The monitoring stations selected (Portland for SO_2, CO, and NO_2; Eugene for PM_{10}; and Cottage Grove for ozone and $PM_{2.5}$) are located between approximately 65 and 165 miles from the Jordan Cove LNG Project. These were the closest available stations for each respective pollutant.

TABLE 4.12.1.2-1

Existing Air Quality Concentrations for Criteria Air Pollutants Near the Jordan Cove LNG Project

Air Pollutant	Averaging Period	Primary NAAQS	Secondary NAAQS	State AAQS	Nearest Ambient Monitoring Site(s)	Monitor Value g/	Background as Fraction of NAAQS
SO_2 (µg/m^3)	1-Hour a/	197	NA	197	Portland	10.5	0.05
	3-Hour b/	NA	1,300	1,300		21.0	0.02
	24-Hour b/	365	NA	260		5.3	0.02
	Annual	80	NA	52		0	0.00
CO (µg/m^3)	1-Hour b/	40,000	NA	40,000	Portland	2,740	0.07
	8-Hour b/	10,000	NA	10,000		2,100	0.21
NO_2 (µg/m^3)	1-Hour c/	188	NA	188	Portland	54.5	0.29
	Annual	100	100	100		17	0.17
Ozone (ppm)	8-Hour d/	0.070	0.070	0.070	Cottage Grove	0.061	0.87
PM_{10} (µg/m^3)	24-Hour b/	150	150	150	Eugene	53	0.35
$PM_{2.5}$ (µg/m^3)	24-Hour e/	35	35	35	Cottage Grove	22	0.63
	Annual f/	12.0	12.0	12		8.2	0.68

a/ NAAQS applies to the 3-year average of the annual (99th percentile) of the daily max.1-hour avg. concentration.
b/ NAAQS is not to be exceeded more than once per calendar year.
c/ NAAQS applies to the 3-year average of the annual (98th percentile) of the daily max. 1-hour avg. concentration.
d/ NAAQS applies to the 3-year average of the annual 4th highest daily max. 8-hour avg. concentration.
e/ NAAQS applies to the 3-year average of the annual 98th percentile 24-hour concentration.
f/ NAAQS applies to the 3-year average of annual concentrations.
g/ For 1-hr SO_2, 1-hr NO_2 ,8-hr ozone, and 24-hour $PM_{2.5}$ the values in this column are the 3-year (2013–2015) averages that the NAAQS applies to. For other pollutants the annual values shown in this column represent the maximum concentrations seen in 2013-2015 and the shorter-term values are high second-high concentrations.

In addition to the NAAQS identified in table 4.12.1.2-1, states are allowed to set more stringent ambient air quality standards. While Oregon has adopted state AAQS that match the NAAQS in most cases, it has set more stringent AAQS for SO_2, as shown in table 4.12.1.2-1.

Each of the criteria pollutants in table 4.12.1.2-1, except ozone, are emitted directly; ozone can also be emitted directly by a few sources but is predominantly a result of reactions between NO_x—predominantly NO_2 and nitrogen oxide (NO)—and VOCs in the air, particularly in the warmer months. For this reason, emissions inventories often refer to NO_x and VOCs as criteria pollutants as well.

In addition to the criteria pollutants, other types of air pollutants include "air toxics" (as defined by ODEQ 340-246)—which include but are not limited to chemicals designated as HAPs by EPA. Air toxics are a set of chemicals and chemical classes that often have carcinogenic, mutagenic, or other especially hazardous properties; most are subsets of criteria pollutants (i.e., several air toxics exist in the form of particulate matter and/or can be classified as VOCs). Ambient air quality standards do not typically exist for these pollutants; ODEQ regulations identify "ambient benchmarks" for some, but not all, and existing monitoring stations do not monitor all of these chemicals either. Aggregate impacts of air toxics are often assessed in terms of the lifetime cancer risk and respiratory hazard index, which are calculated based on conservatively determined cancer risk factors and reference exposure levels. EPA's latest National Air Toxics Assessment (for calendar year 2014) shows that regionally, the lifetime cancer risk associated with ambient air toxics concentrations in Coos Bay and the surrounding area is 30 in a million or less, and the respiratory hazard index is approximately 0.50 or less (EPA 2018c). A respiratory hazard index of less than 1 means that ambient air toxics are unlikely to cause adverse respiratory health effects over a lifetime of exposure.

The term "greenhouse gases" (GHG) refers to the gases and aerosols that occur in the atmosphere both naturally and as a result of human activities, such as the burning of fossil fuels. The primary GHGs are CO_2, methane, and nitrous oxide. GHGs are non-toxic and non-hazardous at normal ambient concentrations, and there are no applicable ambient standards or emission limits for GHG. However, unlike criteria pollutants and air toxics, GHG concentrations have been increasing over time and are continuing to increase. Elevated levels of GHGs are the primary cause of warming of the climatic system.

Emissions of GHGs are typically quantified and regulated in units of carbon dioxide equivalents (CO_2e). The CO_2e takes into account the global warming potential (GWP) of each GHG. The GWP is the measure of a particular GHG's ability to absorb solar radiation as well as its residence time within the atmosphere. The GWP allows comparison of global warming impacts between different gases; the higher the GWP, the more that gas contributes to climate change in comparison to CO_2. Thus, CO_2 has a GWP of 1, methane has a GWP of 25, and nitrous oxide has a GWP of 298.[186]

The Pacific Connector pipeline would pass through predominantly rural areas in Coos, Douglas, Jackson, and Klamath Counties. The Klamath Compressor Station would be located within an agricultural area approximately 1.8 miles northeast of Malin in Klamath County. The areas through

[186] These GWPs are based on a 100-year time period. We have selected their use over other published GWPs for other timeframes because these are the GWPs the EPA has established for reporting of GHG emissions and air permitting requirements. This allows for a consistent comparison with these regulatory requirements.

which the pipeline would pass and in which the compressor station would be located all attain all ambient air quality standards (see section 4.12.1.1), with the exception that approximately 325 feet of pipeline in construction spread 5, between MPs 199 and 200, would be located within the Klamath Falls PM_{10} maintenance area (i.e., an area that currently attains the PM_{10} standard, but was formerly designated as a nonattainment area). The compressor station would be located approximately 14 miles to the southeast of the southeast corner of the nonattainment area. (An additional 4.3 miles of pipeline would be located within the Klamath Falls nonattainment area for the 2006 24-hour $PM_{2.5}$ standard. However, the 2006 $PM_{2.5}$ standard was superseded by the 2012 $PM_{2.5}$ standard, for which the entire pipeline route is in attainment.)

Background air quality data near the compressor station are presented in table 4.12.1.2-2. For SO_2, CO, and NO_2, the nearest active monitors are located in Boise, Idaho for SO_2 and CO (280 miles to the northeast), and in Eureka, California for NO_x (165 miles to the southwest). Because of these great distances, the nearest monitors are not considered to be representative of the ambient air quality near the compressor station location. Therefore, background concentrations are based on values predicted by NW AIRQUEST (2018) Criteria Pollutant Design Value maps and lookup tables. The background concentrations shown for PM_{10} and $PM_{2.5}$ represent the worst-case values recorded by monitors in Klamath, Jackson, and Lane Counties, which respectively are closest to the eastern, central, and western portions of the pipeline. Wildfires in 2014-2015 caused elevated $PM_{2.5}$ near Klamath Falls, resulting in an exceedance of the 24-hour 98th percentile 3-year average for 2013-2015. The ODEQ submitted an exceptional event demonstration in April 2017 requesting that the EPA exclude $PM_{2.5}$ data affected by the wildfire events. The EPA has concurred that a portion of the August 2015 data was affected by an exceptional event, but no formal regulatory action has been taken to exclude the data.

TABLE 4.12.1.2-2

Existing Air Quality Near Proposed Klamath Compressor Station

Air Pollutant	Averaging Period	Most Stringent AAQS	Background Concentration	Background Based On
SO_2 (µg/m³)	1-Hour a/	197	1.0	Design values for 2009-2011 estimated using NW AIRQUEST (2018)
	3-Hour b/	1,300	1.0	
	24-Hour b/	260	0.8	
	Annual	52	0.5	
CO (µg/m³)	1-Hour b/	40,000	942	Design values for 2009-2011 estimated using NW AIRQUEST (2018)
	8-Hour b/	10,000	708	
NO_2 (µg/m³)	1-Hour c/	188	8.1	Design values for 2009-2011 estimated using NW AIRQUEST (2018)
	Annual	100	1.3	
Ozone (ppm)	8-Hour d/	0.070	0.065	Data from Jackson County (Medford) for 2013-2015
PM_{10} (µg/m³)	24-Hour b/	150	71	Data from Jackson County (Medford) for 2013 (no record)
	Annual	50	-	
$PM_{2.5}$ (µg/m³)	24-Hour e/	35	40 g/	Data from Jackson County (Medford) for 2013-2015
	Annual f/	12.0	11 g/	

µg/m³ = microgram per cubic meter
a/ AAQS applies to the 3-year average of the annual (99th percentile) of the daily max.1-hour avg. concentration.
b/ AAQS is not to be exceeded more than once per calendar year.
c/ AAQS applies to the 3-year average of the annual (98th percentile) of the daily max. 1-hour avg. concentration.
d/ AAQS applies to the 3-year average of the annual 4th highest daily max. 8-hour avg. concentration.
e/ AAQS applies to the 3-year average of the annual 98th percentile 24-hour concentration.
f/ AAQS applies to the 3-year average of annual concentrations.
g/ May include data deemed part of the “exceptional event” due to wildfires in the region during 2014 and 2015.

4.12.1.3 Jordan Cove LNG Project Impacts

Construction Air Quality Impacts

During construction, a temporary reduction in ambient air quality may result from emissions and fugitive dust generated by construction equipment. Fugitive dust emission levels would vary in relation to moisture content, composition, and volume of soils disturbed. Fugitive dust and other emissions from construction activities generally do not result in a significant increase in regional pollutant levels, although local pollutant levels could increase temporarily.

Construction air pollutant emissions include exhaust and crankcase emissions from construction equipment, vehicles that transport workers and materials, and vessels that transport equipment and construction materials. Emissions of criteria pollutants from construction activities by year are shown in table 4.12.1.3-1. Emissions would occur over the duration of construction activity, which is anticipated to last five years. The construction emission totals during year 5 including emissions from commissioning and startup of the LNG Project facilities.

Construction tasks for which emissions were estimated include the following broad categories of activity:

- **Site Preparation:** Includes demolition, clearing, and removal of vegetation or existing structures on site; construction of an MOF and TMBB for delivery of construction materials; topsoil removal, cut/fill, and grading of the site; dredge spoil placement; soil improvement to stabilize it against settling and seismic events;
- **Underground Structures:** Includes installation of pilings for the LNG Project structures and marine slip; laying storm drains, utility lines, fire water piping, process piping, and duct banks; construction of all foundations, including the LNG storage tanks, process equipment, and pipe racks; and site restoration, road paving, and landscaping;
- **Marine Facilities:** Includes derrick barges for dredging of the slip basin and access channel; land-based construction equipment to construct the slip face and install armoring; installation of a sheetpile retaining wall; installation of pilings for marine structures, and installation of LNG carrier loading facilities;
- **Marine Waterway Modification:** Includes excavation of submerged areas adjacent to the shipping channel;
- **LNG Storage Tank Construction:** Includes construction of outer concrete foundation, walls, and roof; construction of interior steel plate floor, walls, and roof; hydrostatic pressure testing of the inner tank and pneumatic testing of the outer tank; and installation of insulation, including expanded perlite between the wall liner and inner tank wall;
- **Aboveground Structures:** Includes installation of all process facilities, including both pre-fabricated modules and structures built onsite; installation of aboveground piping; and installation of electrical wiring and instrumentation; and
- **Miscellaneous Construction:** Includes various construction tasks not listed above, including the operation of an on-site concrete batch plant.

TABLE 4.12.1.3-1

Estimated Emissions from Terminal Construction Activities, By Year (tons)

Year	CO	NO_x	SO_2	VOC	PM_{10}	$PM_{2.5}$	HAP	GHG (as CO_2e)
Year 1	120	351	0.35	23	268	39	7.4	53,397
Year 2	184	404	0.43	32	310	100	11.0	66,708
Year 3	199	269	0.33	31	192	87	11.3	52,768
Year 4	81	43	0.08	10	18	17	3.7	13,615
Year 5 (plus commissioning emissions)	85	72	20.94	71	209	68	4.1	925,856
Total	**669**	**1,139**	**22.13**	**167**	**997**	**311**	**37.5**	**1,112,344**

To mitigate construction-related emissions, all construction equipment would be maintained in accordance with manufacturers' recommendations and engine idling time would be minimized. As required by federal regulations, construction equipment would combust diesel fuel with no more than 0.0015 percent sulfur, and vessels would combust fuel that complies with International Convention for the Prevention of Pollution from Ships and EPA standards for sulfur content. Additionally, Jordan Cove would implement the following measures to mitigate construction emissions from mobile and temporary stationary sources:

- reduce use, trips, and unnecessary idling of heavy equipment.
- maintain and tune engines per manufacturer's specifications to perform EPA certification levels, where applicable, and to perform at verified standards applicable to retrofit technologies. Employ periodic, unscheduled inspections to limit unnecessary idling and to ensure that construction equipment is properly maintained, tuned, and modified consistent with established specifications.
- prohibit any tampering with engines and require continuing adherence to manufacturer's recommendations.
- use construction equipment engines that incorporate modern pollution control technology. If practicable, lease new, clean equipment meeting the most stringent of applicable federal or state standards.

To mitigate fugitive dust emissions during construction, Jordan Cove would spray water or use dust suppressants on disturbed soil and access roads. The frequency and methodology of dust suppression would depend on the specific construction activities, terrain, soil conditions, and weather conditions. Additionally, Jordan Cove would implement the following measures to mitigate construction emissions due to fugitive dust:

- use of large off-road equipment for excavation and hauling operations to complete the work in the shortest time and least number of trips;
- stabilization of open storage piles and disturbed areas by covering and/or applying water or chemical/organic dust palliative where appropriate. This applies to both inactive and active sites, during workdays, weekends, holidays, and windy conditions. Installing wind fencing, and phase grading operations, where appropriate, and operate water trucks for stabilization of surfaces under windy conditions;

- pre-wetting of material before excavation in selected areas;
- use of wheel-washing stations to prevent trackout of materials onto public roads;
- use of street sweepers to clean any materials inadvertently tracked onto public roads near the project site; and
- when hauling material and operating non-earthmoving equipment, prevent spillage by covering loads, limiting fill height in trucks, and training operators in the proper hauling and loading of material.

The effect of construction emissions on ambient air quality would vary with time due to the construction schedule, the mobility of the sources, and the variety of emission sources. Fugitive dust and other emissions due to construction activities generally do not pose a significant increase in regional pollutant levels; however, local pollutant levels would increase during the construction period. Based on the duration and scope of construction activities, we determine that construction of the Project would impact local air quality. However, construction emissions would not have a long-term, permanent effect on air quality in the area.

Operational Air Quality Impacts

Operational emissions from the Project include those from the Jordan Cove LNG Project sources, fugitive emissions from evaporative losses, and emissions from the LNG carriers and tugboats (including emissions in the waterway). These emissions are summarized in table 4.12.1.3-2 for routine operation. Commissioning emissions are included in year 5 of the construction emissions in table 4.12.1.3-2.

TABLE 4.12.1.3-2

Estimated Emissions During Operation of the Jordan Cove LNG Project (tons per year)

Source	CO	NO_x	SO_2	VOC	PM_{10}	$PM_{2.5}$	HAP	GHG (as CO_2e)
Combustion Turbines	97.82	81.99	35.19	32.72	112.26	112.26	5.06	1,292,706
Combustion Turbines Startup/Shutdown	0.73	0.23	4.4E-03	0.10	0.11	0.11	6.2E-04	188
Thermal Oxidizer	38.50	63.25	19.84	1.08	3.85	3.85	0.96	622,154
Auxiliary Boiler	1.16	0.96	0.36	0.67	1.3	1.3	0.24	15,193
Firewater Pump Engines	0.80	1.59	2.1E-03	4.5E-02	9.0E-02	9.0E-02	3.6E-03	241
Backup Generator Engines	0.28	3.33	2.5E-03	0.04	0.04	0.04	4.1E-03	278
Black Start Generator Engines	0.21	1.49	8.8E-03	0.09	0.05	0.05	1.5E-02	1,002
Flares	3.90	0.86	3.9E-02	8.31	0.38	0.38	4.3E-02	2,177
Gas-Up	9.5	2.09	0.16	17.53	1.12	1.12	3.8E-02	4,351
Fugitive Emissions	0	0	0	7.98	0	0	1.77	13,116
Aggregate Insignificant Emissions	1.0	1.0	1.0	1.0	1.0	1.0	--	--
LNG Carriers a/	36.68	48.68	9.5	9.47	3.31	3.31	--	14,653
Tugs	17.68	9.51	2.6	1.00	0.32	0.32	--	3,736
Total	**208.26**	**214.98**	**68.71**	**80.04**	**123.83**	**123.83**	**8.13**	**1,969,795**

a/ Values are based on 120 vessel calls per year, assuming worst-case emissions (i.e., vessel type with the highest emissions) for each pollutant. Emissions estimated at 2.2 nautical miles from the Oregon coastline.

Commissioning and Start-Up Emissions: Commissioning of the Jordan Cove LNG Project is planned to occur during year 5 of construction. Table 4.12.1.3-2 includes estimated commissioning and operating emissions from all of the terminal stationary sources in year 5, including compressor turbines and duct burners, startup/shutdown emissions, auxiliary boiler, thermal oxidizer, flares, emergency engines, and fugitive emissions.

Routine Operation: The following sources are expected to operate continuously during routine operation:

- five combustion turbines for the refrigeration compressors;
- one thermal oxidizer;
- flare pilot flames for the enclosed marine flare and multipoint ground flare;
- two LNG storage tanks; and
- fugitive emission sources (valves, flanges, and other equipment).

Intermittent Operation: The following sources or activities would only operate intermittently. The auxiliary boiler would provide high-pressure steam if none of the LNG trains are operating, and the other intermittent sources would only operate during startup or shutdown events, planned maintenance, process upsets, readiness testing, or emergency situations:

- combustion turbine startup and shutdown events;
- one auxiliary boiler;
- one enclosed marine flare;
- one multipoint ground flare;
- two diesel black-start engines;
- two backup engines;
- three fire water pump engines; and
- up to 120 LNG carriers per year, with one tugboat attending each carrier.

The Jordan Cove LNG Project would remain below PSD major source thresholds for emissions of all criteria pollutants, HAP, and GHG, but would be a Title V major source for emissions of NO_x, CO, PM_{10}, and $PM_{2.5}$. As described above, a Type B state-only NSR application was submitted to ODEQ in September 2017.

For the criteria pollutants, dispersion modeling of the combined impacts of the terminal and LNG carriers/tugs was conducted using version 16216r of EPA's preferred dispersion model (AERMOD). Secondary formation of PM was also accounted for in accordance with EPA guidance, by adding the expected secondary formation of $PM_{2.5}$ from NO_x and SO_2 emissions to the modeled result for direct $PM_{2.5}$ impacts. For the permitting of just the stationary sources, regulations state that if worst-case impacts from worst-case project emissions are below the "significant" levels identified in OAR 240-200-0020 Table 1 (which are well below the NAAQS standards in table 4.12.1.2-1 and the PSD increments in 4.12.1.3-2), there is no need to quantitatively model impacts from other nearby sources as well. The ACDP permit application showed that 1-hour SO_2 impacts, as well as short-term and annual impacts for NO_2, $PM_{2.5}$, and PM_{10}, were above "significant" levels. Therefore, multisource modeling was conducted which incorporated emissions from eight other nearby facilities (RFP, Westrum Funeral Services, Bandon Concrete, Southport Forest Products, Allweather Wood, LTM Incorporated, Coastal Cremation and Funeral Services, and Georgia-Pacific Wood Products). The multisource modeling also included emissions from LNG carriers/tugs. Results are shown in table 4.12.1.3-3.

TABLE 4.12.1.3-3

Maximum Combined Impacts of Jordan Cove LNG Project, Marine Vessels, and Nearby Major Sources

Air Pollutant	Averaging Period	Maximum Cumulative Impact	Class II Increment	Maximum Cumulative Impact + Background	AAQS
SO_2 (µg/m^3)	1-Hour	30.1	NA	33.2	199
NO_2 (µg/m^3)	1-Hour	132.3	NA	148.3	188
	Annual	4.1	25.0	6.0	100
PM_{10} (µg/m^3)	24-Hour	9.3	30.0	44.3	150
	Annual	1.4	17.0	1.4	NA
$PM_{2.5}$ (µg/m^3)	24-Hour	8.3	9.0	18.2	35.0
	Annual	1.7	4.0	8.4	12.0

µg/m^3 = microgram per cubic meter

For all pollutants, the combined impacts at the points of highest concentration are below the applicable NAAQS and the PSD increments. Impacts on the distant Class I areas[187] are discussed in section 4.12.1.5. Therefore, we conclude that based on the maximum predicted impacts of the LNG terminal and LNG carriers, in addition to nearby major sources, there would be no significant impacts on regional air quality.

4.12.1.4 Pacific Connector Pipeline Project Impacts

Construction Air Quality Impacts

Construction of the pipeline and compressor station would result in a temporary increase in emissions due to the combustion of fuel in vehicles and equipment, dust generated from soil disturbance, and general construction activities (e.g., painting and welding). Pipeline construction spread activities would occur in sequence or in assembly-line fashion along the right-of-way with one crew following the next from clearing until final cleanup. Emissions from any given stage of construction would therefore be spread out along the construction corridor due to the sequence/assembly-line nature of the work, rather than being concentrated in a specific stationary location. As work proceeds, there are often small periods between job tasks when work at a specific location on the right-of-way is delayed such as between trenching and pipe stringing or pipe stringing and welding. As the work crews move along the corridor, the construction equipment would produce emissions and these emission sources would move along the corridor as work progresses. Local residents nearby to construction may notice a localized increase in dust (i.e., directly around the Project area) from construction activities; however, Pacific Connector would spray water on the right-of-way, and may use Dustlock®, in addition to water, for dust control. Pipeline construction crews would move quickly down the right-of-way in a linear fashion, and few locations would see sustained construction for significant lengths of time.

Pacific Connector estimated total pollutant emissions from the entire duration of construction activities, as detailed in table 4.12.1.4-1. Helicopters may be used during logging for right-of-way clearance; however, their use is uncertain and, due to the limited scope and duration of the activity, the associated emissions were not quantified.

[187] Areas designated as "Class I" include international parks and various national wilderness areas and parks above specified sizes.

TABLE 4.12.1.4-1

Estimated Emissions from Construction of the Klamath Compressor Station and Pacific Connector Pipeline (tons)

Source	CO	NO_x	SO_2	VOC	PM_{10}	$PM_{2.5}$	HAP	GHG (as CO_2e)
Compressor Station – Fugitive Dust on Unpaved Roads	0	0	0	0	4.67	0.47	0	0
Compressor Station – Fugitive Dust from Materials Handling	0	0	0	0	2.04	2.04	0	0
Compressor Station – Construction Equipment Exhaust	1.48	1.52	0.07	0.29	0.21	0.20	0.22	378
Pipeline – Fugitive Dust from Materials Handling	0	0	0	0	146.32	146.32	0	0
Pipeline – Fugitive Dust from Roads	0	0	0	0	123.45	12.55	0	0
Timber Removal – Fugitive Dust from Roads	0	0	0	0	30.92	3.22	0	0
Pipeline (Spread 1) – Construction Equipment Exhaust	12.96	35.39	2.39	4.40	4.36	4.23	3.66	14,342
Pipeline (Spread 2) – Construction Equipment Exhaust	12.60	32.82	2.18	4.06	3.99	3.87	3.37	13,099
Pipeline (Spread 3) – Construction Equipment Exhaust	10.58	25.77	1.64	3.10	3.02	2.93	2.56	9,784
Pipeline (Spread 4) – Construction Equipment Exhaust	9.10	23.56	1.52	2.79	2.82	2.73	2.34	9,082
Pipeline (Spread 5) – Construction Equipment Exhaust	8.06	20.11	1.33	2.50	2.46	2.39	2.09	8,003
Total	**54.78**	**139.17**	**9.13**	**17.14**	**324.26**	**180.95**	**14.24**	**54,688**

Emissions from construction equipment have been reduced over time as a result of the federal regulations for mobile engines and fuels, and measures would be taken by Pacific Connector to minimize fugitive dust. The predominant source of PM is fugitive dust (for which emissions estimation procedures have typically largely over-predicted emissions compared to what is seen in ambient measurements) (Watson and Chow 2000; Countess Environmental 2001). Pacific Connector would implement the following measures to mitigate the air emissions during pipeline construction:

Fugitive Dust Source Controls:

- Limit drop heights of soil excavation activities.
- Water the right-of-way, laydown areas, and temporary roads at least daily in areas of active construction, if necessary.
- Control project-related traffic speeds on dirt access roads and on linear facility rights-of-way.
- Ensure that speeds on the construction right-of-way would not exceed 15 mph where fugitive dust can be generated.
- Water gravel or dirt access roads in areas of heavy traffic, as determined necessary to control fugitive dust.
- Decrease speed limits when excessive winds prevail and where sensitive areas such as public roads may be adjacent to access roads or the right-of-way.
- Maintain speed limit signs for the duration of the construction activities and place them where access roads intersect the construction right-of-way.

- Water temporarily stockpiled soils to create a semi-hard protective layer to minimize wind erosion, if necessary.
- Ensure that wind erosion BMPs will be in place during forecasted high wind (greater than 25 mph) weather advisories (see the ECRP).

Mobile and Stationary Source Controls:

- Reduce use, trips, and unnecessary idling of heavy equipment.
- Maintain and tune engines per manufacturer's specifications to perform EPA certification levels, where applicable, and to perform at verified standards applicable to retrofit technologies. Employ periodic, unscheduled inspections to limit unnecessary idling and to ensure that construction equipment is properly maintained, tuned, and modified consistent with established specifications.
- Prohibit any tampering with engines and require continuing adherence to manufacturer's recommendations.
- Use construction equipment engines that incorporate modern pollution control technology. If practicable, lease new, clean equipment meeting the most stringent of applicable federal or state standards.

The impacts on ambient air quality from construction of the Klamath Compressor Station and Pacific Connector pipeline would vary with time due to the construction schedule, the mobility of the sources, and the variety of emission sources. Fugitive dust and other emissions due to construction activities generally do not pose a significant increase in regional pollutant levels; however, local pollutant levels would increase during the construction period. Based on the duration and scope of construction activities, we conclude that construction of the Project would impact local air quality. However, construction emissions would not have a long-term, permanent effect on air quality in areas adjacent to the construction corridor. In addition, emissions from pipeline construction would be distributed along the entire 229-mile-long construction corridor, greatly reducing localized impacts.

Operation Air Quality Impacts

Emissions of criteria pollutants from operation of the compressor station and pipeline are shown in table 4.12.1.4-2. Most of the emissions result from fuel combustion in the compressor station turbines, boiler, and standby generator. Fugitive emissions result from the normal leakage of small amounts of methane, VOC, and HAP compounds from valves, flanges, and other components in the compressor station piping, as well as meter stations or valve sites along the pipeline. Venting emissions result from infrequent process upsets and planned maintenance activities.

TABLE 4.12.1.4-2

Criteria Pollutant Emissions from Operation of Klamath Compressor Station and Pacific Connector Pipeline (tons per year)

Source	CO	NO_x	SO_2	VOC	PM_{10}	$PM_{2.5}$	HAPs	GHGs (as CO_2e)
Compressor Station Turbines a/	146.4	144.6	8.7	9.9	17.1	17.1	2.88	379,251
Compressor Station Fugitive Emissions	0	0	0	7.3	0	0	0.27	10,307
Boiler a/	2.7	1.6	0.02	0.18	0.25	0.25	0.06	3,912
Generator	0.6	0.3	0.00	0.2	0.01	0.00	0.04	88
Pipeline Fugitive and Venting Emissions	0	0	0	1.01	0	0	--	162
Total	**149.7**	**146.5**	**8.72**	**18.59**	**17.36**	**17.35**	**3.25**	**393,720**

a/ Based on maximum potential emissions for all three turbines and boiler operating continuously at their rated capacities, with the exception that turbine operation at temperatures below 0 degrees Fahrenheit is excluded. This value corresponds to the potential-to-emit (PTE) for the Project based on the permitted number of turbines.

Routine Operation: The following compressor station and pipeline sources are expected to operate continuously during routine operation:

- three combustion turbines for the compressor drives;
- one boiler;
- compressor station fugitive emission sources (condensate tank, valves, flanges, and other equipment); and
- pipeline fugitive emission sources (valves, flanges, and other equipment at three meter and regulator stations).

Intermittent Operation: The following sources or activities would only operate intermittently, during startup or shutdown events, planned maintenance, process upsets, readiness testing, or emergency situations:

- one standby generator engine; and
- periodic venting and blowdown events, estimated at three major blowdown events per year.

The compressor station would remain below PSD major source thresholds for emissions of all criteria pollutants, HAP, and GHG, but would be a Title V major source for emissions of NO_x and CO. Pacific Connector submitted a standard ACDP initial application to ODEQ in May 2015 and submitted a modification to its standard ACDP application in September 2017.

Potential emissions of HAP from the turbines, boiler, and generator are estimated to be just 1.3 TPY. Potential emissions of four pollutants at the Klamath Compressor Station (NO_x, CO, PM_{10}, and $PM_{2.5}$) exceed the Significant Emission Rate threshold at OAR 340-200-0020 and require a dispersion modeling analysis. Potential emissions of SO_2 are below the Significant Emission Rate, but modeling of SO_2 was also performed as requested by the FERC. A screening model (AERSCREEN) was used for all pollutants and averaging periods with the exception of 1-hour NO_2 and 24-hour $PM_{2.5}$, which were modeled twice, first with AERSCREEN and then with AERMOD. AERMOD is a more refined model that allows the use of hourly meteorological data and produces a less conservative result than AERSCREEN. Modeling results are presented in table 4.12.1.4-3. Pacific Connector filed an ACDP air permit application with ODEQ in 2015, and the modeling was performed in accordance with the modeling protocol that was approved by ODEQ at that time. ODEQ may request updates to that modeling protocol as part of the state air permitting process.

Based on the results of the screening analysis using AERSCREEN, and the refined AERMOD analysis for 1-hour NO_2 and 24-hour $PM_{2.5}$, we conclude that the Project would not have a significant impact on regional air quality.

TABLE 4.12.1.4-3

Screening-Level CO and NO_2 Impacts from Compressor Station Turbines

Air Pollutant	Averaging Period	Model	Maximum Impact	Background a/	Maximum Impact + Background	AAQS
NO_2 (µg/m³)	1-Hour	AERMOD	96.4 b/	10.0	106.4	188
	Annual	AERSCREEN	29.6 b/	2.1	31.7	100
CO (µg/m³)	1-Hour	AERSCREEN	433	993	1,426	40,000
	8-Hour	AERSCREEN	390	748	1,138	10,000
PM_{10} (µg/m³)	24-Hour	AERSCREEN	32	32	64	150
$PM_{2.5}$ (µg/m³)	24-Hour	AERMOD	4.2	17	21.2	35
	Annual	AERSCREEN	5.3	5.3	10.6	12
SO_2 (µg/m³)	1-Hour	AERSCREEN	26.5	1.3	27.8	196
	3-Hour	AERSCREEN	26.5	1.3	27.8	1,300
	24-Hour	AERSCREEN	23.9	0.8	24.7	NA
	Annual	AERSCREEN	2.65	0.5	3.1	NA

a/ Background concentrations based on design values for 2009-2011 estimated using NW AIRQUEST.
b/ Based on an assumed in-stack NO_2 to NO_X ratio of 0.19.

4.12.1.5 Environmental Consequences on Federal Lands

A quantitative analysis of air quality impacts from potential stationary emissions sources at the Jordan Cove LNG Project (but not the marine vessels or other major sources that obtained permits since the baseline dates) was conducted for Class I areas within 200 kilometers (km) of the Project site. First, AERMOD was used to evaluate impacts at receptors placed at a radius of 50 km from the Project site (the farthest distance for which AERMOD is recommended for use). If modeled impacts at all of the 50 km receptors were below the significant impact level (SIL) for a given pollutant and averaging period, then it was presumed that impacts would also be below the SIL at each Class I area (ranging in distance from 110 to 178 km from the Project site).

However, if modeled impacts at 50 km were above a SIL, then further analysis was conducted to simulate what impacts would be at the nearest boundary of each Class I area. This simulation was performed by selecting the receptor along the 50-km radius that had the highest modeled concentration (i.e., impact) when averaged over five years, and then comparing that impact at 50 km to the five-year average impact at a receptor located just 1 km from the Project site, in the direction of the maximum-impact 50 km receptor. The results at the 1-km and 50-km receptors were then extrapolated (using an exponential decay function) to evaluate impacts at the distance of each Class I area.

The results of this analysis are shown in table 4.12.1.5-1 and indicate that impacts from the Jordan Cove LNG Project at all Class I areas would be well below the SILs.

TABLE 4.12.1.5-1

Maximum Impacts of Jordan Cove LNG Project at Class I Areas

Air Pollutant	Averaging Period	Maximum Impact at 50 km	Maximum Impact at Class I Area Boundary	Class I SIL a/
SO_2 (µg/m^3)	3-Hour	1.33	0.24	1.0
	24-Hour	0.35	0.023	0.2
	Annual	0.012	N/A	0.1
NO_2 (µg/m^3)	Annual	0.032	N/A	0.1
PM_{10} (µg/m^3)	24-Hour	0.854	0.061	0.3
	Annual	0.026	N/A	0.2
$PM_{2.5}$ (µg/m^3)	24-Hour	0.854	0.061	0.07
	Annual	0.026	N/A	0.06

a/ SILs are based on the first highest concentration at any one location.
µg/m^3 = microgram per cubic meter

In addition to the modeling analysis described above, a screening test was also performed for Air Quality Related Values (AQRV) at Class I areas. This screening test is used by federal land managers to determine whether a source more than 50 km from a Class I area is likely to have any adverse impact on an AQRV, such as visibility impairment. If the ratio of emissions in tons per year (Q) divided by the distance to a Class I area in km (D) is less than 10, then a source is considered not to cause or contribute to a visibility impairment. This screening calculation showed that the Q/D ratio for combined annual emissions of NO_x, SO_2, and PM from stationary sources at the Jordan Cove LNG Project was less than or equal to 10, indicating that no further Class I AQRV impact analyses are required.

Air pollution regulations treat other (Class II) federal lands in the same manner as non-federal Class II lands. The nearest federal lands in the vicinity of the Jordan Cove LNG Project include the ODNRA immediately north, and COE and BLM land on the North Spit. The pipeline route would cross various parcels of Class II areas administered by the BLM, Forest Service, and Reclamation. Dispersion modeling of terminal operations illustrated that impacts at the locations nearest the terminal would be less than the maximum Class II impacts identified above in section 4.12.1.3.

The closest Class I area to the Klamath Compressor Station is Lava Beds National Monument in California. This Class I area is approximately 37 km (about 23 miles) to the southwest of the compressor station site. A Class I AQRV screening analysis for potential impacts from compressor station operational emissions on Lava Beds National Monument shows that the Q/D ratio is much less than 10, indicating that no further Class AQRV impact analyses are required.

The pipeline route would pass closest to the Mountain Lakes Wilderness Class I area. The shortest distance between the Mountain Lakes Wilderness boundary and the pipeline is 4.5 miles (7.3 km), located at about MP 172.5. Pipeline construction spread 5 would operate between MPs 169.5 and 228.8, a total distance of 59.3 miles (95.4 km). Thus, emission sources for construction spread 5 would vary in distance from Mountain Lakes as the spread moves along the right-of-way. The potential air quality impact on Mountain Lakes would decrease as the distance between construction spread activity and Mountain Lakes increases (as the spread moves away from the closest point to Mountain Lakes). Pipeline construction would generally occur at a steady pace; therefore, it is reasonable to expect that these construction emissions for spread 5 would be evenly distributed throughout the spread 5 construction corridor (except for in areas where terrain or other factors slow the rate of construction). For the pollutants of highest concern, emissions expected per kilometer of pipeline route would only be 0.21 ton/km of NO_x, 0.01 ton/km of SO_2, and 1.56 ton/km of PM_{10}. Applying the Class I AQRV screening analysis mentioned above to these emissions again results in impacts far below the screening criteria.

Pacific Connector would consult with the federal land managers of Class I areas during the air permit process. For the Class II federal lands areas that are crossed by the pipeline, construction sources would have only a temporary impact on air quality and there are no operational sources of emissions located in those areas (i.e., the terminal and compressor station are not located on or near federal lands).

Terminal sources are distant from federal lands. The nearest Class I area is more than 100 km (about 62.1 miles) away, and a quantitative air quality impact analysis, as summarized in table 4.12.1.5-1, shows that impacts from the Jordan Cove LNG Project would not be significant on federal lands. About 71 miles of pipeline route would cross federal lands. Emissions associated with pipeline construction activities are very low; and these activities would be temporary and transient as crews move in a linear fashion along the right-of-way. Therefore, based on the analysis presented above, Pacific Connector's commitment to consult with federal land managers of Class I areas, and the temporary nature of construction emissions on Class II areas, we conclude that the Project would not adversely affect air quality on federal lands.

4.12.1.6 Conclusion

Constructing and operating the Project would result in sort and long-term impacts on air quality. However, based on the implementation of the required BMPs, the Project would not significantly affect air quality.

4.12.2 Noise and Vibration

Noise would affect the local environment during both the construction and operation of the Project. At any location, both the magnitude and frequency of environmental noise may vary considerably over the course of the day and throughout the week. For construction activities, this variation in noise levels is caused primarily by changes in equipment operations and activity locations. For operational noise conditions, this variation is caused in part by variations in operational activities, changing weather conditions, and the effects of seasonal vegetative cover. In this section of the EIS, analysis of potential noise impacts on human receptors are discussed, while noise impacts on wildlife are addressed in sections 4.5 and 4.6.

Noise can be measured and quantified using many different metrics. Some of the most commonly used metrics used by federal agencies and presented in subsequent sections of this EIS are the equivalent sound level (L_{eq}), day-night sound level (L_{dn}), and the maximum sound level (L_{max}). Conventionally expressed in dBA, the L_{eq} is the energy-averaged, A-weighted sound level for the complete time period. It is defined as the steady, continuous sound level over a specified time, which has the same total sound energy as the actual varying sound levels over the specified period. The L_{dn} measures the 24-hour average noise level at a given location. It was adopted by the EPA for developing criteria for the evaluation of community noise exposure and also by the FERC when assessing noise. The L_{dn} is calculated by averaging the 24-hour hourly L_{eq} levels at a given location after adding 10 dB to the nighttime period (10:00 p.m. to 7:00 a.m.) to account for the increased sensitivity of people to noises that occur at night. The L_{max} sound level can be used to quantify the maximum instantaneous sound pressure level over a given measurement period or maximum sound generated by a source. The human ear's threshold of perception for noise change is considered to be 3 dBA; 6 dBA is clearly noticeable to the human ear, and 10 dBA is perceived as a doubling of noise (Bies and Hansen 1988).

4.12.2.1 Regulatory Requirements for Noise

Federal Noise and Vibration Criteria

In 1974, the EPA published *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (EPA 1974). This publication evaluates the effects of environmental noise with respect to health and safety. The document provides information for state and local governments to use in developing their own ambient noise standards. The EPA has determined that in order to protect the public from activity interference and annoyance outdoors in residential areas, noise levels should not exceed an L_{dn} of 55 dBA. The FERC has adopted this criterion for new compression and associated pipeline facilities, and it is used here to evaluate noise emissions from operation of the Project. An L_{dn} of 55 dBA is equivalent to a continuous noise level of 48.6 dBA L_{eq} for facilities that operate at a constant level of noise. Therefore, a constant sound level of less than 48.6 dBA L_{eq} would ensure compliance with the FERC requirement limiting the L_{dn} at the nearest NSAs to less than or equal to 55 dBA.

The Commission has regulations in 18 CFR 380.12k(4)(v)(B) that state that any new or modified facility may not result in an increase in perceived vibration. In addition, the American National Standards Institute (ANSI) published ANSI S12.2-2008 that identifies criteria for sound pressure levels that should not be exceeded to avoid moderately perceptible vibration and rattle inside a room. These criteria are 65 dB and 70 dB in the 31.5 hertz (Hz) and 63 Hz octave bands, respectively, and are used to assess vibration levels.

State Noise and Vibration Standards

The State of Oregon has established statewide noise limits for industrial and commercial noise sources (OAR, Chapter 340, Division 35). No statewide vibration limits have been established. The specified noise limits apply to either the property line location closest to the noise source or to locations 25 feet toward the noise source from the noise-sensitive building, whichever distance from the noise source is greater. Noise-sensitive property includes residences and other facilities normally used for sleeping, schools, churches, hospitals, and public libraries. The primary noise limits set by the Oregon regulations are based on the statistical distribution of varying noise levels during daytime and nighttime hours. Noise limits are specified in terms of three percentile levels: L_{50}, the noise level exceeded 50 percent of the time; L_{10}, the noise level exceeded 10 percent of the time, and L_{01}, the noise level exceeded 1 percent of the time. In addition to noise limits for noise-sensitive properties, Oregon noise regulations establish additional noise limits for industrial and commercial noise sources in or near designated quiet areas. Quiet areas are defined as land or facilities where the qualities of serenity, tranquility, and quiet are of extraordinary importance and serve a public need. The State of Oregon has not designated any quiet areas, but some local noise ordinances have done so (Beyer 2007). Noise limits established by the Oregon noise control regulations are summarized in table 4.12.2.1-1.

TABLE 4.12.2.1-1

Oregon Noise Limits For Industrial and Commercial Noise Sources

Percentile Noise Level In Any One Hour	**Noise-Sensitive Properties Located Outside Designated Quiet Areas**		**Within Designated Quiet Areas at a Point 400 Feet or More from the Noise Source**	
	7 a.m. – 10 p.m.	**10 p.m. – 7 a.m.**	**7 a.m. – 10 p.m.**	**10 p.m. – 7 a.m.**
L_{50}	55 dBA	50 dBA	50 dBA	45 dBA
L_{10}	60 dBA	55 dBA	55 dBA	50 dBA
L_{01}	75 dBA	60 dBA	60 dBA	55 dBA

Notes: The noise limits in this table do not apply to noise from construction sites, agricultural or forestry operations, vehicle traffic, rail traffic, aircraft operations, and various other exempt sources.
Source: OAR 340-035-0035(1)(a), 340-035-0035(1)(b), and 340-035-0035(1)(c).

In addition to the overall dBA limits summarized in table 4.12.2.1-1, the Oregon noise regulations establish additional limits for discrete tones from industrial and commercial noise sources. These octave band noise limits are summarized in table 4.12.2.1-2.

TABLE 4.12.2.1-2

Octave Band Noise Limits For Industrial and Commercial Noise Sources

Center Frequency of Octave Band (Hertz)	**Median Sound Pressure Level Limit a/**	
	7 a.m. – 10 p.m.	**10 p.m. – 7 a.m.**
31.5 Hz	68 dB	65 dB
63 Hz	65 dB	62 dB
125 Hz	61 dB	56 dB
250 Hz	55 dB	50 dB
500Hz	52 dB	46 dB
1,000 Hz	49 dB	43 dB
2,000 Hz	46 dB	40 dB
4,000 Hz	43 dB	37 dB
8,000 Hz	40 dB	34 dB

a/ The noise limits in this table do not apply to noise from construction sites, agricultural or forestry operations, vehicle traffic, rail traffic, aircraft operations, and various other exempt sources.
The noise limits in this table apply to either the property line location closest to the noise source or to locations 25 feet toward the noise source from the noise-sensitive building, whichever distance from the noise source is greater.
If noise levels for any 1/3 octave band exceeds the encompassing octave band limit by more than 10 dB, additional limitations may apply.
Source: OAR 340-035-0035(1)(f).

Oregon noise regulations also establish a numerical noise level increase standard for new industrial or commercial noise sources located on a previously unused site. The regulations limit the increase in hourly L_{10} and L_{50} noise levels as measured at noise-sensitive properties to 10 dBA above the ambient background L_{10} and L_{50} noise levels (OAR 340-035-0035(1)(b)(B)(i)). The 10 dBA operational noise increment standard does not apply to noise from construction activities, agricultural or forestry operations, vehicle traffic, rail traffic, aircraft operations, or various other exempt sources.

Local Noise Standards

The City of North Bend has a noise ordinance that prohibits the making of "unnecessary noise," but the ordinance does not establish specific numerical noise limits (North Bend City Code, Section 9.04.030). Daytime construction activity between the hours of 7 a.m. and 6 p.m. is exempt from the City of North Bend noise ordinance. The counties of Coos, Douglas, and Jackson, Oregon, do not have local noise ordinances. Klamath County cites compliance to occur when federal and/or state noise regulations are met (Klamath County 2010, Policy 5).

Underwater Noise Criteria

Potential underwater noise impacts on marine mammals and fish were also evaluated as part of the Project assessment. Applicable criteria are prescribed by NMFS and are provided in section 4.5.2.

Noise Levels

Existing noise levels are variable depending on location relative to the Project. Therefore, the existing sound environment is broken down by the Project area near the Jordan Cove LNG Project and areas near the Pacific Connector pipeline.

4.12.2.2 Existing Conditions

Jordan Cove LNG Project

The major existing anthropogenic noise sources in the vicinity of the Jordan Cove LNG Project include vehicle traffic on the Trans-Pacific Parkway and U.S. Highway 101, RV use in the ODNRA, and boat traffic on Coos Bay. Aircraft operations at the Southwest Oregon Regional Airport in North Bend are an additional intermittent anthropogenic noise source. Wind, birds, and insects contribute to natural background noise levels. There are no noise sensitive areas (NSAs) within 1 mile of the LNG terminal site.

Jordan Cove has conducted several baseline sound surveys in the vicinity of the Project including one in 2005, 2013 and one most recently in 2017 which collected data for approximately 30 minutes per measurement. All NSAs and distances to the LNG terminal are shown in figure M-1 in appendix M and are described below. The purple shaded area identifies the overall Project area. However, the Project facilities and majority of construction activities would occur in the western portion of the Project area. Noise generated from the eastern portions of the Project area would be minimal. The overall facility site plan is shown in figures 2.1-1 and 2.1-3 located in chapter 2.

- NSA 1 consists of single-family residences in a subdivision consisting of approximately 180 single-family residences located about 1.3 miles south of the LNG terminal noise-producing equipment in the city of North Bend along the south side of the bay adjacent to the airport. The subdivision is bordered on the north by Colorado Avenue and on the west by Arthur Street.
- NSA 2 is a group of approximately 50 single-family residences, located approximately 2.2 miles east on Russell Point. Noise levels at this location are influenced by highway traffic located along the Oregon Coast Highway.
- NSA 3 is the Horsfall campground, the closest campground to the Jordan Cove LNG Project, located approximately 1.2 miles northeast of the LNG terminal noise producing equipment.
- REC 1 is the recreation area located to the west and northwest of the LNG terminal noise-producing equipment. The recreation area does not incorporate campground facilities.

Jordan Cove monitored the ambient noise levels at those NSAs over a period of greater than 24 hours; the results are presented in table 4.12.2.2-1.

TABLE 4.12.2.2-1

Ambient Noise Levels for the Jordan Cove LNG Terminal Measured at Nearby NSAs a/

Receptor	Distance from LNG Terminal to Receptor (miles)	Direction	Daytime L_{eq}, dBA	Nighttime L_{eq}, dBA	Ambient L_{dn}, dBA b/
NSA 1	1.3	South	52	44	53
NSA 2	2.2	East	63	58	65
NSA 3	1.3	Northeast	58	40	56
REC 1	0.7	West	51	48	55

a/ Data collected during the 2017 sound survey
b/ The L_{dn} is calculated by averaging the actual daytime noise levels with the nighttime levels plus 10 dBA.

Ambient underwater sound levels were also considered. Ambient underwater noise levels range from about 74 dB to 100 dB re 1 µPa in the open ocean with no ship traffic nearby, to about 115 dB to 135 dB re 1 µPa in large marine inlets with some recreational boat traffic (CaDOT 2009). Since Coos Bay is fairly active with existing shipping traffic, ambient underwater noise levels are expected to correspond to the latter range in the presence of shipping but may be lower at times corresponding to reduced boat traffic activity.

Pacific Connector Pipeline Project

For the Pacific Connector pipeline, ambient sound level data were collected in the vicinity of the proposed Klamath Compressor Station in 2012. Background sound levels obtained in the 2012 survey are appropriate for continued use in this analysis because there have been no changes to the surrounding land uses and no development that would increase background noise levels since the 2012 survey. The GTN and Ruby meter facilities, farm animals and equipment, traffic on local roads, and an occasional aircraft overhead are the existing noise sources that were captured in the background noise monitoring study. All NSAs and distances to the LNG terminal are shown on figure M-6 in appendix M and are described as follows:

- NSA 1: 34545 Malin Loop Road (Subsequent to the 2012 noise survey, PCGP purchased this property);
- NSA 2: 33909 Malin Loop Road (Subsequent to the 2012 noise survey, PCGP purchased this property);
- NSA 3: 20933 Morelock Road;
- NSA 4: 33535 Malin Loop Road;
- NSA 5: 33770 Malin Loop Road;
- NSA 6: 34631 Malin Loop Road; and
- NSA 7: possible new home 1,230 feet north of station location.

Pacific Connector monitored the ambient noise levels at those NSAs over a period of greater than 24 hours, and the results are presented in table 4.12.2.2-2.

TABLE 4.12.2.2-2

Ambient Noise Levels for the Klamath Compressor Station Measured at Nearby NSAs

Receptor	Distance from Compressor Station, feet	Direction	Daytime L_{eq}, dBA	Nighttime L_{eq}, dBA	Ambient L_{dn}, dBA b/
NSA 1			Property owned by Pacific Connector		
NSA 2			Property owned by Pacific Connector		
NSA 3	1839	Northwest	35	32	39
NSA 4	2,820	Southwest	32	30	37
NSA 5	2,275	Southwest	54	36	52
NSA 6	1,500	Southeast	41	39	46
NSA 7 a/	1,230	North	39	37	43

a/ Residence to be built. Existing noise level based on level measured at NSA 1.
b/ The L_{dn} is calculated by averaging the actual daytime noise levels with the nighttime levels plus 10 dBA.

4.12.2.3 Jordan Cove LNG Project Impacts

Construction Noise Impacts

Construction of the Jordan Cove LNG Project would occur over a period of about four years. Major components would include berth facilities, buildings, LNG storage tanks, and mechanical/electrical equipment. Noise associated with construction activities would be intermittent because equipment is operated on an as-needed basis and mostly during daylight hours. During the site grading and filling operations, the equipment may be operated on two 10-hour shifts, 6 days per week, with the potential to increase to a 24/7 schedule if required. Construction would not result in generation of, or exposure of persons to, excessive noise or vibration levels. No blasting is anticipated to be required for construction as the entire site area consists of sand.

The most prevalent sound source during construction is anticipated to be the internal combustion engines used to provide mobility and operating power to construction equipment. The sound level at NSAs from construction operations would depend on the type of equipment used, the mode of operation of the equipment, the length of time the equipment is in use, the number of equipment used simultaneously, and the distance between the sound source and sensitive site. These factors would be constantly changing throughout the construction period, making it difficult to calculate an L_{dn} or L_{eq} sound level at any given location. However, construction noise was estimated using the Federal Highway Administration’s Roadway Construction Noise Model. Table M-1 in appendix M shows a schedule of the equipment expected to potentially be in simultaneous operation, along with the maximum sound level, L_{max}, at 50 feet, the usage percentage, and the expected L_{eq} at 50 feet considering the usage percentage. Noise levels from the construction equipment are expected to range from 71 dBA L_{eq} to 81 dBA L_{eq} at 50 feet.

Noise modeling was conducted with the commercially available computer-aided noise abatement (CadnaA) noise prediction model. The software is standards based, and the International Organization for Standardization (ISO) 9613 Part 2 standard was used for air absorption and other noise propagation calculations. Standard atmospheric conditions were selected and all receptor locations were modeled with all sound sources assumed to be in operation simultaneously. The ground absorption coefficient for all water surfaces was set to highly acoustically reflective with the remaining surfaces set to partially acoustically absorptive.

Table 4.12.2.3-1 presents the predicted daytime and nighttime sound levels at NSAs associated with general construction activities based on planned equipment usage for the currently planned equipment allocation for each year of construction. Figure M-2 in appendix M also visually displays the sound generated during general construction activities throughout the Project area in the form of color-coded sound contours.

TABLE 4.12.2.3-1

Predicted Construction Noise Levels at NSAs (dBA)

Receptor	Ambient L_{dn}	Construction Noise Level, Daytime, L_d	Construction Noise Level, Nighttime, L_n	Construction Noise Level, L_{dn}	Future Combined Level, L_{dn}	Increase over Ambient, L_{dn}
NSA 1	53	49	44	52	56	3
NSA 2	65	39	34	41	65	<1
NSA 3	56	42	37	45	57	<1
REC 1	55	49	44	52	57	2

The loudest construction activity would be installation of the LNG carrier berth sheet pile wall and installation of the piles associated with the marine slip docks. Up to 14 concurrent diesel impact pile hammers would be used during construction of the facility to drive approximately 3,600 pipe piles in the plant facility area. Up to six vibratory hammers would be in use to install the sheet piles. The pipe pile diameters would range from 24 to 72 inches, and the maximum sound pressure level data were analyzed. Vibratory pile drivers were modeled using an L_{max} level of 101 dBA at a distance of 50 feet having applied a usage factor of 20 percent.

Table 4.12.2.3-2 presents the predicted sound levels associated with pile driving activities at NSAs having accounted for equipment operating during daytime or nighttime periods and accounting for two daytime and nighttime hours during which there are no planned pile-driving activities due to the crew shift change. Additionally, table 4.12.2.3-2 provides the predicted L_{max} values of pile driving activities. The L_{dn} is a useful metric when evaluating continuous noise sources; however, for impulsive sound sources, L_{max} better represents the sound impacts of short and intense noise sources. Figure M-3 in appendix M also visually displays the sound generated during pile driving throughout the Project area in the form of color-coded sound contours.

TABLE 4.12.2.3-2

Predicted Pile Driving Noise Levels at NSAs (dBA)

Receptor	Ambient L_{dn}	Pile Driving Noise Level, Daytime, L_d	Pile Driving Noise Level, Nighttime, L_n	Pile Driving Noise Level, L_{dn}	Future Combined Level, L_{dn}	Increase over Ambient, L_{dn}	Predicted Maximum Level, L_{max}
NSA 1	53	54	53	60	61	8	65
NSA 2	65	39	38	45	65	<1	55
NSA 3	56	42	42	48	57	1	60
REC 1	55	51	51	57	59	4	69

Based on the noise levels provided in table 4.12.2.3-2, it is predicted that pile-driving operations could result in an increase greater than 3 dB L_{dn} on the ambient noise level at two NSAs. Additionally, using the L_{max} values, pile-driving activities would result in noise impacts at all NSAs at or greater than our noise criterion of 48.6 dBA L_{eq}[188]. Pile-driving operations are

[188] note that a L_{dn} of 55 dBA is equivalent to a continuous noise level of 48.6 dBA L_{eq} for facilities that operate at a constant level of noise

currently proposed to occur 20 hours a day for construction of the Jordan Cove LNG Project for 2 years. Based on the large number of residents who live across Coos Bay on the south and the east, the impulsive (short, intense) noise impacts associated with pile-driving activities, the predicted and perceptible noise impacts on nearby NSAs, the duration of pile-driving activities, as well as the lack of noise mitigation measures proposed by Jordan Cove, **we recommend that:**

- **<u>Following the start of pile-driving activities</u>, Jordan Cove should monitor daytime pile-driving and file <u>weekly</u> noise data reports with the Secretary that identify the noise impact on the nearest NSAs. If any measured daytime noise impacts (L_{max}) at the nearest NSAs are greater than 10 dBA over the L_{eq} ambient levels, Jordan Cove should:**

  a. cease pile-driving activities and implement noise mitigation measures; and

  b. file with the Secretary evidence of noise mitigation installation and request written notification from the Director of OEP that pile driving may resume.

Given the proximity of residences to construction and the predicted noise levels associated with pile driving, we conclude that pile-driving activities, without further noise mitigation, should be concluded within reasonable working hours. Therefore, **we recommend that**:

- **Jordan Cove should conduct all pile-driving activities only between the hours of 7 a.m. and 7 p.m. <u>throughout the duration of construction</u>.**

Dredging would also take place during the first three years of the Project. Dredging is anticipated to occur on a 24-hour basis during construction, and its sound level is estimated to be 59 dBA at a distance of 500 feet. Open water dredging activities would occur in five separate work areas, with four work areas along the Federal Navigation Channel and one in the slip area of the Project. Sound was conservatively modeled assuming dredging would take place concurrently at each of the five separate work areas, with all equipment operating simultaneously. Table 4.12.2.3-3 presents the predicted sound levels at NSAs associated with dredging activities. An additional NSA, labeled NSA D1, was included in the dredging evaluation because it is the closest residential area to the Federal Navigation Channel dredging area. Figure M-4 in appendix M visually displays the sound generated during dredging throughout the Project area in the form of color-coded sound contours.

TABLE 4.12.2.3-3

Predicted Dredging Noise Levels at NSAs (dBA)

Receptor	Ambient L_{dn}	Predicted Sound Level, L_{eq}	Predicted Sound Level, L_{dn}	Future Combined Level, L_{dn}	Increase over Ambient, L_{dn}
NSA 1	53	36	42	53	<1
NSA 2	65	25	31	65	<1
NSA 3	56	22	28	56	<1
REC 1	55	28	34	55	<1
NSA D1 a/	53	45	51	55	2

a/ Ambient sound levels at NSA D1 are assumed to be the same as at NSA 1, a residence in the same neighborhood, and the same distance from the bay and ocean as NSA D1

Noise from a cutter suction dredge varies with the capacity of the dredger and the type of material being dredged. A smaller dredge with an anticipated sound power level of 157 dB would be used for the Project; however, a larger dredger was also considered to assess worst-case noise impacts. Noise associated with dredging is largely related to ship traffic. It is not anticipated that dredging noise would cause more severe effects on marine mammals or fish than behavioral disturbance (see section 4.5). The noise from dredging and vessel movements would be similar to existing noise levels due to existing dredging and vessel activity in the Coos Bay channel.

Operational Noise Impacts

Operational noise associated with the Jordan Cove Project was modeled using noise prediction software (CadnaA version 2017) in accordance with ISO 9613. The following major noise-producing equipment would normally be in operation at the Jordan Cove LNG Project and were included in the acoustic modeling analysis:

- Five refrigerant compressors, combustion turbines, heat recovery steam generators, and associated piping;
- Refrigerant compressor interstage and discharge aerial coolers;
- Three steam turbines and their associated air-cooled condensers;
- Two BOG compressors with interstage and discharge aerial coolers; and
- Various other smaller condensers, coolers, pumps and valves.

The model simulates the outdoor propagation of sound from each noise source and accounted for sound wave divergence, atmospheric and ground absorption, sound directivity, and shielding due to interceding barriers and terrain. A database was developed that specified the location, octave-band sound levels, and sound directivity of each noise source. The model calculates the A-weighted sound pressure levels from the Project at the NSA locations. Noise modeling was based on normal operation, which excludes intermittent activities such as start-up, shut down, and any other abnormal or upset operating conditions.

To assess compliance relative to the OAR anti-degradation standard, the increase in sound level was assessed relative to the measured nighttime 1-hour L_{eq}, which is used by Jordan Cove as a surrogate to the L_{50}. The results of the analysis (table 4.12.2.3-4) indicate that the predicted NSA sound levels are below the 55 dBA L_{dn} FERC noise criterion. In addition, the Project demonstrates compliance with the OAR anti-degradation standard as there are no expected increases greater than 10 dBA relative to the measured nighttime 1-hour L_{eq}/L_{50} sound level.

TABLE 4.12.2.3-4

Predicted Project Noise Emissions at NSAs compared to Regulatory Limits for Jordan Cove LNG Project (dBA)

Receptor	Predicted Project Sound Level (L_{eq})	2017 Nighttime Measured 1-hour L_{eq}/L_{50}	Increase Over Existing Ambient	Predicted Project Sound Level (L_{dn})	Existing Ambient L_{dn}	Future Level (Project + Ambient)	Increase Over Existing Ambient
NSA 1	45	44	1	51	53	55	2
NSA 2	37	58	0	43	65	65	<1
NSA 3	43	40	3	49	56	57	1
REC 1	49	48	1	55	55	58	3

As currently designed, Jordan Cove would not install additional noise mitigation measures such as acoustical enclosures, acoustical barriers, or custom silencers beyond mitigation inherent to the specified equipment analyzed.

As far as ground-borne and low frequency air-borne vibration, facility equipment is designed and balanced to minimize extraneous vibration to preserve and extend the service life of the equipment. Ground-borne and low-frequency airborne vibration resulting from the Jordan Cove LNG Project equipment is not expected at the NSAs.

In terms of environmental noise, an increase to the ambient sound level of 3 dB is generally considered barely detectable by the human ear. The expected increases in L_{dn} noise levels at the nearest NSAs due to normal operation are less than 3 dB; however, to ensure that the noise from operation of the Jordan Cove LNG Project would not be significant, **we recommend that:**

- **Jordan Cove should file a full power load noise survey with the Secretary for the LNG terminal <u>no later than 60 days after</u> each liquefaction train is placed into service. If the noise attributable to operation of the equipment at the LNG terminal exceeds an L_{dn} of 55 dBA at the nearest NSA, <u>within 60 days</u> Jordan Cove should modify operation of the liquefaction facilities or install additional noise controls until a noise level below an L_{dn} of 55 dBA at the NSA is achieved. Jordan Cove should confirm compliance with the above requirement by filing a second noise survey with the Secretary <u>no later than 60 days</u> after it installs the additional noise controls.**

- **Jordan Cove should file a full power load noise survey with the Secretary <u>no later than 60 days after placing the entire LNG terminal into service</u>. If a full load noise survey is not possible, Jordan Cove should file an interim survey at the maximum possible horsepower load <u>within 60 days</u> of placing the LNG terminal into service and file the full operational surveys <u>within 6 months</u>. If the noise attributable to the operation of all the equipment of the LNG terminal exceeds 55 dBA L_{dn} at any nearby NSAs, under interim or full load conditions, Jordan Cove should file a report on what changes are needed and install additional noise controls to meet the level <u>within 1 year</u> of the in-service date. Jordan Cove should confirm compliance with this requirement by filing a second full power noise survey with the Secretary <u>no later than 60 days</u> after it installs the additional noise controls.**

Flaring would generate noise; however, since it would occur very infrequently, it is not considered part of typical operations. Cold process flaring is expected to occur five times a year and last for approximately 30 minutes, and warm process flaring is expected to take place once every three years and last for approximately two hours. The marine flare is expected to be used four times a year and could last approximately 14 hours per event.

Noise associated with flaring was modeled using measurement data from another similar flare and/or engineering references, as appropriate. Table 4.12.2.3-5 presents the predicted sound levels at NSAs associated with flaring. Since flaring lasts for fewer than 24 hours, the predictions were adjusted to reflect actual operation time. Compliance with the FERC noise criterion and State of Oregon noise requirements was successfully demonstrated for all flaring scenarios. Figure M-5 in appendix M also visually displays the sound generated during flaring throughout the Project area in the form of color-coded sound contours. Though process and marine flaring are not expected to take place simultaneously, they were also modeled together to be conservative. As shown in table 4.12.2.3-5, process flaring is substantially louder than marine flaring and therefore dominates the combined case, with process flaring as the only even with an increase over ambient levels being greater than 1 L_{dn}.

TABLE 4.12.2.3-5

Predicted Process and Marine Flare Noise Levels at NSAs (dBA)

Receptor	Predicting Flaring Sound Level, L_{eq}	Predicting Flaring Sound Level (Adjusted for Event Duration), L_{eq}	2017 Nighttime Measured 1-hour L_{eq}/L_{50}	Increase Over Existing Ambient	Predicting Flaring Sound Level (Adjusted for Event Duration), L_{dn}	Ambient L_{dn}	Future Combined Level, L_{dn}	Increase over Ambient, L_{dn}
Process Flare								
NSA 1	47	38	44	<1	44	53	53	1
NSA 2	40	31	58	<1	37	65	65	<1
NSA 3	46	37	40	<1	43	56	57	<1
REC 1	60	51	48	<1	57	55	59	4
Marine Flare								
NSA 1	25	25	44	<1	31	53	53	<1
NSA 2	16	16	58	<1	22	65	65	<1
NSA 3	12	12	40	<1	18	56	56	<1
REC 1	28	28	48	<1	34	55	55	<1
Combined Process and Marine Flares								
NSA 1	47	38	44	<1	44	53	53	1
NSA 2	40	31	58	<1	37	65	65	<1
NSA 3	46	37	40	<1	43	56	57	<1
REC 1	47	38	48	<1	44	55	53	1

During operation of the Jordan Cove LNG Project, the primary underwater sound sources would consist of LNG ships and tug boats. The Jordan Cove LNG Project would add about 110-120 LNG carriers on an annual basis to the existing 50 deep draft vessels per year operating in the area.

Noise from large vessels can range up to 188 dB re 1 µPa at 1 meter. Noise from vessels varies depending on size, power, propulsion system loading, and vessel speed. Typical transit speed for vessels within Coos Bay navigation channel is 7 knots. JASCO Research (2006) states that broadband noise from LNG carriers at half speed is expected to be around 175 re 1 µPa at 1 meter. Noise from tug boats is less speed dependent and, in fact, tugs under load can be noisier than larger vessels.

In accordance with the NMFS (2016) technical guidance, a cumulative assessment was conducted for vessel-related noise. The results showed that the noise from transiting vessels and tugs does not represent a potential risk of PTS to any of the identified marine mammal species. When tugs are operating semi-stationary under full power near the facility, individual harbor porpoises would need to remain within about 1 mile of the tug for 1 hour for there to be a potential for PTS. Killer whales would need to remain within about 100 feet of the tug for 1 hour for there to be potential for PTS.

4.12.2.4 Pacific Connector Pipeline Project Impacts

Construction Noise Impacts

Construction activities at the Klamath Compressor Station are expected to last between 12 and 18 months and would involve clearing and grading, placement of fill, excavation for foundations for the compressor unit packages, other equipment settings, ancillary equipment, associated unit housing, piping, and structures. Table M-2 in appendix M presents typical noise emission levels at various distances for the noise producing equipment that would be operating during the construction of the station.

Construction of the Klamath Compressor Station would cause temporary increases in ambient noise levels in the immediate vicinity of the construction site. Pacific Connector's standard construction operating hours are 7:00 a.m. to 7:00 p.m., Monday through Saturday. OAR 340-035-0035(5)(g) provides an exemption for construction noise from compliance with noise standards.

During construction of the Pacific Connector pipeline, construction noise would be audible to NSAs near the construction right-of-way. Some of the land crossed by the pipeline is categorized for residential, commercial, or industrial use. Over 100 structures are within 150 feet of the pipeline right-of-way or TEWAs, and several residences are within 50 feet of the pipeline construction right-of-way or TEWAs. See section 4.7 of this EIS for more information on land use. Due to the assembly-line nature of pipeline construction, activities in any area could occur intermittently over a period lasting from several weeks to a few months.

Construction equipment would be operated on an as-needed basis. Phase 6 includes rock blasting and represents the highest sound levels associated with pipeline construction. A blasting plan has been prepared within the POD that details mitigation measures for blasting activities. For this phase, sound levels at 50 feet are predicted to be 95 dBA L_{eq} and would attenuate to 87 dBA L_{eq} and 74 dBA L_{eq} at 100 feet and 300 feet, respectively. Noise would diminish rapidly as the distance from the noise source increases.

Access roads would be used by construction equipment to reach the right-of-way. There may be areas where access roads are limited in width, grade, or availability. Helicopters may be used during logging for right-of-way clearance. Helicopters that may be used for the Project are assumed to be at most 115 dBA at 50 feet (Michael Minor & Associates 2008), 112 dBA at 100 feet, and 98 dBA at 300 feet. The primary sources of wideband acoustic energy from helicopters are the main and tail rotor. Helicopters generally fly at low altitudes; therefore, potential temporary increases to ambient sound levels would occur in the area where helicopters are operating as well as along their flight path.

In addition to temporary disturbance near residences or other noise-sensitive land uses, construction noise would have localized but temporary effects on wildlife. In general, temporary noise from construction activities would result in some wildlife movements away from the pipeline corridor. See additional discussion of potential pipeline construction noise effects on wildlife in sections 4.5 and 4.6 of this EIS.

The majority of pipeline construction would occur during daytime hours only, with the exception of HDD operations. Other activities often conducted at night include operation of pumps at dry-ditch waterbody crossings; hydrostatic testing; and tie-ins. Pacific Connector may opt to perform these additional construction activities at night. The following mitigation measures would be implemented, as necessary, during construction of the pipeline and/or the Klamath Compressor Station:

- ensure that all equipment has sound control devices no less effective than those provided by the manufacturer;
- ensure that equipment would have muffled exhausts; and
- to the extent feasible, the construction site would be configured in a manner that keeps noisier equipment and activities as far as possible from noise sensitive locations.

If necessary, for greater noise reduction, moveable paneled noise shields, barriers, or enclosures adjacent to or around noisy equipment would be installed where required to meet applicable Project noise limits. If properly installed, temporary barriers can result in a noise reduction of up to 10 dBA at the receptor.

Horizontal Directional Drilling and Direct Pipe Crossings

Pacific Connector proposes to use HDD technology to cross under six waterbodies and a powerline/steep slope location at six sites. Some portions of HDD operations would occur as 12-hour work shifts, while other activities would normally occur as 24-hour-per-day operations. The overall duration of HDD operations is site-specific and would be determined by the drilling contractor. HDD operations are expected to last up to 4 weeks at each site.

The equipment would consist of an HDD drilling rig and auxiliary support equipment including electric mud pumps, a crane, mud mixing and cleaning equipment, and a shale shaker. Most significant noise sources would be at the entry and noise levels from the exit locations would be less than the entry noise levels. Table M-4 in appendix M provides sound power level data for the proposed HDD equipment by octave band.

Using a methodology consistent with ambient data collection for other portions of the Project, a measurement survey was conducted near each HDD crossing. The results of that survey are presented in table 4.12.2.4-1.

TABLE 4.12.2.4-1

Ambient Noise Levels for the Pacific Connector HDD Sites Measured at Nearby NSAs

Crossing	Measurement Location	Daytime L_{eq}, dBA	Nighttime L_{eq}, dBA	Ambient L_{dn}, dBA
Coos Bay East and West Entry	Measurement Site #1	63	46	61
	Measurement Site #2	65	46	63
MP25 (BPA Powerline Corridor)	NSA #1	54	49	56
	NSA #2	43	45	51
Coos River	NSA #1	65	35	63
	NSA #2	65	38	63
	NSA #3	60	41	58
	NSA #4	60	37	58
South Umpqua	NSA #1	53	50	57
	NSA #2	63	59	66
	NSA #3	57	51	59
	NSA #4	62	53	63

TABLE 4.12.2.4-1 (continued)

Ambient Noise Levels for the Pacific Connector HDD Sites Measured at Nearby NSAs

Crossing	Measurement Location	Daytime L_{eq}, dBA	Nighttime L_{eq}, dBA	Ambient L_{dn}, dBA
Rogue River	NSA #1	46	35	46
	NSA #2	46	35	46
	NSA #3	46	35	46
	NSA #4	46	35	46
	NSA #5	54	35	52
	NSA #6	36	35	42
	NSA #7	45	35	45
Klamath River	NSA #1	62	46	61
	NSA #2	57	47	57
	NSA #3	53	43	53

Sound levels at the NSAs due to HDD construction were modeled assuming two scenarios: no noise mitigation and with noise mitigation, if necessary. The noise mitigation options considered were a barrier wall and two types of acoustic tents. The 20-foot-high barrier wall would wrap around the entire HDD site. The tents include a vinyl acoustic tent installed over the entire drilling site. The tent would be approximately 190 feet long by 90 feet wide by 35 feet high and would contain all equipment on the site and an additional special fabric acoustic tent installed over the entire drilling site. Table 4.12.2.4-2 shows the existing ambient sound level, expected drilling noise including mitigation (if necessary), future combined sound level and net increase in sound level above ambient, presented in terms of L_{eq} sound levels. In most cases, the HDD noise produced adheres to the FERC noise criterion of 55 dBA L_{dn} (or 48.6 dBA L_{eq}); however, there are a few instances where exceedances are predicted at the Coos Bay West and East crossings. At the Coos Bay West crossing, NSA#1 is expected to experience received sound levels above 48.6 dBA L_{eq}; however, during daytime hours, existing ambient sound levels are such that the increase in sound level due to HDD would be negligible. During nighttime hours, HDD activity would result in a net increase in sound level of approximately 7 dBA above nighttime ambient sound levels. At the Coos Bay East crossing, NSA #2 would experience an exceedance of the FERC noise criterion during nighttime hours and HDD activity would result in a net increase in sound level of approximately 7 dBA above nighttime ambient sound levels. We conclude that the noise from the HDD operations, especially during nighttime operations, should be mitigated. Therefore, **we recommend that:**

- **Prior to drilling activities at HDD sites, Pacific Connector should file a site-specific nighttime noise mitigation plan with the Secretary for review and written approval by the Director of OEP. During any drilling operations, Pacific Connector should implement the approved plan, monitor noise levels, and file in its biweekly reports documentation that the noise levels attributable to the drilling operations at NSAs does not exceed 55 L_{dn} dBA.**

Figures M-7 through M-13 in appendix M depict the HDD locations, predicted sound levels for HDD activity, and the location of the nearest NSAs.

TABLE 4.12.2.4-2

Summary of HDD Acoustic Modeling Results

Crossing	NSA	Distance (ft) / Direction from HDD a/	Ambient Sound Level L_{dn}, dBA	HDD Noise, L_{dn}, dBA	Future Combined Sound Level, L_{dn}, dBA	Net Increase, dBA
Coos Bay West (20' Barrier Wall)	NSA #1	1,469 / South	61	51	61	<1
	NSA #2	1,652 / Southeast	61	46	61	<1
	NSA #3	4,493 / North	61	39	61	<1
	NSA #4	2,058 / Southeast	61	45	61	<1
Coos Bay East (20' Barrier Wall)	NSA #1	1,193 / Southwest	61	41	61	<1
	NSA #2	490 / South	61	51	61	<1
	NSA #3	4,431 / North	61	40	61	<1
	NSA #4	873 / Southeast	61	44	61	<1
MP25 - BPA Powerline Corridor (No Mitigation)	NSA #1	9,842 / Northwest	56	37	56	<1
	NSA #2	4,104 / Southeast	51	48	53	2
Coos River (20' Barrier Wall)	NSA #1	1,232 / South	63	38	63	<1
	NSA #2	1,258 / South	63	36	63	<1
	NSA #3	479 / Southeast	58	51	59	1
	NSA #4	375 / Southwest	58	53	59	1
S Umpqua (20' Barrier Wall)	NSA #1	2,025 / South	57	33	57	<1
	NSA #2	818 / East	66	46	66	<1
	NSA #3	1,325 / Northeast	59	50	60	1
	NSA #4	2,345 / Southeast	63	50	63	<1
Rogue River East Entry (Special Acoustic Tent)	NSA #1	464 / North	46	51	52	6
	NSA #2	1,000 / East	46	43	48	2
	NSA #3	800 / South	46	47	50	4
	NSA #4	490 / Southwest	46	52	53	7
Rogue River East Entry (20' Barrier Wall)	NSA #5	1,300 / West	52	48	53	1
	NSA #6	>1,300 b/	42	55	55	13
	NSA #7	>1,300 b/	45	45	48	3
Klamath River East Entry (Special Acoustic Tent)	NSA #1	650 / Northeast	61	53	62	1
	NSA #2	>1,500 b/	57	43	57	<1
	NSA #3	1,500 / South	53	44	54	1
Klamath River East Entry (20' Barrier Wall)	NSA #1	650 / Northeast	61	51	61	<1
	NSA #2	>1,500 b/	57	51	58	1
	NSA #3	1,500 / South	53	53	56	3

a/ Distances and direction were estimated from the figures in appendix M.
b/ NSA was not shown in the figures. It is assumed that these NSA's are at a greater distance from the HDD than the NSA shown on the figure.

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The DP method is another trenchless construction methods that would be used to cross some waterbodies by Pacific Connector (see section 2), which is similar to HDD but is also combined with the process of microtunneling. Compared to HDD, a much larger cutterhead is used, eliminating the reaming process. Excavation and hole boring are performed with a microtunneling machine and cutterhead. Generally, completing a DP crossing takes less time than an HDD crossing and is considered less noisy since the majority of equipment is located at the crossing entry point, as opposed to both entry and exit points. Therefore, it is expected that the assessment of potential noise impacts using HDD technology is a conservative approach in comparison to use of the DP method.

Operational Noise Impacts

Compressor Station Operation

Operational noise associated with the Klamath Compressor Station was evaluated using manufacturers' noise emission data for the anticipated compressors, associated noise producing equipment, and typical noise control applications. The Klamath Compressor Station detailed design has not been completed; therefore, estimates of compressor station operational noise levels are based on best available information. Primary noise sources from equipment at the compressor station, along with corresponding estimated noise emission data and noise control equipment reduction values, were derived from measurements of similar equipment at other similar facilities (see table M-5 in appendix M).

Operational noise levels for the Klamath Compressor Station were estimated using CadnaA, as previously discussed, and noise prediction techniques consistent with ISO 9613 for sound propagation outdoor. These techniques take into account the noise generation of individual equipment items, shielding by buildings and barriers, spreading losses, ground and atmospheric effects, and reflections from surfaces. The modeling conservatively predicted the noise contribution during the operation of all three compressor units operating under full load conditions. The modeling included effects of the hillside excavated to form a partial noise barrier to the east.

During development of the detailed design, best practices applicable to noise reduction would be incorporated. Best design practices routinely incorporated in gas turbine stations are low noise air intakes; exhaust silencers; blow down silencers; gas cooler fans; and sound insulated buildings, housings, and piping. In rare cases, if necessary for compliance with noise limits, noise barriers may be installed. Insertion loss values of the noise mitigation measures incorporated into the acoustic modeling analysis are presented in table M-6 in appendix M.

The results of the operational acoustic modeling analysis are shown in table 4.12.2.4-3. FERC regulations require that during operation, compressor station noise increments not exceed an L_{dn} of 55 dBA (equivalent to a continuous noise level of 48.6 dBA L_{eq}) at the nearest NSA. Oregon noise regulations require that operational noise from new commercial or industrial facilities must not increase ambient L_{50} noise levels by more than 10 dBA. For a facility that operates continuously at a steady level, the L_{50} is often very similar to the L_{eq} level; therefore, predictions of compressor station sound levels are in L_{eq} but are comparable to L_{50} baseline sound levels. The results indicate that, having incorporated the indicated noise mitigation measures, the received sound levels at NSAs would be in compliance with the 55 dBA L_{dn} FERC noise criterion and the

Oregon noise regulations. In addition, figure M-14 in appendix M shows the sound contours associated with the operation of the Klamath Compressor Station.

TABLE 4.12.2.4-3

Predicted Operational Noise Levels of the Klamath Compressor Station

Receptor Location	Distance (feet) and Direction	Existing L_{50} (dBA)	Predicted L_{eq} (dBA)	Predicted Increase Over Existing L_{50} (dBA)	Existing L_{dn} (dBA)	Predicted L_{dn} (dBA)	Combined Existing plus Predicted L_{dn}, dBA	Predicted Increase Over Existing L_{dn} (dBA)
NSA 1				Property Purchased by Pacific Connector				
NSA 2				Property Purchased by Pacific Connector				
NSA 3	1,839/Northwest	32	40	9	39	46	47	8
NSA 4	2,820/Southwest	30	35	6	37	41	42	6
NSA 5	2,275/Southwest	36	37	4	52	43	43	1
NSA 6	1,500/Southeast	39	41	4	49	47	47	2
NSA 7	1,230/North	37	43	7	43	50	50	8

Pacific Connector has committed to implementing the following noise mitigation measures for the facility:

- The turbine intake and/or exhaust systems should be equipped with silencers having greater insertion losses than the standard Solar Titan 130 silencers in order to reduce the noise contribution at the nearest NSA (NSA 1) to a level below L_{dn} 55 dBA.
- The turbine exhaust duct located between the compressor building wall and the silencer should be acoustically insulated.
- The turbine lube oil coolers should have noise levels approximately equal to Solar's 85 dBA cooler. The cooler noise level at a horizontal distance of 50 feet from the center of each cooler would be about 54 dBA.
- The gas after-coolers should be designed so that the noise levels at a horizontal distance of 50 feet from the center of each cooler would be about 60 dBA.
- Outdoor aboveground gas piping should be inserted underground soon after exiting the compressor building.
- The compressor building should be acoustically insulated with 6 inches of 8 pounds/cubic feet density mineral wool insulation. The building shell should have 22-gauge metal outer sheeting in the walls and roof and a 26-gauge perforated metal liner.
- The compressor building roll-up door should have a minimum noise reduction rating of STC-28 through the door (this may require a double door).
- Personnel doors should be standard insulated doors with an STC-26 noise reduction rating.
- The compressor building ventilation system has not yet been designed. The building ventilation openings should be acoustically designed so that they are compatible with the silencing in the rest of the station.
- The compressor impeller wheels have not yet been selected and the unit piping noise levels could not be evaluated. It is expected that the unit piping would require acoustic insulation.

As shown in table 4.12.2.4-3, operation of the Klamath Compressor Station would result in clearly noticeable increases in noise levels at three of the five NSAs. However, the station's contribution would be less than the FERC requirement of L_{dn} 55 dBA. Although the Klamath Compressor Station is anticipated to operate in compliance with the applicable noise requirements to ensure that actual operational noise is at or below the FERC-recommended limits, and that there would be no significant effects on noise quality at the nearest NSAs, **we recommend that:**

- **Pacific Connector should file a noise survey with the Secretary <u>no later than 60 days after placing the Klamath Compressor Station in service</u>. If a full load condition noise survey is not possible, Pacific Connector should provide an interim survey at the maximum possible horsepower load and provide the full load survey <u>within six months</u>. If the noise attributable to the operation of all of the equipment at the Klamath Compressor Station under interim or full horsepower load conditions exceeds an L_{dn} of 55 dBA at any nearby NSAs, Pacific Connector should file a report on what changes are needed and should install the additional noise controls to meet the level <u>within one year</u> of the in-service date. Pacific Connector should confirm compliance with the above requirement by filing a second noise survey with the Secretary <u>no later than 60 days</u> after it installs the additional noise controls.**

<u>Venting/Blowdown Events</u>

These events are a venting of gas for safety purposes to relieve pressure in a pipeline component or at a compressor station prior to performing maintenance work (anticipated to occur on an annual basis). A venting or blowdown event at individual MLV locations is a rare and infrequent event. A blowdown vent with a silencer results in a sound power level of approximately 83 dBA. Noise levels at various distances based on that sound power level expected for routine blowdown events are given in table 4.12.2.4-4.

TABLE 4.12.2.4-4

Blowdown Valve Sound Pressure Level at Various Distances

	Distance (feet)/ Received Sound Level (dBA)			
Sound Source	**50**	**100**	**300**	**1,000**
Blowdown Valve with Silencer	48	42	33	22

Acoustic modeling was conducted to determine received sound levels associated with routine blowdowns at the closest NSAs to the block valve locations (table 4.12.2.4-5). Modeling results indicate compliance with applicable noise requirements prescribed by the FERC and the State of Oregon.

TABLE 4.12.2.4-5

Summary of Blowdown Acoustic Modeling Results

Receptor	County	Distance (Feet)	Sound Pressure Level, L_{eq} (dBA)	Sound Pressure Level, L_{dn} (dBA)
02 - AGF 15.69 (BVA #2)	Coos	72	25	31
05 - AGF 59.58 (BVA #5)	Douglas	1,224	21	27
06 - AGF 71.46 (BVA #6)	Douglas	1,096	21	27
08 - AGF 94.66 (BVA #8)	Douglas	20	36	42
10 - AGF 122.18 (BVA #10)	Jackson	89	23	29
15 - AGF 197.77 (BVA #15)	Klamath	1,092	21	27
16 - AGF 214.28 (BVA #16)	Klamath	60	27	33
17 - AGF 228.13 (Klamath Compressor Station, BVA #17)	Klamath	74	25	31

MLV blowdowns, if scheduled for maintenance activities during the life of the pipeline, would be communicated to the surrounding landowners in writing (e.g., letters and "door-hangers") in advance of the event. These events are conducted during daylight hours only. Such transient events are of very short duration and do not represent continuous or routine noise or disturbance to NSAs. Based on the infrequent and short duration of blowdowns, these events would not have significant adverse noise impacts on nearby NSAs.

Metering Station Noise

One meter station would be located very close to the Jordan Cove LNG terminal (at the gas gate), and two meter stations would be located within the Klamath Compressor Station fenceline. Noise may be generated by gas flow in the pipe used for measurement at the meter stations. However, noise generated by operation of the Jordan Cove LNG Project would dominate over the meter station near the terminal; similarly, noise generated by operation of the compressor station would dominate over the meter stations at the compressor station. Noise would not be expected to be audible beyond the edge of the meter station sites or pipeline right-of-way. Additionally, our recommendation that Pacific Connector and Jordan Cove complete noise surveys at both the compressor station and the LNG terminal would be inclusive of noise generated by the meter stations in and near these respective facilities; therefore, we do not believe that noise impacts due to operation of the meter stations would result in significant impacts on nearby NSAs.

4.12.2.5 Environmental Consequences on Federal Lands

The southern boundary of the ODNRA is less than 0.7 mile northwest of the Jordan Cove LNG Project. As shown on the noise contour maps in figure 4.12-3, estimated noise from general Jordan Cove LNG Project construction is expected to remain below an L_{dn} of 55 dBA (i.e., the noise level used by the EPA and FERC to protect the public from activity interference and annoyance outdoors in residential areas); however, during pile driving for installation of berth facilities at the Jordan Cove marine slip, predicted noise levels at the ODNRA are expected to exceed the FERC noise criterion (figure 4.12-4). In addition, predicted noise levels at the BLM boat ramp located about 1 mile southwest of the terminal site would exceed 55 dBA (figureM-4 in appendix M). Noise from pile driving would be noticeable to users of the ODNRA and BLM boat ramp during construction. This impact would be a temporary annoyance to users of the ODNRA and boat ramp. Due to the noise-generating activities associated with the ODNRA and BLM boat ramp, these locations are not considered to be an NSA.

During operation and flaring, predicted noise generated from the Jordan Cove LNG Project may also exceed the 55 dBA L_{dn} FERC noise criterion at the ODNRA and BLM boat ramp. During operation of the Jordan Cove LNG Project, BLM and COE lands near the Coos Bay navigation channel would receive limited noise impacts from LNG carriers arriving at and departing from the terminal. An estimated 110-120 ships per year would call on the Jordan Cove LNG Project. Noise levels during ship movements are estimated to be about 63 dBA at a distance of 300 feet during each passby event, which would be similar to noise generated from deep-draft cargo ships that currently traverse the Coos Bay navigation channel. Because the Coast Guard would impose a moving safety zone around LNG carriers, only one large vessel would be traversing any one location along the channel at any point in time. Current ship traffic at the Port is about 50 deep-draft commercial ship calls per year. The increase in the number of vessel calls at the Port resulting from operation of the Jordan Cove LNG Project would be less than one ship movement per day. Noise from LNG carriers would not be expected to create a noticeable change in overall noise levels at BLM and COE lands along the Coos Bay navigation channel.

During construction of the Pacific Connector pipeline, there would be temporary noise impacts on federal lands crossed by the pipeline or crossed by construction access roads. Construction noise could have localized and temporary effects on recreational users and wildlife on federal lands. Pipeline construction would proceed in a linear fashion along the right-of-way, and equipment would be operated on an as-needed basis; therefore, exact noise at a particular point cannot be determined. However, we can estimate noise levels as a function of the distance of the receptor from the equipment. Table M-3 in appendix M provides predicted construction noise levels at 50 feet, 100 feet, and 300 feet for pipeline construction. Noise would diminish rapidly as the distance from the noise source increases.

During operation of the pipeline, there would be no noise generated from the buried pipeline. Aboveground MLVs would be located within BLM lands. During operation, sound is sometimes detectable within several feet of MLVs; however, any noise impact during operation of the MLVs, with the exception of blowdown events discussed previously, would not be humanly perceptible beyond the operational right-of-way for the pipeline. The main source of noise from operation of the Pacific Connector would be from the Klamath Compressor Station, which would be located on private land, with no federal land adjacent or nearby. We conclude that construction and operation of the Pacific Connector Pipeline Project would not have significant adverse noise impacts on users of federal lands.

4.12.2.6 Conclusion

Constructing and operating the Project would result in noise-related impacts. However, based on the implementation of the proposed BMPs as well as inclusion of the recommendations made in this EIS, the Project would not cause significant noise-related impacts.

4.13 RELIABILITY AND SAFETY

4.13.1 Jordan Cove LNG Project

4.13.1.1 LNG Facility Reliability, Safety, and Security Regulatory Oversight

LNG facilities handle flammable and sometimes toxic materials that can pose a risk to the public if not properly managed. These risks are managed by the companies owning the facilities, through selecting the site location and plant layout as well as through suitable design, engineering, construction, and operation of the LNG facilities. Multiple federal agencies share regulatory authority over the LNG facilities and the operator's approach to risk management. The safety, security, and reliability of the Jordan Cove LNG Project would be regulated by the USDOT, the Coast Guard, and the FERC.

In February 2004, the USDOT, the Coast Guard, and the FERC entered into an Interagency Agreement to ensure greater coordination among these three agencies in addressing the full range of safety and security issues at LNG terminals and LNG marine vessel operations, and maximizing the exchange of information related to the safety and security aspects of LNG facilities and related marine operations. Under the Interagency Agreement, the FERC is the lead federal agency responsible for the preparation of the analysis required under NEPA for impacts associated with terminal construction and operation. The USDOT and the Coast Guard participate as cooperating agencies but remain responsible for enforcing their regulations covering LNG facility siting, design, construction, operation, and maintenance. All three agencies have some oversight and responsibility for the inspection and compliance during the LNG facility's operation.

The USDOT establishes and has the authority to enforce the federal safety standards for the location, design, installation, construction, inspection, testing, operation, and maintenance of onshore LNG facilities under the Natural Gas Pipeline Safety Act (49 U.S.C. 1671 et seq.). The USDOT's LNG safety regulations are codified in 49 CFR 193, which prescribes safety standards for LNG facilities used in the transportation of gas by pipeline that are subject to federal pipeline safety laws (49 U.S.C. 60101 et seq.), and 49 CFR 192. On August 31, 2018, USDOT and FERC signed a memorandum of understanding (MOU) regarding methods to improve coordination throughout the LNG permit application process for FERC jurisdictional LNG facilities. In the MOU, USDOT agreed to issue a Letter of Determination (LOD) stating whether a proposed LNG facility would be capable of complying with location criteria and design standards contained in Subpart B of Part 193. The Commission committed to rely upon the USDOT determination in conducting its review of whether the facilities would be consistent in the public interest. The issuance of the LOD does not abrogate USDOT's continuing authority and responsibility over a proposed project's compliance with Part 193 during construction and future operation of the facility. The USDOT's conclusion on the siting and hazard analysis required by Part 193 is based on preliminary design information which may be revised as the engineering design progresses to final design. USDOT regulations also contain requirements for the design, construction, installation, inspection, testing, operation, maintenance, qualifications and training of personnel, fire protection, and security for LNG facilities as defined in 49 CFR 193, which would be completed during later stages of the Project. If the Project is authorized and constructed, LNG facilities as defined in 49 CFR 193, would be subject to the USDOT's inspection and enforcement programs to ensure compliance with the requirements of 49 CFR 193.

The Coast Guard has authority over the safety of an LNG terminal's marine transfer area and LNG marine vessel traffic, as well as over security plans for the waterfront facilities handling LNG and LNG marine vessel traffic. The Coast Guard regulations for waterfront facilities handling LNG are codified in 33 CFR 105 and 33 CFR 127. As a cooperating agency, the Coast Guard assists the FERC staff in evaluating whether an applicant's proposed waterway would be suitable for LNG marine vessel traffic and whether the waterfront facilities handling LNG would be operated in accordance with 33 CFR 105 and 33 CFR 127. If the facilities are constructed and become operational, the facilities would be subject to the Coast Guard inspection program to ensure compliance with the requirements of 33 CFR 105 and 33 CFR 127.

The FERC authorizes the siting and construction of LNG terminals under the NGA and delegated authority from the DOE. The FERC requires standard information to be submitted to perform safety and reliability engineering reviews. FERC's filing regulations are codified in 18 CFR 380.12 (m) and (o), and requires each applicant to identify how its proposed design would comply with the USDOT's siting requirements of 49 CFR 193 Subpart B. The level of detail necessary for this submittal requires the applicant to perform substantial front-end engineering of the complete project. The design information is required to be site-specific and developed to the extent that further detailed design would not result in significant changes to the siting considerations, basis of design, operating conditions, major equipment selections, equipment design conditions, or safety system designs. As part of the review required for a FERC order, we use this information from the applicant to assess whether the proposed facilities would have a public safety impact and to suggest additional mitigation measures for the Commission to consider for incorporation as conditions in the order. If the facilities are approved and the suggested mitigation measures are incorporated into the order as conditions, FERC staff would review material filed to satisfy the conditions of the order and conduct periodic inspections throughout construction and operation.

In addition, the Energy Policy Act of 2005 requires FERC to coordinate and consult with the Department of Defense (DOD) on the siting, construction, expansion, and operation of LNG terminals that would affect the military. On November 21, 2007, the FERC and the DOD entered into a MOU formalizing this process.[189] On January 29, 2019, the FERC received a response letter from the DOD Siting Clearinghouse stating that Jordan Cove LNG Project would have a minimal impact on military training and operations conducted in the area.

4.13.1.2 USDOT Siting Requirements and 49 CFR Part 193 Subpart B Determination

Siting LNG facilities, as defined in 49 CFR 193, with regard to ensuring that the proposed site selection and location would not pose an unacceptable level or risk to public safety is required by USDOT's regulations in 49 CFR 193 Subpart B. The Commission's regulations under 18 CFR 380.12 (o) (14) require Jordan Cove to identify how the proposed design complies with the siting requirements in USDOT's regulations under 49 CFR 193 Subpart B. The scope of USDOT's siting authority under 49 CFR 193 applies to LNG facilities used in the transportation of gas by pipeline subject to the federal pipeline safety laws and 49 CFR 192.[190]

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[189] http://www.ferc.gov/legal/mou/mou-dod.pdf

[190] 49 CFR 193.2001 (b) (3), Scope of part, excludes any matter other than siting provisions pertaining to marine cargo transfer systems between the LNG marine vessel and the last manifold (or in the absence of a manifold, the last valve) located immediately before a storage tank.

The requirements in 49 CFR 193 Subpart B, state that an operator or government agency must exercise legal control over the activities as long the facility is in operation that can occur within an "exclusion zone," defined as the area around an LNG facility that could be exposed to specified levels of thermal radiation or flammable vapor in the event of a release of LNG or ignition of LNG vapor. Approved mathematical models must be used to calculate the dimensions of these exclusion zones. The siting requirements specified in NFPA 59A (2001), an industry consensus standard for LNG facilities, are incorporated into 49 CFR 193 Subpart B by reference, with regulatory preemption in the event of conflict. The following sections of 49 CFR 193 Subpart B specifically address siting requirements:

- Section 193.2051, Scope, states that each LNG facility designed, replaced, relocated or significantly altered after March 31, 2000, must be provided with siting requirements in accordance with Subpart B and NFPA 59A (2001). In the event of a conflict with NFPA 59A (2001), the regulatory requirements in Part 193 prevail.
- Section 193.2057, Thermal radiation protection, requires that each LNG container and LNG transfer system have thermal exclusion zones in accordance with section 2.2.3.2 of NFPA 59A (2001).
- Section 193.2059, Flammable vapor-gas dispersion protection, requires that each LNG container and LNG transfer system have a dispersion exclusion zone in accordance with sections 2.2.3.3 and 2.2.3.4 of NFPA 59A (2001).
- Section 193.2067, Wind forces, requires that shop fabricated containers of LNG or other hazardous fluids less than 70,000 gallons must be designed to withstand wind forces based on the applicable wind load data in American Society of Civil Engineers (ASCE) 7 (2005). All other LNG facilities must be designed for a sustained wind velocity of not less than 150 mph unless the USDOT Administrator finds a lower wind speed is justified or the most critical combination of wind velocity and duration for a 10,000-year mean return interval.

As stated in 49 CFR 193.2051, LNG facilities must meet the siting requirements of NFPA 59A (2001), Chapter 2, and include but may not be limited to:

- NFPA 59A (2001) section 2.1.1 (c) requires consideration of protection against forces of nature.
- NFPA 59A (2001) section 2.1.1 (d) requires that other factors applicable to the specific site that have a bearing on the safety of plant personnel and surrounding public be considered, including an evaluation of potential incidents and safety measures incorporated in the design or operation of the facility.
- NFPA 59A (2001) section 2.2.3.2 requires provisions to minimize the damaging effects of fire from reaching beyond a property line, and requires provisions to prevent a radiant heat flux level of 1,600 British thermal units per square foot per hour (Btu/ft^2-hr) from reaching beyond a property line that can be built upon. The distance to this flux level is to be calculated with LNGFIRE3 or with models that have been validated by experimental test data appropriate for the hazard to be evaluated and that have been approved by USDOT.
- NFPA 59A (2001) section 2.2.3.4 requires provisions to minimize the possibility of any flammable mixture of vapors from a design spill from reaching a property line that can be built upon and that would result in a distinct hazard. Determination of the distance that the

flammable vapors extend is to be determined with DEGADIS or approved alternative models that take into account physical factors influencing LNG vapor dispersion.[191]

Taken together, 49 CFR 193 Subpart B, and NFPA 59A (2001) require that flammable LNG vapors from design spills do not extend beyond areas in which the operator or a government agency legally controls all activities. Furthermore, consideration of other hazards which may affect the public or plant personnel must be evaluated as prescribed in NFPA 59A (2001), section 2.1.1 (d).

Title 49 CFR 193 Subpart B, and NFPA 59A (2001) also specify three radiant heat flux levels which must be considered for LNG storage tank spills for as long as the facility is in operation:

- 1,600 Btu/ft^2-hr - This level can extend beyond the plant property line that can be built upon but cannot include areas that are used for outdoor assembly by groups of 50 or more persons;[192]
- 3,000 Btu/ft^2-hr - This level can extend beyond the plant property line that can be built upon but cannot include areas that contain assembly, educational, health care, detention or residential buildings or structures;[193] and
- 10,000 Btu/ft^2-hr - This level cannot extend beyond the plant property line that can be built upon.[194]

The requirements for design spills from process or transfer areas are more stringent. For LNG spills, the 1,600 Btu/ft^2-hr flux level cannot extend beyond the plant property line onto a property that can be built upon. In addition, section 2.1.1 of NFPA 59A (2001) requires that factors applicable to the specific site with a bearing on the safety of plant personnel and the surrounding public must be considered, including an evaluation of potential incidents and safety measures incorporated into the design or operation of the facility. USDOT has indicated that potential incidents, such as vapor cloud explosions and toxic releases should be considered to comply with Part 193 Subpart B.[195]

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191 USDOT has approved two additional models for the determination of vapor dispersion exclusion zones in accordance with 49 CFR 193.2059: FLACS 9.1 Release 2 (Oct. 7, 2011) and PHAST-UDM Version 6.6 and 6.7 (Oct. 7, 2011).

192 The 1,600 Btu/ft^2-hr flux level is associated with producing pain in less than 15 seconds, first degree burns in 20 seconds, second degree burns in approximately 30 to 40 seconds, 1 percent mortality in approximately 120 seconds, and 100 percent mortality in approximately 400 seconds, assuming no shielding from the heat, and is typically the maximum allowable intensity for emergency operations with appropriate clothing based on average 10 minute exposure.

193 The 3,000 Btu/ft^2-hr flux level is associated with producing pain in less than 5 seconds, first degree burns in 5 seconds, second degree burns in approximately 10 to 15 seconds, 1 percent mortality in approximately 50 seconds, and 100 percent mortality in approximately 180 seconds, assuming no shielding from the heat, and is typically the critical heat flux for piloted ignition of common building materials (e.g., wood, PVC, fiberglass, etc.) with prolonged exposures.

194 The 10,000 Btu/ft^2-hr flux level is associated with producing pain in less than 1 seconds, first degree burns in 1 seconds, second degree burns in approximately 3 seconds, 1 percent mortality in approximately 10 seconds, and 100 percent mortality in approximately 35 seconds, assuming no shielding from the heat, and is typically the critical heat flux for unpiloted ignition of common building materials (e.g., wood, PVC, fiberglass) and degradation of unprotected process equipment after approximate 10 minute exposure and to reinforced concrete after prolonged exposure.

195 The USDOT PHMSA's "LNG Plant Requirements: Frequently Asked Questions" item H1, https://www.phmsa.dot.gov/pipeline/liquified-natural-gas/lng-plant-requirements-frequently-asked-questions, accessed Aug. 2018.

In accordance with the August 31, 2018 MOU, USDOT will issue a LOD to the Commission after USDOT completes its analysis of whether the proposed facilities would meet the USDOT siting standards. The LOD will evaluate the hazard modeling results and endpoints used to establish exclusion zones, as well as Jordan Cove's evaluation on potential incidents and safety measures incorporated in the design or operation of the facility specific to the site that have a bearing on the safety of plant personnel and surrounding public. The LOD will serve as one of the considerations for the Commission to deliberate in its decision to authorize or deny an application.

4.13.1.3 Coast Guard Safety Regulatory Requirements and Letter of Recommendation

LNG Marine Vessel Historical Record

Since 1959, marine vessels have transported LNG without a major release of cargo or a major accident involving an LNG marine vessel. There are more than 370 LNG marine vessels in operation routinely transporting LNG between more than 100 import/export terminals currently in operation worldwide. Since U.S. LNG terminals first began operating under FERC jurisdiction in the 1970s, there have been thousands of individual LNG marine vessel arrivals at terminals in the U.S. For more than 40 years, LNG shipping operations have been safely conducted in U.S. ports and waterways.

A review of the history of LNG maritime transportation indicates that there has not been a serious accident at sea or in a port which resulted in a spill due to rupturing of the cargo tanks. However, insurance records, industry sources, and public websites identify a number of incidents involving LNG marine vessels, including minor collisions with other marine vessels of all sizes, groundings, minor LNG releases during cargo unloading operations, and mechanical/equipment failures typical of large vessels. Some of the more significant occurrences, representing the range of incidents experienced by the worldwide LNG marine vessel fleet, are described below:

- **El Paso Paul Kayser** grounded on a rock in June 1979 in the Straits of Gibraltar during a loaded voyage from Algeria to the United States. Extensive bottom damage to the ballast tanks resulted; however, no cargo was released because no damage was done to the cargo tanks. The entire cargo of LNG was subsequently transferred to another LNG marine vessel and delivered to its U.S. destination.
- **Tellier** was blown by severe winds from its docking berth at Skikda, Algeria in February 1989 causing damage to the loading arms and the LNG marine vessel and shore piping. The cargo loading had been secured just before the wind struck, but the loading arms had not been drained. Consequently, the LNG remaining in the loading arms spilled onto the deck, causing fracture of some plating.
- **Mostefa Ben Boulaid** had an electrical fire in the engine control room during unloading at Everett, Massachusetts on February 5, 1996. The LNG marine vessel crew extinguished the fire and the ship completed unloading.
- **Khannur** had a cargo tank overfill into the LNG marine vessel's vapor handling system on September 10, 2001, during unloading at Everett, Massachusetts. Approximately 100 gallons of LNG were vented and sprayed onto the protective decking over the cargo tank dome, resulting in several cracks. After inspection by the Coast Guard, the Khannur was allowed to discharge its LNG cargo.

- **Mostefa Ben Boulaid** had LNG spill onto its deck during loading operations in Algeria in 2002. The spill, which is believed to have been caused by overflow rather than a mechanical failure, caused significant brittle fracturing of the steelwork. The LNG marine vessel was required to discharge its cargo, after which it proceeded to dock for repair.
- **Norman Lady** was struck by the USS Oklahoma City nuclear submarine while the submarine was rising to periscope depth near the Strait of Gibraltar in November 2002. The 87,000 m^3 LNG marine vessel, which had just unloaded its cargo at Barcelona, Spain, sustained only minor damage to the outer layer of its double hull but no damage to its cargo tanks.
- **Tenaga Lima** grounded on rocks while proceeding to open sea east of Mopko, South Korea due to strong current in November 2004. The shell plating was torn open and fractured over an approximate area of 20 by 80 feet, and internal breaches allowed water to enter the insulation space between the primary and secondary membranes. The LNG marine vessel was refloated, repaired, and returned to service.
- **Golar Freeze** moved away from its docking berth during unloading on March 14, 2006, in Savannah, Georgia. The powered emergency release couplings on the unloading arms activated as designed, and transfer operations were shut down.
- **Catalunya Spirit** lost propulsion and became adrift 35 miles east of Chatham, Massachusetts on February 11, 2008. Four tugs towed the LNG marine vessel to a safe anchorage for repairs. The Catalunya Spirit was repaired and taken to port to discharge its cargo.
- **Al Gharrafa** collided with a container ship, Hanjin Italy, in the Malacca Strait off Singapore on December 19, 2013. The bow of the Al Gharrafa and the middle of the starboard side of the Hanjin were damaged. Both ships were safely anchored after the incident. No loss of LNG was reported.
- **Al Oraiq** collided with a freight carrier, Flinterstar, near Zeebrugge, Belgium on October 6, 2015. The freight carrier sank, but the Al Oraiq was reported to have sustained only minor damage to its bow and no damage to the LNG cargo tanks. According to reports, the Al Oraiq took on a little water but was towed to the Zeebrugge LNG terminal where its cargo was unloaded using normal procedures. No loss of LNG was reported.
- **Al Khattiya** suffered damage after a collision with an oil tanker off the Port of Fujairah on February 23, 2017. Al Khattiya had discharged its cargo and was anchored at the time of the incident. A small amount of LNG was retained within the LNG marine vessel to keep the cargo tanks cool. The collision damaged the hull and two ballast tanks on the Al Khattiya, but did not cause any injury or water pollution. No loss of LNG was reported.

LNG Marine Vessel Safety Regulatory Oversight

The Coast Guard exercises regulatory authority over LNG marine vessels under 46 CFR 154, which contains the United States safety standards for self-propelled LNG marine vessels transporting bulk liquefied gases. The LNG marine vessels visiting the proposed facility would also be constructed and operated in accordance with the IMO *Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and the International Convention for the Safety of Life at Sea*. All LNG marine vessels entering U.S. waters are required to possess a valid

IMO Certificate of Fitness and either a Coast Guard Certificate of Inspection (for U.S. flag vessels) or a Coast Guard Certificate of Compliance (for foreign flag vessels). These documents certify that the LNG marine vessel is designed and operating in accordance with both international standards and the U.S. regulations for bulk LNG marine vessels under 46 CFR 154.

The LNG marine vessels that would deliver or receive LNG to or from the proposed facility would also need to comply with various U.S. and international security requirements. The IMO adopted the *International Ship and Port Facility Security Code* in 2002. This code requires both ships and ports to conduct vulnerability assessments and to develop security plans. The purpose of the code is to prevent and suppress terrorism against ships; improve security aboard ships and ashore; and reduce the risk to passengers, crew, and port personnel on board ships and in port areas. All LNG marine vessels, as well as other cargo vessels (e.g., 500 gross tons and larger), and ports servicing those regulated vessels, must adhere to the IMO standards. Some of the IMO requirements for ships are as follows:

- marine vessels must develop security plans and have a Vessel Security Officer;
- marine vessels must have a ship security alert system to transmit ship-to-shore security alerts identifying the ship, its location, and indication that the security of the ship is under threat or has been compromised;
- marine vessels must have a comprehensive security plan for international port facilities, focusing on areas having direct contact with ships; and
- marine vessels may have equipment onboard to help maintain or enhance the physical security of the ship.

In 2002, the Maritime Transportation Security Act (MTSA) was enacted by the U.S. Congress and aligned domestic regulations with the maritime security standards of the *International Ship and Port Facility Security Code and the Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk and the International Convention for the Safety of Life at Sea*. The Coast Guard's regulations in 33 CFR 104 require marine vessels to conduct a vessel security assessment and develop a vessel security plan that addresses each vulnerability identified in the vessel security assessments. All LNG marine vessels servicing the facility would have to comply with the MTSA requirements and associated regulations while in U.S. waters.

The Coast Guard also exercises regulatory authority over LNG facilities that affect the safety and security of port areas and navigable waterways under EO 10173; the Magnuson Act (50 U.S.C. section 191); the Ports and Waterways Safety Act of 1972, as amended (33 U.S.C. section 1221, et seq.); and the MTSA of 2002 (46 U.S.C. section 701). The Coast Guard is responsible for matters related to navigation safety, LNG marine vessel engineering and safety standards, and all matters pertaining to the safety of facilities or equipment located in or adjacent to navigable waters up to the last valve immediately before the receiving tanks. The Coast Guard also has authority for LNG facility security plan review, approval, and compliance verification as provided in 33 CFR 105.

The Coast Guard regulations in 33 CFR 127 apply to the marine transfer area of waterfront facilities between the LNG marine vessel and the last manifold or valve immediately before the receiving tanks. Title 33 CFR 127 applies to the marine transfer area for LNG of each new waterfront facility handling LNG and to new construction in the marine transfer areas for LNG of each existing waterfront facility handling LNG. The scope of the regulations includes the design, construction, equipment, operations, inspections, maintenance, testing, personnel training, firefighting, and security of the marine transfer area of LNG waterfront facilities. The safety systems, including communications, emergency shutdown, gas detection, and fire protection, must comply with the regulations in 33 CFR 127. Under 33 CFR 127.019, Jordan Covewould be required to submit two copies of its Operations and Emergency Manuals to the Coast Guard Captain of the Port (COTP) for examination.

Both the Coast Guard regulations under 33 CFR 127 and FERC regulations under 18 CFR 157.21, require an applicant who intends to build an LNG terminal facility to submit a Letter of Intent (LOI) to the Coast Guard no later than the date that the owner/operator initiates pre-filing with FERC, but, in all cases, at least 1 year prior to the start of construction. In addition, the applicant must submit a Preliminary WSA to the COTP with the LOI.

The Preliminary WSA provides an initial explanation of the port community and the proposed facility and transit routes. It provides an overview of the expected impacts LNG operations may have on the port and the waterway. Generally, the Preliminary WSA does not contain detailed studies or conclusions. This document is used by the COTP to begin his or her evaluation of the suitability of the waterway for LNG marine traffic. The Preliminary WSA must provide an initial explanation of the following:

- port characterization;
- characterization of the LNG facility and the LNG marine vessel route;
- risk assessment for maritime safety and security;
- risk management strategies; and
- resource needs for maritime safety, security, and response.

A Follow-On WSA must be provided no later than the date the owner/operator files an application with FERC, but in all cases at least 180 days prior to transferring LNG. The Follow-on WSA must provide a detailed and accurate characterization of the waterfront facilities handling LNG, the LNG marine vessel route, and the port area. The Follow-on WSA provides a complete analysis of the topics outlined in the Preliminary WSA. It should identify credible security threats and navigational safety hazards for the LNG marine vessel traffic, along with appropriate risk management measures and the resources (i.e., federal, state, local, and private sector) needed to carry out those measures. Until a facility begins operation, applicants must also annually review their WSAs and submit a report to the COTP as to whether changes are required. This document is reviewed and validated by the Coast Guard and forms the basis for the agency’s Letter of Recommendation (LOR) to the FERC.

In order to provide the Coast Guard COTPs/Federal Maritime Security Coordinators, members of the LNG industry, and port stakeholders with guidance on assessing the suitability of a waterway for LNG marine traffic, the Coast Guard has published a Navigation and Vessel Inspection Circular – *Guidance on Assessing the Suitability of a Waterway for Liquefied Natural Gas (LNG) Marine Traffic* (NVIC 01-11).

NVIC 01-11 directs the use of the three concentric Zones of Concern, based on LNG marine vessels with a cargo carrying capacity up to 265,000 m^3, used to assess the maritime safety and security risks of LNG marine traffic. The Zones of Concern are:

- Zone 1 – impacts on structures and organisms are expected to be significant within 500 meters (1,640 feet). The outer perimeter of Zone 1 is approximately the distance to thermal hazards of 37.5 kilowatts per square meter (kW/m^2) (12,000 Btu/ft^2-hr) from a pool fire.
- Zone 2 – impacts would be significant but reduced, and damage from radiant heat levels are expected to transition from severe to minimal between 500 and 1,600 meters (1,640 and 5,250 feet). The outer perimeter of Zone 2 is approximately the distance to thermal hazards of 5 kW/m^2 (1,600 Btu/ft^2-hr) from a pool fire.
- Zone 3 – impacts on people and property from a pool fire or an un-ignited LNG spill are expected to be minimal between 1,600 meters (5,250 feet) and a conservative maximum distance of 3,500 meters (11,500 feet or 2.2 miles). The outer perimeter of Zone 3 should be considered the vapor cloud dispersion distance to the lower flammability limit from a worst case un-ignited release. Impacts to people and property could be significant if the vapor cloud reaches an ignition source and burns back to the source.

Once the applicant submits a complete Follow-On WSA, the Coast Guard reviews the document to determine if it presents a realistic and credible analysis of the public safety and security implications from LNG marine traffic both in the waterway and when in port. As required by its regulations (33 CFR 127.009), the Coast Guard is responsible for issuing a LOR to the FERC regarding the suitability of the waterway for LNG marine traffic with respect to the following items:

- physical location and description of the facility;
- the LNG marine vessel's characteristics and the frequency of LNG shipments to or from the facility;
- waterway channels and commercial, industrial, environmentally sensitive, and residential areas in and adjacent to the waterway used by LNG marine vessels en route to the facility, within 25 kilometers (15.5 miles) of the facility;
- density and character of marine traffic in the waterway;
- locks, bridges, or other manmade obstructions in the waterway;
- depth of water;
- tidal range;
- protection from high seas;
- natural hazards, including reefs, rocks, and sandbars;
- underwater pipes and cables; and
- distance of berthed LNG marine vessels from the channel and the width of the channel.

The Coast Guard may also prepare an LOR Analysis, which serves as a record of review of the LOR and contains detailed information along with the rationale used in assessing the suitability of the waterway for LNG marine traffic.

Jordan Cove LNG Project's Waterway Suitability Assessment

On January 9, 2017, Jordan Cove submitted a LOI and a Preliminary WSA to the COTP, Sector Colombia River, to notify the Coast Guard that it proposed to construct an LNG export terminal. The Preliminary WSA was based on a WSA dated April 10, 2006 that was previously submitted to the Coast Guard and was updated on December 29, 2012 for export operations. In addition, Jordan Cove has submitted annual WSA updates to the Coast Guard since the 2012 WSA update. On January 23, 2017, the Coast Guard accepted the Project's existing WSA as it relates to the new proposed project and stated that a new Follow-On WSA is not required.

LNG Marine Vessel Routes and Hazard Analysis

An LNG marine vessel's transit to the terminal would begin when it reaches the entrance of Coos Bay from the Pacific Ocean. Once inside the entrance, the marine vessel would turn north at the City of Charleston, Oregon and would transit to the Jordan Cove LNG Project marine berth. After reaching the turning basin near the Project site, the LNG marine vessel would turn to the right and back into the eastern side of the marine slip. The total inbound transit distance to the Jordan Cove LNG Project marine berth would be approximately 8.0 miles from the entrance of Coos Bay. The route would be reversed for outbound LNG marine vessel transits.

Pilotage is compulsory for foreign marine vessels and U.S. marine vessels under registry in foreign trade when in U.S. waters. All deep draft marine vessels currently entering the shared waterway would employ a U.S. pilot. The National Vessel Movement Center in the U.S. would require a 96-hour advance notice of arrival for deep draft marine vessels calling on U.S. ports. During transit, LNG marine vessels would be required to maintain voice contact with controllers and check in on designated frequencies at established way points.

NVIC 01-11 references the "Zones of Concern" for assisting in a risk assessment of the waterway. As LNG marine vessels proceed along the intended transit route, the estimated zones of concern would extend over resources such as residential and industrial areas, military installations, and also non-residential areas accessible to the public such as parks. Hazard Zone 1 would remain almost entirely over the water and would encompass coastal areas in Charleston and Coos Bay. Commercial vessels, recreational vessels, fishing vessels, Cape Arago Dock, I.C.I. Marine Industrical Park, North Bay Marine Industrial Park, and Roseburg Forest Products Facility would also fall within Zone 1. Zone 2 would cover a wider swath of coastal areas along Charleston, Coos Bay, Barview, and North Bend and would include multiple residential buildings, commercial buildings, industrial buildings, numerous Recreational Vehicle hook-up Parks, numerous recreational areas and boat launch ramps, Marine Research Center, Charleston Marina, South Slough Bridge, Coast Guard Sector Charleston, Charleston Fire District Stations 1 and 3, Madison Elementary School, Sunset Middle School, Coos Bay Fire Department Station 2, and the Southwestern Oregon Regional Airport. Zone 3 would span larger portions of Charleston, Coos Bay, Barview, and North Bend and would include Coast Guard Group North Bend, Railroad Bridge, Oregon Dunes Recreational Park, Southwestern Oregon Community College.

The areas impacted by the three different hazard zones are illustrated for accidental and intentional events in figures 4.13-1 and 4.13-2, respectively.

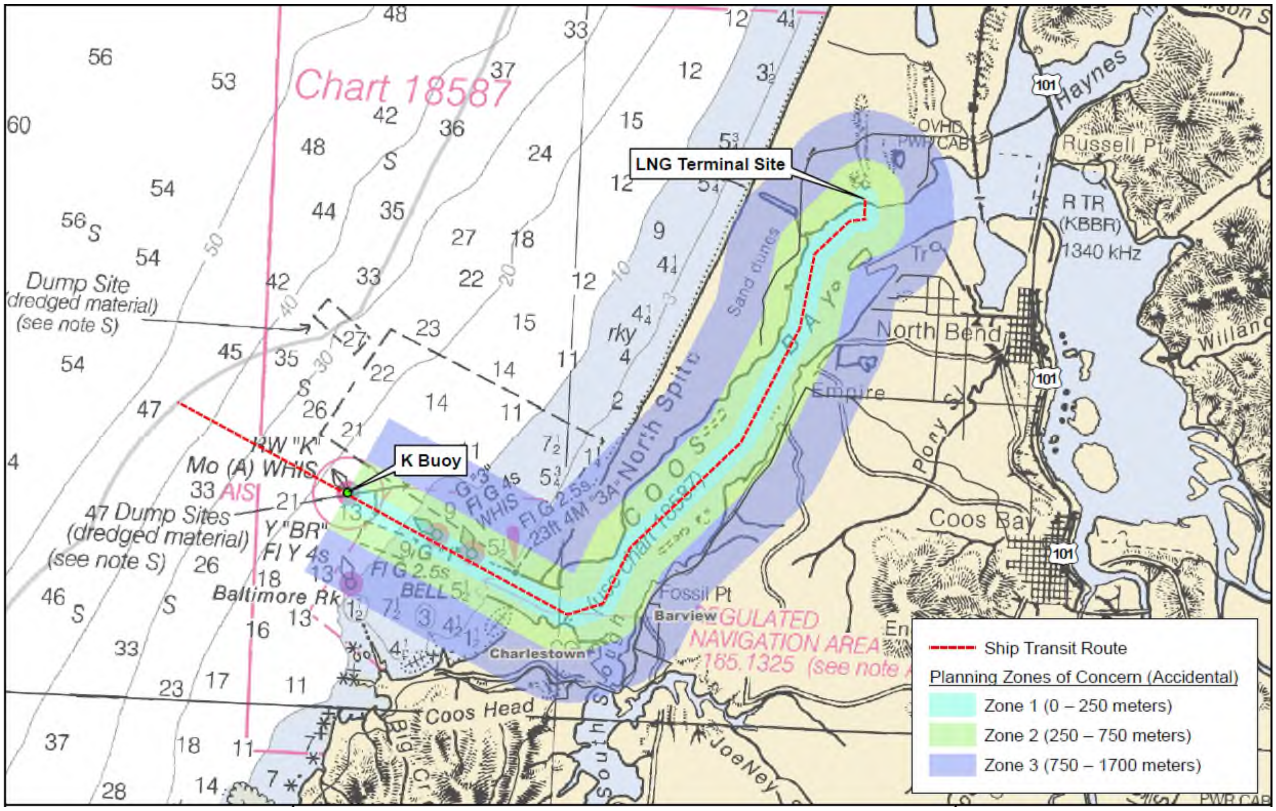

Figure 4.13-1 Accidental Hazard Zones along LNG Marine Vessel Route

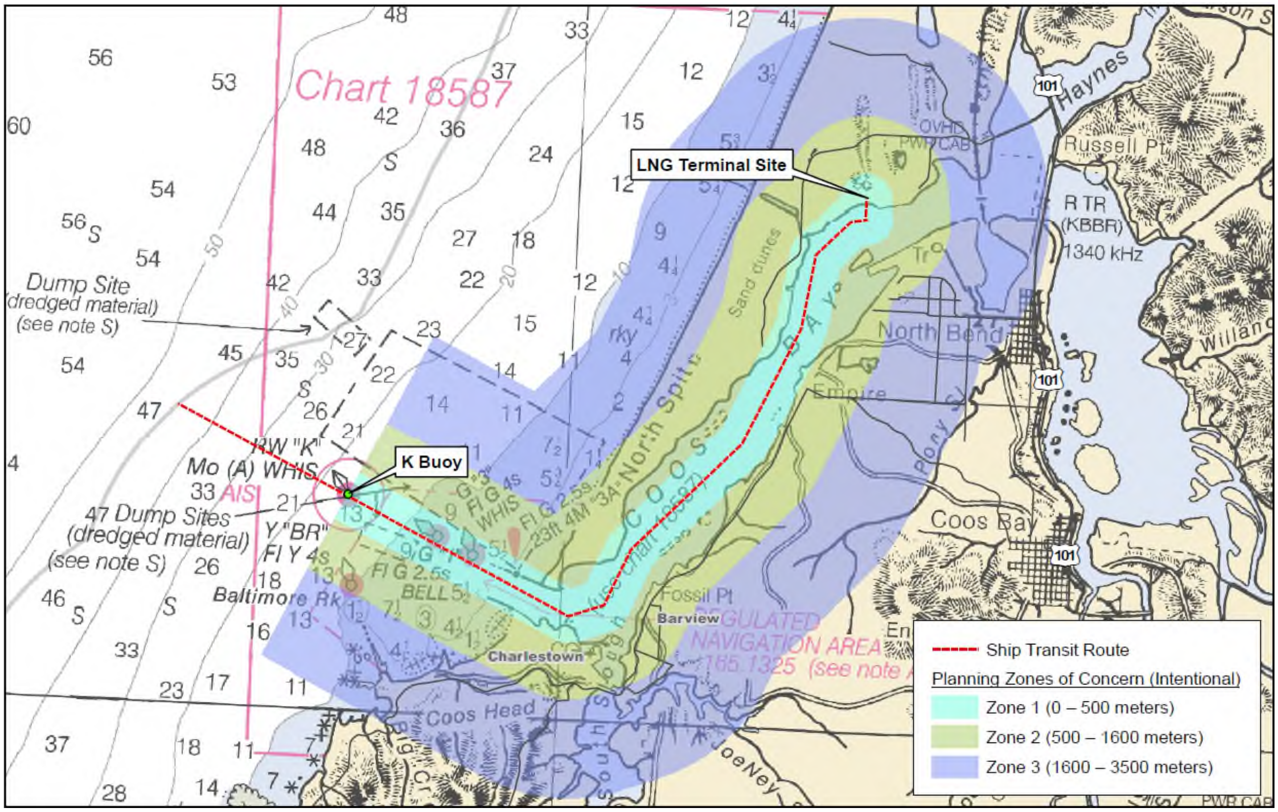

Figure 4.13-2. Intentional Hazard Zones along LNG Marine Vessel Route

U.S. Coast Guard Letter of Recommendation and Analysis

In a letter dated May 10, 2018, the Coast Guard issued an LOR and LOR Analysis to FERC stating that the Coos Bay Channel would be considered suitable for accommodating the type and frequency of LNG marine traffic associated with this Project. As part of its assessment of the safety and security aspects of this Project, the COTP Sector Columbia River consulted a variety of stakeholders including the Area Maritime Security Committees, Harbor Safety Committees, state representatives, pilot organizations, and local emergency responders. The LOR was based on full implementation of the strategies and risk management measures identified by the Coast Guard to Jordan Cove in its WSA.

Although Jordan Cove has suggested mitigation measures for responsibly managing the maritime safety and security risks associated with LNG marine traffic, the necessary vessel traffic and/or facility control measures may change depending on changes in conditions along the waterway. The Coast Guard regulations in 33 CFR 127 require that applicants annually review WSAs until a facility begins operation and submit a report to the Coast Guard identifying any changes in conditions, such as changes to the port environment, the LNG facility, or the LNG marine vessel route, that would affect the suitability of the waterway for LNG marine traffic.

The Coast Guard's LOR is a recommendation, regarding the current status of the waterway, to the FERC, the lead agency responsible for siting the on-shore LNG facility. Neither the Coast Guard nor the FERC has authority to require waterway resources of anyone other than the applicant under any statutory authority or under the Emergency Response Plan (ERP) or the Cost Sharing Plan.

As stated in the LOR, the Coast Guard would assess each transit on a case by case basis to identify what, if any, safety and security measures would be necessary to safeguard the public health and welfare, critical infrastructure and key resources, the port, the marine environment, and the LNG marine vessel.

Under the Ports and Waterways Safety Act, the Magnuson Act, the MTSA, and the Security and Accountability For Every (SAFE) Port Act, the COTP has the authority to prohibit LNG transfer or LNG marine vessel movements within his or her area of responsibility if he or she determines that such action is necessary to protect the waterway, port, or marine environment. If this Project is approved and if appropriate resources are not in place prior to LNG marine vessel movement along the waterway, then the COTP would consider at that time what, if any, vessel traffic and/or facility control measures would be appropriate to adequately address navigational safety and maritime security considerations.

4.13.1.4 LNG Facility Security Regulatory Requirements

The security requirements for the proposed project are governed by 33 CFR 105, 33 CFR 127, and 49 CFR 193 Subpart J - Security. Title 33 CFR 105, as authorized by the MTSA, requires all terminal owners and operators to submit a Facility Security Assessment (FSA) and a Facility Security Plan (FSP) to the Coast Guard for review and approval before commencement of operations of the proposed Project facilities. Jordan Cove would also be required to control and restrict access, patrol and monitor the plant, detect unauthorized access, and respond to security threats or breaches under 33 CFR 105. Some of the responsibilities of the applicant include, but are not limited to:

- designating a Facility Security Officer with a general knowledge of current security threats and patterns, security assessment methodology, vessel and facility operations, conditions, security measures, emergency preparedness, response, and contingency plans, who would be responsible for implementing the FSA and FSP and performing an annual audit for the life of the Project;
- conducting an FSA to identify site vulnerabilities, possible security threats and consequences of an attack, and facility protective measures; developing a FSP based on the FSA, with procedures for: responding to transportation security incidents; notification and coordination with federal, state, and local authorities; prevention of unauthorized access; measures to prevent or deter entrance with dangerous substances or devices; training; and evacuation;
- defining the security organizational structure with facility personnel with knowledge or training in current security threats and patterns; recognition and detection of dangerous substances and devices, recognition of characteristics and behavioral patterns of persons who are likely to threaten security; techniques to circumvent security measures; emergency procedures and contingency plans; operation, testing, calibration, and maintenance of security equipment; and inspection, control, monitoring, and screening techniques;
- implementing scalable security measures to provide increasing levels of security at increasing maritime security levels for facility access control, restricted areas, cargo handling, LNG marine vessel stores and bunkers, and monitoring; ensuring that the Transportation Worker Identification Credential (TWIC) program is properly implemented;

- ensuring coordination of shore leave for LNG marine vessel personnel or crew change out as well as access through the facility for visitors to the LNG marine vessel;
- conducting drills and exercises to test the proficiency of security and facility personnel on a quarterly and annual basis; and
- reporting all breaches of security and transportation security incidents to the National Response Center.

Title 33 CFR 127 has requirements for access controls, lighting, security systems, security personnel, protective enclosures, communications, and emergency power. In addition, an LNG facility regulated under 33 CFR 105 and 33 CFR 127 would be subject to the TWIC Reader Requirements Rule issued by the Coast Guard on August 23, 2016. This rule requires owners and operators of certain vessels and facilities regulated by the Coast Guard to conduct electronic inspections of TWICs (e.g., readers with biometric fingerprint authentication) as an access control measure. The final rule would also include recordkeeping requirements and security plan amendments that would incorporate these TWIC requirements. The implementation of the rule was first proposed to be in effect August 23, 2018. In a subsequent notice issued on June 22, 2018, the Coast Guard indicated delaying the effective date for certain facilities by three years, until August 23, 2021. On August 2, 2018, the President of the United States signed into law the Transportation Worker Identification Credential Accountability Act of 2018 (H.R. 5729). This law prohibits the Coast Guard from implementing the rule requiring electronic inspections of TWICs until after the Department of Homeland Security (DHS) has submitted a report to the Congress. Although the implementation of this rule has been postponed for certain facilities, the company should to consider the rule when developing access control and security plan provisions for the facility.

Title 49 CFR 193 Subpart J also specifies security requirements for the onshore components of LNG terminals, including requirements for conducting security inspections and patrols, liaison with local law enforcement officials, design and construction of protective enclosures, lighting, monitoring, alternative power sources, and warning signs. If the Project is authorized and constructed, compliance with the security requirements of 33 CFR 105, 33 CFR 127, and 49 CFR 193 Subpart J would be subject to the respective Coast Guard and USDOT inspection and enforcement programs.

Jordan Cove provided preliminary information as well as data request responses on these security features and indicated additional details would be completed in the final design. The Project site would install an impervious vapor barriers of heights ranging from 20 feet to 100 feet around portions of the property boundary. However, details of intrusion detection on the barriers would not be finalized until final design. We recommend in section 4.13.1.6 that Jordan Cove provide final design details on these security features for review and approval, including: lighting coverage drawings that illustrate photometric analyses demonstrating the lux levels at the interior of the terminal are in accordance with API 540, and other federal regulations for lighting along the perimeter fence line and along paths/roads of access and egress; camera coverage drawings that illustrate coverage areas of each camera such that the entire perimeter of the plant is covered with redundancy and the interior of plant is covered, including a camera be provided at the top of each LNG storage tank, within pretreatment areas, within liquefaction areas, within truck transfer areas, within marine transfer areas, and buildings; fencing drawings that demonstrate a fence would deter or mitigate entry along the perimeter of the entire facility and is set back from exterior structures and vegetation, and from interior hazardous piping and equipment by at least 10 feet; vehicle barrier and controlled access point drawings that demonstrate crash-rated barriers are provided to prevent uncontrolled access, inadvertent entry, and impacts to components containing hazardous fluids from vehicles. Furthermore, in accordance with the February 2004 Interagency Agreement among FERC, USDOT, and Coast Guard, FERC staff would collaborate with the Coast Guard and USDOT on the Project's security features.

4.13.1.5 FERC Engineering and Technical Review of the Preliminary Engineering Designs

LNG Facility Historical Record

The operating history of the U.S. LNG industry has been free of safety-related incidents resulting in adverse effects on the public or the environment with the exception of the October 20, 1944, failure at an LNG plant in Cleveland, Ohio. The 1944 incident in Cleveland led to a fire that killed 128 people and injured 200 to 400 more people.[196] The failure of the LNG storage tank was due to the use of materials not suited for cryogenic temperatures. LNG migrated through streets and into underground sewers due to inadequate spill impoundments at the site. Current regulatory requirements ensure that proper materials suited for cryogenic temperatures are used in the design and that spill impoundments are designed and constructed properly to contain a spill at the site. To ensure that this potential hazard would be addressed for proposed LNG facilities, we evaluate the preliminary and final specifications for suitable materials of construction and for the design of spill containment systems that would properly contain a spill at the site.

Another operational accident occurred in 1979 at the Cove Point LNG plant in Lusby, Maryland. A pump electrical seal located on a submerged electrical motor LNG pump leaked causing flammable gas vapors to enter an electrical conduit and settle in a confined space. When a worker switched off a circuit breaker, the flammable gas ignited, causing severe damage to the building and a worker fatality. With the participation of the FERC, lessons learned from the 1979 Cove Point accident led to changes in the national fire codes to better ensure that the situation would not occur again. To ensure that this potential hazard would be addressed for proposed facilities that have electrical seal interfaces, we evaluated the preliminary designs and recommend in section 4.13.1.6 that Jordan Cove provide, for review and approval, the final design details of the electrical seal design at the interface between flammable fluids and the electrical conduit or wiring system, details of the electrical seal leak detection system, and the details of a downstream physical break (i.e. air gap) in the electrical conduit to prevent the migration of flammable vapors.

On January 19, 2004, a blast occurred at Sonatrach's Skikda, Algeria, LNG liquefaction plant that killed 27 and injured 56 workers. No members of the public were injured. Findings of the accident investigation suggested that a cold hydrocarbon leak occurred at Liquefaction Train 40 and was introduced into a high-pressure steam boiler by the combustion air fan. An explosion developed inside the boiler firebox, which subsequently triggered a larger explosion of the hydrocarbon vapors in the immediate vicinity. The resulting fire damaged the adjacent liquefaction process and liquid petroleum gas separation equipment of Train 40, and spread to Trains 20 and 30. Although Trains 10, 20, and 30 had been modernized in 1998 and 1999, Train 40 had been operating with

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[196] For a description of the incident and the findings of the investigation, see "U.S. Bureau of Mines, Report on the Investigation of the Fire at the Liquefaction, Storage, and Regasification Plant of the East Ohio Gas Co., Cleveland, Ohio, October 20, 1944," dated February 1946.

its original equipment since start-up in 1981. To ensure that this potential hazard would be addressed for proposed facilities, we evaluated the preliminary design for mitigation of flammable vapor dispersion and ignition in buildings and combustion equipment to ensure they would be adequately covered by hazard detection equipment that could isolate and deactivate any combustion equipment whose continued operation could add to or sustain an emergency. We also recommend in section 4.13.1.6 that Jordan Cove provide, for review and approval, the final design details of hazard detection equipment, including the location and elevation of all detection equipment, instrument tag numbers, type and location, alarm indication locations, and shutdown functions of the hazard detection equipment.

On March 31, 2014, a detonation occurred within a gas heater at Northwest Pipeline Corporation's LNG peak-shaving plant in Plymouth, Washington.[197] This internal detonation subsequently caused the failure of pressurized equipment, resulting in high velocity projectiles. The plant was immediately shut down, and emergency procedures were activated, which included notifying local authorities and evacuating all plant personnel. No members of the public were injured, but one worker was sent to the hospital for injuries. As a result of the incident, the liquefaction trains and a compressor station located onsite were rendered inoperable. Projectiles from the incident also damaged the control building that was located near pre-treatment facilities and penetrated the outer shell of one of the LNG storage tanks. All damaged facilities were ultimately taken out of service for repair. The accident investigation showed that an inadequate purge after maintenance activities resulted in a fuel-air mixture remaining in the system. The fuel-air mixture auto-ignited during startup after it passed through the gas heater at full operating pressure and temperature. To ensure that this potential hazard would be addressed for proposed facilities, we recommend in section 4.13.1.6 that Jordan Cove provide a plan for purging, for review and approval, which addresses the requirements of the American Gas Association Purging Principles and Practice and to provide justification if not using an inert or non-flammable gas for purging. In evaluating such plans, we would assess whether the purging could be done safely based on review of other plans and lessons learned from this and other past incidents. If a plan proposes the use of flammable mediums for cleaning, dry-out or other activities, we would evaluate the plans against other recommended and generally accepted good engineering practices, such as NFPA 56, Standard for Fire and Explosion Prevention during Cleaning and Purging of Flammable Gas Piping Systems.

We also recommend in section 4.13.1.6 that Jordan Cove provide, for review and approval, operating and maintenance plans, including safety procedures, prior to commissioning. In evaluating such plans, we would assess whether the plans cover all standard operations, including purging activities associated with startup and shutdown. Also, in order to prevent other sources of projectiles from affecting occupied buildings and storage tanks, we recommend in section 4.13.1.6 that Jordan Cove incorporate mitigation into their final design with supportive information, for review and approval, that demonstrates it would mitigate the risk of a pressure vessel burst or boiling liquid expanding vapor explosion (BLEVE) from occurring.

FERC Preliminary Engineering Review

FERC requires an applicant to provide safety, reliability, and engineering design information as part of its application, including hazard identification studies and front-end-engineering-design (FEED) information for its proposed Project. FERC staff evaluates this information with a focus

[197] For a description of the incident and the findings of the investigation, see Root Cause Failure Analysis, Plymouth LNG Plant Incident Investigation under CP14-515.

on potential hazards from within and nearby the site, including external events, which may have the potential to cause damage or failure to the Project facilities, and the engineering design and safety and reliability concepts of the various protection layers to mitigate the risks of potential hazards.

The primary concerns are those events that could lead to a hazardous release of sufficient magnitude to create an offsite hazard or interruption of service. Furthermore, the potential hazards are dictated by the site location and the engineering details. In general, FERC staff considers an acceptable design to include various layers of protection or safeguards to reduce the risk of a potentially hazardous scenario from developing into an event that could impact the offsite public. These layers of protection are generally independent of one another so that any one layer would perform its function regardless of the initiating event or failure of any other protection layer. Such design features and safeguards typically include:

- a facility design that prevents hazardous events, including the use of inherently safer designs; suitable materials of construction; adequate design margins from operating limits for process piping, process vessels, and storage tanks; adequate design for wind, flood, seismic, and other outside hazards;
- control systems, including monitoring systems and process alarms, remotely-operated control and isolation valves, and operating procedures to ensure that the facility stays within the established operating and design limits;
- safety instrumented prevention systems, such as safety control valves and emergency shutdown systems, to prevent a release if operating and design limits are exceeded;
- physical protection systems, such as appropriate electrical area classification, proper equipment and building spacing, pressure relief valves, spill containment, and cryogenic, overpressure, and fire structural protection, to prevent escalation to a more severe event;
- site security measures for controlling access to the plant, including security inspections and patrols, response procedures to any breach of security, and liaison with local law enforcement officials; and
- onsite and offsite emergency response, including hazard detection and control equipment, firewater systems, and coordination with local first responders, to mitigate the consequences of a release and prevent it from escalating to an event that could impact the public.

The inclusion of such protection systems or safeguards in a plant design can minimize the potential for an initiating event to develop into an incident that could impact the safety of the offsite public. The review of the engineering design for these layers of protection are initiated in the application process and carried through to the next phase of the proposed project in final design if authorization is granted by the Commission.

The reliability of these layers of protection is informed by occurrence and likelihood of root causes and the potential severity of consequences based on past incidents and validated hazard modeling. As a result of the continuous engineering review, we recommend mitigation measures and continuous oversight to the Commission for consideration to include as conditions in the order. If a facility is authorized and recommendations are adopted as conditions to the order, FERC staff would continue its engineering review through final design, construction, commissioning, and operation.

Process Design

In order to liquefy natural gas, most liquefaction technologies require that the feed gas stream be pre-treated to remove components that could freeze out and clog the liquefaction equipment or would otherwise be incompatible with the liquefaction process or equipment, including mercury, H_2S, CO_2, water, and heavy hydrocarbons. For example, mercury is typically limited to concentrations of less than 0.01 micrograms per normal cubic meter because it can induce embrittlement and corrosion resulting in a catastrophic failure of equipment.

The inlet gas would be conditioned to remove solids and water droplets prior to entering feed gas pretreatment processes. Once the inlet gas is conditioned, the feed gas would enter the mercury removal system to reduce the mercury concentration in the feed gas. After mercury removal, the feed gas would contact an amine-based solvent solution in the amine contactor column to remove the H_2S and CO_2 (i.e., acid gas) present in the feed gas. Once the acid gas components accumulate in the amine solution, the amine solution is routed to an amine regenerator column that utilizes a reboiler to create hot amine vapor. Contact with the hot amine vapor would regenerate the amine solution by using heat to release the acid gas. The regenerated amine solution would be recycled back to the amine contactor column and the removed acid gas would be sent through a sulfur removal unit to remove H_2S. The acid gas stream is then routed to a thermal oxidizer, where CO_2, trace amounts of H_2S not removed in the sulfur removal unit, and trace amounts of hydrocarbons would be incinerated. The feed gas exiting the amine contactor column enters a knock out drum where bulk water would be recovered and recycled back to the amine contactor column. After the knock out drum, any remaining water in the feed gas would be removed using regenerative molecular sieve beds. Water collected during the molecular sieve regeneration process would be routed back to the amine contactor column. After water removal, the treated dry gas would flow to the liquefaction unit.

Heavy hydrocarbon removal would be integrated into the liquefaction process. The first pass through the refrigeration process would be used to remove heavy hydrocarbons at intermediate temperatures. The feed gas would flow into deethanizer to remove the liquids. The vapor portion would reenter the refrigeration process and would be sub-cooled into LNG. The liquid portion from the deethanizer would flow into the deethanizer reboiler stabilizer to further separate the heavier hydrocarbons from the lighter hydrocarbons. The heavier hydrocarbons exiting the deethanizer reboiler would be sent to the fuel gas system and the lighter hydrocarbons would be returned to the deethanizer for further processing. The LNG exiting the refrigeration process would flow to an LNG expander to reduce pressure, then into an LNG flash vessel before being pumped to two full containment LNG storage tanks.

In order to achieve the cryogenic temperatures needed to liquefy the natural gas stream in the above process, the gas would be cooled by a thermal exchange process driven by a closed loop refrigeration system using mixed refrigerants comprised of a mixture of nitrogen, methane, ethylene, propane, and isopentane. Methane would be provided from the treated dry feed gas stream entering the refrigeration process and the other refrigerants required for the liquefaction process would be delivered by truck and stored onsite for initial filling and use, as needed, for make-up. Truck unloading facilities would be provided to unload make-up refrigerants.

During export operations, LNG stored within the LNG storage tanks would be sent out through multiple in-tank pumps (the pump discharge piping would penetrate through the roof and is an inherently safer design when compared to penetrating the side of an LNG storage tank) and would be routed through a marine transfer line and multiple liquid marine transfer arms connected to an LNG marine vessel. In order to keep the marine transfer line cold between LNG export cargoes, an LNG recirculation line would keep the marine transfer line cold and avoid cool down prior to every LNG marine vessel loading operation. The LNG transferred to the LNG marine vessel would displace vapors from the marine vessel, which would be sent back through a vapor marine transfer arm, a vapor return line, and into the boil-off gas (BOG) header. Once loaded, the LNG marine vessel would be disconnected and leave for export. Low pressure BOG generated from stored LNG (LNG is continuously boiling), vapors returned during LNG marine vessel filling operations, and flash gas from the LNG flash vessel would be compressed and would be routed to the fuel gas system. The closed BOG system would prevent the release of BOG to the atmosphere and would be in accordance with NFPA 59A. This would be an inherently safer design when compared to allowing the BOG to vent to the atmosphere.

The Project would include many utilities and associated auxiliary equipment. The major auxiliary systems required for the operation of the liquefaction facility include BOG, fuel gas, flares, instrument and utility air supply, water supply, demineralized water, steam, aqueous ammonia, nitrogen, diesel, and backup power. Three flare systems would be designed to handle and control the vent gases from the process areas. The warm and cold flare would be routed to a common ground flare and the marine flare would be routed to a dedicated enclosed cylindrical ground flare. High pressure steam created using refrigerant compressor driver exhaust gas waste heat would generate electricity for the facility via the Steam Turbine Generators and would also supply heat to the Regeneration Gas Heater. Low pressure steam would provide heat to the Feed Inlet Heater, Amine Reboiler, Sulfur Scavenger Inlet Heater, Fuel Gas Superheater, and the Defrost Heater. An auxiliary steam boiler would be provided to generate steam when the refrigerant compressors are not in operation. A diesel storage tank would be provided to supply two standby diesel generators that would support the black start and power backup capability. The diesel storage tank would also supply three diesel firewater pumps. Trucks would fill a liquid nitrogen storage tank and vaporizers would supply gaseous nitrogen for refrigerant make-up. Site generated nitrogen would be used for compressor seals, purging activities, and utility stations as well as for pre-commissioning and start-up activities. In addition, aqueous ammonia would be used for pH adjustment in the steam system and to reduce nitrogen oxide emissions from the refrigerant compressor drivers.

The failure of process equipment could pose potential harm if not properly safeguarded through the use of appropriate engineering controls and operation. Jordan Cove would install process control valves and instrumentation to safely operate and monitor the facilities. Alarms would have visual and audible notification in the control room to warn operators that process conditions may be approaching design limits. Jordan Cove would design their control systems and human machine interfaces to the International Society for Automation (ISA) Standards 5.3, 5.5, 60.1, 60.3, 60.4, and 60.6, and other standards and recommended practices. Jordan Cove indicates that an alarm management program in accordance with ISA Standard 18.2 would be in place to ensure the effectiveness of the alarms. We recommend in section 4.13.1.6 that Jordan Cove develop and implement the alarm management program prior to introduction of hazardous fluids.

Operators would have the capability to take action from the control room to mitigate an upset. Jordan Cove would develop facility operation procedures after completion of the final design; this timing is fully consistent with accepted industry practice. We recommend in section 4.13.1.6 that Jordan Cove provide more information, for review and approval, on the operating and maintenance procedures, including safety procedures, hot work procedures and permits, abnormal operating conditions procedures, and personnel training prior to commissioning. We would evaluate these procedures to ensure that an operator can operate and maintain all systems safely, based on benchmarking against other operating and maintenance plans and comparing against recommended and generally accepted good engineering practices, such as American Institute of Chemical Engineers (AIChE) Center for Chemical Process Safety (CCPS), *Guidelines for Writing Effective Operating and Maintenance Procedures*, AIChE CCPS, *Guidelines for Management of Change for Process Safety*, AIChE CCPS, *Guidelines for Effective Pre-Startup Safety Reviews, AGA, Purging Principles and Practices*, and NFPA 51B, *Standards for Fire Prevention During Welding, Cutting, and Other Hot Work*. In addition, we recommend in section 4.13.1.6 that Jordan Cove tag and label instrumentation and valves, piping, and equipment and provide car-seals/locks to address human factor considerations and improve facility safety and prevent incidents.

In the event of a process deviation, emergency shutdown (ESD) valves and instrumentation would be installed to monitor, alarm, shutdown, and isolate equipment and piping during process upsets or emergency conditions. The Project would also have a plant-wide emergency shutdown system to initiate closure of valves and shutdown of the process during emergency situations as well as the ability to shutdown specific areas to address local emergency conditions. Safety-instrumented systems would comply with ISA Standard 84.00.01 and other recommended and generally accepted good engineering practices. We also recommend in section 4.13.1.6 that Jordan Cove file information, for review and approval, on the final design, installation, and commissioning of instrumentation and emergency shutdown equipment to ensure appropriate cause-and-effect alarm or shutdown logic and enhanced representation of the emergency shutdown system in the plant control room and throughout the plant.

In developing the FEED, Jordan Cove conducted a Hazard Identification (HAZID) review project's preliminary design based on the proposed process flow diagrams and the plot plans. In addition, the Jordan Cove performed two Hazard and Operability and Layer of Protection Analysis (HAZOP and LOPA) Studies. Each HAZOP was used to identify and analyze the potential hazards within the design that might pose an unacceptable risk to people, the environment, and assets and was based on the piping and instrumentation diagrams. Each LOPA was used to analyze selected scenarios of high risk to personnel, the environment, or assets, as identified in the HAZOP, to assure the appropriate risk level reduction, based on risk reduction factors for the hazard.

A more detailed hazard and operability review (HAZOP) analysis would be performed by Jordan Cove during the final design to identify the major process hazards that may occur during the operation of the facilities. The HAZOP study would be intended to address hazards of the process, engineering, and administrative controls and would provide a qualitative evaluation of a range of possible safety, health, and environmental consequences that may result from the process hazard, and identify whether there are adequate safeguards (e.g., engineering and administrative controls) to prevent or mitigate the risk from such events. Where insufficient engineering or administrative controls were identified, recommendations to prevent or minimize these hazards would be generated from the results of the HAZOP review. We recommend in section 4.13.1.6 that Jordan Cove file the HAZOP study on the completed final design for review and approval. We would evaluate the HAZOP to ensure all systems and process deviations are addressed appropriately based on likelihood, severity, and risk values with commensurate layers of protection in accordance with recommended and generally accepted good engineering practices, such as American Institute of Chemical Engineers, Guidelines for Hazard Evaluation Procedures. We also recommend in section 4.13.1.6 that Jordan Cove file the resolutions of the recommendations generated by the HAZOP review be provided for review and approval by FERC staff. Once the design has been subjected to a HAZOP review, the design development team would track, manage, and keep records of changes in the facility design, construction, operations, documentation, and personnel. Jordan Cove would evaluate these changes to ensure that the safety, health, and environmental risks arising from these changes are addressed and controlled based on its management of change procedures. If our recommendations are adopted into the order, resolutions of the recommendations generated by the HAZOP review would be monitored by FERC staff. We also recommend in section 4.13.1.6 that Jordan Cove file all changes to their FEED for review and approval by FERC staff. However, major modifications could require an amendment or new proceeding.

If the Project is authorized and constructed, Jordan Cove would install equipment in accordance with its design. We recommend in section 4.13.1.6 that Project facilities be subject to construction inspections and that Jordan Cove provide, for review and approval, commissioning plans, procedures and commissioning demonstration tests that would verify the performance of equipment. In addition, we recommend in section 4.13.1.6 that Jordan Cove provide semi-annual reports that include abnormal operating conditions and planned facility modifications. Furthermore, we recommend in section 4.13.1.6 that the Project facilities be subject to regular inspections throughout the life of the facilities to verify that equipment is being properly maintained and to verify basis of design conditions, such as feed gas and sendout conditions, do not exceed the original basis of design.

Mechanical Design

Jordan Cove provided codes and standards for the design, fabrication, construction, and installation of piping and equipment and specifications for the facility. The design specifies materials of construction and ratings suited to the pressure and temperature conditions of the process design. Piping would be designed, fabricated, assembled, erected, inspected, examined, and tested in accordance with the American Society of Mechanical Engineers (ASME) Standards B31.3, B36.10, and B36.19. Valves and fittings would be designed to standards and recommended practices such as API Standards 594, 598, 600, 602, 603, 607, 608, 609, and 623; ASME Standards B16.5, B16.9, B16.10, B16.20, B16.21, B16.25, B16.34, B16.36 and B16.47; and ISA Standards 75.01.01, 75.05.01, 75.08.01, and 75.08.05. Portions of the facility regulated under 33 CFR 127 for the marine transfer system, including piping, hoses, and loading arms should also be tested in accordance with 33 CFR 127.407.

Pressure vessels must be designed, fabricated, inspected, examined, and tested in accordance with ASME Boiler and Pressure Vessel Code (BPVC) Section VIII and per 49 CFR 193 Subparts C, D, and E and NFPA 59A (2001). LNG storage tanks must be designed, fabricated, tested, and inspected in accordance with 49 CFR 193 Subpart D, NFPA 59A (2001 and 2006), and API Standard 620. In addition, Jordan Cove would design, fabricate, test, and inspect the LNG storage tanks in accordance with API Standard 625 and American Concrete Institute (ACI) 376. Other low-pressure storage tanks such as the amine storage tank would be designed, inspected, and maintained in accordance with the API Standards 650 and 653. All LNG storage tanks would also include boil-off gas compression to prevent the release of boil-off to the atmosphere in accordance with NFPA 59A (2001) for an inherently safer design. The Heat exchangers would be designed to ASME BPVC Section VIII standards; API Standards 660 and 661; the Tubular Exchanger Manufacturers Association (TEMA) standards; and Aluminum Plate-Fin Heat Exchanger Manufacturer's Association (ALPEMA) guidelines. Rotating equipment would be designed to standards and recommended practices, such as API Standards 610, 613, 614, 617, 618, 619, 670, 672, 674, 675, 676, and 682; and ASME Standards B73.1 and B73.2. Fired heaters would be specified and designed to standards and recommended practices, such as API Standards 530, 556 and 560, and NFPA 85.

Pressure and vacuum safety relief valves, a vent stack, and flares would be installed to protect the storage containers, pressure vessels, process equipment, and piping from an unexpected or uncontrolled pressure excursion. The safety relief valves would be designed to handle process upsets and thermal expansion within piping, per NFPA 59A (2001) and ASME Section VIII; and would be designed in accordance with API Standards 520, 521, 526, 527, 537, and 2000; ASME Standards B31.3; and other recommended and generally accepted good engineering practices. In addition, the operator should verify the set pressure of the pressure relief valves meet the requirements in 33 CFR 127.407. We recommend in section 4.13.1.6 Jordan Cove provide final design information on pressure and vacuum relief devices, vent stack, and flares, for review and approval, to ensure that the final sizing, design, and installation of these components are adequate and in accordance with the standards reference and other recommended and generally accepted good engineering practices.

Although many of the codes and standards were listed as ones the project would meet, Jordan Cove did not make reference to all codes and standards required by regulations or are recommended and generally accepted good engineering practices. Therefore, we recommend in section 4.13.1.6 that Jordan Cove provide the final specifications for all equipment and a summarized list of all referenced codes and standards for review and approval. If the Project is authorized and constructed, Jordan Cove would install equipment in accordance with its specifications and design, and FERC staff would verify equipment nameplates to ensure equipment is being installed based on approved design. In addition, FERC staff would conduct construction inspections including reviewing quality assurance and quality control plans to ensure construction work is being performed according to proposed Project specifications, procedures, codes, and standards. We recommend in section 4.13.1.6 Jordan Cove provide semi-annual reports that include equipment malfunctions and abnormal maintenance activities. In addition, we recommend in section 4.13.1.6 that the Project facilities be subject to inspections to verify that the equipment is being properly maintained during the life of the facility.

Hazard Mitigation Design

If operational control of the facilities were lost and operational controls and emergency shutdown systems failed to maintain the Project within the design limits of the piping, containers, and safety relief valves, a release could potentially occur. FERC regulations under 18 CFR 380.12 (o) (1) through (4) require applicants to provide information on spill containment, spacing and plant layout, hazard detection, hazard control, and firewater systems. In addition, 18 CFR 380.12 (o) (7) require applicants to provide engineering studies on the design approach and 18 CFR 380.12 (o) (14) requires applicants to demonstrate how they comply with 49 CFR 193 and NFPA 59A.

As required by 49 CFR 193 Subpart I and by incorporation section 9.1.2 of NFPA 59A (2001), fire protection must be provided for all USDOT regulated LNG facilities based on an evaluation of sound fire protection engineering principles, analysis of local conditions, hazards within the facility, and exposure to or from other property. NFPA 59A (2001) also requires the evaluation on the type, quantity, and location of hazard detection and hazard control, passive fire protection, emergency shutdown and depressurizing systems, and emergency response equipment, training, and qualifications. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 Subpart I and would be subject to USDOT's inspection and enforcement programs. However, NFPA 59A (2001) also indicates the wide range in size, design, and location of LNG facilities precludes the inclusion of detailed fire protection provisions that apply to all facilities comprehensively and includes subjective performance-based language on where ESD systems and hazard control are required and does not provide any additional guidance on placement or selection of hazard detection equipment and provides minimal requirements on firewater. Also, the project marine facilities would be subject to 33 CFR 127, which incorporates sections of NFPA 59A (1994), which have similar performance-based guidance. Therefore, FERC staff evaluated the proposed spill containment and spacing, hazard detection, emergency shutdown and depressurization systems, hazard control, firewater coverage, structural protection, and onsite and offsite emergency response to ensure they would provide adequate protection of the LNG facilities as described below.

Jordan Cove performed a preliminary fire protection evaluation to ensure that adequate mitigation would be in place, including spill containment and spacing, hazard detection, emergency shutdown and depressurization systems, hazard control, firewater coverage, structural protection, and onsite and offsite emergency response. We recommend in section 4.13.1.6 that Jordan Cove provide a final fire protection evaluation that evaluates the type, quantity, and location of hazard detection and hazard control, passive fire protection, emergency shutdown and depressurizing systems, and emergency response equipment, training, and qualifications in accordance with NFPA 59A (2001), and to provide more information on the final design, installation, and commissioning of spill containment, hazard detection, hazard control, firewater systems, structural fire protection, and onsite and offsite emergency response procedures for review and approval.

Spill Containment

In the event of a release, sloped areas at the base of storage and process facilities would direct a spill away from equipment and into the impoundment system. This arrangement would minimize the dispersion of flammable vapors into confined, occupied, or public areas and minimize the potential for heat from a fire to impact adjacent equipment, occupied buildings, or public areas if ignition were to occur.

Title 49 CFR 193.2181 Subpart C specifies that each impounding system serving an LNG storage tank must have a minimum volumetric liquid capacity of 110 percent of the LNG tank's maximum design liquid capacity for an impoundment serving a single tank, unless surge is accounted for in the impoundment design. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 Subpart C and would be subject to USDOT's inspection and enforcement programs. For full containment LNG tanks, we also consider it prudent to provide a barrier to prevent liquid from flowing to an unintended area (i.e., outside the plant property). The purpose of the barrier is to prevent liquid from flowing off the plant property and does not define containment or an impounding area for thermal radiation or flammable vapor exclusion zone calculations or other code requirements already met by sumps and impoundments throughout the site. Jordan Cove proposes two full-containment LNG storage tanks for which the outer tank wall would serve as the impoundment system. FERC staff verified that the LNG storage tank's outer concrete wall would have a liquid capacity of at least 110 percent of the inner LNG tank's maximum liquid capacity. In addition, Jordan Cove would also install a berm around the LNG storage tank area to prevent liquid in the storage tank area from flowing off-site in the event of an outer tank impoundment failure.

Jordan Cove proposes to install curbing, paving, and trenches to direct potential LNG, refrigerant, and heavy hydrocarbon liquid releases to the Process/Tank Impoundment Basin. LNG releases from ship loading piping would be directed to either the Process/Tank Impoundment Basin or the Marine Impoundment Basin. Releases in the refrigerant storage area or from refrigerant delivery trucks would be collected in curbed areas and directed via a trench to the Refrigerant Storage Impoundment Basin. This basin would be sized to be greater than the largest refrigerant storage tank. Jordan Cove would also include local containment walls around the Amine Make-up Storage Tank, Liquid Nitrogen Storage Tank, Ammonia Storage Tank, and Diesel Storage Tank which would have a volumetric capacity of greater than 110 percent of the maximum liquid volume in each storage tank. The design would also include curbed areas in the acid gas removal area to contain amine releases. However, Jordan Cove did not propose a spill containment system to collect liquid releases from the Warm Flare Knockout Drum. Therefore we recommend in section 4.13.1.6 that Jordan Cove specify a spill containment system around the Warm Flare Knockout Drum.

Under NFPA 59A (2001), section 2.2.2.2, the capacity of impounding areas for vaporization, process, or LNG transfer areas must equal the greatest volume that can be discharged from any single accidental leakage source during a 10-minute period or during a shorter time period based upon demonstrable surveillance and shutdown provisions acceptable to the USDOT. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 Subpart C and would be subject to USDOT's inspection and enforcement programs. The impoundment system design for the marine facilities would be subject to the Coast Guard's 33 CFR 127, which does not specify a spill or duration for impoundment sizing. However, we evaluate whether all hazardous liquids are provided with spill containment based on the largest flow capacity from a single pipe for 10 minutes accounting for de-inventory or the liquid capacity of the largest vessel (or total of impounded vessels) served, whichever is greater and whether providing spill containment reduces consequences from a release. We recommend in section 4.13.1.6 that Jordan Cove provide additional information on the final design of the impoundment systems for review and approval.

Jordan Cove indicated that all piping, hoses, and equipment that could produce a hazardous liquid spill would be provided with spill collection and/or spill conveyance systems. Furthermore, Jordan Cove indicates that the stormwater pumps would be automatically operated by level control and interlocked using redundant low temperature detectors to prevent pumps from operating if LNG is present within the LNG spill basins. Although stormwater removal pumps would be proposed for the large impoundment basins, Jordan Cove proposes to install normally-closed valves on local curbed areas and within bund walls to allow analysis of stormwater prior to routing it to the drainage channels. Jordan Cove is consulting with USDOT on the use of normally-closed valves instead of stormwater removal pumps required in 49 CFR 193 Subpart C. Therefore we recommend in section 4.13.1.6 that Jordan Cove provide correspondence from USDOT on the use of normally closed valves to remove stormwater from curbed areas. In addition, low temperature detectors would not stop the stormwater removal pumps from operating in the event a relatively warm heavy hydrocarbon release reaches the impoundment basins. Therefore, Jordan Cove indicated that gas detectors would be provided to prevent the stormwater removal pumps from operating if warm refrigerant or heavy hydrocarbon releases could reach an impoundment basin. If the facilities are approved and constructed, final compliance with the requirements of 49 CFR 193 Subpart C, would be subject to USDOT's inspection and enforcement programs.

If a project is authorized and constructed, Jordan Cove would install spill impoundments in accordance with its design and FERC staff would verify during construction inspections that the spill containment system including dimensions, and slopes of curbing and trenches, and volumetric capacity matches final design information. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility to verify that impoundments are being properly maintained.

Spacing and Plant Layout

The spacing of vessels and equipment between each other, from ignition sources, and to the property line must meet the requirements of 49 CFR 193 Subparts C, D, and E, which incorporate NFPA 59A (2001). NFPA 59A (2001) includes spacing and plant layout requirements and further references NFPA 30, NFPA 58, and NFPA 59 for additional spacing and plant layout requirements. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 and would be subject to USDOT's inspection and enforcement programs.

In addition, FERC staff evaluated the spacing to determine if there could be cascading damage and to inform what fire protection measures may be necessary to reduce the risk of cascading damage. If spacing to mitigate the potential for cascading damage was not practical, we evaluated whether other mitigation measures were in place and evaluated those systems in further detail as discussed in subsequent sections in section 4.13.5.5. We evaluated the spacing of buildings in line with AIChE CCPS *Guidelines for Evaluating Process Plant Buildings for External Explosions and Fires* and API 752, which provide guidance on identifying and evaluating explosion and fire impacts to plant buildings and occupants resulting from events external to the buildings. Jordan Cove submitted a building siting analysis based on API 752 and also indicated it would meet ASCE 59 to determine explosion impacts to plant buildings. In addition, FERC staff evaluated other hazards associated with releases and whether any damage would likely occur at buildings or would result in cascading damage.

To minimize the risk of cryogenic spills causing structural supports and equipment from cooling below their minimum design metal temperature, Jordan Cove would generally locate cryogenic equipment away from process areas and would have spill containment systems for cryogenic spills that would direct them to a remote impoundment. In addition, Jordan Cove would protect equipment and structural steel against cold shocks through selection of suitable materials of construction or by the application of cold spill protection. We recommend in section 4.13.1.6 that Jordan Cove file drawings and specifications for structural passive protection systems to protect equipment and supports that could be exposed to cryogenic releases.

To minimize risk for flammable or toxic vapor ingress into buildings and from reaching areas that could result in cascading damage from explosions, Jordan Cove would generally locate buildings away from process areas and would locate fired equipment and ignition sources away from process areas. In addition, the LNG storage tanks are generally located away from process equipment and process facilities are relatively unconfined and uncongested. Therefore, we recommend in section 4.13.1.6 that Jordan Cove conduct a technical review of facility, for review and approval, identifying all combustion/ventilation air intake equipment and the distances to any possible flammable gas or toxic release; and verify that these areas would be adequately covered by hazard detection devices that would isolate or shut down any combustion or heating ventilation and air conditioning equipment whose continued operation could add to or sustain an emergency. In addition, we recommend in section 4.13.1.6 that Jordan Cove demonstrate adequate ventilation and detection in the battery rooms to mitigate hydrogen build up from battery off-gas. We also recommend in section 4.13.1.6 that Project facilities be subject to periodic inspections during construction to verify flammable/toxic gas detection equipment is installed in heating, ventilation, and air condition intakes of buildings at appropriate locations. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facilities to continue to verify that flammable/toxic gas detection equipment installed in building air intakes function as designed and are being maintained and calibrated.

To minimize overpressures from vapor cloud explosions, we evaluated how flammable vapors would be prevented from accumulating within confined areas. Jordan Cove would design for overpressures in accordance with API 753, ASCE 41088, and other recommended and generally accepted good engineering practices. In addition, explosions in process areas were evaluated and demonstrated to produce less than 1 psi side on overpressure at the LNG storage tanks. However, vapor dispersion could disperse underneath the LNG storage tanks. Therefore, we recommend in section 4.13.1.6 that Jordan Cove file an analysis for review and approval that demonstrates the flammable vapor dispersion from design spills would be prevented from dispersing underneath the elevated LNG storage tanks or detail how the LNG storage tanks would be able to withstand an overpressure due to ignition of the flammable vapors that disperse underneath the elevated LNG storage tanks.

To minimize the risk of pool fires from causing cascading damage, Jordan Cove located the spill impoundments such that the radiant heats would have a minimal impact on most areas of the plant. Fires within the process impoundments would be spaced such that there would not be high radiant heats on any equipment. A fire from the LNG storage tank outer containment walls would result in radiant heats over 10,000 Btu/ft^2-hr at the adjacent LNG storage tank. Therefore, we recommend in section 4.13.1.6 that Jordan Cove file an analysis for review and approval demonstrating the tanks can withstand the radiant heat from adjacent LNG storage tank fires. In addition, a fire from the tank outer walls would result in less than 4,000 Btu/ft^2-hr in most other areas of the plant with the exception of the LNG Flash Drum and the Auxiliary Boiler. Jordan Cove would install fixed water spray systems that would cover the LNG Flash Drum and Auxiliary Boiler. In addition, the LNG Flash Drum would be insulated for cryogenic service which would shield the equipment from the radiant heat.

To minimize the risk of jet fires from causing cascading damage that could exacerbate the initial hazard, Jordan Cove would shroud the LNG transfer piping and LNG product header and would locate flammable and combustible containing piping and equipment away from buildings and process areas that do not handle flammable and combustible materials. Jordan Cove would also install emergency shutdown systems that would limit the duration of a jet fire event, depressurization systems that would reduce the pressure in equipment, and would install firewater systems to cool equipment and structures as described in subsequent sections in section 4.13.5.5. In addition, we recommend in section 4.13.1.6 that Jordan Cove file drawings of the passive structural fire protection for review and approval for structural supports and equipment.

In addition, FERC staff evaluated the spacing to determine if there could be cascading damage and to inform what fire protection measures may be necessary to reduce the risk of cascading damage. Thermal radiation levels from an LNG tank roof top fire and other impoundments could potentially impact process equipment, process vessels, and piperacks located within the pretreatment area, liquefaction trains, BOG compressor area, the utility area, and at the Marine Flare. To mitigate against a LNG tank roof top fire, impoundment fires, and jet fires within the plant, Jordan Cove proposes thermal radiation mitigation measures to prevent cascading events in the design, including thermal protection insulation, fire-retardant insulation materials, emergency depressurization, flame, combustible gas and low temperature detectors, fire proofing of structural steel columns supporting critical equipment, fixed automatic firewater spray system, high expansion foam system, and firewater monitors and hydrants. However, details of these systems would be done in final design. Therefore, we recommend in section 4.13.1.6 that Jordan Cove provide the final design of these thermal mitigation measures, for review and approval, to demonstrate cascading events would be mitigated.

If the project is authorized, Jordan Cove would finalize the plot plan, and we recommend in section 4.13.1.6 that Jordan Cove provide any changes for review and approval to ensure capacities and setbacks are maintained. If the facilities are constructed, Jordan Cove would install equipment in accordance with the spacing indicated on the plot plans. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to periodic inspections during construction to verify equipment is installed in appropriate locations and the spacing is met in the field. We also recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facilities to continue to verify that equipment setbacks from other equipment and ignition sources are being maintained during operations.

Ignition Controls

Jordan Cove LNG Project's plant areas would be designated with a hazardous electrical classification and process seals commensurate with the risk of the hazardous fluids being handled in accordance with NFPA 59A (2001), 70, 497, and API RP 500. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 and would be subject to USDOT's inspection and enforcement programs, which require compliance, by incorporation by reference, with NFPA 59A (2001) and NFPA 70 (1999). The marine facilities must comply with similar electrical area classification requirements of NFPA 59A (1994) and NFPA 70 (1993), which are incorporated by reference into the Coast Guard regulations in 33 CFR 127. Depending on the risk level, these areas would either be unclassified or classified as Class 1 Division 1, or Class 1 Division 2. Electrical equipment located in these areas would be designed such that in the event a flammable vapor is present, the equipment would have a minimal risk of igniting the vapor. We evaluated Jordan Cove's electrical area classification drawings to determine whether Jordan Cove would meet these electrical area classification requirements and good engineering practices in NFPA 59A, 70, 497, and API RP 500. We recognize that Jordan Cove appears to meet NFPA 59A (1994 and 2001), NFPA 70 (1993 and 1999), and most of NFPA 497 and API 500, and recommend in section 4.13.1.6 that Jordan Cove provide final electrical area classification drawings for review and approval.

If the project is authorized, Jordan Cove would finalize the electrical area classification drawings and would describe changes made from the FEED design. We recommend in section 4.13.1.6 that Jordan Cove file the final design of the electrical area classification drawings for review and approval. If facilities are constructed, Jordan Cove would install appropriately classed electrical equipment, and we recommend in section 4.13.1.6 that Project facilities be subject to periodic inspections during construction for FERC staff to spot check electrical equipment and verify equipment is installed per classification and are properly bonded or grounded in accordance with NFPA 70. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility to ensure electrical equipment is maintained (e.g., bolts on explosion proof equipment properly installed and maintained, panels provided with purge, etc.), and electrical equipment are appropriately de-energized and locked out and tagged out when being serviced.

In addition, submerged pumps and instrumentation must be equipped with electrical process seals, and instrumentation in accordance with NFPA 59A (2001) and NFPA 70. We recommend in section 4.13.1.6 that Jordan Cove provide, for review and approval, final design drawings showing process seals installed at the interface between a flammable fluid system and an electrical conduit or wiring system that meet the requirements of NFPA 59A (2001) and NFPA 70. In addition, we recommend in section 4.13.1.6 that Jordan Cove file, for review and approval, details of an air gap or vent equipped with a leak detection device that should continuously monitor for the presence of a flammable fluid, alarm the hazardous condition, and shut down the appropriate systems. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility to ensure electrical process seals for submerged pumps continue to conform to NFPA 59A and NFPA 70 and that air gaps are being properly maintained.

Hazard Detection, Emergency Shutdown, and Depressurization Systems

Jordan Cove would also install hazard detection systems to detect cryogenic spills, flammable and toxic vapors, and fires. The hazard detection systems would alarm and notify personnel in the area and control room to initiate an emergency shutdown, depressurization, or initiate appropriate procedures, and would meet NFPA 72, ISA Standard 12.13, and other recommended and generally accepted good engineering practices. In addition, we recommend in section 4.13.1.6 that Jordan Cove provide specifications, for review and approval, for the final design of fire safety specifications, including hazard detection, hazard control, and firewater systems.

FERC staff also evaluated the adequacy of the general hazard detection type, location, and layout to ensure adequate coverage to detect cryogenic spills, flammable and toxic vapors, and fires near potential release sources (i.e., pumps, compressors, sumps, trenches, flanges, and instrument and valve connections). We recommend in section 4.13.1.6 that Jordan Cove file a hazard detection study to evaluate the effectiveness of their flammable and combustible gas detection and flame and heat detection systems in accordance with ISA 84.00.07 or equivalent methodologies. This evaluation would need to demonstrate that 90 percent or more of releases (unignited and ignited) that could result in an off-site or cascading impact would be detected by two or more detectors and result in isolation and de-inventory within 10 minutes. The analysis should take into account the set points, voting logic, wind speeds, and wind directions. FERC staff also reviewed the fire and gas cause and effect matrices to evaluate the detectors that would initiate an alarm, shutdown, depressurization, or other action based on the FEED. Jordan Cove did not provide the fire and gas system cause and effect matrices that indicate how each detector would initiate an alarm, shutdown, depressurization, or conduct other action. Therefore, we recommend in section 4.13.1.6 that Jordan Cove provide, for review and approval, the cause and effect matrices for process instrumentation, fire and gas detection system, and emergency shutdown system.

In addition, Jordan Cove specified low oxygen detectors at the liquid nitrogen storage tanks, but did not denote the location of the low oxygen detectors in the Project drawings. Therefore, we recommend in section 4.13.1.6 that Jordan Cove provide additional information, for review and approval, on the final design of all hazard detection systems (e.g., manufacturer and model, elevations, etc.) and hazard detection layout drawings. If the project is authorized and constructed, Jordan Cove would install hazard detectors according to its final specifications and drawings, and we recommend in section 4.13.1.6 that Project facilities be subject to periodic inspections during construction to verify hazard detectors and ESD pushbuttons are appropriately installed per approved design and functional based on cause and effect matrixes prior to introduction of hazardous fluids. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility to verify hazard detector coverage and functionality is being maintained and are not being bypassed without appropriate precautions.

Hazard Control

If ignition of flammable vapors occurred, hazard control devices would be installed to extinguish or control incipient fires and releases, and would meet NFPA 59A; NFPA 10, 12, 17, and 2001; API Standard 2510A; and other recommended and generally accepted good engineering practices. We evaluated the adequacy of the number and availability of handheld, wheeled, and fixed fire extinguishing devices throughout the site based on the FEED. FERC staff also evaluated whether the spacing of the fire extinguishers would meet NFPA 10 and agent type and capacities meet NFPA 59A (2009 and later editions). The hazard control plans appeared to meet NFPA 10 travel distances to most components containing flammable or combustible fluids (Class B) for handheld fire extinguishers (30 to 50 feet) and wheeled extinguishers (100 feet) and NFPA 10 travel distance to most other components that could pose an ordinary combustible hazard (Class A) or associated electrical (Class C) hazard for handheld extinguishers (75 feet). Buildings also appear to be provided with handheld extinguishers that appear to satisfy NFPA 10 requirements, including placement at each entry/exit. The agent type (potassium bicarbonate) and agent storage capacities for wheeled (minimum 125 pounds [lb]) and for handheld extinguishers (minimum 20 lb) also appear to meet NFPA 59A requirements. In addition, travel distances, installation heights, visibility, flow rate capacities, and other requirements should be confirmed in final design and in the field where design details, such as manufacturer, obstructions, and elevations, would be better known. Therefore, we recommend in section 4.13.1.6 that Jordan Cove files the final design of these systems, for review and approval, where details are yet to be determined (e.g., manufacturer and model, elevations, flowrate, capacities, etc.) and where the final design could change as a result of these details or other changes in the final design of the Project.

In addition, we evaluated whether clean agent systems would be installed in all instrumentation buildings in accordance with NFPA 2001. Jordan Cove would install clean agent fire suppression systems in accordance with NFPA 2001 in buildings that house electrical and control equipment such as the Control Room, power distribution equipment rooms, and power generation houses. Jordan Cove also indicated that CO2 extinguishers as well as dry chemical extinguishers would be provided in the electrical powerhouses. In addition, Jordan Cove would provide a carbon dioxide extinguishing system for the refrigerant compressors turbines in accordance with NFPA 12.

If the Project is authorized and constructed, Jordan Cove would install hazard control equipment, and we recommend in section 4.13.1.6 that Project facilities be subject to periodic inspections during construction to verify hazard control equipment is installed in the field and functional prior to introduction of hazardous fluids. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility to verify in the field that hazard control coverage and is being properly maintained and inspected.

Passive Cryogenic and Fire Protection

If cryogenic releases or fires could not be mitigated from impacting facility components to insignificant levels, passive protection (e.g., fireproofing structural steel, cryogenic protection, etc.) should be provided to prevent failure of structural supports of equipment and pipe racks. The structural fire protection would comply with NFPA 59A (2001) and other recommended and generally accepted good engineering practices. NFPA 59A (2001) section 6.4.1 requires pipe supports, including any insulation systems used to support pipe whose stability is essential to plant safety, to be resistant to or protected against fire exposure, escaping cold liquid, or both, if they are subject to such exposure. However, NFPA 59A (2001) does not provide the criteria for determining if they are subject to such exposure or the level of protection needed to protect the pipe supports against such exposures. In addition, NFPA 59A does not address cryogenic or structural protection of pressure vessels or other equipment.

Therefore, FERC staff evaluated whether passive cryogenic and fire protection would be applied to pressure vessels and structural supports to facilities that could be exposed to cryogenic liquids or radiant heats of 4,000 Btu/ft^2-hr or greater from fires with durations that could result in failures[198] and that they are specified in accordance with recommended and generally accepted good engineering practices with a fire protection rating commensurate to the exposure. The structural fire protection would comply with NFPA 59A (2001); API RP 2218; Association of the Wall and Ceiling Industry Technical Paper 12-A; International Organization for Standardization (ISO) 12944 and 22899; Underwriters Laboratories (UL) 1709; and other recommended and generally accepted good engineering practices.

To minimize the risk of cryogenic spills causing structural supports and equipment from cooling below their minimum design metal temperature, Jordan Cove would protect equipment and structural steel against cold shocks through selection of suitable materials of construction or by the application of coldproofing. In addition, Jordan Cove would have spill containment systems surrounding cryogenic equipment and would generally locate cryogenic equipment away from process areas that do not handle cryogenic materials. Cryogenic protection would comply with NFPA 59A (2001), ISO 20088, and other recommended and generally accepted good engineering practices. In addition, Jordan Cove would install a firewall between the refrigerant storage tanks and the Refrigerant Storage Impoundment Basin to prevent cascading damage from radiant heats in excess of 4,000 Btu/ft^2-hr. We recommend in section 4.13.1.6 that Jordan Cove file drawings and specifications of the final design, for review and approval, for the structural passive protection systems to protect equipment and supports from cryogenic releases.

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198 Pool fires from impoundments are generally mitigated through use of emergency shutdowns, depressurization systems, structural fire protection, and firewater, while jet fires are primarily mitigated through the use of emergency shutdowns, depressurization systems, and firewater with or without structural fire protection.

To minimize the risk of a pool or jet fire from causing cascading damage, Jordan Cove would generally locate flammable and combustible containing piping, equipment, and impoundments away from buildings and other process areas that do not handle flammable and combustible materials. Jordan Cove demonstrated that the radiant heats from pool fires from the LNG storage tank outer containment walls and impoundments would have a minimal impact on most areas of the plant. A pool fire from the outer tank wall would result in less than 4,000 Btu/ft^2-hr in most other areas of the plant with the exception of the LNG Flash Drum and Auxiliary Boiler. Fires within the other impoundments would be spaced such that there would be less than 4,000 Btu/ft^2-hr on any equipment.

In addition, we recommend in section 4.13.1.6 that Jordan Cove demonstrate that passive protection is provided in areas where jet fires may result in failure of structural supports. Jordan Cove would need to file drawings of the passive structural fire protection for review and approval for structural supports and equipment that could result in a failure when exposed to a jet fire. In addition, we recommend in section 4.13.1.6 that Jordan Cove provide additional information on final design of these systems, for review and approval, where details are yet to be determined (e.g., calculation of structural fire protection materials, thicknesses, etc.) and where the final design could change as a result of these details or other changes in the final design of the Project.

We also note that it was unclear whether Jordan Cove would install fire walls in transformer areas, which would be required for certain transformers. Therefore, we recommend in section 4.13.1.6 that Jordan Cove separate or provide fire walls for transformer in accordance with NFPA 850 or equivalent that would prevent cascading damage.

If the Project is authorized and constructed, Jordan Cove would install structural cryogenic and fire protection according to its design, and we recommend in section 4.13.1.6 that Project facilities be subject to periodic inspections during construction to verify structural cryogenic and fire protection is properly installed in the field as designed prior to introduction of hazardous fluids. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility to continue to verify that passive protection is being properly maintained.

Firewater Systems

Jordan Cove would also provide firewater systems, including remotely operated firewater monitors, sprinkler systems, fixed water spray systems, and firewater hydrants and hoses for use during an emergency to cool the surface of storage vessels, piping, and equipment exposed to heat from a fire. These firewater systems would be designed, tested, and maintained to meet NFPA 59A (2001), 13, 14, 15, 20, 22, 24, and 25 requirements. Jordan Cove would also provide high expansion foam for each LNG spill impoundment basin to reduce vaporization rates from LNG pools and would meet NFPA 59A (2001) and NFPA 11. FERC staff evaluated the adequacy of the general firewater or foam system coverage and verified the appropriateness of the associated firewater demands of those systems and worst-case fire scenarios to size the firewater and foam systems. Jordan Cove provided firewater coverage drawings for the firewater monitors and fire hydrants, however, where coverage circles intersect pipe racks, large vessels or process equipment, the firewater coverage could be blocked, and the coverage circles should be modified to account for obstructions during the final design. Additionally, not all areas of the gas pretreatment are adequately covered. We recommended in section 4.13.1.6 that Jordan Cove provide adequate firewater coverage for all of the pretreatment equipment. We recommend in section 4.13.1.6 that Jordan Cove file additional information on the final design of these systems, for review and approval, where details are yet to be determined (e.g., manufacturer and model, nozzle types, etc.) and where the final design could change as a result of these details or other changes in the final design of the Project.

FERC staff also assessed whether the reliability of the firewater pumps, firewater source, and onsite storage volume would be appropriate. Jordan Cove would provide a primary and backup firewater pump with different drivers per NFPA 20. Jordan Cove also states that the firewater tanks would meet NFPA 22 and API Standard 650. However, the firewater tank data sheet denotes that the firewater tanks would be designed to API Standard 650 and does not make reference to NFPA 22. Therefore, we recommend in section 4.13.1.6 that Jordan Cove design the firewater tanks in accordance with NFPA 22 or justify how API Standard 650 provides an equivant or better level of safety. Furthermore, Jordan Cove would provide a fully staffed fire department adjacent to the firewater tanks that would meet NFPA 600.

We also recommend in section 4.13.1.6 that Jordan Cove should specify that the firewater flow test meter is equipped with a transmitter and that a pressure transmitter is installed upstream of the flow transmitter, which should both be connected to the DCS and recorded to keep a history of flow test data. In addition, we recommend in section 4.13.1.6 that the largest firewater pump or component be able to be removed for maintenance from the firewater pump shelter. If the Project is authorized and constructed, Jordan Cove would install the firewater and foam systems as designed, and we recommend in section 4.13.1.6 that Project facilities be subject to periodic inspections during construction and that companies provide results of commissioning tests to verify the firewater and foam systems are installed and functional as designed prior to introduction of hazardous fluids. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility to ensure firewater and foam systems are being properly maintained and tested.

Geotechnical and Structural Design

Jordan Cove provided geotechnical and structural design information for its facilities to demonstrate the site preparation and foundation designs would be appropriate for the underlying soil characteristics and to ensure the structural design of the Project facilities would be in accordance with federal regulations, standards, and recommended and generally accepted good engineering practices. The application focuses on the resilience of the Project facilities against natural hazards, including extreme geological, meteorological, and hydrological events, such as earthquakes, tsunamis, seiche, hurricanes, tornadoes, floods, rain, ice, snow, regional subsidence, sea level rise, landslides, wildfires, volcanic activity, and geomagnetism.

Geotechnical Evaluation

FERC regulations under 18 CFR 380.12 (h) (3) require geotechnical investigations to be provided. In addition, FERC regulations under 18 CFR 380.12 (o) (14) require an applicant demonstrate compliance with regulations under 49 CFR 193 and NFPA 59A. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 and would be subject to USDOT's inspection and enforcement programs. USDOT regulations incorporate by reference NFPA 59A (2001). NFPA 59A (2001) section 2.1.4 requires soil and general investigations of the site to determine the design basis for the facility. However, no additional requirements are set out in 49 CFR 193 or NFPA 59A on minimum requirements for evaluating existing soil site conditions or evaluating the adequacy of the foundations, therefore FERC staff evaluated the existing site conditions, geotechnical report, and proposed foundations to ensure they are adequate for the LNG facilities as described below.

The Project would be located within the Pacific Border Physiographic province at the western edge of the coastal headlands of the Central Coast Mountain Range, on the North Spit of Coos Bay. The North Spit of Coos Bay marks the southern edge of the Holocene Epoch Coos Bay dune sheet (Peterson et al. 2006). The Project would be located near the eastern edge of the Cascadia Subduction Zone (CSZ), where the North American Plate is overriding the Explorer, Juan de Fuca, and Gorda tectonic plates (Wells et al. 2016). The converging tectonic plates have resulted in the accumulation of marine deltaic sediments and volcanic seamounts, referred to as the Siletzia Terrance, along the western edge of the North American tectonic plate (Heller and Ryberg 1983). The plates have also created a deformation zone along the western edge of the accumulation wedge complex, strike-slip and thrust/reverse faulting in the North American tectonic place, and a zone of bedrock folding extending from the coast eastward. The major tectonic elements associated with the subduction zone include the accumulation wedge complex, a deformed forearc basin consisting of the Coast Range and Willamette Valley, a volcanic arc complex consisting of the Cascade Mountain Range, and a backarc in eastern Oregon and Washington. The Project would be located at the junction of the accumulation wedge complex and the forearc basin. Local bedrock structures reflect east-west compressional deformation resulting from ongoing oblique subduction of the CSZ that has occurred since the late-middle Miocene Epoch (Wells and Peck 1961), and includes the megathrust itself, north-south trending folds, north-south trending reverse and thrust faults, and west-northwest trending oblique strike-slip faults (Black and Madin 1995; Madin et al. 1995; Goldfinger et al. 1992). The location and extent of local fold and fault structures have been inferred from stratigraphic, geomorphic, and geophysical evidence. Geologic structures south of the site include the South Slough Syncline, the Westport Arc (anticline), and the eastern and the western forks on the Westport Arc (Allen and Baldwin 1944).

Jordan Cove contracted KBJ (a joint venture consisting of Kiewit, Black & Veath, and JGC) and its subconsultants to conduct geotechnical investigations and report to evaluate existing soil site conditions and proposed foundation design for the Project. During the investigation, the facility was subdivided into three primary areas: Ingram Yard area, Access and Utility Corridor area and South Dunes area. The LNG liquefaction trains, LNG storage tanks, and marine facilities would be located in the Ingram Yard area. The average elevation of the existing grade in Ingram Yard area ranged from +20 to +125 feet North American Vertical Datum 1988 (NAVD 88), the Access and Utility Corridor area ranged from +20 to +135 feet NAVD 88, and the South Dune area was less variable and was approximately +15 feet NAVD 88. KBJ indicated that the geologic profile consists primarily of sand overlying sand and silt, and then overlies clayey silt. Below elevation −30 feet NAVD 88, the subsurface material is relatively consistent and generally dense. Above elevation −30 feet, the material is more variable, with organics, clay, and fill present in the upper near surface profile in portions of the Project site. The Project site would be demolished, cleared, relocated, grubbed, and prepared using standard earthmoving and compaction equipment. Site preparation would result in a final grade elevation from +46 to +70 feet NAVD 88 with varying amounts of fill/cut that cross the site. Exceptions include the LNG storage tanks and water-dependent facilities such as the marine terminal and the Material Offloading Facility (MOF). The LNG storage tank basins would have an elevation of approximately +27 feet NAVD 88 that would be surrounded by a tertiary protective berm with a crest elevation of no less than +46 feet NAVD

88. Jordan Cove indicated that the parts of the marine facilities that would be normally occupied or operational would typically be at an elevation of +34.5 feet or greater, whereas normally unoccupied/non-operational parts of the marine facilities may be at a lower elevation.

KBJ conducted subsurface investigations work including mud-rotary borings with standard penetration tests (SPTs), cone penetration test (CPT) soundings, test pits, electrical resistivity testing, measurement of shear and compression wave velocities, pressuremeter testing, infiltrometer testing, pump testing, geophysical surveys, and laboratory testing. The borings and shear wave velocity logging on the Project site were completed to depths of approximately 300 feet. Geotechnical laboratory testing was completed on representative samples of the soil obtained from the explorations for the purpose of determining its physical characteristics and engineering properties. Approximately 132 borings to depths ranging from 14 to 300 feet below existing grade, approximately 90 cone penetration tests (CPTs) to depths ranging from 16 to 80 feet (or to refusal) below existing grade, 21 temporary piezometers to measure groundwater levels, and over 5 different tests on recovered soil samples, including classification tests (water content, Atterberg liquid and plastic limits, sieve tests), compression tests, corrosion potential tests (pH, sulfate, chloride, electrical resistivity) in general accordance with pertinent American Society for Testing and Materials (ASTM) standards. Based on the results of analytical laboratory testing, the exposure of concrete and steel to the soil would not require special considerations. The results for sulfate in the groundwater tested indicate that no special considerations would be required to protect the concrete for the existing groundwater conditions. The electrical resistivity test results indicate a corrosion specialist should be consulted. In addition, Coos Bay is a salt water environment; therefore, materials in contact with the surface water in Coos Bay or in the immediate vicinity of Coos Bay should be protected from exposure to salt water. Currently the groundwater below the site is fresh water; however, if the marine slip is authorized and dredged, it is unclear how much water from Coos Bay would infiltrate into the dredged sands and increase the chloride content. Therefore, it is standard practice that the chloride content of the dredged sand be tested as dredging is performed. If the chloride contents are oberserved to increase during dredging, then any necessary corrosion protection should be implemented.

Based on the test borings conducted, a number of design profiles were developed for the Project site. At Ingram Yard area: the subsurface conditions are relatively consistent below EL −30 feet. The existing sands above EL −30 feet consists of either existing sand fill or native dune or estuary sand deposits. In the area of the dune on the eastern portion of the Ingram Yard area, the sands are native starting at the ground surface. Below EL −30 feet, the native sands is predominantly fine-grained, with occasional shells and silt zones. A sand-silt unit is present beneath the native sand at elevations ranging from −110 feet to −140 feet. Investigation borings completed near the south LNG storage tank in the Ingram Yard area encountered hard clayey silt that was classified as poorly indurated silty shale at a depth of approximately −252 feet. Another boring drilled about 480 feet north, did not encounter the poorly indurated silty shale when terminated at a depth of about −280 feet. At the Access and Utility Corridor area, the subsurface conditions are generally similar to Ingram Yard. Below EL −30 feet, the conditions are similar to the Ingram Yard area. Above EL −30 feet, the soil consists primarily of sand with both fill and native sand encountered. Organics and peat were encountered only in the western end of the Access and Utility Corridor between EL −11 feet and EL −10.5 feet. At the South Dune area, as at Ingram Yard and along the Access Utility Corridor, the subsurface conditions at the South Dunes area are relatively constant below EL −30 feet. The conditions above EL −30 feet vary mainly because of variation in the sands and the presence or absence of peat/organics. Peat/organics were encountered in several areas of the South Dunes area at elevations ranging from 4 to 9 feet. The existing sand above EL −30 feet consists of fill, and native dune and estuary sand deposits. In the northeast quadrant of the South Dunes a layer of clay was encountered from EL 6 to 3.5 feet. The clay thickness varies from 0.3 foot to 2.5 feet and the material is very soft to soft with high plasticity. In the east central portion of the South Dunes, the driftwood was estimated to extend not more than 10 feet below ground surface. Below elevation −30 feet, the South Dunes subsurface conditions are fairly consistent. The native sand is predominantly fine grained, with occasional shells and silt zones. A deep boring at the South Dunes indicates that the native sand extends to elevation −151 feet. Below EL −151 feet, dark gray, very stiff to very hard, moist, and high plasticity clayey silt with sand and cementation was encountered that extended to an elevation of at least −223 feet.

The subsurface data from geotechnical soil borings and CPT soundings indicate that the subsurface conditions are relatively consistent across the site. Generally, the profile consists of existing sand fill from the ground surface near EL 20 feet to EL 9.5 feet. Near approximately EL 9.5 feet, an up to 2 feet thick layer of peat is present in many locations across the site. Beneath the peat layer is medium dense, native sand that extends to EL −30 feet. The medium dense, native sand would be improved by vibro-compaction to mitigate potentially liquefiable soils prior to construction of the LNG storage tanks. The peat layer would be removed and replaced prior to the ground improvement for soil liquefaction mitigation. Below EL −30 feet is dense to very dense, native sand that extends to about EL −135 feet. From EL −135 feet to below EL −260 feet. A clayey silt material identified as poorly indurated silty shale was found below about EL −235 feet.

FERC staff evaluated the geotechnical investigation to ensure the adequacy in the number, coverage, and types of the geotechnical borings, CPTs, SCPTs, and other tests, and found them to adequately cover major facilities, including the marine facilities, liquefaction areas, pretreatment areas, flare system, buildings, power generation, storage tanks, and berms at the site. Jordan Cove states that additional investigation would be performed to support final final design, including borings, CPTs, PMTs, and geophysical testing. FERC staff will continue its review of the results of the geotechnical investigation to ensure foundation designs are appropriate prior to construction of final design and throughout the life of the facilities.

Measured groundwater elevations have varied from a high of approximately 18 feet to 1 foot NAVD 88 below grade. Groundwater elevations increase with distance to the north away from Coos Bay. Considering the subsurface conditions for the LNG facility, Jordan Cove is proposing to support the LNG storage tanks and most of the facility structures on shallow isolated foundations, raft foundations, or deep foundations placed on improved ground. The recommended deep foundations to support large loads proposed would be either drilled piers or open-ended steel pipe piles. KBJ indicated the estimated depth of frost penetration for the site is approximately 1 foot below ground surface, therefore, the bottom of the foundations should be located at minimum depth of 1 foot below finished grade. The subsurface conditions at the site require soil improvement before any structures can be built for the LNG facilities. These conditions include peat, clay, buried driftwood, and liquefiable soil. KBJ provided considerations for ground improvement techniques including vibro-compaction; sand compaction; dry excavation and removal; wet excavation and removal and soil mixing. In areas where ground improvement would be utilized, Jordan Cove proposes to utilize vibro-compaction and deep soil mixing ranging in depth from the groundwater table to a maximum of approximately EL −30 feet NAVD 88, depending on the foundation loading and soil suitability for ground improvement, to bring foundations capacities and settlements within acceptable limits. Deep soil mixing would consist of installing overlapping (secant) soil mixed columns to create shear walls that reinforce the liquefiable soil mass. The deep soil mixed shear walls would be installed. KBJ performed settlement analysis for the Project site. At Ingram Yard, the potential total settlement was estimated to be none to approximately 11.5 inches. Along the Access and Utility Corridor, the potential total settlement was estimated to be approximately 0.8 to 9.5 inches. At the South Dunes, the potential total settlement was estimated to be approximately 0.5 inch up to 7 inches. KBJ stated that the ground improvement, vibro compaction method was proposed to reduce the settlement to 3 inch or less. KBJ stated that the preliminary estimates of LNG storage tank settlement based on the available ground investigation data and proposed ground improvement indicate that differential settlements would be in line with the requirements of ACI 376. The influence of soil structure interaction on local settlement gradients near the LNG storage tank edge would be evaluated with more detailed analysis and models in the detailed design phase, together with the limits that can be absorbed by the tank components. Due to the wide range of settlement values, we recommend in section 4.13.1.6 that Jordan Cove file an upper limit for total settlement for large flexible foundations and the maximum total edge settlement for equipment and structures consistent with applicable codes, including but not limited to API 620, API 625, API 653, and ACI 376.

Dredging would be required for the LNG marine vessels to traverse to the terminal as well as for the construction of the marine facilities. The existing shoreline would be excavated, dredged, and sloped during construction. To prevent slumping of the dredged slope, maintain the berthing line position, and provide structural integrity support to the landside facilities, the excavated shoreline would be protected from scour and erosion using stone or cement based rip-rap armoring. The Project basin shoreline would be protected from scour and erosion using stone or a cement based rip rap. The North Slope would be protected against scour from the toe to above the water line. Above the waterline, alternative scour (and wind/rain erosion) protection systems for less frequent events would be provided using any number of potential techniques including; concrete cellular mattresses, grout-injected geotextile fabric mattresses (fabriform) and/or geotextile reinforced vegetative planting. The proposed rip-rap armoring would minimize the potential for erosion where the shoreline would be excavated.

The results of Jordan Cove's geotechnical investigation at the Project site indicate that subsurface conditions are suitable for the proposed facilities, if proposed site preparation, foundation design, and construction methods are implemented in addition to the satisfaction of proposed recommendations.

Structural and Natural Hazard Evaluation

FERC regulations under 18 CFR 380.12 (m) requires applicants address the potential hazard to the public from failure of facility components resulting from accidents or natural catastrophes, evaluate how these events would affect reliability, and describe what design features and procedures that would be used to reduce potential hazards. In addition, 18 CFR 380.12 (o) (14) require an applicant to demonstrate how they would comply with 49 CFR 193 and NFPA 59A. USDOT regulations under 49 CFR 193 have some specific requirements on designs to withstand certain loads from natural hazards and also incorporates by reference NFPA 59A (2001 and 2006) and ASCE 7-05 and ASCE 7-93 via NFPA 59A (2001). NFPA 59A (2001) section 2.1.1 (c) also requires that Jordan Cove consider the plant site location in the design of the Project, with respect to the proposed facilities being protected, within the limits of practicality, against natural hazards, such as from the effects of flooding, storm surge, and seismic activities. This would be covered in USDOT's LOD on 49 CFR 193 Subpart B. However, the LOD would not cover whether the facility is designed appropriately against these hazards, which would be part of 49 CFR 193 Subpart C. Unlike other natural hazards, wind loads are covered in 49 CFR 193 Subpart B and would be covered in the LOD. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 and would be subject to USDOT's inspection and enforcement programs. The marine facilities would be subject to 33 CFR 127, which requires if the waterfront facility handling LNG is in a region subject to earthquakes the piers and wharves must be designed to resist earthquake forces. In addition, Coast Guard regulations under 33 CFR 127 incorporates by reference certain portions of NFPA 59A (1994) and ASCE 7-88 via NFPA 59A (1994). However, Coast Guard regulations do not provide criteria for a region subject to earthquakes or the earthquake forces the piers and wharves are to withstand and NFPA 59A (1994) section referenced in 33 CFR 127 is for seismic design only and is applicable to stationary LNG containers, which would not be under 33 CFR 127. Therefore, we evaluated the basis of design for all facilities for all natural hazards under FERC jurisdiction, including those under USDOT and Coast Guard jurisdiction.

Jordan Cove states that FERC and NEPA 59A requirements to design in accordance with ASCE 7-05 conflict with local building code requirements in the Oregon Structural Specialty Code (OSSC) of 2014. Specifically, OSSC 2014 is based on ASCE 7-10. To alleviate this conflict, Jordan Cove indicated that they would follow the requirements of ASCE 7-05 and ASCE 7-10 in parallel, with the final design made equal to or greater than the requirements of ASCE 7-05 and ASCE 7-10. Jordan Cove also indicated that in case of conflict, the more stringent requirement would govern. Thus, the final design would be intended to satisfy the FERC, NEPA 59A, ASCE 7-05, and ASCE 7-10 requirements. Jordan Cove states the facilities would also be constructed to the requirements in the 2006 International Building Code (IBC) and the 2014 Oregon State Specialty Code. These standards require various structural loads to be applied to the design of the facilities, including live (i.e., dynamic) loads, dead (i.e., static) loads, and environmental loads. FERC staff also evaluated potential engineering design to withstand impacts from natural hazards, such as earthquakes, tsunamis, seiche, hurricanes, tornadoes, floods, rain, ice, snow, regional subsidence, sea level rise, landslides, wildfires, volcanic activity, and geomagnetism. We recommend in section 4.13.1.6 that Jordan Cove file final design information (e.g., Civil/Structural drawings, specifications, and calculations) and associated quality assurance and control procedures with the documents reviewed, approved, and stamped and sealed by the professional engineer of record in Oregon.

If a project is authorized and constructed, the company would install equipment in accordance with its final design. In addition, we recommend in section 4.13.1.6 that Jordan Cove file, for review and approval, settlement results during hydrostatic tests of the LNG storage containers and periodically thereafter to verify settlement is as expected and does not exceed the applicable criteria in API Standards 620, 625, 653, and ACI 376.

Earthquakes, Tsunamis, and Seiche

FERC regulations under 18 CFR 380.12 (h) (5) requires evaluation of earthquake hazards based on whether there is potential seismicity, surface faulting, or liquefaction. Earthquakes and tsunamis have the potential to cause damage from shaking ground motion and fault ruptures. Earthquakes and tsunamis often result from sudden slips along fractures in the earth's crust (i.e., faults) and the resultant ground motions caused by those movements, but can also be a result of volcanic activity or other causes of vibration in the earth's crust. The damage that could occur as a result of ground motions is affected by the type/direction and severity of the fault activity and the distance and type of soils the seismic waves must travel from the hypocenter (or point below the epicenter where seismic activity occurs). To assess the potential impact from earthquakes and tsunamis, Jordan Cove evaluated historic earthquakes along fault locations and their resultant ground motions.

The USGS maintains a database containing information on surface and subsurface faults and folds in the United States that are believed to be sources of earthquakes of greater than 6.0 magnitude occurring during the past 1.6 million years (Quaternary Period).[199] KBJ performed a site-specific fault and seismic analysis for the Project, involving field investigations and subsequent data evaluation. The project site is covered by more than 100 feet of unconsolidated sand that prevents direct inspection of the bedrock, faults within 5 miles of the Project site have been identified from existing geologic maps. A total of 12 active and potentially active faults were identified within 100 miles of the Project site, but only the Barview fault is within 5 miles of the site. The Barview fault is a south dipping thrust fault that has offset the Miocene Epoch (23 to 5.3 million years ago) Empire Formation and Pleistocene Epoch (2.6 million to 11.7 thousand years ago) marine terrace platforms by about 3 feet. The mapped length of the Barview fault is less than 2 miles and extends from Coos Bay to the east-southeast north of Barview, Oregon (Madin et al., 1995). Based on the distance of the Barview fault from the Project site and its west-northwest strike, the Barview fault would not create a potential for fault offset at or near the ground surface at or near the Project site. KBJ indicated that neither fault is identified to potentially fault material younger than the Eocene Epoch and the location and extent of both faults is uncertain, they are considered unlikely to potentially create fault offset at or near the ground surface at the Project site. The Barview fault is included with South Slough thrust and reverse faults in the USGS Quaternary Fault and Fold database. Ground motions that Barview fault could potentially generate at the site would be evaluated in the Deterministic Seismic Hazard Analysis (DSHA). The Barview Fault and the South Slough thrust and reverse faults are both incorporate into the Probabilisitc Seismic Hazard Analysis (PSHA) as part of the gridded seismic sources and are not explicitly modeled as individual faults. Additionally, Jordan Cove states that there is no historically reported earthquakes have been associated with faults within 5 miles of the site; and the subsurface investigations at the site have not identified fault ruptures and there is no potential for affection faulting on the site.

The Jordan Cove LNG Project is in a region that has exhibited moderate to low seismic activity during the historic record, within the last 170 years. The region has been subject to numerous earthquakes of moment magnitude (MW) 4 or greater; however, the regional rate of seismicity is lower than in California and Washington. Earthquake records dating back to 1900 indicate there is only one record or an earthquake with a magnitude greater than 3 within a 50 km radius of the site. Near-fault effects such as rupture directivity and velocity or displacement pulses are typical for faults within 15 to 30 km of the site (National Earthquake Hazards Reduction [NEHRP], 2009; 2015). Directivity pulses are reasonably likely at 10 to 20 km from a site and polarization of seismic waves in the fault-normal and fault-parallel directions typically extends about 3 to 5 km from the fault (NEHRP 2015). The rupture directivity and pulses are considered for the Project

[199] USGS, Earthquake Hazards Program, Quaternary Fault and Fold Database of the United States, https://earthquake.usgs.gov/hazards/qfaults/, accessed Aug 2018.

site while fault-normal and fault-parallel directions of grounds motion are not considered. KBJ stated the Project site would not be located up-dip from the fault plane and significant directivity or pulses are unlikely. While large magnitude earthquakes have not occurred in the Pacific Northwest during the Historical record, based on the geological record, large magnitude earthquakes with moment magnitudes of 9 have occurred on the CSZ during the past 11,000 years with the last occurring in the year 1700. The CSZ is the dominate earthquake ground motion hazard source for the site. Onshore directivity is not expected for the CSZ because of the anticipated rupture geometry (Baker et al. 2012). Jordan Cove stated that the subsurface investigations at the Project site have not identified fault ruptures, and identified active faults in the region do not have a potential for affecting faulting, and growth faults are not present. While the presence of major tectonic faults and growth faults can require special consideration, the presence or lack of major tectonic faults identified near the site does not define whether earthquake ground motions can impact the site because ground motions can be felt large distances away from an earthquake hypocenter depending on number of factors. Jordan Cove stated that ground motions at the facility would be monitored by three sets of seismometers. An open-field seismometer located in a clear area away from other equipment would provide a baseline ground movement reference for any event. Two seismometers located on the top and bottom of each LNG storage tank. If any of the three seismometers exceeds safe limits, an alarm would sound in the control room where operators could shut down operations.

To address the potential ground motions at the site, USDOT regulations in 49 CFR 193.2101 Subpart C require that field-fabricated LNG tanks must comply with section 7.2.2 of NFPA 59A (2006) for seismic design. NFPA 59A (2006) requires LNG storage tanks be designed to continue safely operating with earthquake ground motions at the ground surface at the site that have a 10 percent probability of being exceeded in 50 years (475 year mean return interval), termed the operating basis earthquake (OBE). In addition, USDOT regulations in 49 CFR 193.2101 Subpart C require that LNG tanks be designed to have the ability to safely shutdown when subjected to earthquake ground motions which have a 2 percent probability of being exceeded in 50 years (2,475 year mean return interval), termed the safe shutdown earthquake (SSE). USDOT regulations in 49 CFR 193.2101 Subpart C also incorporate by reference NFPA 59A (2001) Chapter 6, which require piping systems conveying flammable liquids and flammable gases with service temperatures below −20°F, be designed as required for seismic ground motions. If authorized and constructed, LNG facilities as defined in 49 CFR 193, would be subject to the USDOT's inspection and enforcement programs.

In addition, FERC staff recognizes Jordan Cove would also need to address hazardous fluid piping with service temperatures at −20 degrees Fahrenheit and higher and equipment other than piping, and LNG storage (shop built and field fabricated) containers. We also recognize the current FERC regulations under 18 CFR 380.12 (h) (5) continue to incorporate National Bureau of Standards Information Report (NBSIR) 84-2833. NBSIR 84-2833 provides guidance on classifying stationary storage containers and related safety equipment as Category I and classifying the remainder of the LNG project structures, systems, and components as either Category II or Category III, but does not provide specific guidance for the seismic design requirements for them. Absent any other regulatory requirements, this guidance recommends that other LNG project structures classified as Seismic Category II or Category III be seismically designed to satisfy the Design Earthquake (DE) and seismic requirements of the ASCE 7-05 in order to demonstrate there is not a significant impact on the safety of the public. ASCE 7-05 is recommended as it is a complete American National Standards Institute (ANSI) consensus design standard, its seismic requirements are based directly on the National Earthquake Hazards Reduction Program (NEHRP) Recommended Provisions, and it is referenced directly by the IBC. Having a link directly to the IBC and ASCE 7 is important to accommodate seals by the engineer of record because the IBC is directly linked to state professional licensing laws while the NEHRP Recommended Provisions are not.

The geotechnical investigations of the existing site performed by KBJ indicate the site class was determined in accordance with ASCE 7-05, ASCE 7-10, and the 2014 edition of the OSSC (Oregon Structural Special Specialty Code) in the Geotechnical Report (KBJ, 2017) using the shear wave velocity measurements form the downhole P-S suspension logging and cross hole seismic logging. The average shearwave velocity in the upper 100 feet (30 meters), VS30 of 697.5 to 783 feet per second, at two of the three locations at the LNG storage tanks. The shear wave velocity measurement at the one location indicated Seismic Site Class E (VS30 of 480.9 feet per second); however, all the locations would be Seismic Site Class D after ground improvement to mitigate liquefiable soils. Seismic Site Class D is valid once liquefiable soils at the site have been mitigated to eliminate Seismic Site Class F conditions (KBJ, 2017). This is in accordance with ASCE 7-05, which is incorporated directly into 49 CFR 193 for shop fabricated containers less than 70,000 gallons and via NFPA 59A (2006) for field fabricated containers.[200] This is also in accordance with IBC (2006). Sites with soil conditions of this type would experience significant amplifications of surface earthquake ground motions at longer periods. Due to the presence of the CSZ (dips under the site) the seismic risk to the site is considered high.

KBJ performed a site-specific seismic hazard study for the site. The study concluded that the site would have a Horizontal Operating Basis Earthquake (OBE) peak spectral ground acceleration at 0.2 s-period of 0.857 g, and a Horizontal Safe Shutdown Earthquake (SSE) peak spectral ground acceleration at 0.2 s-period of 1.537 g based on improved site conditions. The OBE has a 10% probability of being exceed in 50 years (475 year mean return interval) while the SSE has a 2% chance of being exceeded in 50 years (2,475 year mean return interval). The study also provided the site-specific Design Earthquake (DE) values SDS and SD1 of 1.025 g and 1.002 g, respectively. KBJ also developed the Vertical response spectra using the horizontal response spectra and vertical-to-horizontal (V/H) ratios and indicated the V/H ratios are not less than ½ for the Project. Based on the design ground motions for the site and the importance of the facilities, the facility seismic design is assigned Seismic Design Category D in accordance with the IBC (2006) and ASCE 7-05. FERC staff independently evaluated the OBE PGA, SSE PGA, 0.2-second design spectral acceleration, and 1.0-second design spectral accelerations for the site using the Applied Technology Council (ATC) and USGS Earthquake Hazards Program Seismic Design Maps[201] and Unified Hazard[202] tools for all occupancy categories (I through IV). Based on the ATC and USGS tools, FERC found the OBE and SSE peak spectral accelerations at 0.2 s-period for the site based on Site Class D to equal 0.722 g and 1.694 g, respectively. The OBE and SSE that Jordan Cove

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[200] There are six different site classes in ASCE 7-05, A through F, that are representative of different soil conditions that impact the ground motions and potential hazard ranging from Hard Rock (Site Class A), Rock (Site Class B), Very dense soil and soft rock (Site Class C), Stiff Soil (Site Class D), Soft Clay Soil (Site Class E), to soils vulnerable to potential failure or collapse, such as liquefiable soils, quick and highly sensitive clays, and collapsible weakly cemented soils (Site Class F).

[201] USGS, Changes to U.S. Seismic Design Maps Web Tools, https://earthquake.usgs.gov/designmaps/us/application.php, accessed December 2018

[202] USGS, Unified Hazards Tool , https://earthquake.usgs.gov/hazards/interactive/, accessed Dec 2018

provided are about 80 percent of the values from the ATC/USGS websites which would be acceptable for site specific values.

In addition to the review of the peak ground accelerations, FERC staff reviewed the correlation between the peak ground accelerations, the Modified Mercalli Intensity scale,[203] and Richter scale. FERC staff found that there is no direct correlation between an earthquake's magnitude and the peak ground accelerations experience at a site. The peak ground accelerations at a site are determined by multiple factors such as site classification, soil types, the distance from an earthquake's epicenter, and would vary from location to location; while an earthquake's magnitude is determined by the amplitude of the seismic wave and energy dispersed. Although there is no direct correlation between a site's peak ground acceleration and a magnitude on the Richter scale, there is an empirical correlation, by the USGS, between the peak ground acceleration and the Modified Mercalli Intensity scale, as well as between the Modified Mercalli Intensity scale and the Richter scale.[204] The Modified Mercalli Intensity scale measures the perceived intensity of an earthquake and the potential damage that could occur to structures based on ground acceleration and velocity. Given the OBE and SSE values provided in the study, the site would experience an Intensity rating of 9, which corresponds to perceived violent shaking and a potential for heavy damage to structures. Taking the Modified Mercalli Intensity rating of 9 and comparing that to the Richter scale, FERC staff found that the OBE and SSE would correspond to a magnitude 6 or greater earthquake from the closest fault. However, FERC staff also acknowledges that this is not a direct comparison and relies on multiple empirical correlations between the accelerations and scales.

ASCE 7-05 also requires determination of the Seismic Design Category based on the Occupancy Category (or Risk Category in ASCE 7-10 and 7-16) and severity of the earthquake design motion. The Occupancy Category (or Risk Category) is based on the importance of the facility and the risk it poses to the public.[205] FERC staff has identified the Project as a Seismic Design Category D based on the ground motions for the site and an Occupancy Category (or Risk Category) of II or III or IV, this seismic design categorization would appear to be consistent with the IBC (2006) and ASCE 7-05 (and ASCE 7-10).

Seismic events can also result in soil liquefaction in which saturated, non-cohesive soils temporarily lose their strength/cohesion and liquefy (i.e., behave like viscous liquid) as a result of

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203 USGS, The Sidebar Computer Program, a seismic-shaking intensity meter: users' manual and software description, http://pubs.er.usgs.gov/publication/ofr03202, accessed March 2019

204 USGS, Magnitude/Intensity Comparison, https://earthquake.usgs.gov/learn/topics/mag_vs_int.php, accessed March 2019

205 ASCE 7-05 defines Occupancy Categories I, II, III, and IV. Occupancy Category I represents facilities with a low hazard to human life in even of failure, such as agricultural facilities; Occupancy Category III represents facilities with a substantial hazard to human life in the event of failure or with a substantial economic impact or disruption of day to day civilian life in the event of failure, such as buildings where more than 300 people aggregate, daycare facilities with facilities greater than 150, schools with capacities greater than 250 for elementary and secondary and greater than 500 for colleges, health care facilities with 50 or more patients, jails and detention facilities, power generating stations, water treatment facilities, telecommunication centers, hazardous facilities that could impact public; Occupancy Category IV represents essential facilities, such as hospitals, fire, rescue, and police stations, emergency shelters, power generating stations and utilities needed in an emergency, aviation control towers, water storage and pump structures for fire suppression, national defense facilities, and hazardous facilities that could substantially impact public; and Occupancy Category II represents all other facilities. ASCE 7-10 changed the term to Risk Categories I, II, III, and IV with some modification.

increased pore pressure and reduced effective stress when subjected to dynamic forces such as intense and prolonged ground shaking. Areas susceptible to liquefaction may include saturated soils that are generally sandy or silty. Typically, these soils are located along rivers, streams, lakes, and shorelines or in areas with shallow groundwater. The site-specific seismic study indicates liquefiable soils are present throughout the Project site, and their depths vary with the location. The liquefiable soils at Ingram Yards area and the Access and Utility Corridor have a maximum of approximately EL −30 feet NAVD 88. At the LNG terminal and the Access and Utility Corridor, the liquefiable layers are predicted to extend below the dunes present on the site. At the South Dunes Area, liquefaction is estimated in a soil zone that starts at the groundwater table and extends to variable depths from EL 0 feet to approximately EL −25 feet NAVD 88. Jordan Cove indicated that a detailed review of the potential methods of soil improvement has been undertaken, and a number of these proven methods could be employed for the Project, depending on the results of the final site investigations planned. Those methods are: vibro-compaction; sand compaction; dry excavation and removal; wet excavation and removal and soil mixing. Jordan Cove has indicated that the LNG facilities at the site would be constructed on either a site improved with deep soil mixing or in some cases deep foundations, which would mitigate any potential impacts of soil liquefaction to minimize or eliminate any effects soil liquefaction. Also to counteract associated lateral spreading effects at the marine facilities, Jordan Cove has elected to install a permanent sheet pile wall in combination with improved soils for the LNG marine vessel berth.

Seismic events in waterbodies can also cause tsunamis or seiches by sudden displacement of the sea floors in the ocean or standing water. Tsunamis and seiche may also be generated from volcanic eruptions or landslides. Tsunami wave action can cause extensive damage to coastal regions and facilities. The west coast of the United States has historically been subject to minor inundation from tsunamis generated by distant earthquakes in South America, Alaska, and Japan. Kelsey et al. (2005) note that tsunamis generated from these distant subduction zone earthquakes have minor inundation effects because of the long diagonal approach of tsunami waves to the west coast form these sources. In addition, northern California, Oregon, and Washington have been subjected to large tsunamis from CSZ megathrust earthquakes, with the last one occurring approximately in the year 1700. Jordan Cove conducted hydrodynamic and tsunami modeling studies for the Project site and indicated a tsunami generated by a megathrust earthquake on the CSZ would present the greatest tsunami inundation risk at the project site and the maximum design tsunami run-up elevation for the project site is no greater than 34.5 feet NAVD 88 including co-seismic subsidence and sea level rise effects. The co-seismic subsidence information indicates that the largest coastal subsidence, of 3 to 6 feet, occurred in northern Oregon and southern Washington, with subsidence ranging from 0 to 3 feet elsewhere. Leonard et al. (2004) estimated an average of 2 feet of co-seismic subsidence occurred in the Coos Bay area during the 1700 earthquake. For the Project site and in accordance with more recent tsunami modeling completed for the Southern Oregon Coast (Witter et al. 2011), the estimated subsidence would be on the order of 7.6 feet. Jordan Cove indicated that the Project would be designed to mitigate inundation due to the design tsunami and the design tsunami run-up elevations are established including an allowance for subsidence. In addition, Jordan Cove indicated the design tsunami run-up elevations have been determined in conjuction with a mean high water tide. Jordan Cove also indicated that furthermore tsunami protection berms, safety critical elements of the facility, point of support elevations, invert levels and underside of essential equipment, would be at least 1 foot above the estimated maximum run-up elevation and most will be far above that elevation. The criteria used to evaluate tsunami wave heights it based on new requirements provided in ASCE 7-16 which indicates that Maximum Considered Tsunami (MCT) events should use the same maximum earthquake criteria as used to determine Maximum Consider Ground Motions (and SSE ground motions). FERC staff worked with NOAA who helped developed Tsunami maps for ASCE 7-16 and NOAA determined that inundation elevations from the MCT event for the Jordan Cove LNG Project site were consistent with those determined by Jordan Cove. Therefore, FERC staff agrees that the tsunami elevations that Jordan Cove provided are suitable for the Project site.

Hurricanes, Tornadoes, and other Meteorological Events

Hurricanes, tornadoes, and other meteorological events have the potential to cause damage or failure of facilities due to high winds and floods, including failures from flying or floating debris. To assess the potential impact from hurricanes, tornadoes, and other meteorological events, Jordan Cove evaluated such events historically. The severity of these events are often determined on the probability that they occur and are sometimes referred to as the average number years that the event is expected to re-occur, or in terms of its mean return/recurrence interval.

Because of its location, the Project site would not likely be subject to hurricane force winds during the life of the Project, however, strong extratropical cyclones (baroclinic, cold core systems are common in the region. These storms are capable of producing winds of hurricane force, and as such, Jordan Cove has indicated that the project site would be designed to withstand strong wind events. However, because wind speeds at the Project location are considerably less than those that occur in the Gulf Coast east region and the east cose of the US, Jordan Cove stated that the wind load combinations specified in Chapter 2 of ASCE 7-10 should be used. Jordan Cove stated that the design wind speed using ASCE 7-10 Load and Resistance Factor Design (LRFD) and Allowable Stress Design (ASD) for LNG facilities and hazardous structures, which would be categorized as Risk Category III and IV (Occupancy Category in ASCE 7-05).

Jordan Cove hired Cermak Peterka Peterson (CPP) to perform a site specific wind speed assessment for this Project. CPP determined 127 mph 3-second gust as the Design Wind Speed (3-second gust, 33 feet, Exposure category C). The 127 mph 3-second gust was determined based on the criteria specified in 49 CFR 193.2067 and ASCE 7 based on a 10,000 year mean return interval, or a 0.5 percent probability of occurrence within a 50-year period for the site. CPP stated that the 127 mph wind speed is a strength level speed corresponding directly to the mean recurrence interval (MRI) criteria. The 127 mph 3-second gust converts to a sustained wind speed of approximately 102 mph. When using this wind speed with ASCE 7-05 load combinations, the value should be reduced by a factor of square root of 1.6 or the design wind pressure reduced by a factor of 1.6 in order to achieve the desired 10,000-year MRI. When using the 127 mph wind speed with ASCE 7-10 load combinations, no additional factors are required. In both cases, the wind importance factor is not applicable due to the wind speed directly corresponding with the required return period. The 127 mph 3-second gust equates to a strong Category 2 Hurricane using the Saffir-Simpson scale (96 to 110 mph sustained winds, 117 to 140 mph 3-second gusts). FERC staff found that when reviewing Figure 6-1A of ASCE 7-05, the Project location would be closest to the 90 mph 3-second gust isocontour in the special wind region area. Because the Project site is located within a special wind region, FERC staff did not utilize the ATC hazard tool, but instead utilized the ASCE 7 hazard tool, which provides the 3-second gust at a height of 33 feet above ground level and Exposure Category C. For the Project site, the ASCE 7-10 3-second gust is observed to be 115 mph. Jordan Cove indicated that non-hazardous buildings and structures would be designed to satisfy the design win speed requirements of the OSSC, rather than the requiremnts of USDOT regulations. Moreover, Jordan Cove confirmed that all facilities, including those containing LNG or other hazardous fluids (and associated safety systems), would be designed for wind loads in accordance with Chapters 26 through 31 of ASCE 7-10 using the site specific wind speed in accordance with 49 CFR 193.2067 and code-based wind directionality factor, velocity pressure exposure coefficient and topographic factor as specified in ASCE 7-10 based on Exposure Category D and structure type, accordingly. For simplicity and consistency, Jordan Cove intends to use a single conservative Exposure Category D for all wind design regardless of physical location within the facility. Jordan Cove's final wind speed design 127 mph 3-second gust, 33 feet, Exposure Category D is more conservative than CPP suggested 127 mph 3-second gust, 33 feet, Exosure Category C. However it is unclear whether some of the non-hazardous buildings and structures would qualify as LNG facilities under USDOT regulations, and, if so, whether a 10,000 year return period (123 mph 3-second gust, Exposure Category D) would meet USDOT requirements. Therefore, we recommend in section 4.13.1.6 that Jordan Cove consult with USDOT staff as to whether the design wind speed for other non-hazardous buildings and structures would be subject to USDOT requirements prior to the end of the comment period of the draft EIS.

Jordan Cove must meet 49 CFR 193.2067 Subpart B for wind load requirements. In accordance with the MOU, the USDOT will evaluate in its LOD whether an applicant's proposed Project meets the USDOT requirements under Subpart B. If the Project is authorized and constructed, the facilities would be subject to the USDOT's inspection and enforcement programs. Final determination of whether the facilities are in compliance with the requirements of 49 CFR 193 Subpart B would be made by the USDOT staff.

In addition, as noted in the limitation of ASCE 7-05 section 6.5.4.3 and ASCE 7-10 section 26.5.4, tornadoes were not considered in developing basic wind speed distributions. This leaves a potential gap in potential impacts from tornadoes. Therefore, FERC staff evaluated the potential for tornadoes. Appendix C of ASCE 7-05 makes reference to American Nuclear Society 2.3 (1983 edition), *Standard for Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites*. This document has since been revised in 2011 and reaffirmed in 2016 and is consistent with NUREG/CR-4461, *Tornado Climatology of the Contiguous U.S.*, Rev. 2 (NUREG 2007). These documents provide maps of a 100,000 mean year return period for tornadoes using 2 degree latitude and longitude boxes in the region to estimate a tornado impacting a structure with a 200 foot characteristic length. Figures 5-8 and 8-1 from NUREG/CR-4461 indicate a 100,000 year maximum tornado wind speeds would be less than 65 mph 3-second gusts for the Project site location. Later editions of ASCE 7 (ASCE 7-10 and ASCE 7-16) make reference to International Code Council (ICC) 500, *Standard for Design and Construction of Storm Shelters*, for 10,000 year tornadoes. However, the ICC 500 maps were conservatively developed based on tornadoes striking regions and indicate a 130 mph 3-second gust for a 10,000 year event, which is higher than the 65 mph 3-second gust in American Nuclear Society 2.3 and NUREG/CR-4461. As a result, we conclude the use of an equivalent 127 mph 3-second gust, 33 feet, Exposure Category D, is adequate for the LNG storage tanks and conservative from a risk standpoint for the other LNG and hazardous facilities. USDOT will provide a LOD on the Project's compliance with 49 CFR 193 Subpart B in regard to wind speed. This determination will be provided to the Commission as further consideration to the Commission on its decision to authorize or deny the Project.

The USDOT regulations in 49 CFR 193.2067 Subpart B would require the impounding system for the LNG storage tanks to withstand impact forces from wind borne missiles. ASCE 7 also recognizes the facility would be in a wind borne debris region. Wind borne debris has the potential to perforate equipment and the LNG storage tanks if not properly designed to withstand such impacts. The potential impact is dependent on the equivalent projectile wind speed, characteristics of projectile, and methodology or model used to determine whether penetration or perforation would occur. However, no criteria are provided in 49 CFR 193 or ASCE 7 for these specific parameters. NFPA 59A (2016) recommends Comite Euro-International du Beton (CEB) 187 be used to determine projectile perforation depths. In order to address the potential impact, we recommend in section 4.13.1.6 that Jordan Cove provide a projectile analysis for review and approval to demonstrate that the outer concrete impoundment wall of a full-containment LNG tank could withstand wind borne projectiles prior to construction of the final design. The analysis should detail the projectile speeds and characteristics and method used to determine penetration or perforation depths. FERC staff would compare the analysis and specified projectiles and speeds using established methods, such as CEB 187, and DOE and Nuclear Regulatory Commission (NRC) guidance.

In addition, FERC staff evaluated historical tropical storm, hurricane, and tornado tracks in the vicinity of the project facilities using data from the Department of Homeland Security (DHS) Homeland Infrastructure Foundation Level Data (HILFD) and NOAA Historical Hurricane Tracker.[206,207] Since 1900, there is no historical storm or hurricane that has been reported within 65 nautical miles of the LNG terminal site. Hurricanes do not occur near the LNG terminal site as the environment does not support these barotropic, warm core systems. Since 1950, there is no historical tornado event that has been reported within 10 nautical miles of the LNG terminal site. Although tropical cyclones do not occur at the Project site, extreme storms offshore sometimes cause the water level along the coastline to raise significantly beyond the normal tide levels. This phenomenon is referred to as storm surge. Jordan Cove discussed storm surge expected at the site based on the NAVD 88 using a Federal Emergency Management Agency (FEMA) conversion factor, indicating a storm surge elevation of 24.62 feet at the Project site. Jordan Cove indicated that the storm surge is not considered additive to the tsunami inundation height as both storm surge and tsunami are low frequency events. FERC staff agrees that storm surge and tsunami would not need to be considered simultaneously.

Potential flood levels may also be informed from the FEMA Flood Insurance Rate Maps, which identify Special Flood Hazard Areas (base flood) that have a 1 percent probability of exceedance in 1 year to flood (or a 100 year mean return interval) and moderate flood hazard areas that have a 0.2 percent probability of exceedance in 1 year to flood (or a 500 year mean return interval). According to the FEMA National Flood Hazard Layer, portions of the Project would be located in the 100-year floodplain. In addition, according to FEMA flood hazard maps (2018), the 100-year flood elevation at the site is +12.4 feet NAVD 88 and the 500-year flood elevation is +13 feet NAVD 88. We recognize that a 500 year flood event has been recommended as the basis of design for critical infrastructure in publications, including ASCE 24, Flood Resistant Design and Construction. Therefore, it is our opinion that it is good practice to design critical energy infrastructure to withstand 500 year event from a safety and reliability standpoint for the still water elevation (SWEL) and wave crests. Furthermore, we determined the use of intermediate values

[206] DHS, Homeland Infrastructure Foundation Level Data, https://hifld-geoplatform.opendata.arcgis.com/, August 2018.
[207] NOAA, Historical Hurricane Tracker, https://coast.noaa.gov/hurricanes/, August 2018.

from NOAA for sea level rise and subsidence is more appropriate for design and higher projections are more appropriate for planning in accordance with NOAA (2017)[208] which recommends defining a central estimate or mid-range scenario as baseline for shorter-term planning, such as setting initial adaptation plans for the next two decades and defining upper bound scenarios as a guide for long-term adaptation strategies and a general planning envelope. Jordan Cove has indicated that the facility would be designed to handle a 100-year storm surge without any wave overtopping, and would be designed to accommodate the wave overtopping that would occur from a 500-year storm surge. Jordan Cove stated the storm surge expected at the site based on the NAVD 88 using a FEMA conversion factor, indicating a coastal flooding (storm surge) elevation of 24.62 feet at the Project site. The Project site elevations of pipeline and all above ground facilities are higher than the maximum coastal flooding elevations estimated.

Jordan Cove proposes to construct most structures above the elevation +46 feet NAVD 88 which would minimize impacts associated with potential storm surges. Exceptions include the LNG storage tanks and water-dependent facilities such as the marine terminal and Material Offloading Facility (MOF). The LNG storage tank base would have an elevation of approximately +27 feet NAVD 88 would be surrounded by a tertiary protective berm with a crest elevation of no less than +46 feet NAVD 88. Jordan Cove indicated that the parts of the marine facilities that are normally occupied or operational would typically be at an elevation of +34.5 feet or greater, whereas normally unoccupied/non-operational parts of the marine facilities may be at a lower elevation.

We generally evaluate the design against a 500-year SWEL with a 500-year wave crest and relative sea level rise and subsidence. According to FEMA Flood Insurance Study (FIS) for Coos County, Oregon, the average wave height offshore from Coos County is 8.5 feet, while the average peak spectral wave period is 11.1 seconds, although a period of 20 to 25 seconds is not uncommon. Also we would expect an intermediate projected sea level rise of 1.02 feet between 2020 and 2050 as provided by NOAA (2017). Adding the 500-year storm surge, wave crest elevations, relative sea level rise and subsidence results in a total elevation of 42 feet. FERC staff evaluated Jordan Cove's proposed 500-year flood against the 2014 FEMA Flood Insurance Study (FIS) for Coos County, Oregon, which provides various transection lines and associated 10-, 50-, 100-, and 500-year SWELs, 500-year wave envelopes, and 500-year wave effects along the length of the transection lines. We believe the use of intermediate values from NOAA for relative sea level rise and subsidence is more appropriate for design and higher projections are more appropriate for planning envelope. Also, the Project area is outside of the VE (velocity wave) zone that corresponds to the 100-year (1 percent annual chance) coastal floodplains that have additional hazards associated with storm waves. The Project area is also outside the 500-year (0.2 percent annual chance) flood area. As a result, we conclude that the facility would be able to withstand storm surge without damage during a 500-year storm event.

Shoreline erosion could occur at the Project site and along the opposite shoreline as a result of waves, currents, and vessel wakes. Jordan Cove stated that the Project basin shoreline would be protected from scour and erosion using stone or a cement based rip rap. Even though shoreline erosion is a concern at the site, the proposed mitigation measures would minimize erosion and scour impacts.

[208] Global And Regional Sea Level Rise Scenarios for the United States, U.S. Department Of Commerce, National Ocean and Atmospheric Administration, National Ocean Service Center for Operational Oceanographic Products and Services, January 2017.

FERC staff evaluated the basis of design for the Project relating to withstanding rain, ice, and snow events. To handle the rain the area receives, Jordan Cove stated that the roofs of permanent structures to be located onsite would be designed to preclude instability resulting from ponding effects by ensuring adequate primary and secondary drainage systems, slope, and member stiffness. Jordan Cove discussed the ice load design for the Project and stated the ice load is not applicable for the Project site and design ice thickness is 0 inches in accordance with ASCE 7-10 and climatological studies. The coastal location of this Project also impacts the amount of snow the area receives. Jordan Cove states that the snow design for this Project was based on ASCE 7-10 design maps and the 2014 OSSC. Jordan Cove indicated the snow load design bases for this Project are 5 pounds per square foot (psf) for ground snow load and 20 psf for the roof snow load.

Landslides and other Natural Hazards

Landslides in the United States occur in all 50 states. The primary regions of landslide occurrence and potential are the coastal and mountainous areas of California, Oregon, and Washington, the states comprising the intermountain west, and the mountainous and hilly regions of the eastern United States. Jordan Cove evaluated the type and occurrence of landslides in the vicinity of the Project site and indicated that no landslide deposits were identified within the Project area. There is a moderate to high landslide susceptibility hazard on the dune ridges at the Project site; however, the active landslides have not been identified on the sand dunes. The high susceptibility at the Project site is primarily based on the steep slopes of the dune deposits. Jordan Cove states that they would regrade the steep dunes thereby eliminating potential landslide hazards related to dune sand stability. The potential for tsunamis associated with submarine landslides is more likely a source in the CSZ. Jordan Cove evaluated the type and occurrence of landslides for the Project area and indicated that no landslides deposits were identified with the Project site. A moderate to high landslide susceptibility hazard is mapped on the dune ridges at the Project site; however, active landslides have not been identified on the sand dunes. The high susceptibility indicated at the Project site is primarily based on the steep slopes of the dune deposits. Jordan Cove would regrade the steep dunes thereby eliminating potential landslide hazards related to dune sand stability.

Volcanic activity is primarily a concern along plate boundaries on the West Coast and Alaska and also Hawaii. Based on FERC staff review of maps from USGS[209] and DHS[210] and Jordan Cove report: the Cascade Mountain Range is the volcanic arc complex of the CSZ and is located approximately 100 miles east of the Project site. Volcanoes of the Cascade Mountains are found from northern California to British Columbia. The nearest Cascade Volcano is the Crater Lake caldera that was formed during the eruption and collapse of Mount Mazama approximately 7,700 years ago. The Project site would not be directly affected by the various types of volcanic eruption hazards due to the distance of the hazards, the upwind location of the Project site from the volcanic hazard, and the low likelihood of volcanic eruption during the lifetime of the Project.

The west coast is often associated with the potential of wildfires. According to the Oregon Department of Forestry (ODF), have been a number of fires that have occurred within 100 miles of the Jordan Cove site, however, none of these fires occurred in the immediate proximity of Coos

[209] United States Geological Survey, U.S. Volcanoes and Current Activity Alerts, https://volcanoes.usgs.gov/index.html, accessed Aug 2018.

[210] Department of Homeland Security, Homeland Infrastructure, Foundation-Level data (HIFLD), Natural Hazards, hifld-geoplatform.opendata.arcgis.com, accessed Aug 2018

Bay. In addition, Jordan Cove site is surrounded by water on the southern and eastern side, separating the site from the more forested areas to the east of the site. As such, it is unlikely that a wildfire would occur at the Project site. Additionally, Jordan Cove indicated that the plans for how to handle fires are provided in the Emergency Response Plan that has been developed for the site.

Geomagnetic disturbances (GMDs) may occur due to solar flares or other natural events with varying frequencies that can cause geomagnetically induced currents, which can disrupt the operation of transformers and other electrical equipment. USGS provides a map of GMD intensities with an estimated 100 year mean return interval.[211] The map indicates the Jordan Cove site could experience GMD intensities of 400 nano-Tesla (nT) with a 100 year mean return interval. However, Jordan Cove would be designed such that if a loss of power were to occur the valves would move into a fail-safe position. In addition, Jordan Cove is an export facility that does not serve any U.S. customers.

External Impact Review

To assess the potential impact from external events, FERC staff conducted a series of reviews to evaluate transportation routes, land use, and activities within the facility and surrounding the the LNG terminal site, and the safeguards in place to mitigate the risk from events, where warranted. FERC staff coordinated the results of the reviews with other federal agencies to assess potential impacts from vehicles and rail; aircraft impacts to and from nearby airports and heliports; pipeline impacts from nearby pipelines; impacts to and from adjacent facilities that handle hazardous materials under the EPA's Risk Management Plan (RMP) regulations and power plants, including nuclear facilities under the Nuclear Regulatory Commission's regulations. Specific mitigation of impacts from use of external roadways, rail, helipads, airstrips, or pipelines are also considered as part of the engineering review done in conjunction with the NEPA review.

FERC staff uses a risk-based approach to assess the potential impact of the external events and the adequacy of the mitigation measures. The risk-based approach uses data based on the frequency of events that could lead to an impact and the potential severity of consequences posed to the LNG terminal site and the resulting consequences to the public beyond the initiating events. The frequency data is based on past incidents and the consequences are based on past incidents and/or hazard modeling of potential failures.

Road

FERC staff reviewed whether any truck operations would be associated with the project and whether any existing roads would be located near the site. FERC staff uses this information to evaluate whether the project and any associated truck operations could increase the risk along the roadways and subsequently to the public and whether any pre-existing unassociated vehicular traffic could adversely increase the risk to a project site and subsequently increase the risk to the public. In addition, if authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 and would be subject to the USDOT's inspection and enforcement programs. USDOT regulations under 49 CFR 193.2155 (a) (5) (ii) Subpart C require that structural members of an impoundment system must be designed and constructed to

[211] United States Geological Survey, Magnetic Anomaly Maps and Data for North America, https://mrdata.usgs.gov/magnetic/map-us.html#home, accessed Aug 2018.

prevent impairment of the system's performance reliability and structural integrity as a result of a collision by or explosion of a tank truck that could reasonably be expected to cause the most severe loading if the liquefaction facility adjoins the right-of-way of any highway. Similarly, NFPA 59A (2001), section 8.5.4, requires transfer piping, pumps, and compressors to be located or protected by barriers so that they are safe from damage by rail or vehicle movements. However, the USDOT regulations and NFPA 59A (2001) requirements do not indicate what collision(s) or explosion(s) could reasonably be expected to cause the most severe loading. FERC staff evaluated consequence and frequency data from these events to evaluate these potential impacts.

FERC staff evaluated the risk of the truck operations based on the consequences from a release, incident data from the USDOT's Federal Highway Administration (FHWA), National Highway Traffic Safety Administration (NHTSA), and Pipeline and Hazardous Materials Safety Administration (PHMSA), EPA, NOAA, and other reports[212,213,214,215,216,217,218], and frequency of trucks and proposed mitigation to prevent or reduce the impacts of a vehicular incident.

Incident data from DOT FHWA, DOT NHTSA, and DOT PHMSA indicate hazardous material incidents are very infrequent (4e-3 incidents per lane mile per year) and nearly 75 to 80 percent of hazardous material vehicular incidents occur during unloading and loading operations while the other 20 to 25 percent occur while in transit or in transit storage. In addition, approximately 99 percent of releases are 1,000 gallons or less and catastrophic events that would spill 10,000 gallons or more make up less than 0.1 percent of releases. In addition, less than 1 percent of all reportable hazardous material incidents with spillage result in injuries and less than 0.1 percent of all reportable hazardous material incidents with spillage result in fatalities.

The EPA and NOAA report that 80 percent of fires that lead to container ruptures results in projectiles and that 80 percent of projectiles from liquefied petroleum gas (LPG) incidents, which constitute the largest product involved in BLEVEs, travel less than 660 feet. The EPA also reports that on average container ruptures would result in less than four projectiles for cylindrical containers and 8.3 for spherical vessels. FERC staff evaluated other reports that affirmed the EPA estimates based on data for approximately 150 experimental and accidental pressure vessel bursts (PVBs) and BLEVEs with approximately 683 total projectiles (4.6 average fragments per incident) that showed approximately 80 percent of fragments traveled 490 to 820 feet and within 6.25 times the estimated or observed fireball radius. The data also showed projectiles have traveled up to 3,900 feet for large LPG vessels and 1,200 feet for LPG rail cars. In all the documented cases, the

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212 USDOT FHWA, Office of Highway Policy Information, *Highway Statistics 2016*, https://www.fhwa.dot.gov/policyinformation/statistics/2016/, accessed March 2019.

213 USDOT NHTSA, *Traffic Safety Facts Annual Report Tables*, https://cdan.nhtsa.gov/tsftables/tsfar.htm, accessed March 2019.

214 USDOT PHMSA, Office of Hazardous Material Safety, *Incident Reports Database Search*, https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/Welcome.aspx, accessed March 2019.

215 U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, ALOHA®, User's Manual, The CAMEO® Software System, February 2007.

216 Birk, A.M., BLEVE Response and Prevention Technical Documentation, 1995.

217 American Institute of Chemical Engineers, Center for Chemical Process Safety, Guidelines for Vapor Cloud Explosion, Pressure Vessel Burst, BLEVE, and Flash Fire Hazards, Second Edition, 2010.

218 Lees, F.P, Lees' Loss Prevention in the Process Industries: Hazard Identification, Assessment, and Control, Volume 2, Second Edition, 1996.

projectiles traveled less than 15 times the fireball diameter, but one of the reports indicated up to 30 times the fireball diameter is possible albeit very rare.

Unmitigated consequences under average ambient conditions from releases of 1,000 gallons through a 1-inch hole would result in distances ranging from 25 to 200 feet for flammable vapor dispersion, and 75 to 175 feet for jet fires. Unmitigated consequences under worst case weather conditions from catastrophic failures of trucks proposed at the site generally can range from 200 to 2,000 feet for flammable vapor dispersion, 275 to 350 feet for radiant heat of 5 kW/m^2 from jet fires, 800 to 1,050 feet to a 1 psi overpressure from a BLEVE, 850 to 1,500 feet for a heat dose equivalent to a radiant heat of 5 kW/m^2 over 40 seconds from 250 to 325 feet radii fireballs burning for 5 to 15 seconds from a BLEVE, and projectiles from BLEVEs possibly extending farther. Based on distribution function of the projectile distances, FERC staff estimate approximately 90 percent of all projectiles for a 10,000-gallon tanker truck would be within 0.5 mile and there is approximately a 1 percent probability they would extend beyond 1 mile and less than 0.1 percent probability they would extend 30 times the fireball diameter. These values are also close to the distances provided by the USDOT FHWA for designating hazardous material trucking routes (0.5 mile for flammable gases for potential impact distance) and USDOT PHMSA for emergency response (0.5 to 1 mile for initial evacuation and 1 mile for potential BLEVEs for flammable gases).

During startup and operation of the project, Jordan Cove estimates 22 refrigerant make-up trucks, 8 amine trucks, 4 nitrogen trucks, 160 aqueous ammonia trucks, and 28 diesel trucks would be needed at the site annually. The most frequent truck deliveries would occur during commissioning and startup activity at the site and would deliver refrigerants to load the liquefaction trains. Between 15 and 20 trucks are expected over an approximately 2 week timefame to load each liquefaction train. The refrigerant deliveries would be repeated for the startup of each subsequent liquefaction train. Jordan Cove does not plan to utilize any trucks to deliver LNG. The Transpacific Parkway, which connects to State Highway (SH) 101 is located directly to the north of the facility property and would be used to access the Jordan Cove Project site. The Transpacific Parkway is a two lane bi-directional route with a 45 mph speed limit. Jordan Cove provided a Road Safety and Reliability Impact Study (RSRIS). The RSRIS addresses potential safety and reliability impacts of proposed tanker trucks loaded or unloaded at the LNG terminal, and from commercial and recreational roadway traffic along the Transpacific Parkway. The separation distance between the Transpacific Parkway and the Project facilities that would contain hazardous fluids would be greater than 300 feet which would exceed the distances estimated for flammable vapor dispersion and radiant heat from an LNG truck 1-inch hole release. In addition, the Project would install an 80-feet tall impervious barrier that would separate the Transpacific Parkway and the process equipment located in the Ingram Yards area. FERC staff did not identify any other major highways or roads within close proximity to piping or equipment containing hazardous materials at the site that would not be protected by this separation distance and 80-feet tall barrier to raise concerns of direct impacts from a vehicle impacting the site.

Therefore, we conclude that the Project would not pose a significant risk or significant increase in risk to the public due to vehicle impacts as a result of the potential consequences, incident data, frequency of trucks, proposed mitigation by Jordan Cove, and additional mitigation measures proposed by FERC staff.

Rail

FERC staff reviewed whether any rail operations would be associated with the Project and whether any existing rail lines would be located near the site. FERC staff uses this information to evaluate whether the Project and any associated rail operations could increase the risk along the rail line and subsequently to the public and whether any pre-existing unassociated rail operations could adversely increase the risk to the Jordan Cove site and subsequently increase the risk to the public. In addition, if authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 and would be subject to the USDOT's inspection and enforcement programs. USDOT regulations under 49 CFR 193.2155 (a) (5) (ii) Subpart C state that if the LNG facility adjoins the right-of-way of any railroad, the structural members of an impoundment system must be designed and constructed to prevent impairment of the system's performance reliability and structural integrity as a result of a collision by or explosion of a train or tank car that could reasonably be expected to cause the most severe loading.

Section 8.5.4 of NFPA 59A (2001), incorporated by reference in 49 CFR 193, requires transfer piping, pumps, and compressors to be located or protected by barriers so that they are safe from damage by rail or vehicle movements. However, the USDOT regulations and NFPA 59A (2001) requirements do not indicate what collision(s) or explosion(s) could reasonably be expected to cause the most severe loading. Therefore, FERC staff evaluated consequence and frequency data from these events to evaluate these potential impacts. FERC staff evaluated the risk of the rail operations based on the consequences from a release, incident data from the Federal Rail Administration (FRA) and PHMSA, and frequency of rail operations nearby Jordan Cove.

FERC staff evaluated the risk of the rail operations based on the consequences from a release, incident data from the DOT Federal Railroad Administration (FRA) and DOT PHMSA, and frequency of rail operations near the LNG Terminal site. Incident data from DOT FRA and DOT PHMSA indicates hazardous material incidents are very infrequent (6e-3 incidents per rail mile per year). In addition, approximately 95 percent of releases are 1,000 gallons or less, and catastrophic events that would spill 30,000 gallons or more make up less than 1 percent of releases. In addition, less than 1 percent of hazardous material incidents result in injuries and less than 0.1 percent of hazardous material incidents result in fatalities.

As previously discussed, the EPA and NOAA report that 80 percent of fires that lead to container ruptures results in projectiles and that 80 percent of projectiles from LPG incidents, which constitute the largest product involved in BLEVEs, travel less than 660 feet. The EPA also reports that on average container ruptures would result in less than four projectiles for cylindrical containers and 8.3 for spherical vessels. FERC staff evaluated other reports that affirmed the EPA estimates based on data for approximately 150 experimental and accidental PVBs and BLEVEs with approximately 683 total projectiles (4.6 average fragments per incident) that showed approximately 80 percent of fragments traveled 490 to 820 feet and within 6.25 times the estimated or observed fireball radius. The data also showed projectiles have traveled up to 3,900 feet for large LPG vessels and 1,200 feet for LPG rail cars. In all the documented cases, the projectiles traveled less than 15 times the fireball diameter, but one of the reports indicated up to 30 times the fireball diameter is possible albeit very rare.

Unmitigated consequences under average ambient conditions from releases of 1,000 gallons through a 1-inch hole would result in distances ranging from 25 to 200 feet for flammable vapor dispersion, and 75 to 175 feet for jet fires. Unmitigated consequences under worst-case weather conditions from catastrophic failures of rail cars containing various flammable products generally can range from 300 to 3,000 feet for flammable vapor dispersion, 450 to 575 feet for radiant heat of 5 kW/m^2 from jet fires, 1,225 to 1,500 feet to a 1 psi overpressure from a BLEVE, 1,250 to 2,100 feet for a heat dose equivalent to a radiant heat of 5 kW/m^2 over 40 seconds from 350 to 450 feet radii fireballs burning for 7 to 20 seconds from a BLEVE, and projectiles from BLEVEs possibly extending farther. Based on distribution function of the projectile distances, FERC staff estimate approximately 80 percent of all projectiles for a 30,000 gallon rail car would be within 0.5 mile and there is approximately a 5 percent probability they would extend beyond 1 mile and less than 0.1 percent probability they would extend 30 times the fireball diameter. These values are also close to the distances provided by USDOT PHMSA for emergency response (0.5 to 1 mile for initial evacuation and 1 mile for potential BLEVEs for flammable gases).

The closest rail line would be the Coos Bay Rail Line (CBRL) located directly to the north of the Project site. The CBRL is a single line railroad that provides delivery of forestry products (e.g., wood products, fertilizer, organic dairy feed) to the nearby Roseburg Forest Products Plant. The Project would install an 80-feet tall impervious barrier that would separate the CBRL and the process equipment. BakerRisk, Inc. performed a rail risk safety analysis and security risk assessment for Jordan Cove that evaluated the potential safety, security, and reliability impacts from the CBRL.

The closest Project facilities would be the ground flare approximately 60 feet from the rail line separated by a retaining wall, the closest auxiliary power generators and pretreatment facilities approximately 400 to 450 feet from the rail line, the closest LNG storage tank approximately 1,150 feet from the rail line, and the closest liquefaction train approximately 1,200 feet from the rail line. However the rail line would not transport pressurized or flammable hazard fluids. Therefore the rail road would not pose a vapor dispersion, fireball, jet fire, pool fire, BLEVE, or projectile hazard to the Project. In addition, Jordan Cove would coordinate with local emergency responders with regard to potential rail incidents. Due to the extremely low likelihood and mitigating actions, we conclude the Project would not pose a significant increase in risk to the public as a result of the proximity of the Project to the rail lines

In addition Jordan Cove would install a railroad construction spur within the plant boundaries that would be located approximately 750 feet east of the process equipment and anticipates to utilize the construction spur approximately 2 times every 3 years for maintenance. The Project would install a 100-feet tall impervious barrier that would separate the construction spur and the process equipment. If the Project is authorized, Jordan Cove would keep the construction spur in place to provide delivery of maintenance equipment, spare parts, and other oversized equipment that would be suited for rail transport. Based on the potential consequences, incident data, distance, and location of the CBRL as well as the anticipated frequency of railroad delivery via the construction spur, we conclude that the Project would not pose a significant increase in risk to the public as a result of the proximity of the Project to the rail lines.

Air

FERC staff reviewed whether any aircraft operations would be associated with the Project and whether any existing aircraft operations would be located near the site. FERC staff uses this information to evaluate whether the Project and any associated aircraft operations could increase the risk to the public and whether any pre-existing unassociated aircraft operations could adversely increase the risk to the Project site and subsequently increase the risk to the public. In addition, if authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 193 and would be subject to the USDOT's inspection and enforcement programs. USDOT regulations under 49 CFR 193.2155 (b), Subpart C, require a LNG storage tank must not be located within a horizontal distance of one mile from the ends, or 0.25 miles from the nearest point of a runway, whichever is longer and that the height of LNG structures in the vicinity of an airport must comply with USDOT FAA requirements. In addition, FERC staff evaluated the risk of an aircraft impact from nearby airports.

Two mixed use aviation airports, Southwest Oregon Regional Airport and Lakeside Municipal Airport, would be located 0.6 mile southeast and 10.9 miles northeast of the LNG terminal site, respectively. The one general aviation airport is the Sunnyhill- North Bend Airport located 4.7 miles northeast of the LNG terminal site. These are all farther than the 0.25-mile distance referenced in USDOT regulations.

FAA regulations in 14 CFR 77 require Jordan Cove to provide a notice to the FAA of its proposed construction. This notification should identify all equipment that are more than 200 feet above ground level or lesser heights if the facilities are within 20,000 feet of an airport (at 100:1 ratio or 50:1 ratio depending on length of runway) or within 5,000 feet of a helipad (at 100:1 ratio). In addition, mobile objects, including the LNG marine vessel that would be above the height of the highest mobile object that would normally traverse it would require notification to FAA.

The Project would include permanent structures that would be taller than 200 feet. Therefore, in accordance with the regulations in 14 CFR 77, Jordan Cove submitted notice to the FAA for an aeronautical obstruction study for the tallest structures at its property. However, Jordan Cove did not submit a notice for temporary construction equipment, such as cranes, derricks, etc., which may be taller than permanent structures and would be used during construction of the Project. Therefore we recommend in section 4.13.1.6 that Jordan Cove file notice to the FAA for temporary structures that would require an Aeronautical Study.

On May 7, 2018, the FAA issued its findings for the LNG marine vessel (at multiple locations during transit), LNG storage tanks, Amine regenerator column, and the thermal oxidizer stack and stated that each of the structures would exceed obstruction standards and would be a presumed hazard to air navigation. However, it should also be noted that the FAA's Notice of Presumed Hazard is not a final determination and each notice states that if the maximum heights of the structures that exceed obstruction standards were reduced to 167 feet above mean seal level (AMSL), it would not create a substantial adverse effect and a favorable determination could subsequently be issued. Jordan Cove has indicated that it would continue to meet with FAA to investigate potential options for eliminating or mitigating the presumed hazards. While Jordan Cove did not provide any additional correspondence with FAA or Southwest Oregon Regional Airport, these potential hazards were previously discussed in the Jordan Cove Energy Project FEIS under Docket Number CP13-483-000 and would be applicable here as similar tall structures reported in the previous application also received a Notice of Presumed Hazard.

As discussed in the Jordan Cove Energy Project FEIS under Docket Number CP13-483-000, two options were identified for mitigating the presumed hazards. One option would maintain the existing flight pattern and require additional lighting and markings on the LNG storage tanks and amine columns. Raising the altitude of planes would provide another level of safety. The other option would "flip" the flight patterns for Runway 04 from their current alignment as a left-handed pattern to the north of the airport that would fly over the Project site, to a right-handed pattern south of the airport that would avoid the terminal. However, the Southwest Oregon Regional Airport did not support the concept of flipping the flight patterns at Runway 04 because that would place aircraft over a populated area. Instead, the Southwest Oregon Regional Airport preferred marking the tanks and towers and concluded that the Jordan Cove LNG terminal would not represent a substantial hazard to aircraft because:

- the existing floor of the airport's traffic pattern is 1,000 feet AMSL and no aircraft flying in the pattern would have to change course or altitude to avoid any of the proposed structures;
- the amine towers are lower than surrounding structures, terrain, and surveyed trees. The LNG storage tanks are taller than the trees, but still lower than the McCullough bridge located within the flight pattern area at 268 feet AMSL; and
- marked obstacles (including both structures and trees) are higher than the airport's elevation and require aircraft to operate at altitudes more than 500 feet above the amine towers and the LNG tanks and no current visual flight rules would have to change course or altitude to avoid the proposed structures.

However, since the FAA has not issued the final determination, there is a potential significant impact to the safe air operations of the Southwest Oregon Regional Airport if a resolution cannot be settled. Therefore, we recommend in section 4.13.1.6 that Jordan Cove should file the final determinations from the FAA prior to initial site preparation that indicate there will be no hazard to aircraft using the Southwest Oregon Regional Airport, and copies of all studies related to the Project's potential impact on the airport. If a determination of no hazard cannot be reached then a notice to proceed with the project would not be granted and a modification, variance, or amendment may be needed.

In addition, FERC staff used DOE Standard 3014, Accident Analysis for Aircraft Crash into Hazardous Facilities, which utilizes a 22-mile threshold radius around the hazardous facility for consideration of hazards posed by airport and heliport operations to the Project facilities. There are two mixed use airports (commercial, military, and general aviation), and one general aviation airport within the 22-mile radius. Per the DOE standard 3014, heliports need only be considered if there are local overflights associated with facility operations and/or area operations. The Project site does have a facility associated heliport in the South Dunes area that would be located approximately 1.2 miles east of processing areas. The heliport would support the Southwest Oregon Regional Safety Center and would generally be used for emergency response and annual exercises. In addition, the Project would install a 100-feet tall impervious barrier that would located between the process equipment and the heliport. Based on the potential separation distance between the process equipment and the heliport as well as the anticipated limited use of the heliport, we conclude the impact risk due to heliport operations would not be significant.

Comments from the public and feedback from FAA indicated potential impacts to and from the Project and the nearby Southwest Oregon Regional Airport. FERC staff conducted internal analyses, and requested information from the applicant on the likelihood and consequences from a potential aircraft impacting the Project and determined that the potential impact to the facility would be above the initial 3e-5 per year screening threshold identified for the process areas and the LNG storage tanks. The potential consequences of such an incident at the tank roof or in the process areas would likely result in a release and fire that would be within the existing hazard footprints already evaluated for a complete tank roof fire and full impoundment fire that is sized for the largest spill in the process area. However depending on the location of impact and extent of damage, the potential fire hazard could extend beyond those evaluated from the LNG storage tank roof fire and the impoundment basin fires. Therefore, FERC staff evaluated whether the full containment walls would withstand aircraft impacts using established methods, such as CEB 187 and other publications. Based on this analysis, FERC staff determined that the full containment LNG storage tanks could withstand general aviation impacts without perforation of the outer tank wall from aircraft impacts that exceed frequencies of 3e-5 per year. However, FERC staff also determined that the LNG storage tanks may not withstand commercial aviation impacts without perforation of the outer tank wall from aircraft impacts that exceed frequencies of 3e-5 per year. As discussed above, potential fire hazard distances from aircraft impacts to the LNG storage tank could extend beyond the property lines, however, these fire hazards would not impact the public. Therefore, we conclude that with the implementation of our recommendations, the Project would not pose a significant risk or increase risk to the public from aircraft impacts to either the LNG storage tanks or the process areas due to the potential consequences, incident data, and the distance and position of aircraft operations relative to the populated areas in the North Bend community.

Pipelines

FERC staff reviewed whether any pipeline operations would be associated with the Project and whether any existing pipelines would be located near the site. FERC staff uses this information to evaluate whether the Project and any associated pipeline operations could increase the risk to the pipeline facilities and subsequently to the public and whether any pre-existing unassociated pipeline operations could adversely increase the risk to the Project site and subsequently increase the risk to the public. In addition, pipelines associated with this Project must meet USDOT regulations under 49 CFR 192 and are discussed in section 4.13.3. If authorized and constructed, LNG facilities as defined in 49 CFR 193, must comply with the requirements of 49 CFR 192 and 49 CFR 193 and would be subject to the USDOT's inspection and enforcement programs. FERC staff evaluated the risk of a pipeline incident impacting the Project and the potential of cascading damage increasing the risk to the public based on the consequences from a release, incident data from the USDOT PHMSA, and proposed mitigation to prevent or reduce the impacts of a pipeline incident from Jordan Cove.

For existing pipelines, FERC staff identified an existing natural gas pipeline located approximately 1.75 miles southwest of the site. FERC staff evaluated the potential risk from an incident from the pipeline and its potential impacts by considering the design and operating conditions and location of the pipeline. This pipeline would be located too far to impact the Project site in the event of an incident.

In addition, based on the potential likelihood of pipeline incidents and potential consequences from a pipeline incident, we conclude that the Project would not significantly increase the risk to the public beyond existing risk levels that would be present from a pipeline leak or pipeline rupture worst-case event near the Project site.

Hazardous Material Facilities and Power Plants

FERC staff reviewed whether any EPA RMP regulated facilities handling hazardous materials and power plants were located near the site to evaluate whether the facilities could adversely increase the risk to the Project site and whether the Project site could increase the risk to the EPA RMP facilities and power plants and subsequently increase the risk to the public.

There were no facilities handling hazardous materials or power plants identified adjacent to the site. The closest EPA RMP regulated facilities handling hazardous materials would be the City of North Bend Wastewater Treatment Plant located approximately 1.03 miles away, and the Pony Creek Water Treatment Plant located approximately 3.50 miles away. The EPA RMP regulations require certain hazard distances to be calculated and a risk management plan to be developed commensurate with those consequences. In addition, the closet power plant identified would be the Douglas County Forest Products Biomass Plant approximately 46 miles away and the closest nuclear plant would be the Columbia Generating Station located over 300 miles away.

Given the distances, locations, and risk management plan requirements of the facilities relative to the populated areas of the North Bend communities, we conclude that the Project would not pose a significant increase in risk to the public or that the hazardous material facilities and power plants would not pose a significant risk to the Project and subsequently to the public.

Onsite and Offsite Emergency Response Plans

As part of its application, Jordan Cove indicated that the Project would develop a comprehensive ERP with local, state, and federal agencies and emergency response officials to discuss the Facilities. Jordan Cove would continue these collaborative efforts during the development, design, and construction of the Project. The emergency procedures would provide for the protection of personnel and the public as well as the prevention of property damage that may occur as a result of incidents at the Project facilities. The facility would also provide appropriate personnel protective equipment to enable operations personnel and first responder access to the area.

As required by 49 CFR 193.2509 Subpart F, Jordan Cove would need to prepare emergency procedures manuals that provide for: a) responding to controllable emergencies and recognizing an uncontrollable emergency; b) taking action to minimize harm to the public including the possible need to evacuate the public; and c) coordination and cooperation with appropriate local officials. Specifically, 49 CFR 193.2509 (b) (3) requires "Coordinating with appropriate local officials in preparation of an emergency evacuation plan…," which sets forth the steps required to protect the public in the event of an emergency, including catastrophic failure of an LNG storage tank. USDOT regulations under 49 CFR 193.2905 Subpart J also require at least two access points in each protective enclosure to be located to minimize the escape distance in the event of emergency.

Title 33 CFR 127.307 also requires the development of emergency manual that incorporates additional material, including LNG release response and emergency shutdown procedures, a description of fire equipment, emergency lighting, and power systems, telephone contacts, shelters, and first aid procedures. In addition, 33 CFR 127.207 establishes requirements for warning alarm systems. Specifically, 33 CFR 127.207 (a) requires that the LNG marine transfer area to be equipped with a rotating or flashing amber light with a minimum effective flash intensity, in the horizontal plane, of 5000 candelas with at least 50 percent of the required effective flash intensity in all directions from 1.0 degree above to 1.0 degree below the horizontal plane. Furthermore, 33 CFR 127.207 (b) requires the marine transfer area for LNG to have a siren with a minimum 1⁄3- octave band sound pressure level at l meter of 125 decibels referenced to 0.0002 microbars. The siren must be located so that the sound signal produced is audible over 360 degrees in a horizontal plane. Lastly, 33 CFR 127.207 (c) requires that each light and siren must be located so that the warning alarm is not obstructed for a distance of 1.6 km (1 mile) in all directions. The warning alarms would be required to be tested in order to meet 33 CFR 127. Jordan Cove would be required to meet the warning alarms requirements specified in 33 CFR 127.207.

In accordance with the EPAct 2005, FERC must also approve an ERP covering the terminal and ship transit prior to construction. Section 3A (e) of the NGA, added by section 311 of the EPAct 2005, stipulates that in any order authorizing an LNG terminal, the Commission must require the LNG terminal operator to develop an ERP in consultation with the Coast Guard and state and local agencies. The final ERP would need to be evaluated by appropriate emergency response personnel and officials. Section 3A (e) of the NGA (as amended by EPAct 2005) specifies that the ERP must include a Cost-Sharing Plan that contains a description of any direct cost reimbursements the applicant agrees to provide to any state and local agencies with responsibility for security and safety at the LNG terminal and in proximity to LNG marine vessels that serve the facility. The Cost-Sharing Plan must specify what the LNG terminal operator would provide to cover the cost of the state and local resources required to manage the security of the LNG terminal and LNG marine vessel, and the state and local resources required for safety and emergency management, including:

- direct reimbursement for any per-transit security and/or emergency management costs (for example, overtime for police or fire department personnel);
- capital costs associated with security/emergency management equipment and personnel base (for example, patrol boats, firefighting equipment); and
- annual costs for providing specialized training for local fire departments, mutual aid departments, and emergency response personnel; and for conducting exercises.

The cost-sharing plan must include the LNG terminal operator's letter of commitment with agency acknowledgement for each state and local agency designated to receive resources.

Jordan Cove submitted a draft ERP to address emergency events and potential release scenarios in the Application. The ERP would include public notification, protection, and evacuation. As part of the FEED review, FERC staff evaluated the initial draft of the emergency response procedures to assure that it covers the hazards associated with the Project. In addition, we recommend in section 4.13.1.6 that Jordan Cove provide additional information, for review and approval, on development of updated emergency response plans prior to initial site preparation. We also recommend in section 4.13.1.6 that Jordan Cove file three dimensional drawings, for review and approval, that demonstrate there is a sufficient number of access and egress locations. If this Project is authorized and constructed, Jordan Cove would coordinate with local, state, and federal agencies on the development of an emergency response plan and cost sharing plan. We recommend in section 4.13.1.6 that Jordan Cove provide periodic updates on the development of these plans for review and approval, and ensure they are in place prior to introduction of hazardous fluids. In addition, we recommend in section 4.13.1.6 that Project facilities be subject to regular inspections throughout the life of the facility and would continue to require companies to file updates to the ERP.

4.13.1.6 Recommendations from FERC Preliminary Engineering and Technical Review

Based on our preliminary engineering and technical review of the reliability and safety of the Jordan Cove LNG Project, we recommend the following mitigation measures as conditions to any order authorizing the Project. These recommendations would be implemented prior to the end of the DEIS comment period, prior to initial site preparation, prior to construction of final design, prior to commissioning, prior to introduction of hazardous fluids, prior to commencement of service, and throughout the life of the facility to enhance the reliability and safety of the facility and to mitigate the risk of impact on the public.

- **Prior to end of the draft EIS comment period, Jordan Cove should file with the Secretary documentation of consultation with USDOT PHMSA staff as to whether the design wind speed for other non-hazardous buildings and structures would be subject to USDOT requirements.**

- **Prior to the end draft EIS comment period, Jordan Cove should file with the Secretary an analysis that demonstrates the flammable vapor dispersion from design spills would be prevented from dispersing underneath the elevated LNG storage tanks, or the LNG storage tanks would be able to withstand an overpressure due to ignition of the flammable vapor dispersion cloud that disperses underneath the elevated LNG storage tanks.**

- **Prior to initial site preparation, Jordan Cove should file with the Secretary documentation demonstrating it has received a determination of no hazard (with or without conditions) by USDOT FAA for all permanent structures, temporary construction equipment, and mobile objects that exceed the height requirements in 14 CFR 77.9.**

- **Prior to construction of final design, Jordan Cove should file with the Secretary the following information, stamped and sealed by the professional engineer-of-record, registered in Oregon:**

  a. site preparation drawings and specifications;

  b. LNG terminal structures, LNG storage tank, and foundation design drawings and calculations (including prefabricated and field constructed structures);

  c. seismic specifications for procured Seismic Category I equipment prior to the issuing of request for quotations;

  d. quality control procedures to be used for civil/structural design and construction; and

  e. a determination of whether soil improvement is necessary to counteract soil liquefaction.

  In addition, Jordan Cove should file, in its Implementation Plan, the schedule for producing this information.

- **<u>Prior to construction of final design,</u> Jordan Cove should file with the Secretary consultation with USDOT PHMSA staff as to whether the use of normally closed valves to remove stormwater from curbed areas would meet USDOT PHMSA requirements.**

- **<u>Prior to commencement of service</u>, Jordan Cove should file with the Secretary a monitoring and maintenance plan, stamped and sealed by the professional engineer-of-record registered in Oregon, which ensures the facilities are protected for the life of the LNG terminal considering settlement, subsidence, and sea level rise.**

Information pertaining to the following specific recommendations should be filed with the Secretary for review and written approval by the Director of OEP, or the Director's designee, within the timeframe indicated by each recommendation. Specific engineering, vulnerability, or detailed design information meeting the criteria specified in Order No. 833 (Docket No. RM16-15-000), including security information, should be submitted as critical energy infrastructure information pursuant to 18 CFR 388.113. See Critical Electric Infrastructure Security and Amending Critical Energy Infrastructure Information, Order No. 833, 81 Fed. Reg. 93,732 (December 21, 2016), FERC Stats. & Regs. 31,389 (2016). Information pertaining to items such as offsite emergency response, procedures for public notification and evacuation, and construction and operating reporting requirements would be subject to public disclosure. All information should be filed **<u>a minimum of 30 days</u>** before approval to proceed is requested.

- **<u>Prior to initial site preparation</u>, Jordan Cove should file an overall Project schedule, which includes the proposed stages of the commissioning plan.**

- **<u>Prior to initial site preparation</u>, Jordan Cove should file procedures for controlling access during construction.**

- **<u>Prior to initial site preparation</u>, Jordan Cove should file quality assurance and quality control procedures for construction activities for both the Engineering Procurement Contractor and Jordan Cove to monitor construction activities.**

- **<u>Prior to initial site preparation</u>, Jordan Cove should specify a spill containment system around the Warm Flare Knockout Drum.**

- **<u>Prior to initial site preparation</u>, Jordan Cove should develop an ERP (including evacuation) and coordinate procedures with the Coast Guard; state, county, and local emergency planning groups; fire departments; state and local law enforcement; and appropriate federal agencies. This plan should include at a minimum:**

  a. designated contacts with state and local emergency response agencies;

  b. scalable procedures for the prompt notification of appropriate local officials and emergency response agencies based on the level and severity of potential incidents;

  c. procedures for notifying residents and recreational users within areas of potential hazard;

  d. evacuation routes/methods for residents and public use areas that are within any transient hazard areas along the route of the LNG marine transit;

e. **locations of permanent sirens and other warning devices; and**

f. **an "emergency coordinator" on each LNG marine vessel to activate sirens and other warning devices.**

Jordan Cove should notify the FERC staff of all planning meetings in advance and should report progress on the development of its ERP <u>at 3‑month intervals</u>.

- **<u>Prior to initial site preparation</u>, Jordan Cove should file a Cost-Sharing Plan identifying the mechanisms for funding all Project-specific security/emergency management costs that would be imposed on state and local agencies. This comprehensive plan should include funding mechanisms for the capital costs associated with any necessary security/emergency management equipment and personnel base. Jordan Cove should notify FERC staff of all planning meetings in advance and should report progress on the development of its Cost Sharing Plan at <u>3-month intervals</u>.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file change logs that list and explain any changes made from the FEED provided in Jordan Cove LNG Project's application and filings. A list of all changes with an explanation for the design alteration should be provided and all changes should be clearly indicated on all diagrams and drawings.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file information/revisions pertaining to Jordan Cove's response numbers 8c, 13, 15, 21, 22, 23, 24, 26, 27, 28, and 31 of its December 20, 2018 filing and 6, 9, 10, 11, 17, 19, 32, 34, and 36 of its February 6, 2019 filing which indicated features to be included or considered in the final design.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file drawings and specifications for crash rated vehicle barriers at each facility entrance for access control.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file drawings of the security fence. The fencing drawings should provide details of fencing that demonstrates it would restrict and deter access around the entire facility and has a setback from exterior features (e.g., power lines, trees, etc.) and from interior features (e.g., piping, equipment, buildings, etc.) that does not allow the fence to be overcome.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file drawings of internal road vehicle protections, such as guard rails, barriers, and bollards to protect transfer piping, pumps, compressors, hydrants, monitors, etc. to ensure that they are located away from roadway or protected from inadvertent damage from vehicles.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file security camera and intrusion detection drawings. The security camera drawings should show the locations, areas covered, and features of each camera (e.g., fixed, tilt/pan/zoom, motion detection alerts, low light, mounting height, etc.) to verify camera coverage of the entire perimeter with redundancies for cameras interior to the facility to enable rapid monitoring of the facility, including a camera at the top of each LNG storage tank,**

and coverage within pretreatment areas, within liquefaction areas, within truck transfer areas, within marine transfer areas, and buildings. The drawings should show or note the location of the intrusion detection to verify it covers the entire perimeter of the facility.

- **<u>Prior to construction of final design</u>, Jordan Cove should file lighting drawings. The lighting drawings should show the location, elevation, type of light fixture, and lux levels of the lighting system and should be in accordance with API 540 and provide illumination along the perimeter of the facility, process equipment, mooring points, and along paths/roads of access and egress to facilitate security monitoring and emergency response operations.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a plot plan of the final design showing all major equipment, structures, buildings, and impoundment systems. This lighting plan should also be in compliance with the lighting recommendation in section 4.5.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file three-dimensional plant drawings to confirm plant layout for maintenance, access, egress, and congestion.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file up-to-date process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) including vendor P&IDs. The PFDs should include heat and material balances. The P&IDs should include the following information:**

  a. **equipment tag number, name, size, duty, capacity, and design conditions;**
  b. **equipment insulation type and thickness;**
  c. **storage tank pipe penetration size and nozzle schedule;**
  d. **valve high pressure side and internal and external vent locations;**
  e. **piping with line number, piping class specification, size, and insulation type and thickness;**
  f. **piping specification breaks and insulation limits;**
  g. **all control and manual valves numbered;**
  h. **relief valves with size and set points; and**
  i. **drawing revision number and date.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file P&IDs, specifications, and procedures that clearly show and specify the tie-in details required to safely connect subsequently constructed facilities with the operational facilities.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a car seal philosophy and a list of all car-sealed and locked valves consistent with the P&IDs.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file information to demonstrate the EPC contractor has verified that all FEED HAZOP and LOPA recommendations have been addressed.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a hazard and operability review prior to issuing the P&IDs for construction. A copy of the review, a list of the recommendations, and actions taken on the recommendations should be filed.**

- **Prior to construction of final design<u>, Jordan Cove should provide a check valve upstream of the amine contractor column to prevent backflow or provide a a dynamic simulation that shows that upon plant shutdown, the swan neck would be sufficient for this purpose.</u>**

- **<u>Prior to construction of final design</u>, Jordan Cove should specify how Mole Sieve Gas Dehydrator support and sieve material would be prevented from migrating to the piping system.**

- **<u>Prior to construction of final design</u>, Jordan Cove should specify how the regeneration gas heater tube design temperature would be consistent with the higher shell side steam temperatures.**

- **<u>Prior to construction of final design</u>, Jordan Cove should specify a cold gas bypass around the defrost gas heater to prevent defrost gas heater high temperature shutdown during low flow and startup conditions.**

- **<u>Prior to construction of final design</u>, Jordan Cove shall demonstrate that the differential pressure (dp) level transmitters on the LNG flash drum would not result in an excess number of false high-high-high level shutdowns.**

- **<u>Prior to construction of final design</u>, Jordan Cove should specify a means to stop LNG flows to the BOG suction drum when the BOG compressor is shutdown to prevent filling the BOG suction drum with LNG.**

- **<u>Prior to construction of final design</u>, Jordan Cove should specify a low instrument air pressure shutdown to prevent loss of control to air operated valve.**

- **<u>Prior to construction of final design</u>, Jordan Cove should evaluate and, if applicable, address the potential for cryogenic feed gas back flow in the event relief valve 30-PSV-01002A/B is open.**

- **<u>Prior to construction of final design</u>, Jordan Cove should include LNG tank fill flow measurement with high flow alarm.**

- **<u>Prior to construction of final design</u>, Jordan Cove should specify a discretionary vent valve on each LNG storage tank that is operable through the Distributed Control System (DCS). In addition, a car sealed open manual block valve should be provided upstream of the discretionary vent valve.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file the safe operating limits (upper and lower), alarm and shutdown set points for all instrumentation (e.g., temperature, pressures, flows, and compositions).**

- **<u>Prior to construction of final design</u>, Jordan Cove should file cause-and-effect matrices for the process instrumentation, fire and gas detection system, and emergency shutdown system. The cause-and-effect matrices should include alarms and shutdown functions, details of the voting and shutdown logic, and set points.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file an up-to-date equipment list, process and mechanical data sheets, and specifications. The specifications should include:**

  a. **building specifications (e.g., control buildings, electrical buildings, compressor buildings, storage buildings, pressurized buildings, ventilated buildings, blast resistant buildings);**

  b. **mechanical specifications (e.g., piping, valve, insulation, rotating equipment, heat exchanger, storage tank and vessel, other specialized equipment);**

  c. **electrical and instrumentation specifications (e.g., power system, control system, safety instrument system [SIS], cable, other electrical and instrumentation); and**

  d. **security and fire safety specifications (e.g., security, passive protection, hazard detection, hazard control, firewater).**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a list of all codes and standards and the final specification document number where they are referenced.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a complete specifications and drawings of the proposed LNG tank design and installation.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file an evaluation of emergency shutdown valve closure times. The evaluation should account for the time to detect an upset or hazardous condition, notify plant personnel, and close the emergency shutdown valve(s).**

- **<u>Prior to construction of final design</u>, Jordan Cove should file an evaluation of dynamic pressure surge effects from valve opening and closure times and pump startup and shutdown operations.**

- **<u>Prior to construction of final design</u>, Jordan Cove should demonstrate that, for hazardous fluids, piping and piping nipples 2 inches or less in diameter are designed to withstand external loads, including vibrational loads in the vicinity of rotating equipment and operator live loads in areas accessible by operators.**

- **<u>Prior to construction of final design</u>, Jordan Cove should clearly specify the responsibilities of the LNG tank contractor and the EPC contractor for the piping associated with the LNG storage tank.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file the sizing basis and capacity for the final design of the flares and/or vent stacks as well as the pressure and vacuum relief valves for major process equipment, vessels, and storage tanks.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file an updated fire protection evaluation of the proposed facilities. A copy of the evaluation, a list of recommendations and supporting justifications, and actions taken on the recommendations should be filed. The evaluation should justify the type, quantity, and location of hazard detection and hazard control, passive fire protection, emergency shutdown and depressurizing systems, firewater, and emergency response equipment, training, and qualifications in accordance with NFPA 59A (2001). The justification for the flammable and combustible gas detection and flame and heat detection systems should be in accordance with ISA 84.00.07 or equivalent methodologies and would need to demonstrate 90 percent or more of releases (unignited and ignited) that could result in an off-site or cascading impact would be detected by two or more detectors and result in isolation and de inventory within 10 minutes. The analysis should take into account the set points, voting logic, wind speeds, and wind directions. The justification for firewater should provide calculations for all firewater demands based on design densities, surface area, and throw distance as well as specifications for the corresponding hydrant and monitors needed to reach and cool equipment.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file spill containment system drawings with dimensions and slopes of curbing, trenches, impoundments, and capacity calculations considering any foundations and equipment within impoundments, as well as the sizing and design of the down-comers. The spill containment drawings should show containment for all hazardous fluids including all liquids handled above their flashpoint, from the largest flow from a single line for 10 minutes, including de-inventory, or the maximum liquid from the largest vessel (or total of impounded vessels) or otherwise demonstrate that providing spill containment would not significantly reduce the flammable vapor dispersion or radiant heat consequences of a spill.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file electrical area classification drawings.**

- **<u>Prior to construction of final design</u>, Jordan Cove should provide documentation demonstrating adequate ventilation, detection, and electrical area classification based on the final selection of the batteries, and associated hydrogen off-gassing rates.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file drawings and details of how process seals or isolations installed at the interface between a flammable fluid system and an electrical conduit or wiring system meet the requirements of NFPA 59A (2001).**

- **<u>Prior to construction of final design</u>, Jordan Cove should file details of an air gap or vent installed downstream of process seals or isolations installed at the interface between a flammable fluid system and an electrical conduit or wiring system. Each**

air gap should vent to a safe location and be equipped with a leak detection device that should continuously monitor for the presence of a flammable fluid, alarm the hazardous condition, and shut down the appropriate systems.

- **<u>Prior to construction of final design</u>, Jordan Cove should file complete drawings and a list of the hazard detection equipment. The drawings should clearly show the location and elevation of all detection equipment. The list should include the instrument tag number, type and location, alarm indication locations, and shutdown functions of the hazard detection equipment.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a technical review of facility design that:**

  a. identifies all combustion/ventilation air intake equipment and the distances to any possible flammable gas or toxic release; and

  b. demonstrates that these areas are adequately covered by hazard detection devices and indicates how these devices would isolate or shutdown any combustion or heating ventilation and air conditioning equipment whose continued operation could add to or sustain an emergency.

- **<u>Prior to construction of final design</u>, Jordan Cove should file a design that includes hazard detection suitable to detect high temperatures and smoldering combustion products in electrical buildings and control room buildings.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file an evaluation of the voting logic and voting degradation for hazard detectors.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a list of alarm and shutdown set points for all hazard detectors that account for the calibration gas of the hazard detectors when determining the lower flammable limit set points for methane, ethylene, propane, isopentane, and condensate.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a list of alarm and shutdown set points for all hazard detectors that account for the calibration gas of hazard detectors when determining the set points for toxic components such as condensate and hydrogen sulfide.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a drawing showing the location of the emergency shutdown buttons. Emergency shutdown buttons should be easily accessible, conspicuously labeled, and located in an area which would be accessible during an emergency.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file facility plan drawings and a list of the fixed and wheeled dry-chemical, hand-held fire extinguishers, and other hazard control equipment. Plan drawings should clearly show the location by tag number of all fixed, wheeled, and hand-held extinguishers and should demonstrate the spacing of extinguishers meet prescribed NFPA 10 travel distances. The list should include the equipment tag number, type, capacity, equipment covered, discharge rate,**

and automatic and manual remote signals initiating discharge of the units and should demonstrate they meet NFPA 59A.

- **<u>Prior to construction of final design</u>, Jordan Cove should file drawings and specifications for the structural passive protection systems to protect equipment and supports from cryogenic releases.**
- **<u>Prior to construction of final design</u>, Jordan Cove should file calculations or test results for the structural passive protection systems to protect equipment and supports from cryogenic releases.**
- **<u>Prior to construction of final design</u>, Jordan Cove should file drawings and calculations that demonstrate passive protection is provided in areas where jet fires may result in failure of structural supports.**
- **<u>Prior to construction of final design</u>, Jordan Cove should file a detailed quantitative analysis to demonstrate that adequate thermal mitigation would be provided for each significant component within the 4,000 Btu/ft^2-hr zone from an impoundment, or provide an analysis that assesses the consequence of pressure vessel bursts and boiling liquid expanding vapor explosions. Trucks at the truck transfer station should be included in the analysis. A combination of passive and active protection should be provided and demonstrate the effectiveness and reliability. Effectiveness of passive mitigation should be supported by calculations for the thickness limiting temperature rise and effectiveness of active mitigation should be justified with calculations demonstrating flow rates and durations of any cooling water would mitigate the heat absorbed by the vessel.**
- **<u>Prior to construction of final design</u>, Jordan Cove should file an evaluation and associated specifications and drawings of how they would prevent cascading damage of transformers (e.g., fire walls or spacing) in accordance with NFPA 850 or equivalent.**
- **<u>Prior to construction of final design</u>, Jordan Cove should file facility plan drawings showing the proposed location of the firewater and any foam systems. Plan drawings should clearly show the location of firewater and foam piping, post indicator valves, and the location and area covered by, each monitor, hydrant, hose, water curtain, deluge system, foam system, water-mist system, and sprinkler. All areas of the pretreatment area should have adequate coverage. The drawings should also include piping and instrumentation diagrams of the firewater and foam systems.**
- **<u>Prior to construction of final design</u>, Jordan Cove should specify that the firewater pump shelter is designed to remove the largest firewater pump or other component for maintenance with an overhead or external crane.**
- **<u>Prior to construction of final design</u>, Jordan Cove should demonstrate that the firewater storage tanks are in compliance with NFPA 22 or demonstrate how API Standard 650 provides an equivalent or better level of safety.**

- **<u>Prior to construction of final design</u>, Jordan Cove should specify that the firewater flow test meter is equipped with a transmitter and that a pressure transmitter is installed upstream of the flow transmitter. The flow transmitter and pressure transmitter should be connected to the DCS and recorded.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file the settlement results during hydrostatic tests of the LNG storage containers and periodically thereafter to verify settlement is as expected and does not exceed the applicable criteria in API 620, API 625, API 653, and ACI 376.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file drawings of the storage tank piping support structure and support of horizontal piping at grade including pump columns, relief valves, pipe penetrations, instrumentation, and appurtenances.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file the structural analysis of the LNG storage tank and outer containment demonstrating they are designed to withstand all loads and combinations.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file an analysis of the structural integrity of the outer containment of the full containment LNG storage tank demonstrating it can withstand the radiant heat from a roof tank top fire or adjacent tank roof fire.**

- **<u>Prior to construction of final design</u>, Jordan Cove should file a projectile analysis to demonstrate that the outer concrete impoundment wall of a full-containment LNG storage tank could withstand projectiles from explosions and high winds. The analysis should detail the projectile speeds and characteristics and method used to determine penetration or perforation depths.**

- **<u>Prior to commissioning</u>, Jordan Cove should file a detailed schedule for commissioning through equipment startup. The schedule should include milestones for all procedures and tests to be completed: prior to introduction of hazardous fluids and during commissioning and startup. Jordan Cove should file documentation certifying that each of these milestones has been completed before authorization to commence the next phase of commissioning and startup will be issued.**

- **<u>Prior to commissioning</u>, Jordan Cove should file detailed plans and procedures for: testing the integrity of onsite mechanical installation; functional tests; introduction of hazardous fluids; operational tests; and placing the equipment into service.**

- **<u>Prior to commissioning</u>, Jordan Cove should file settlement results from the hydrostatic tests of the LNG storage containers and should file a plan to periodically verify settlement is as expected and does not exceed the applicable criteria set forth in API 620, API 625, API 653, and ACI 376. The program should specify what actions would be taken after various levels of seismic events.**

- **<u>Prior to commissioning</u>, Jordan Cove should file the operation and maintenance procedures and manuals, as well as safety procedures, hot work procedures and**

permits, abnormal operating conditions reporting procedures, simultaneous operations procedures, and management of change procedures and forms.

- **<u>Prior to commissioning</u>, Jordan Cove should file a plan for clean-out, dry-out, purging, and tightness testing. This plan should address the requirements of the American Gas Association's Purging Principles and Practice, and should provide justification if not using an inert or non-flammable gas for clean-out, dry-out, purging, and tightness testing.**

- **<u>Prior to commissioning</u>, Jordan Cove should tag all equipment, instrumentation, and valves in the field, including drain valves, vent valves, main valves, and car-sealed or locked valves.**

- **<u>Prior to commissioning</u>, Jordan Cove should file a plan to maintain a detailed training log to demonstrate that operating, maintenance, and emergency response staff have completed the required training.**

- **<u>Prior to commissioning</u>, Jordan Cove should file the procedures for pressure/leak tests which address the requirements of ASME VIII and ASME B31.3. The procedures should include a line list of pneumatic and hydrostatic test pressures.**

- **<u>Prior to introduction of hazardous fluids</u>, Jordan Cove should complete and document a pre-startup safety review to ensure that installed equipment meets the design and operating intent of the facility. The pre-startup safety review should include any changes since the last hazard review, operating procedures, and operator training. A copy of the review with a list of recommendations, and actions taken on each recommendation, should be filed.**

- **<u>Prior to introduction of hazardous fluids</u>, Jordan Cove should complete and document all pertinent tests (Factory Acceptance Tests, Site Acceptance Tests, Site Integration Tests) associated with the DCS and SIS that demonstrates full functionality and operability of the system.**

- **<u>Prior to introduction of hazardous fluids</u>, Jordan Cove should develop and implement an alarm management program to reduce alarm complacency and maximize the effectiveness of operator response to alarms.**

- **<u>Prior to introduction of hazardous fluids</u>, Jordan Cove should complete and document a clean agent acceptance tests.**

- **<u>Prior to introduction of hazardous fluids</u>, Jordan Cove should complete and document a firewater pump acceptance test and firewater monitor and hydrant coverage test. The actual coverage area from each monitor and hydrant should be shown on facility plot plan(s).**

- **<u>Prior to introduction of hazardous fluids</u>, Jordan Cove should complete and document foam system and sprinkler system acceptance tests.**

- **Jordan Cove should file a request for written authorization from the Director of OEP <u>prior to unloading or loading the first LNG commissioning cargo</u>. After production of first LNG, Jordan Cove should file weekly reports on the commissioning of the proposed systems that detail the progress toward demonstrating the facilities can safely and reliably operate at or near the design production rate. The reports should include a summary of activities, problems encountered, and remedial actions taken. The weekly reports should also include the latest commissioning schedule, including projected and actual LNG production by each liquefaction train, LNG storage inventories in each storage tank, and the number of anticipated and actual LNG commissioning cargoes, along with the associated volumes loaded or unloaded. Further, the weekly reports should include a status and list of all planned and completed safety and reliability tests, work authorizations, and punch list items. Problems of significant magnitude should be reported to the FERC within 24 hours.**

- **<u>Prior to commencement of service</u>, Jordan Cove should file a request for written authorization from the Director of OEP. Such authorization would only be granted following a determination by the Coast Guard, under its authorities under the Ports and Waterways Safety Act, the Magnuson Act, the MTSA of 2002, and the Security and Accountability For Every Port Act, that appropriate measures to ensure the safety and security of the facility and the waterway have been put into place by Jordan Cove or other appropriate parties.**

- **<u>Prior to commencement of service</u>, Jordan Cove should notify the FERC staff of any proposed revisions to the security plan and physical security of the plant.**

- **<u>Prior to commencement of service</u>, Jordan Cove should label piping with fluid service and direction of flow in the field, in addition to the pipe labeling requirements of NFPA 59A (2001).**

- **<u>Prior to commencement of service</u>, Jordan Cove should provide plans for any preventative and predictive maintenance program that performs periodic or continuous equipment condition monitoring.**

- **<u>Prior to commencement of service</u>, Jordan Cove should develop procedures for offsite contractors' responsibilities, restrictions, and limitations and for supervision of these contractors by Jordan Cove staff.**

In addition, we recommend that the following measures should apply <u>throughout the life of the Jordan Cove LNG Project</u>.

- **The facility should be subject to regular FERC staff technical reviews and site inspections on at least an <u>annual</u> basis or more frequently as circumstances indicate. Prior to each FERC staff technical review and site inspection, Jordan Cove should respond to a specific data request including information relating to possible design and operating conditions that may have been imposed by other agencies or organizations. Up-to-date detailed P&IDs reflecting facility modifications and provision of other pertinent information not included in the semi-annual reports described below, including facility events that have taken place since the previously submitted semi-annual report, should be submitted.**

- **<u>Semi-annual</u> operational reports should be filed with the Secretary to identify changes in facility design and operating conditions; abnormal operating experiences; activities (e.g., ship arrivals, quantity and composition of imported and exported LNG, liquefied and vaporized quantities, boil off/flash gas); and plant modifications, including future plans and progress thereof. Abnormalities should include, but not be limited to, unloading/loading/shipping problems, potential hazardous conditions from offsite vessels, storage tank stratification or rollover, geysering, storage tank pressure excursions, cold spots on the storage tank, storage tank vibrations and/or vibrations in associated cryogenic piping, storage tank settlement, significant equipment or instrumentation malfunctions or failures, non-scheduled maintenance or repair (and reasons therefore), relative movement of storage tank inner vessels, hazardous fluids releases, fires involving hazardous fluids and/or from other sources, negative pressure (vacuum) within a storage tank, and higher than predicted boil off rates. Adverse weather conditions and the effect on the facility also should be reported. Reports should be submitted <u>within 45 days after each period ending June 30 and December 31</u>. In addition to the above items, a section entitled "Significant Plant Modifications Proposed for the Next 12 Months (dates)" should be included in the semi-annual operational reports. Such information would provide the FERC staff with early notice of anticipated future construction/maintenance at the LNG facilities.**

- **In the event the temperature of any region of the LNG storage container, including any secondary containment and imbedded pipe supports, becomes less than the minimum specified operating temperature for the material, the Commission should be notified <u>within 24 hours</u> and procedures for corrective action should be specified.**

- **Significant non-scheduled events, including safety-related incidents (e.g., LNG, condensate, refrigerant, or natural gas releases; fires; explosions; mechanical failures; unusual over pressurization; and major injuries) and security-related incidents (e.g., attempts to enter site, suspicious activities) should be reported to the FERC staff. In the event that an abnormality is of significant magnitude to threaten public or employee safety, cause significant property damage, or interrupt service, notification should be made <u>immediately</u>, without unduly interfering with any necessary or appropriate emergency repair, alarm, or other emergency procedure. In all instances, notification should be made to the FERC staff <u>within 24 hours</u>. This notification practice should be incorporated into the liquefaction facility's emergency plan. Examples of reportable hazardous fluids-related incidents include:**

  a. **fire;**

  b. **explosion;**

  c. **estimated property damage of $50,000 or more;**

  d. **death or personal injury necessitating in-patient hospitalization;**

  e. **release of hazardous fluids for 5 minutes or more;**

  f. **unintended movement or abnormal loading by environmental causes, such as an earthquake, landslide, or flood, that impairs the serviceability, structural**

integrity, or reliability of an LNG facility that contains, controls, or processes hazardous fluids;

g. **any crack or other material defect that impairs the structural integrity or reliability of an LNG facility that contains, controls, or processes hazardous fluids;**

h. **any malfunction or operating error that causes the pressure of a pipeline or LNG facility that contains or processes hazardous fluids to rise above its maximum allowable operating pressure (or working pressure for LNG facilities) plus the build-up allowed for operation of pressure-limiting or control devices;**

i. **a leak in an LNG facility that contains or processes hazardous fluids that constitutes an emergency;**

j. **inner tank leakage, ineffective insulation, or frost heave that impairs the structural integrity of an LNG storage tank;**

k. **any safety-related condition that could lead to an imminent hazard and cause (either directly or indirectly by remedial action of the operator), for purposes other than abandonment, a 20 percent reduction in operating pressure or shutdown of operation of a pipeline or an LNG facility that contains or processes hazardous fluids;**

l. **safety-related incidents from hazardous fluids transportation occurring at or en route to and from the LNG facility; or**

m. **an event that is significant in the judgment of the operator and/or management even though it did not meet the above criteria or the guidelines set forth in an LNG facility's incident management plan.**

In the event of an incident, the Director of OEP has delegated authority to take whatever steps are necessary to ensure operational reliability and to protect human life, health, property, or the environment, including authority to direct the LNG facility to cease operations. Following the initial company notification, the FERC staff would determine the need for a separate follow-up report or follow up in the upcoming semi-annual operational report. All company follow-up reports should include investigation results and recommendations to minimize a reoccurrence of the incident.

4.13.2 Pacific Connector Pipeline Project

The transportation of natural gas by pipeline involves some incremental risk to the public due to the potential for accidental release of natural gas. The greatest hazard is a fire or explosion following a major pipeline rupture.

Methane, the primary component of natural gas, is colorless, odorless, and tasteless. It is not toxic, but is classified as a simple asphyxiant, possessing a slight inhalation hazard. If breathed in high concentration, oxygen deficiency can result in serious injury or death. Methane has an auto-ignition temperature of 1,000°F and is flammable at concentrations between 5.0 percent and 15.0

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percent in air. An unconfined mixture of methane and air is not explosive; however, it may ignite and burn if there is an ignition source.

4.13.2.1 Safety Standards

The USDOT is mandated to provide pipeline safety under 49 U.S.C. § 601. The PHMSA Office of Pipeline Safety (OPS) administers the national regulatory program to ensure the safe transportation of natural gas and other hazardous materials by pipeline. It develops safety regulations and other approaches to risk management that ensure safety in the design, construction, testing, operation, maintenance, and emergency response of pipeline facilities. Many of the regulations are written as performance standards which set the level of safety to be attained and allow the pipeline operator to use various technologies to achieve safety. The PHMSA ensures that people and the environment are protected from the risk of pipeline incidents. This work is shared with state agency partners and others at the federal, state, and local level. Section 5(a) of the Natural Gas Pipeline Safety Act provides for a state agency to assume all aspects of the safety program for intrastate facilities by adopting and enforcing the federal standards, while section 5(b) permits a state agency that does not qualify under section 5(a) to perform certain inspection and monitoring functions. A state may also act as the USDOT's agent to inspect interstate facilities within its boundaries; however, the USDOT is responsible for enforcement action. Most of the states have either 5(a) certifications or 5(b) agreements, while nine states act as interstate agents.

Under an MOU on natural gas transportation facilities dated January 15, 1993 between the USDOT and the FERC, the USDOT has the exclusive authority to promulgate federal safety standards used in the transportation of natural gas. The USDOT pipeline standards are published in 49 CFR Parts 190-199; Part 192 of 49 CFR specifically addresses natural gas pipeline safety issues. Section 157.14(a)(9)(vi) of the FERC's regulations require that an applicant certify that it will design, install, inspect, test, construct, operate, replace, and maintain the facility for which a certificate is requested in accordance with federal safety standards and plans for maintenance and inspection, or shall certify that it has been granted a waiver of the requirements of the safety standards by the USDOT in accordance with section 3(e) of the Natural Gas Pipeline Safety Act. The FERC accepts this certification and does not impose additional safety standards other than the USDOT standards. If the Commission becomes aware of an existing or potential safety problem, there is a provision in the MOU to promptly alert the USDOT. The MOU also provides for referring complaints and inquiries made by state and local governments as well as the general public involving safety matters related to pipelines under the Commission's jurisdiction.

The FERC also participates as a member of the USDOT's Technical Pipeline Safety Standards Committee, which determines if proposed safety regulations are reasonable, feasible, and practicable.

The Pacific Connector pipeline and aboveground facilities must be designed, constructed, operated, and maintained in accordance with the USDOT Minimum Federal Safety Standards in 49 CFR Part 192. The regulations are intended to ensure adequate protection for the public and to prevent natural gas facility accidents and failures. The USDOT specifies material selection and qualification; minimum design requirements; and protection from internal, external, and atmospheric corrosion.

The USDOT also defines area classifications, based on population density in the vicinity of the pipeline, and specifies more rigorous safety requirements for populated areas. The class location unit is an area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipeline. The four area classifications are defined below:

- Class 1 – Location with 10 or fewer buildings intended for human occupancy;
- Class 2 – Location with more than 10 but less than 46 buildings intended for human occupancy;
- Class 3 – Location with 46 or more buildings intended for human occupancy or where the pipeline lies within 100 yards of any building, or small well-defined outside area occupied by 20 or more people on at least 5 days per week for 10 weeks in any 12-month period; and
- Class 4 – Location where buildings with four or more stories aboveground are prevalent.

Class locations representing more populated areas require higher safety factors in pipeline design, testing, and operation. Pipelines constructed on land in Class 1 locations must be installed with a minimum depth of cover of 30 inches in normal soil and 18 inches in consolidated (solid) rock. Class 2, 3, and 4 locations, as well as drainage ditches of public roads and railroad crossings, require a minimum cover of 36 inches in normal soil and 24 inches in consolidated rock.

Class locations also specify the maximum distance to a sectionalizing block valve (e.g., 10.0 miles in Class 1, 7.5 miles in Class 2, 4.0 miles in Class 3, and 2.5 miles in Class 4). Pipe wall thickness and pipeline design pressures, hydrostatic test pressures, MAOP, inspection and testing of welds, and frequency of pipeline patrols and leak surveys must also conform to higher standards in more populated areas. Class locations by MP are listed in table 4.13.2-1.

TABLE 4.13.2.1-1

USDOT Class Locations for the Proposed Pacific Connector Pipeline

Beginning MP	Ending MP	Class Location
0	1.24	1
1.24	1.33	3
1.33	2.34	1
2.34	3.11	2
3.11	3.38	1
3.38	6.47	2
6.47	21.12	1
21.12	21.25	3
21.25	22.39	1
22.39	22.74	2
22.74	22.89	1
22.89	23.26	2
23.26	50.66	1
50.66	51.14	2
51.14	51.39	1
51.39	51.59	2
51.6	55.54	1
55.54	57.76	2
57.76	94.67	1
94.68	94.89	2
94.89	121.88	1

TABLE 4.13.2.1-1 (continued)

USDOT Class Locations for the Proposed Pacific Connector Pipeline

Beginning MP	Ending MP	Class Location
121,88	122.15	2
122.15	122.18	1
122.18	122.43	2
122.43	122.45	1
122.45	123.23	2
123.23	132.46	1
132.47	169.50	1
169.51	197.65	1
197.65	198.08	3
198.08	198.17	1
198.17	198.57	2
198.57	198.61	1
198.61	198.74	3
198.74	198.96	1
198.96	199.09	3
199.09	203.79	1
199.09	203.79	1
203.79	204.13	2
204.13	204.58	2
204.58	204.90	2
204.9	228.81	1

If a subsequent increase in population density adjacent to the right-of-way indicates a change in class location for the pipeline, Pacific Connector would be required to reduce the MAOP or replace the segment with pipe of sufficient grade and wall thickness, if applicable, to comply with the USDOT code of regulations for the new class location.

We received comments requesting that unified safety standards be applied across the entire pipeline route; however, as discussed previously, the FERC does not have the jurisdiction to require safety standards beyond those outlined by Part 192 of 49 CFR (which are required and enforced by the USDOT).

The USDOT Pipeline Safety Regulations require operators to develop and follow a written integrity management program that contain all the elements described in 49 CFR 192.911 and address the risks on each transmission pipeline segment. The rule establishes an integrity management program which applies to all high consequence areas (HCA).

The USDOT has published rules that define HCAs where a gas pipeline accident could do considerable harm to people and their property and requires an integrity management program to minimize the potential for an accident. This definition satisfies, in part, the Congressional mandate for USDOT to prescribe standards that establish criteria for identifying each gas pipeline facility in a high-density population area.

The HCAs may be defined in one of three ways. In the first method, an HCA includes:

- current Class 3 and 4 locations, or

- any area in Class 1 or 2 where the potential impact radius[223] is greater than 660 feet and there are 20 or more buildings intended for human occupancy within the potential impact circle,[224] or
- any area in Class 1 or 2 where the potential impact circle includes an identified site.[225]

In the second method, an HCA includes any area within a potential impact circle which contains:

- 20 or more buildings intended for human occupancy, or
- an identified site.

Once a pipeline operator has determined the HCAs on its pipeline, it must apply the elements of its integrity management program to those segments of the pipeline within HCAs. The USDOT regulations specify the requirements for the integrity management plan at section 192.911. Table 4.13.2.1-2 identifies the HCAs that are crossed by or adjacent to the proposed pipeline route. The pipeline integrity management rule for HCAs requires inspection of the entire pipeline in HCAs every 7 years.

TABLE 4.13.2.1-2

USDOT Class 3 Locations and High Consequence Areas Crossed by and Adjacent to the Proposed Pacific Connector Pipeline

Beginning MP	Ending MP	Criteria
1.24	1.33	Vicinity to ball park and commercial buildings with potential occupancy of over 20 people
21.12	21.25	Vicinity to cell tower with associated commercial buildings with potential occupancy of over 20 people
197.65	198.08	Vicinity to sawmill with potential occupancy of over 20 people
198.61	198.74	Vicinity to commercial buildings with potential occupancy of over 20 people
198.96	199.09	Vicinity to commercial buildings with potential occupancy of over 20 people

Part 192 prescribes the minimum standards for operating and maintaining pipeline facilities, including the requirement to establish a written plan governing these activities. Under section 192.615, each pipeline operator must also establish an emergency response plan (ERP) that includes procedures to minimize the hazards in a natural gas pipeline emergency. Pacific Connector would establish written procedures, in accordance with 49 CFR 192.615, that provide the following:

- establishing and maintaining adequate means of communication with appropriate fire, police, and other public officials;
- notifying appropriate fire, police, medical and other public, local, and state official of gas pipeline emergencies and coordinating with them both planned responses and actual responses during an emergency;
- receiving, identifying, and classifying notices of events that require immediate response by the operator;

[223] The potential impact radius is calculated as the product of 0.69 and the square root of the MAOP of the pipeline in psi multiplied by the pipeline diameter in inches.
[224] The potential impact circle is a circle of radius equal to the potential impact radius.
[225] An identified site is an outside area or open structure that is occupied by 20 or more persons on at least 50 days in any 12-month period; a building that is occupied by 20 or more persons on at least 5 days per week for any 10 weeks in any 12-month period; or a facility that is occupied by persons who are confined, are of impaired mobility, or would be difficult to evacuate.

- prompt and effective response to a notice of each type of emergency (gas detection, fire, explosion, natural disaster); prescribe actions directed toward protecting people first and then property; emergency shutdown and pressure reduction in any section of the pipeline necessary to minimize hazards to life or property;
- actions required to be taken by control room personnel during an emergency in accordance with 49 CFR section 192.631;
- ensuring the availability of service subcontractors, personnel, equipment, tools, and materials, as needed at the scene of any emergency;
- making safe any actual or potential hazard to life or property;
- safely restoring any service outage; and
- beginning incident investigation process as soon after the end of the emergency as possible.

Part 192 requires that each operator must establish and maintain liaison with appropriate fire, police, and public officials to learn the resources and responsibilities of each organization that may respond to a natural gas pipeline emergency, and to coordinate mutual assistance. The operator must also establish a continuing education program to enable customers, the public, government officials, and those engaged in excavation activities to recognize a gas pipeline emergency and report it to appropriate public officials. Operations personnel will attend training for emergency response procedures and plans prior to commencing pipeline operation. No additional specialized local fire protection equipment would be required to handle pipeline emergencies.

Pipeline system emergencies can include gas leaks, fire or explosion, and/or damage to the pipeline and aboveground facilities. Pacific Connector would maintain 24-hour emergency response capabilities, including an emergency-only phone number, which accepts collect charges. The number would be included in informational mail-outs, posted on all pipeline markers (installed at public road crossings), and provided to local emergency agencies in the vicinity of the pipeline and compressor station.

As part of Pacific Connector's ERP, operations personnel would attend training for emergency response procedures and plans prior to commencing pipeline operations. Pacific Connector would meet with local emergency responder groups (fire departments, police departments, land-managing agencies including the BLM, Forest Service, and Reclamation, and other public officials) to review plans and would work with these groups to communicate the specifics about the pipeline facilities in the area and the need for emergency response. Pacific Connector would also meet periodically with the groups to review the plans and revise them when necessary. If requested by local public emergency response personnel, Pacific Connector would participate in any operator-simulated emergency exercises and post-exercise critiques. Pacific Connector would use adequate local or contract resources to support the pipeline and facilities if an emergency occurs.

All of the information that Pacific Connector gathers about its system would be used to tailor its safety and integrity management activities, so that parts of the system in the greatest need of attention receive greater scrutiny, such as residential areas or areas subject to growth and development. For example, Pacific Connector would decide where and when to internally inspect the pipeline based on this information. Risk assessment of the pipeline system determines what inspection criteria are required. This may include many different types of assessment tools that provide specific types of information about the condition of the pipeline.

The Klamath Compressor Station would also be equipped with automatic emergency detection and shut down systems. For example, the station would have hazardous gas and fire detection systems, and an emergency shutdown system. These safety and emergency systems would be tested routinely to ensure they are operating properly. The emergency shutdown system would be designed to shut down and isolate elements of the compressor station in the event of a fire, before the development of a flammable mixture of gas could occur. The system would include sensors for detecting natural gas concentrations as well as ultraviolet sensors for detecting flames. Additionally, the compressor station equipment would be designed to shut down automatically if a mechanical failure poses risk to the equipment or otherwise constitutes a hazard. The compressor station would be equipped with relief valves to protect the piping from over pressurization and would be equipped with a blowdown system that can safely and rapidly depressurize part or all of the compressor station to a safe location.

Personnel would be able to respond to a compressor station emergency in 60 minutes or less during non-scheduled work hours and within a few minutes if they are at the compressor station. Personnel would be on call at all times, 24 hours a day, 365 days a year to respond to emergencies. Emergencies while the compressor station is unattended would be monitored remotely via Pacific Connector's gas control facility. Personnel living within a 30-minute travel time of the compressor station would be dispatched by the gas control facility in the event of an emergency at the compressor station.

Personnel would be Operator Qualified per USDOT PHMSA requirements for operational and emergency situations at the station. Fire protection, first aid, and safety equipment would be maintained at the compressor station, and personnel would be trained in first aid and proper equipment use.

The Pacific Connector pipeline would cross areas subject to ongoing and future land management activities on federal lands managed by BLM, Forest Service, and Reclamation. Pacific Connector would be required to prepare a POD for activities on these federal lands that also addresses other safety and reliability measures requested by the BLM, Forest Service, and Reclamation. The BLM, Forest Service, and Reclamation would review and approve draft plans to ensure all safety concerns associated with construction and operation of the proposed Pacific Connector pipeline on federally managed lands are addressed.

Pipeline Standards to Minimize Fire Risk to Forest Lands

The Pacific Connector pipeline would be in areas where forest fires could occur. Pacific Connector proposes to meet or exceed USDOT pipeline burial depth requirements (found in 49 CFR Part 192) and would install the Pacific Connector pipeline with at least 36 inches of cover in Class I locations with normal soils and at least 24 inches of cover in consolidated rock areas.

Pursuant to 49 CFR 192.615, each pipeline operator must also develop an ERP that includes procedures to minimize the hazards in the event of a natural gas pipeline emergency. The key elements of the required plan include establishing and maintaining communications with local fire officials and coordinating emergency response, emergency shutdown of the system and safe restoration of service, making personnel, equipment, tools, and materials available at the scene of an emergency, and protecting people and property from hazards. Part 192 specifically requires that each pipeline operator establish and maintain liaison with appropriate fire officials to learn the resources and responsibilities of each organization that may respond to a natural gas pipeline emergency, and must coordinate mutual assistance. The previous discussion in section 4.13.9.1 describes the specific emergency response capabilities of the Project, including maintenance by Pacific Connector of 24-hour emergency response capabilities.

In addition, in compliance with the federal requirements discussed above, Pacific Connector must develop an ERP for the entire system. A draft ERP was included as Appendix H to the POD.[226] The ERP requires operations personnel to attend training for emergency response procedures and requires the pipeline operators to meet with local emergency responder groups, including fire departments, to review plans and educate the responder groups on the specifics of the pipeline facilities within the relevant service area. After the initial coordination with local responders, Pacific Connector would also meet periodically with the groups to review plans and revise them when necessary. Finally, if requested by local response personnel, Pacific Connector would participate in any simulated emergency exercises and post-exercise critiques. Through these coordination activities, the fire response personnel would become familiar with the location and specific safety and fire issues associated with the pipeline. This information would significantly reduce risks to the fire response personnel responding to a fire either caused by or in the vicinity of the pipeline alignment. The majority of the training costs would be borne by Pacific Connector; therefore, the coordination requirements would not significantly increase fire suppression costs.

In the event a fire was to occur on the surface in the vicinity of the pipeline, the presence of the pipeline would not increase fire hazards. Fires on the surface are not a direct threat to underground natural gas pipelines because of the insulating effects of soil cover over the pipeline. Soil is a poor conductor of heat with thermal conductivity values ranging from 0.44 to 1.44 Btu/ft-hr-°F. The heat capacity of most soils is 0.20 to 0.25 Btu/lb-°F. Based on the proposed burial depth of 24 to 36 inches, and the insulating effects of soil cover over the pipeline, we do not believe that forest fires would affect pipeline integrity. In addition, we do not believe that additional burial depth beyond what is proposed by Pacific Connector would be necessary to protect against damage by forest fires.

When forest fires arise in the area, Pacific Connector would closely monitor and protect the pipeline from wildfires. Pacific Connector would also have facilities built along the pipeline to aid in protecting the pipeline from wildfires. Along with Pacific Connector's pipeline control there are MLV sites on the pipeline to aid in isolating which portions of the pipeline have product in them. Pacific Connector would be in communications with emergency management office and monitoring the wildfires. Pacific Connector can determine what actions need to be taken to protect the pipeline and facilities in the area of the wildfires. If a wildfire was near Pacific Connector's facility locations or an MLV site, Pacific Connector would consider shutting down and isolating those facilities until the fire risk was mitigated. After all threats to safety for the area were assessed those facilities would be inspected to ensure there was no damage from the fire before restarting. In past situations, local operation personnel have protected above ground mainline valves by burying the valves with sand and earth material. Pacific Connector remains in close

[226] Pacific Connector's POD was filed with the FERC on January 23, 2018.

communication with its operations staff at each of their locations to ensure the circumstance of the fire is tended to accordingly.

Pacific Connector has also developed a *Fire Prevention and Suppression Plan.*[227] This plan is consistent with Forest Service and BLM policies and current practices. Although designed for federal lands, it would be applicable to the entire pipeline route; regardless of landownership. The intent of the plan is to identify measures to minimize the chances of a fire starting and spreading from project facilities and to reduce the risk of wildland and structural fire.

4.13.2.2 Pipeline Accident Data

The USDOT requires all operators of natural gas transmission pipelines to notify the USDOT of any significant incident and to submit a report within 20 days. Significant incidents are defined as any leaks that:

- caused a death or personal injury requiring hospitalization; or
- involve property damage of more than $50,000 (1984 dollars[228]).

During the 20-year period from 1996 through 2015, a total of 1,310 significant incidents were reported on the more than 300,000 total miles of natural gas transmission pipelines nationwide.

Additional insight into the nature of service incidents may be found by examining the primary factors that caused the failures. Table 4.13.2.2-1 provides a distribution of the causal factors as well as the number of each incident by cause.

TABLE 4.13.2-3

Natural Gas Transmission Pipeline Significant Incidents by Cause (1996–2015) a/

Cause	No. of Incidents	Percentage
Corrosion	311	23.7
Excavation b/	210	16.0
Pipeline material, weld or equipment failure	354	27.0
Natural force damage c/	146	11.1
Outside force c/	84	6.4
Incorrect operation	40	3.1
All other causes d/	165	12.6
Total	**1,310**	**100**

a/ All data gathered from PHMSA Significant Transmission Pipeline Incident files. https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Go
b/ Includes third-party damage.
c/ Fire, explosion, vehicle damage, previous damage, intentional damage
d/ Miscellaneous causes or unknown causes

The dominant causes of pipeline incidents are corrosion and pipeline material, weld or equipment failure constituting 50.7 percent of all significant incidents. The pipelines included in the data set in table 4.13.2.2-1 vary widely in age, diameter, and level of corrosion control. Each variable influences the incident frequency that may be expected for a specific segment of pipeline.

[227] Included as Appendix K to Pacific Connector's 2018 POD.
[228] $50,000 in 1984 dollars is approximately $122,000 based on the March 2018 Consumer Price Index.

The frequency of significant incidents is strongly dependent on pipeline age. Older pipelines have a higher frequency of corrosion incidents, since corrosion is a time-dependent process. The use of both an external protective coating and a cathodic protection system[229], required on all pipelines installed after July 1971, significantly reduces the corrosion rate compared to unprotected or partially protected pipe.

Outside forces are the cause in 33.5 percent of significant pipeline incidents. These result from the encroachment of mechanical equipment such as bulldozers and backhoes; earth movements due to soil settlement, washouts, or geologic hazards; weather effects such as winds, storms, and thermal strains; and willful damage.

Older pipelines have a higher frequency of outside forces incidents partly because their location may be less well known and less well marked than newer lines. In addition, the older pipelines contain a disproportionate number of smaller-diameter pipelines; which have a greater rate of outside forces incidents. Small-diameter pipelines are more easily crushed or broken by mechanical equipment or earth movement. Table 4.13.2.2-2 shows the various causes of outside force incidents.

TABLE 4.13.2.2-2

Outside Forces Significant Incidents by Cause (1996-2015) a/

Cause	No. of Incidents	Percent of all Incidents b/, c/
Third-party excavation damage	172	13.6
Operator excavation damage	25	1.9
Unspecified excavation damage/previous damage	13	1.0
Heavy rain/floods	74	5.7
Earth movement	32	2.4
Lightning/temperature/high winds	27	2.1
Natural force (unspecified and other)	13	1.0
Vehicle (not engaged with excavation)	49	3.7
Fire/explosion	9	0.7
Previous mechanical damage	6	0.5
Fishing or maritime activity	9	0.7
Intentional damage	1	0.1
Electrical arcing from other equipment/facility	1	0.1
Other outside force	9	0.7
Total	**440**	**33.5**

a/ All data gathered from PHMSA Significant Transmission Pipeline Incident files. https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll?Go
b/ Percentage of all incidents was calculated as a percentage of the total number of natural gas transmission pipeline significant incidents (i.e., all causes) presented in table 4.13.9.2-1.
c/ Due to rounding, column does not sum to 33.5 percent.

Since 1982, operators have been required to participate in "One Call" public utility programs in populated areas to minimize unauthorized excavation activities in the vicinity of pipelines. The "One Call" program is a service used by public utilities and some private sector companies (e.g., oil pipelines and cable television) to provide preconstruction information to contractors or other maintenance workers on the underground location of pipes, cables, and culverts.

[229] Cathodic protection is a technique to reduce corrosion (rust) of the natural gas pipeline through the use of an induced current or a sacrificial anode (like zinc) that corrodes at faster rate to reduce corrosion.

4.13.2.3 Impact on Public Safety

Pipeline Construction

Active pipeline construction can increase safety risks to the public generally in two ways, from an increase of traffic on roadways in the vicinity of the pipeline, and from potential exposure to construction activity itself within the construction right-of-way.

During periods of active construction, roadways in the vicinity of the pipeline project would experience an increase in small vehicle traffic from the construction work force, as well as large vehicle traffic transporting construction equipment and materials. Where the pipeline would cross roadways, access to and from the right-of-way by construction vehicles and construction activity itself at the roadway crossing could disrupt traffic and create potential safety hazards to the public. Pacific Connector has developed Transportation Plans for both private and federal lands that describe measures that it would implement to minimize public access and safety concerns as a result of construction vehicle traffic and construction activity at roadway crossings (see additional discussion in section 4.10). In addition, Pacific Connector would obtain all necessary permits for public roadway crossings and roadway use, and would comply with traffic control and public safety mitigation measures that are conditions of these permits.

During pipeline construction, the general public could be exposed to safety hazards within the pipeline construction right-of-way itself. Hazards would be typical of a construction site involving clearing, grading, and excavation, and could include timber felling, heavy equipment operation including on steep slopes, open trench, falling or rolling rock on steep slopes, and fly rock from blasting. During active construction the contractor and company personnel present on the job would limit access to the public to potentially hazardous situations such as operation of heavy equipment, or blasting for trench excavation. During construction off hours, the public could be exposed to hazards such open trench or loose rock. Locating the pipeline in non-populated areas helps to minimize the chance for unauthorized public access to the right-of-way.

Where the pipeline would be placed within residential areas, Pacific Connector would minimize impacts and potential safety hazards by ensuring that the construction proceeds quickly through such areas. Where the construction work area would be within 50 feet of a residence, Pacific Connector would install safety fence along the edge of the work area for a distance of 100 feet on either side of the residence. Fencing would be maintained, at a minimum, throughout the open trench phases of pipeline installation. Where feasible, Pacific Connector has reduced the width of the construction right-of-way near residences and placed TEWAs as far as practicable from the residences. In residential areas Pacific Connector would also limit the period of time the trench remains open prior to backfilling to 10 days. For the residences within 50 feet of the proposed right-of-way, Pacific Connector has developed site-specific plans showing the temporary and permanent rights-of-way and noting special construction techniques and mitigation measures.

The BLM, Forest Service, and Reclamation can require Pacific Connector to incorporate additional specific public safety measures into the POD as a condition of a Right-of-Way Grant for use of federal lands.

Pipeline Operation

During pipeline operation Pacific Connector would comply with the USDOT pipeline safety standards as well as regular monitoring and testing of the pipeline. While pipeline failures are rare, the potential for pipeline systems to rupture and the risk to nearby residents is discussed below.

The serious incidents data summarized in table 4.13.2.3-1 include pipeline failures of all magnitudes with widely varying consequences. Table 4.13.2.3-1 presents the average annual injuries and fatalities that occurred on natural gas transmission lines in the 5-year period between 2013 and 2017.

TABLE 4.13.2.3-1

Injuries and Fatalities – Natural Gas Transmission Pipelines

Year	Injuries	Fatalities
2013	2	0
2014	1	1
2015	16	6
2016	3	3
2017	3	3

The majority of fatalities from pipelines are due to local distribution pipelines not regulated by the FERC. These are natural gas pipelines that distribute natural gas to homes and businesses after transportation through interstate natural gas transmission pipelines. In general, these distribution lines are smaller diameter pipes and/or plastic pipes which are more susceptible to damage. Local distribution systems do not have large rights-of-way and pipeline markers common to the FERC-regulated natural gas transmission pipelines.

The nationwide totals of accidental fatalities from various anthropogenic and natural hazards are listed in table 4.13.2.3-2 to provide a relative measure of the industry-wide safety of natural gas transmission pipelines. Direct comparisons between accident categories should be made cautiously, however, because individual exposures to hazards are not uniform among all categories. The data nonetheless indicate a low risk of death due to incidents involving natural gas transmission pipelines compared to the other categories. Furthermore, the fatality rate is much lower than the fatalities from natural hazards such as lightning, tornados, or floods.

TABLE 4.13.2.3-2

Accidental Deaths by Cause

Type of Accident	Number of Fatalities a/
All injuries (unintentional)	146,571
Motor vehicle accident	37,757
Poisoning (unintentional)	47,478
Falls (unintentional)	33,381
Suffocation (unintentional)	6,917
Drowning (unintentional)	3,602
Fire/flame (unintentional)	2,646
Floods b/	84
Lightning b/	47
Natural gas distribution lines c/	11
Natural gas transmission pipelines c/	3

a/ All data, unless otherwise noted, reflect 2015 statistics from the National Vital Statistics Reports https://www.cdc.gov/nchs/data/nvsr/nvsr66/nvsr66_06.pdf
b/ NOAA National Weather Service, Office of Climate, Water and Weather Services, 30-year average (1987-2016) http://www.weather.gov/om/hazstats.shtml.
c/ PHMSA significant incident files, March 16, 2018. https://hip.phmsa.dot.gov/analyticsSOAP/saw.dll, 20-year average.

The available data show that natural gas transmission pipelines continue to be a safe, reliable means of energy transportation. From 1998 to 2017, there were an average of 68 significant incidents, 9 injuries, and 3 fatalities per year. The number of significant incidents over the more than 2.21 million miles of natural gas transmission lines in service indicates that the risk is low for an incident at any given location. The operation of the Pacific Connector pipeline would represent a slight increase in risk to the nearby public.

4.13.3 Conclusions

As part of the NEPA review and NGA determinations, Commission staff assesses the potential impact to the human environment in terms of safety and whether the proposed facilities would operate safely, reliably, and securely.

As a cooperating agency, the USDOT assists the FERC by determining whether Jordan Cove LNG Project's proposed design would meet the USDOT's 49 CFR 193 Subpart B siting requirements. USDOT will provide a Letter of Determination on the Project's compliance with 49 CFR 193 Subpart B. This determination will be provided to the Commission as further consideration to the Commission on its decision to authorize or deny the Project. If the Project is authorized and constructed, the facility would be subject to the USDOT's inspection and enforcement program and final determination of whether a facility is in compliance with the requirements of 49 CFR 193 would be made by the USDOT staff.

As a cooperating agency, the Coast Guard also assisted the FERC staff by reviewing the proposed LNG terminal and the associated LNG marine vessel traffic. The Coast Guard reviewed a WSA submitted by Jordan Cove that focused on the navigation safety and maritime security aspects of LNG marine vessel transits along the affected waterway. On May 10, 2018, the Coast Guard issued an LOR that recommended the Coos Bay Channel be considered suitable for accommodating the type and frequency of LNG marine traffic associated with this Project based on the WSA and in accordance with the guidance in the Coast Guard's NVIC 01-11. If the Project is authorized and constructed, the facilities would be subject to the Coast Guard's inspection and enforcement program to ensure compliance with the requirements of 33 CFR 105 and 33 CFR 127.

FERC staff conducted a preliminary engineering and technical review of the Jordan Cove LNG Project design, including potential external impacts based on the site location. Based on this review, we recommend a number of mitigation measures, which would ensure continuous oversight prior to initial site preparation, prior to construction of final design, prior to commissioning, prior to introduction of hazardous fluids, prior to commencement of service, and throughout life of the facility to enhance the reliability and safety of the facility to mitigate the risk of impact on the public. With the incorporation of these mitigation measures and oversight, FERC staff concluded that the Jordan Cove LNG Project design would include acceptable layers of protection or safeguards that would reduce the risk of a potentially hazardous scenario from developing into an event that could impact the offsite public.

The pipeline would be constructed in compliance with the USDOT pipeline standards (as published in 49 CFR Parts 190-199; Part 192 of 49 CFR). Based on the implementation of the required BMPs and adherence to USDOT standards, the Project would not significantly affect public safety.

4.14 CUMULATIVE IMPACTS

Coastal and southern Oregon have been affected by human activity for thousands of years and the existing environmental conditions in the Project area reflect extensive changes to natural resources brought about by past human activities. In 1850, there were about 432,808 acres of farmland in Oregon. By 1954, farmland increased to 21 million acres. In 2007, 16.4 million acres in Oregon were used for agriculture (Ballard 1959; Sorte et al. 2011). Farming activities have modified the environment through land clearing and planting of non-native species.

Oregon has lost an estimated 38 percent of its original wetlands (Morlan 2000). Most Oregon estuaries have been significantly altered through the diking and draining of marshes in the early to mid-1900s for agricultural use, and urban development. Between 1870 and 1970, tidal wetlands within the Coos Bay estuary decreased an estimated 66 percent (Oregon Progress Board 2009).

Cutting of forests in the region began with Euro-American settlement. Initially, forests in the valley floors were cleared to make way for agriculture. Lowland areas close to population centers were logged first, followed by less accessible areas in more mountainous terrain.

Shortly after World War II, improvements in the gas-powered chain saw and transportation led to increased logging in the Pacific Northwest, with a shift to timber sales on federal lands. There was a boom in demand for wood products during the 1950s and 1960s, with a post-war need for framing lumber and plywood for new housing. More than 70 plywood plants opened in Oregon between 1940 and 1960, including plants in North Bend, Coos Bay, and Coquille. As timber inventories on private lands were depleted, pressure to harvest timber on federal lands increased. In 1952, western Oregon's peak year for timber production, about one-third of the 10.4 billion board feet harvested came from federal lands. By 1963, more timber was harvested on federal lands than private lands.

As a result of over a century of logging and fire control, the portions of forests of the Pacific Northwest consist of a mosaic of recent clearcuts, thinned stands, and young plantations interspersed with unmanaged stands. The remaining unmanaged stands range from 1,000-year-old or older forests with large trees to relatively young, even-aged stands that have regenerated following wildfires. Because wildfires and windstorms often killed only some of the trees in a stand, natural stands are frequently characterized by a mixture of trees that survived a catastrophic event and younger trees that filled in the understory after the event. Where many large old trees remain in the overstory, these stands have been referred to as "old growth," "late successional," or "ancient" forests (FEMAT 1993). Where only scattered individuals or patches of large old trees remain and the majority of the stand consists of young or mature trees, stands are referred to as "mixed age" or even "young." Mixed-age stands are particularly common in some areas, such as the Oregon Coast Range, where extensive fires occurred in the 1800s. Species associated with or dependent on these late-successional and old-growth forests, such as the NSO and MAMU, have been negatively affected by habitat loss (see section 4.6 of this EIS).

Today, Oregon's environment reflects a mixture of natural processes and human influences across a range of conditions, from areas defined by relatively natural structures and functions to areas completely dominated by human activities (Oregon Progress Board 2000). In the past decade, large, stand-replacing wildfires have affected public lands in southwest Oregon. Since the inception of the NWFP in 1994, the majority of the NSO habitat loss in the region has been the result of stand-replacing wildfire.

Concerning these past activities, the CEQ issued an interpretive memorandum on June 24, 2005, regarding analysis of past actions, which stated: "agencies can conduct an adequate cumulative effects analysis by focusing on the current aggregate effects of past actions without delving into the historical details of individual past actions." These activities are included herein to provide historical context. To understand the contribution of past actions to the cumulative effects of the proposed action, this analysis relies on current environmental conditions as a proxy for the effects of past actions. Existing conditions reflect the aggregate effects of all prior human actions and natural events that have affected the environment and might contribute to cumulative effects. In this analysis, we generally consider the effects of past projects as part of the affected environment (environmental baseline) which was described previously. However, this analysis does consider, as applicable, the present effects of past actions.

This analysis is also consistent with Forest Service implementing NEPA Regulations (36 CFR 220.4(f)) (July 1, 2012), which state, in part:

> *CEQ regulations do not require the consideration of the individual effects of all past actions to determine the present effects of past actions. Once the agency has identified those present effects of past actions that warrant consideration, the agency assesses the extent that the effects of the proposal for agency action or its alternatives will add to, modify, or mitigate those effects. The final analysis documents an agency assessment of the cumulative effects of the actions considered (including past, present, and reasonable foreseeable future actions) on the affected environment. With respect to past actions, during the scoping process and subsequent preparation of the analysis, the agency must determine what information regarding past actions is useful and relevant to the required analysis of cumulative effects. Cataloging past actions and specific information about the direct and indirect effects of their design and implementation could in some contexts be useful to predict the cumulative effects of the proposal. The CEQ regulations, however, do not require agencies to catalogue or exhaustively list and analyze all individual past actions. Simply because information about past actions may be available or obtained with reasonable effort does not mean that it is relevant and necessary to inform decision making. (40 CFR 1508.7)*

In accordance with NEPA, we identified other actions near the Project facilities and evaluated the potential for a cumulative effect on the environment. As defined by the CEQ, a cumulative effect is the impact on the environment resulting from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of which agency or person undertakes such other actions. "Past" actions were addressed in the preceding discussion. "Present" actions are those currently ongoing, either being constructed or are in operation and affecting the environment in such a manner that could contribute to a cumulative impact. "Reasonably foreseeable actions" are proposed projects or developments that have applied for a permit from local, state, or federal authorities or planned projects which have been publicly announced.

Consistent with CEQ guidance, and cooperating agencies' regulations and recommendations, we identified and considered present and reasonably foreseeable actions within an appropriate "geographic scope". The geographic scopes considered in this analysis vary depending on the environmental resource and are identified in table 4.14-1. Actions located outside the geographic scopes are not evaluated because their potential to contribute to a cumulative impact diminishes with increasing distance from the Project.

A nearby project must affect the same resource as the Project to have a cumulative impact on that resource. As previously stated, the effects of more distant actions/projects (outside the HUC 10 or HUC 8 watersheds) are not assessed because their impacts are not expected to overlap with the Project; and therefore, would not contribute to a cumulative impact. Two examples representing opposite ends of the spectrum with regard to geographic scope are cultural resources and air quality. With some exceptions, Project effects on cultural resource sites are localized in nature. For example, a direct impact on an archaeological site would typically not affect other sites; therefore, the geographic scope for archaeological sites is limited to the area within which sites could be directly or indirectly affected by an action. In contrast, the impact of air emissions could be felt over a relatively large distance; therefore, the geographic scope for air quality is larger than for other resources. When determining the significance of a cumulative impact, we consider the duration of the impact; the geographic, biological, and/or social context in which the impact would occur; and the magnitude and intensity of the impact. The duration, context, and magnitude of impacts vary by resource and therefore significance varies accordingly.

As identified in table 4.14-1, we are generally considering HUC 10 (fifth-field) watersheds crossed as the geographic scope for potential cumulative impacts. The Project facilities would be located within 19 HUC 10 watersheds (figures 4.14-1a and 4.14-1b). Additionally, the COE currently considers HUC 8 (fourth-field) watershed to assess cumulative effects, therefore, we are including impacts and compensatory mitigation information provided by the COE within the larger HUC 8 watershed area for analysis of cumulative impacts on wetlands and surface waters. Project facilities would be located within six HUC 8 watersheds. Within these watersheds we have identified six general actions/project types that could contribute to a cumulative impact. These actions are: COE permits and mitigation projects, minor federal agency projects (including road/utility improvements, water flow control, weed treatments, and miscellaneous mitigation), residential and commercial development, timber harvest and forest management activities, livestock grazing, and solar power panel fields.

Of these six project types, some additional context is necessary for livestock grazing and timber harvest and forest management. Livestock grazing occupies far and away the largest footprint of any of the project types considered (approximately 292,000 acres or about 83 percent of the projects considered in our analysis). It also displays a complex temporal niche in that grazing, having occurred for hundreds of years in Oregon, is both a present and reasonably foreseeable activity and a large component of the affected environment. That is, the continuation of grazing is now essentially just the maintenance of the existing environment. The exception, of course, is for the addition of lands not previously open to grazing. These additions include an episodic and conversional set of impacts that would be cumulative with the resources also affected by the Project if they occurred during construction and restoration of the pipeline.

The continued use of grazed lands does not contribute episodic impacts, but rather ongoing perturbation that may have a set of related resource impacts, such as suppression of arboreal and natural vegetative communities that would otherwise develop. In addition, livestock grazing disrupts soil profiles, breaks down stream banks, and contributes to water quality degradation of streams. Accordingly, we characterize livestock grazing impacts as ongoing, landscape-level impacts with relatively small incremental impacts distributed over the present and future timeframe that is also affected by the Project. Consequently, livestock grazing impacts during any discrete period of time, such as the limited period that pipeline construction would occur within a given HUC-10 watershed, contributes only minor impacts on the resources also affected by the Project. For this reason, we identify ongoing livestock grazing projects in our list of projects within the geographic scope of our cumulative impacts analysis, but unless otherwise noted, we do not include them in our analysis of potential cumulative impacts on each resource.

Timber harvesting and forest management activities make up the second largest footprint of the project types considered (50,950 acres or about 14 percent of the projects considered in our analysis). Timber harvesting and forest management impacts are episodic and conversional. Timber harvesting dramatically alters multiple interlaced resources including vegetative and wildlife communities, soils, water resources, and visual aesthetics. In addition to the larger scale of the impacts, there is a longer-term temporal impact. While revegetation of affected communities may be allowed to occur after harvesting, complete restoration (i.e., the point in which the affected area no longer contributes to cumulative impacts) is most often measured in decades.

Additionally, non-jurisdictional utilities at the terminal site, the use of LNG carriers, ongoing maintenance dredging, the Port's Channel Modification Project, Project impact mitigation projects, and the removal of PacifiCorp dams on the Klamath River could also contribute to a cumulative impact(s). Table 4.14-2 identifies these actions by watershed, and table N-1 in appendix N lists the resources each project could affect and summarizes the area of known impacts. We generally do not include in our analysis projects such as small commercial developments and small road projects located within towns and other developed areas, because these actions have a small footprint, are consistent with surrounding land uses, and contribute only minutely to cumulative impacts on the resources evaluated in this EIS.

In addition to the geographic relationship between the Project and other projects, we also consider the temporal relationship. For the purposes of this analysis, the temporal extent of other projects would start generally in the past[230] and extend out for the expected duration of the impacts caused by the Project.

Not all future projects that may occur are well defined with regard to scope, location, timing, and resource footprint. Without specific information, inclusion of these projects may not be meaningful. For example, between 2010 and 2017, the counties crossed by the Project have grown by an average of about 4 percent; and along with that growth, numerous residential subdivisions, commercial developments, roads and utilities, and maintenance and upgrading of existing infrastructure have been constructed (or were proposed). If growth continues, similar future actions may occur, affecting a range of natural resources, including soils, waterbodies and wetlands, vegetation, and wildlife. There is also the potential that over time federal and state agencies and private conservation organizations may implement projects and actions that improve habitat, water quality, and air quality throughout the Project area. It is not possible to quantify or assess the potential cumulative impacts or benefits that may accrue from these undefined future projects. In addition, we anticipate that at a future date the Forest Service may address the

[230] We consider only those past projects that contribute ongoing effects on resources. Generally, more recent projects contribute a greater impact.

cumulative effects of currently undefined Project-related mitigation actions that these agencies may require on Forest Service and BLM-managed lands.

Additional discussion of cumulative effects on federally listed and proposed wildlife, fish, and plant species will be provided in our pending BA. The ESA defines cumulative effects as the "effects of future state or private activities, not involving Federal activities (Federal activities are subject to project-specific, individual ESA reviews), that are reasonably certain to occur within the action area of the Federal action subject to consultation." The determinations of effect in the BA will consider cumulative effects. Additionally, the Services are required to consider cumulative effects in formulating their biological opinions (50 CFR §402.14(g)(3) and (4)).

TABLE 4.14-1

Geographic Scope, by Resource, for Cumulative Effects Analysis

Resource	Geographic Scope	Rationale for Potential Cumulative Impact Analysis Area
Soils	HUC-10 watersheds	Projects within the HUC-10 watershed could contribute to cumulative impacts on soils within the watershed; therefore, the Project would result in additional incremental impacts on soils within the HUC-10 watersheds.
Water Resources and Wetlands	HUC-10 watersheds HUC-8 watersheds for COE wetland mitigation projects	Projects within the HUC-10 watershed could contribute to cumulative impacts on water resources and wetlands within the watershed.
Vegetation	HUC-10 watersheds	Projects within the HUC-10 watershed could contribute to cumulative impacts on vegetation within the watershed
Wildlife and Aquatic Resources	HUC-10 watersheds marine waters outside of Coos Bay	Projects within the HUC-10 watershed could contribute to cumulative impacts on wildlife and aquatic resources within the watershed; and projects from the mouth of Coos Bay to the outer continental shelf could contribute to impacts on listed marine species
Land Use	HUC-10 watersheds	Projects within the HUC-10 watershed could contribute to cumulative impacts on land use within the watershed
Recreation and Visual Resources	HUC-10 watersheds Viewshed from which Project construction or permanent facilities can be seen	Projects within the HUC-10 watershed could contribute to cumulative impacts on recreation; and projects within the viewshed of the Project could contribute to cumulative impacts on visual resources
Socioeconomics	Coos, Douglas, Jackson, and Klamath counties	Projects within the four counties with proposed Project facilities could contribute to cumulative impacts on socioeconomics
Environmental Justice	The census tracts directly affected by the Project	Projects within the census tracts directly affected by the proposed Project facilities could contribute to cumulative impacts on Environmental Justice communities
Transportation	Coos, Douglas, Jackson, and Klamath counties and the Coos Bay Federal Navigation Channel	Projects within the four counties with proposed Project facilities, as well as those along the Coos Bay Federal Navigation Channel could contribute to cumulative impacts on transportation
Cultural Resources	Direct and indirect Area of Potential Effect (APE)	Projects within the disturbance footprint (direct APE) or adjacent areas that could potentially experience visual, atmospheric, or audible cumulative impacts from Project construction or operation (indirect APE) could contribute to cumulative impacts on cultural resources
Air Quality	Within 0.25 mile of construction, and 50 km of LNG terminal and Klamath Compressor Station during operation	Projects within these geographic scopes could contribute to cumulative impacts on air quality during construction and operation
Noise	Within 0.25 mile (daytime) and 0.5 mile (nighttime) of construction, and 1 mile of LNG terminal and Klamath Compressor Station during operation	Projects within these geographic scopes could contribute to cumulative impacts on daytime and nighttime noise during construction and operation

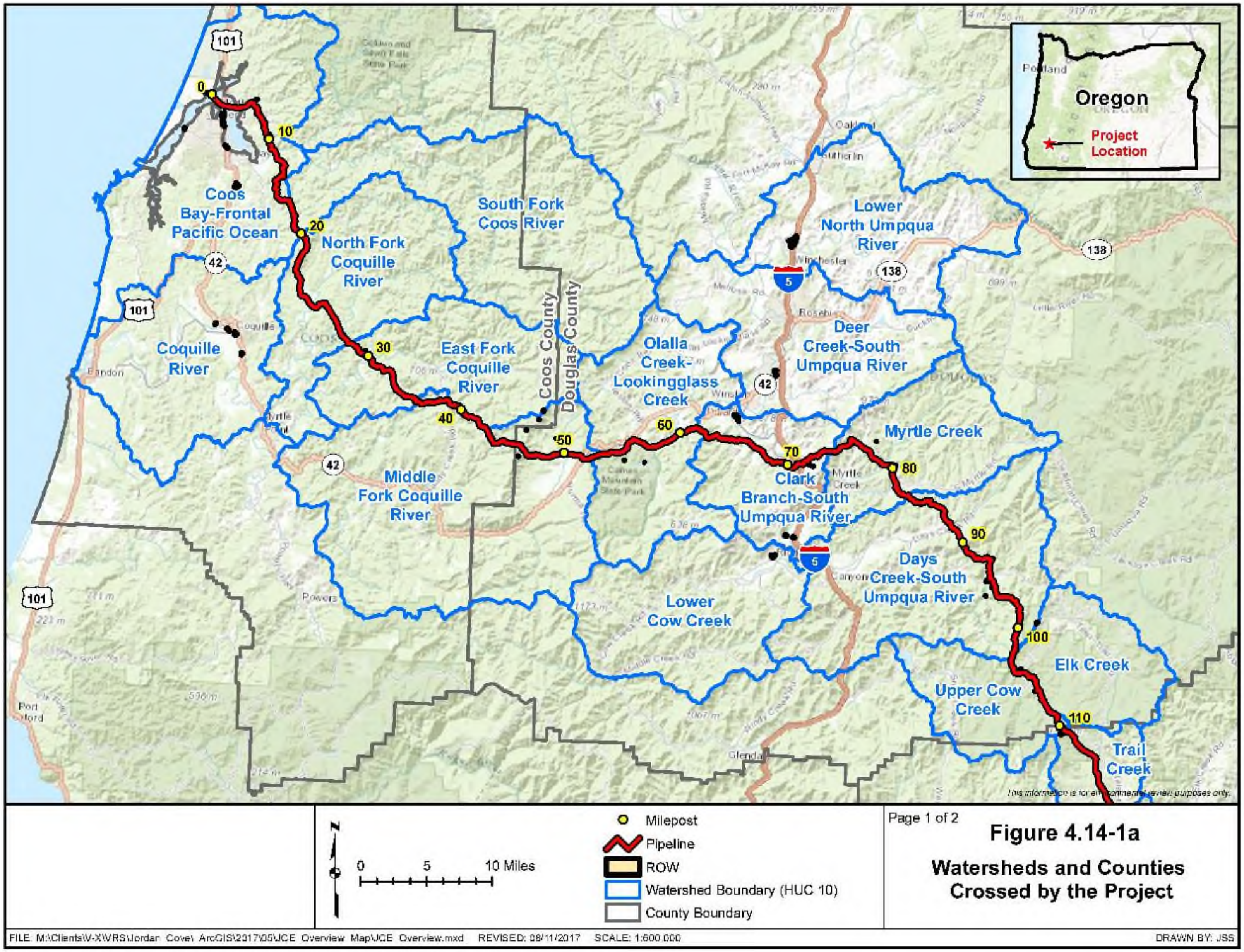

Figure 4.14-1a

Watersheds and Counties Crossed by the Project

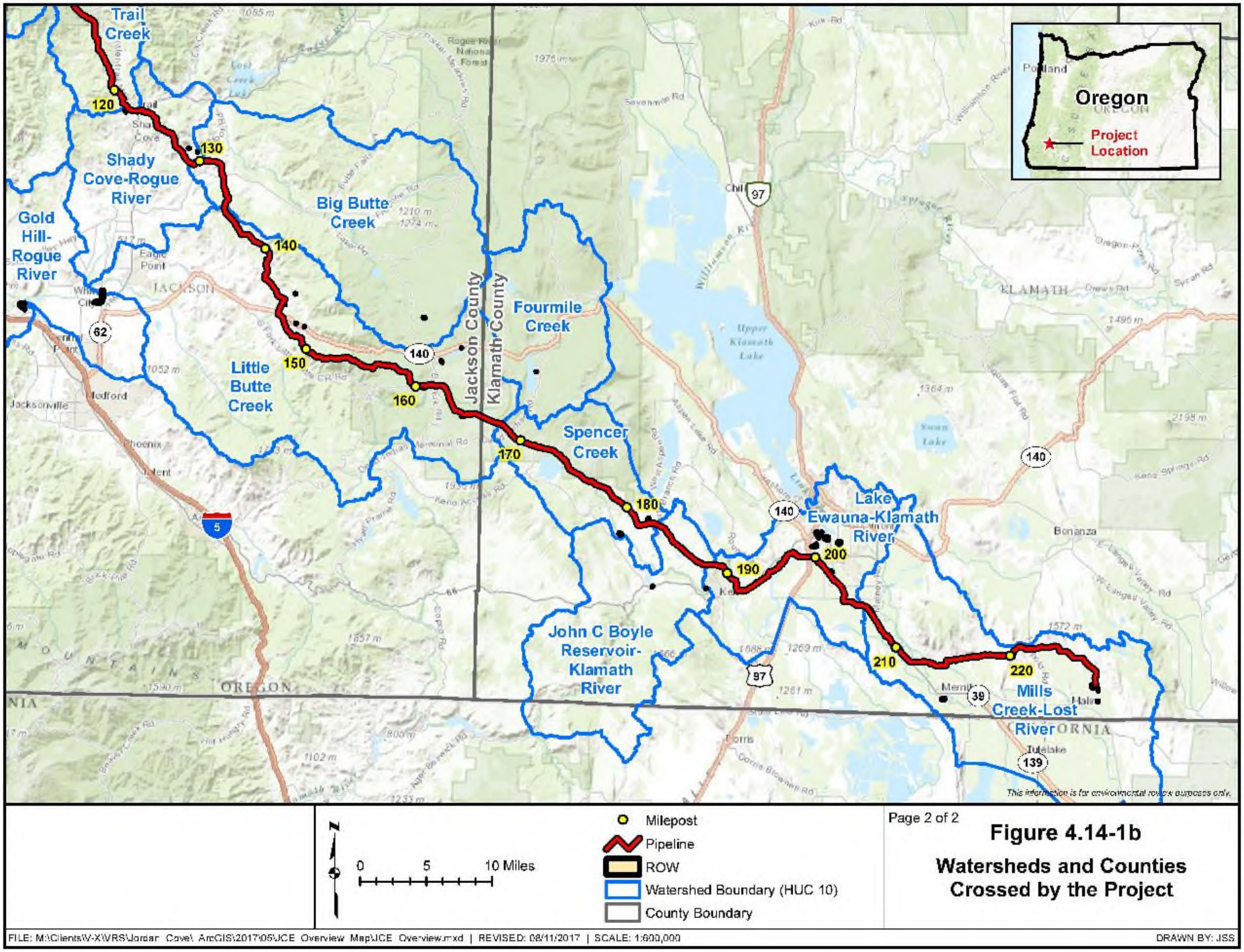

Figure 4.14-1b

Watersheds and Counties Crossed by the Project

TABLE 4.14-2

Past, Present, or Reasonably Foreseeable Actions that May Cumulatively Affect Resources a/

Project	County
Coos Bay-Frontal Pacific Ocean Watershed	
COE - Permits and Mitigation (**Coos Fourth-Field Watershed)**	Various
Non-jurisdictional facility - LNG carriers	Coos
Non-jurisdictional facility – Utilities	Coos
Jordan Cove – Maintenance Dredging	Coos
Jordan Cove – Project impact mitigation	Coos
Port of Coos Bay - Coos Bay Railroad Bridge Rehabilitation	Coos
Port of Coos Bay – Maintenance Dredging	Coos
Port of Coos Bay – Coos Bay Rail Line Tunnel Rehabilitation	Coos
COE - Coos Bay Jetties Rehabilitation Project	Coos
CTCLUSI - Coos Head Area Master Plan, Hollering Place	Coos
City of North Bend – Department of Human Services Building Relocation	Coos
Port of Coos Bay - Coos Bay Section 408/204(f) Channel Modification b/	Coos
COE - Coos Bay Federal Navigation Channel Maintenance Dredging	Coos
Coos County Airport District — Southwest Oregon Regional Airport Expansion	Coos
Tioga Sports Park	Coos
Coos Bay Village commercial development	Coos
BLM — Catching Creek Conversion Timber Sale	Coos
BLM — Other Commercial Thinning Timber Sales	Coos
South Fork Coos River	
BLM - Tioga Creek Instream Restoration Phase 1	Coos
BLM - Helipond and Pump Chance Maintenance EA	Coos
Coquille River Watershed (Fourth Field)	
COE Permits and Mitigation	Coos
Coquille River Watershed	
BLM – Calloway Creek Timber Sale	Coos
BLM – Whistle Stop Conversion Timber Sale	Coos
BLM —Wilson Creek 4 Timber Sale	Coos
BLM — West Cunningham Timber Sale	Coos
BLM – Other CT Timber Sales	Coos
North Fork Coquille River Watershed	
BLM — Manual Maintenance	Coos
BLM — Whiskey Train Timber Sale	Coos
BLM — Steele 23 CT Timber Sale	Coos
BLM — Cloud 19 CT Timber Sale	Coos
BLM — Hungry Mountain Timber Sale	Coos
BLM — Woodward 11 Timber Sale	Coos
BLM - Rock Prairie Timber Sale (Lone Pine EA)	Coos
BLM — Hidden Gem Timber Sale	Coos
BLM — Zumwalt Commercial thinning	Coos
BLM — Johns Creek Commercial thinning	Coos
BLM — Llewellyn Commercial thinning (Lone Pine EA)	Coos
BLM — Other commercial thinning and sales (Lone Pine EA)	Coos
BLM - Helipond and Pump Chance Maintenance EA	Coos
ODFW – Winter Lake Access Road Project	Coos
BLM — Steel Cherry Timber Sale	Coos
BLM — Yankee Panky Timber Sale	Coos
BLM — ERFO Road repairs	Coos
BLM — Weed Treatment	Coos
BLM — Weekly Commercial Thinning	Coos
BLM – Steel Creek Instream Restoration and Riparian Invasive Species removal/planting	Coos
BLM – Helipond and Pump Chance Maintenance EA	Coos
BLM – Scattered Skeeter Density Management Thinning	Coos
BLM – Broken Wagon Density Management Thinning	Coos
Methane Energy Corp (MEC), Coos County Methane Project	Coos

TABLE 4.14-2 (continued)

Past, Present, or Reasonably Foreseeable Actions that May Cumulatively Affect Resources a/

Project	County
BLM – Crosby Timber Sale	Coos
BLM – East Cherry Timber Sale	Coos
BLM – Wagon Road Pilot Timber Sale	Coos
BLM – Steel Trap Density Management Thinning	Coos
BLM – Weed Treatment	Coos
BLM – Brownstone Commercial thinning	Coos
BLM – My Frona Commercial thinning	Coos
BLM – Steel Cherry Commercial Thinning	Coos
Middle Fork Coquille Watershed	
BLM —Weaver Tie Timber Sale	Coos/ Douglas
BLM – Manual Maintenance	Coos/ Douglas
BLM – Weed Treatment	Coos/ Douglas
BLM – Helipond and Pump Chance Maintenance EA	Coos/ Douglas
BLM – Camas Valley Timber Sales	Coos/ Douglas
South Umpqua Watershed (Fourth Field)	
COE Permits and Mitigation	Douglas
Olalla Creek-Lookingglass Watershed	
BLM — Suicide Bar and other Commercial Thinning	Douglas
Clark Branch-South Umpqua River Watershed	
BLM- Shively-Clark Timber Sale EA	Douglas
Myrtle Creek Watershed	
BLM- Myrtle Creek REA Timber Sales	Douglas
Two Industrial Buildings	Douglas
Days Creek-South Umpqua River Watershed	
BLM – Upper Cow Late Successional Reserve Project	Douglas
BLM – Days Creek EA Timber Sales	Douglas
BLM – Shively-Clark EA Timber Sales	Douglas
Deer Creek South Umpqua River Watershed	
Grange Road Development	Douglas
Roseburg Public Works Projects	Douglas
Elk Creek Watershed	
Forest Service — Noxious Weed Treatment	Douglas
Forest Service – Livestock Grazing	Douglas
Forest Service—Tiller Aquatic Restoration Project	Douglas
Forest Service—Elk Creek Watershed Restoration Project	Douglas
Upper Cow Creek Watershed	
Forest Service—Livestock Grazing	Douglas/ Jackson
Forest Service - Upper Cow Creek Hazardous Fuels Project	Douglas/ Jackson
Forest Service –Tiller Aquatic Restoration Project	Douglas
BLM – Upper Cow Late Successional Reserve Project	Douglas
BLM – Young Stand Management	Douglas
BLM – Fuels Treatments	Douglas
Upper Rogue Watershed (Fourth Field)	
COE Permits and Mitigation	Jackson
Trail Creek Watershed	
Forest Service- Livestock Grazing	Jackson
BLM — Proposed Trail Creek Forest Management	Jackson
BLM – Proposed Trail Creek Forest Management	Jackson
BLM – Proposed Trail Creek Forest Management	Jackson
BLM – Proposed Trail Creek Forest Management	Jackson
BLM — Mouse Trail Timber Sale	Jackson
BLM – Livestock Grazing	Jackson
BLM – Elk Camel Forest Management Project	Jackson
BLM – Livestock Grazing	Jackson
Rogue River Drive Estates Subdivision	Jackson

TABLE 4.14-2 (continued)

Past, Present, or Reasonably Foreseeable Actions that May Cumulatively Affect Resources a/

Project	County
Gold-Hill Rogue River Watershed	
Saddlebrook Meadows Subdivision, Phase 2	Jackson
FB Owen Inc - Valley Meadows Estates	Jackson
Big Butte Creek Watershed	
BLM – Big Butte Forest Management Project	Jackson
BLM – Proposed Obenchain Forest Management Project	Jackson
BLM – Livestock Grazing	Jackson
BLM – Friese Camp Forest Management Project	Jackson
BLM - Double Bowen Forest Management Project	Jackson
BLM – Elk Camel Forest Management Project	Jackson
Forest Service-Livestock Grazing	Jackson
Little Butte Creek Watershed	
BLM – Proposed Obenchain Forest Management Project	Jackson/ Klamath
BLM - South Fork Little Butte Timber Sale	Jackson/ Klamath
BLM – Livestock Grazing	Jackson
Forest Service —2013 Big Elk Cinder Pit CE	Jackson/ Klamath
Forest Service- Livestock Grazing	Jackson/ Klamath
Spencer Creek Watershed	
Forest Service – Livestock Grazing	Klamath
Forest Service — Dead Indian Memorial and Clover Creek Roads Noxious Weed Treatment	Klamath
Forest Service — Lake of the Woods VVUI Project b	Klamath
Forest Service – Roadside Firewood Collection	Klamath
BLM — North Landscape Timber Sales	Klamath
BLM — Spencer Creek Thinning	Klamath
Upper Klamath Fourth-Field Watershed	
COE Permits and Mitigation	Klamath
Lost River Fourth-Field Watershed	
COE Permits and Mitigation	Klamath
John C. Boyle Reservoir-Klamath River/Lake Ewauna-Upper Klamath River/Mills Creek-Lost River Watersheds	
Oregon Department of Forestry - Bad Ham Timber Sale	Klamath
BLM — North Landscape Timber Sales	Klamath
BLM — Swan Lake Hydroelectric Pumped Storage Project	Klamath
BLM — Bryant Mountain Vegetation Treatments	Klamath
BLM – Bryant Mountain Juniper Treatment	Klamath
BLM – Stukel Juniper Treatment	Klamath
PacifiCorp. Klamath Dam Removal Project	Klamath
Turkey Hill Solar Project	Klamath
Merrill Solar Project	Klamath
BNSF Railway Crew Facility	Klamath
Klamath Irrigation District – Stukel Spill Project	Klamath
Non-jurisdictional facility – Utilities for Pacific Connector	Klamath and others

a/ Details on most future activities on private lands, such as commercial harvests, are not publicly available. These activities are expected to continue at current rates. See appendix N for acreage, status, approximate location relative to nearest Project facilities, and resources potentially affected by each project listed in this table.

b/ The Port's project is made up of several proposed actions to improve navigation efficiency, reduce shipping transportation costs, and facilitate the shipping industry's transition to larger, more efficient vessels. The Port is currently in the engineering and design phase and is coordinating with the COE since they play several roles in the area, including new long-term maintenance of the channel. The project will also require authorization from the COE and other agencies before conducting the dredging activities. The COE is preparing an EIS to analyze the potential impacts associated with the project.

The Ruby and GTN pipeline system are present in this watershed; however, as stated previously, we consider the effects of past projects as part of the affected environment

4.14.1 Cumulative Effects

Based on available information, the actions listed in table 4.14-2 would affect soils, water resources, vegetation, wildlife, fisheries and aquatic resources, socioeconomics, land use, recreation and visual resources, transportation, cultural resources, air quality, and noise; and as such, we are assessing the potential for cumulative impacts on these resources. Project impacts on geology were assessed in this EIS; however, because impacts on geology (with exceptions) are generally limited, we are not assessing cumulative impacts on geology unless specifically noted.

The acres affected by the projects listed in table 4.14-2 are summarized in table 4.14.1-1 by HUC-10 watershed, including the percentage of each watershed. The values presented for project-related mitigation on federal lands are approximate and may be subject to change within or between watersheds as a result of changing conditions and agency management priorities. In some of these watersheds, the cumulative effects from the other projects included in this analysis represent a relatively large percentage of the total watershed area. In these cases, the significance of the cumulative impact may be only minimally altered by the contribution of the Project. For example, the Elk Creek HUC-10 watershed covers about 54,356 acres. The Project's impacts (as described in the preceding analyses) within this watershed are inconsequential (40 acres) when compared to the total watershed area, and contribute impacts on only 0.07 percent of the watershed. However, the other projects considered have/would impact about 12,248 acres, or 22.6 percent of the watershed. In this example, whether the Project is constructed or not has no discernible effect on the cumulative impact exerted on the resources and approval and implementation of the other projects determines the significance of the cumulative impact.

TABLE 4.14.1-1

Area Affected by Projects Included in Cumulative Effects Analysis, by Watershed

HUC-10 Watershed	Total Area Within HUC-10 Watershed (Acres)	Proposed Project Impact Area (Acres) a/	Other Project Impact Area (Acres) b/	Combined Area of HUC-10 Watershed (%)
Coos Bay-Frontal Pacific	151,611	370	713	0.7
South Fork Coos River	160,146	29	11	0.0
Coquille River	111,644	36	1,029	1.0
North Fork Coquille River	98,406	189	4,802	5.1
East Fork Coquille River	85,963	172	0	0.2
Middle Fork Coquille River	197,314	272	1,097	0.7
Olalla Creek-Lookingglass	103,212	159	188	0.3
Clark's Branch-S Umpqua R	59,577	272	441	1.2
Lower Cow Creek	102,447	16	0	0.0
Myrtle Creek	76,250	247	1,077	1.7
Days Creek-S Umpqua R	141,569	567	3,297	2.7
Deer Creek-S Umpqua R	110,072	16	30	0.0
Lower North Umpqua River	106,406	102	0	0.1
Elk Creek	54,356	40	12,248	22.6
Upper Cow Creek	47499	89	2,419	5.3
Trail Creek	35,338	221	9,597	27.8
Shady Cove-Rogue River	74,268	140	755	1.2
Gold-Hill Rogue River	136,049	106	6	0.1
Big Butte Creek	158,243	89	4,941	3.2
Little Butte Creek	238,879	637	3,770	1.8
Spencer Creek	54,247	231	4,470	8.7
John C. Boyle Reservoir-Klamath River/Lake Ewauna-Upper Klamath River/Mills Creek-Lost River	349	921	9,725	3.1
TOTAL	**2,650,575**	**4,921**	**60,616**	**2.5**

a/ Only includes watersheds with at least 1 acre of Project disturbance.
b/ Includes projects listed in table 4.14-2 and table N-1 with exception of ongoing grazing on existing allotments.

4.14.1.1 Soils and Sediments

The other projects occurring in Coos Bay including the Port's Channel Modification Project and the COE's North Jetty Maintenance Project would temporarily and periodically impact Coos Bay sediments. Disturbing Coos Bay sediments would affect channel dynamics, water quality, adjacent sediments, fisheries and other aquatic organisms, and aquatic vegetation (see sections 4.1, 4.2, 4.3, 4.4, and 4.5). The impacts of these projects when combined with the impacts of the Project could result in a cumulative impact. However, the magnitude of any cumulative impact would depend on the location and timing of the other projects relative to the Project. The Port's Channel Modification Project would occur in part, adjacent to the LNG terminal site and associated marine facilities, but would likely occur after construction of the marine facilities is complete. It is possible that dredging activities associated with both the Project and the Port's Channel Modification Project could overlap. The North Jetty Maintenance Project would occur at the mouth of Coos Bay; however, a final construction schedule is still being developed. The North Jetty Maintenance Project would occur approximately seven river miles downstream from the LNG terminal site, but would be located less than two river miles from the nearest portion of the Project's proposed modifications to the marine waterway.

Sediments present in Coos Bay are naturally disturbed, flushed, and replenished by water inflows into the system. Dredging sediments disrupts the naturally occurring sediment flow process resulting in sediment reductions and accumulations. The other projects could impact the Coos Bay shoreline. Specifically, the use of marine vessels to construct and maintain the other projects would increase wave action within Coos Bay, and when combined with the wave actions resulting from Project-related vessels (tugs, barges, and LNG carriers) could result in a cumulative impact. Based on the location of the Project (including the Project's proposed modifications to the marine waterway), the locations of the other projects relative to the Project, and the expected timing of the other projects impacts (initial construction and maintenance), which we assume will not be concurrent (however, at some point in the future channel maintenance and Project maintenance may occur simultaneously), we conclude that the cumulative impact on sediments and the Coos Bay shoreline would not be significant.

At least six timber sale projects affecting a total of over 5,000 acres of land have or would cross/overlap about six miles of pipeline construction right-of-way and workspace. It is also likely that an undeterminable amount of other timber-related activities; maintenance, commercial thinning, and management have or would cross/overlap pipeline construction right-of-way and workspace. The Project would affect about 4,500 acres of land. Cumulative impacts on soils may result from the additive loss of soil (erosion), rutting and compaction, or disturbance of the profile that may affect the revegetation potential. In general, the use of heavy equipment, and the harvesting and maintenance of timber related to timber sales and other timber-related activities would impact underlying soils in a manner similar to that described for construction of the pipeline. However, these combined impacts would not be significant because the cumulative impact on soils would be limited to the relatively narrow width of the pipeline construction right-of-way (and associated construction workspace) and because of the minimization and protection measures included in the erosion control plans for the projects. The approximately 9,500 acres of land cumulatively affected by the six timber sale projects and the proposed Project that could potentially overlap represents about 0.02 percent of the total amount of land within the watersheds crossed by the Project.

By implementing the measures discussed in section 4.1, the Project would minimize incremental impacts on soils. With the exception of the timber sale projects discussed above, other projects identified in table 4.14-2 would not overlap with the pipeline construction workspace, and therefore, we conclude that the cumulative impact on soils would not be significant.

4.14.1.2 Water Resources and Wetlands

All of the projects identified in table 4.14-2 could affect underlying groundwater. Ground disturbing activities including aboveground facility and pipeline construction; and the use of equipment in support of those activities can affect groundwater recharge (surface water infiltration), subsurface lateral water flow, and groundwater quantity and quality. Together, the Project and the other projects would affect about 65,000 acres of land which represents about 2.5 percent of the total amount of land within the watersheds crossed by the Project. With the exception of three watersheds, cumulative impacts on lands within an individual watershed vary between less than 0.1 percent and 5.3 percent of total land amounts. The three remaining watersheds experience a greater cumulative impact due to the presence of large timber sales, and other timber-related activities (4,470 – 12,248 acres of impact in each watershed). Withdrawal requirements from underlying groundwater associated with these projects, if any, are unknown.

As described previously, we conclude that the impacts of the Project on groundwater would not be significant. These impacts would also be temporary, relatively minor, and localized. Additionally, the ground-disturbance and subsequent effects on groundwater resulting from timber-related activities are common in the region have not been found to be individually or cumulatively significant in other federal actions. Therefore, based on the cumulative amount of land affected and that area's proportion of the overall amount of land within the affected watersheds, we conclude that the cumulative impact on groundwater would not be significant.

The COE permits and mitigation projects, including stream restoration and enhancement projects affecting a total of about 71.0 river/stream miles, would occur in the watersheds affected by the Project. Additionally, the use of the Coos Bay Navigation Channel by LNG carriers travelling to and from the terminal facilities, the proposed modification of this channel, the regular maintenance of the channel, and the removal of dams along the Klamath River would also contribute to a cumulative impact on waterbodies affected by the Project. Other projects that could contribute to a cumulative impact on waterbodies crossed by the Project include minor federal agency projects (instream and aquatic restoration projects), and timber-related activities.

Numerous concerns about cumulative impacts on water quality in Coos Bay have been expressed by the public, the CTLUSI, the CIT, and the COE. The Port's Channel Modification Project would likely have the largest incremental contribution to cumulative impacts on Coos Bay. The Port's Channel Modification Project's impacts will be disclosed through the COE's review process; however, detailed information on this project is limited at this time. Additional information about the Port's Channel Modification Project, would be incorporated into the assessment presented in our final EIS. The CTCLUSI's Hollering Place which includes the installation of sheet piling along the shoreline of Coos Bay is currently under construction and would not significantly contribute to a cumulative impact on water quality. As described previously, other projects in Coos Bay would affect water quality and channel dynamics including channel geometry and flow. Changes to water quality would also affect fisheries and other aquatic organisms, and aquatic vegetation. These impacts when combined with the impacts of the Project could result in a cumulative impact on water resources, but this impact would also depend on the location and timing of the other projects. Based on available information, it is expected that dredging in Coos Bay would be temporary and periodic, generally occurring over several months. Impacts on water quality due to increased turbidity and sedimentation would be localized and temporary, returning to pre-construction conditions in a relatively short amount of time due to the dynamic and natural hydraulic regime of Coos Bay. The navigational channel improvements and the other projects, primarily the Port's Channel Modification Project would contribute to a cumulative impact on channel dynamics (e.g., channel geometry and flow). This change to channel geometry and flow would be permanent; however, the Project's contribution to this change would be significantly less than the Port's Channel Modification Project's contributions, which would have the largest incremental contribution to this permanent effect. Regular channel maintenance activities would not likely occur at the same time as the initial construction dredging activities associated with the Project and the Port's Channel Modification Project; therefore, a cumulative impact during construction is not anticipated, although a cumulative impact during operation is possible. Should channel and Project marine facility maintenance occur at or near the same time, a cumulative impact would occur; however, again, this impact would be temporary. Therefore, we conclude that the cumulative impact on Coos Bay would not be significant.

The impacts of LNG carriers and tug vessels traversing Coos Bay are different in nature than those of dredging projects, but would still affect water quality in the bay. LNG carrier water withdrawals and discharges related to ballast and engine cooling operations would affect small portions of Coos Bay (via potential introduction of invasive species and modifying water temperatures) primarily at and near the LNG marine facilities (see section 4.3 and 4.5). However, given the size of Coos Bay, the frequency of LNG carries in the bay, and the current use of the bay by other marine vessels, we conclude that any cumulative would not be significant.

Along the pipeline route, in-water work and ground disturbing activities near waterbodies can affect water quality. The locations, scopes of work, and timing of the other projects are not all known, so we cannot quantify the specific impacts of these projects or determine if these impacts would overlap with the impacts of the Project. However, based on available information (see table 4.14.-2) and the temporary and localized impacts of the Project on surface waters as described in the preceding environmental analyses, Pacific Connector's use of HDDs to cross major waterbodies, and its implementation of erosion and sediment control measures as well as other impact minimization measures, we conclude that these impacts and the potential impacts of the other projects would result in a cumulative impact; but, this impact would not be significant.

Additionally, the Klamath, Yurok, and Karuk Tribes expressed concern that an adverse cumulative impact on the Klamath River in Klamath County and downstream into California would occur resulting from the Project and the removal of dams along the Klamath River. The tribes expressed concern about impacts on water quality and fish, especially salmon. Pacific Connector would cross the Klamath River using an HDD. Furthermore, Pacific Connector has prepared a site-specific crossing plan for the Klamath River that indicates all workspaces and measures that would be implemented to avoid and minimize impacts on the Klamath River. As described previously, the use of an HDD significantly reduces the potential for impacts on a waterbody. Should an inadvertent release of drilling fluid(s) occur into the Klamath River, water quality would be temporarily affected. The river would experience increased turbidity and sedimentation. However, these increases would subside quickly, and the resulting turbidity would also settle out quickly. The removal of dams along the Klamath River would result in a significant impact on downstream water quality; however, these significant impacts would not occur in areas where the Project's impacts would occur. Furthermore, because the Project would use an HDD to cross the river and would likely be completed before the dams are removed, the Project's incremental contributions to a cumulative impact would not be significant.

COE permits and mitigation projects would affect a total of about 50 acres of wetlands in the watersheds crossed by the Project. The extent of impacts on wetlands from the other projects identified in table 4.14.-2 (beyond the COE permits and mitigation projects in Coos Bay) are unknown, but we assume wetlands could be affected. As described previously, the Project would impact about 200 acres of wetlands, with about 45 percent of the wetlands affected by the Project associated with the LNG terminal facilities. Of the remaining 55 percent, about 110 acres of wetlands would experience temporary to short-term impacts, and about 3 acres of forested wetland would experience long-term impacts. Cumulatively, at least 250 acres of wetlands would be affected. However, this cumulative impact would not be significant given the sizes of the watersheds crossed, relative to the extent and duration of the impacts.

4.14.1.3 Vegetation

Timber sales, commercial thinning, forest management, timber-related activities, and other projects would affect over 40,000 acres of vegetation within the watersheds crossed by the Project. These projects would primarily impact forest and herbaceous vegetation. Impacts include permanent clearing and loss, and long- and short-term disturbance (clearing and thinning). Many of these projects are BLM or Forest Service projects and as such have undergone an environmental review.

As described previously, the Project would affect about 4,500 acres of vegetation. Cumulatively, the Project along with the projects identified in table 4.14-2 would impact over 65,000 acres. If all 65,000 acres were vegetated, this impact would account for about 2.5 percent of the total amount of vegetation within the watersheds crossed by the Project. Considering forest vegetation, if the entire area affected by the projects considered in this analysis were forested it would account for about 4.6 percent of the total amount of forested area within the watersheds based on USGS National Land Cover Database which estimates about 1.4 million acres of forest within the watersheds. Additionally, the Project would impact 773 acres of LSOG forest. Pacific Connector would fund various projects on federal lands that would mitigate for the impacts on LSOG on federal lands to the extent required by BLM and Forest Service LRMPs. Implementation of new LRMPs and RMPs on both BLM and NFS lands in the 1990s resulted in a substantial reduction in lands available for timber harvest due to the establishment of LSRs and Riparian Reserves. Regrowth in previously harvested areas would, over time, result in more area supporting LSOG in the watersheds crossed by the Project. The clearing of LSOG by the Project would represent a loss of 0.01 percent of the remaining LSOG forest in the four physiographic provinces crossed by the Project.

Any of the projects identified in table 4.14-2 could result in the introduction or spread of invasive or noxious weeds as a result of ground disturbance and/or movement of equipment from one site to another. To avoid introducing or spreading invasive species, Jordan Cove would follow recommendations from several state and federal plans and programs including ODA, OISC, and BLM, as well as Project-specific measures (see section 4.4.1.6). It would be expected that the other projects on federal lands, or that would be subject of a federal permit review, would also implement some measures to minimize or control the spread of invasive or noxious weeds. Therefore, based on the analysis provided above, we conclude that the cumulative impact on vegetation would not be significant.

4.14.1.4 Wildlife and Aquatic Resources

All of the projects identified in table 4.14-2 could affect wildlife, including threatened and endangered species, and other species of concern. Ground-disturbing activities; and the use of equipment in support of those activities can increase the rates of stress, injury, and mortality experienced by wildlife. Additionally, these activities can result in the temporary and permanent loss or conversion of wildlife habitats. Threatened and endangered species may be particularly vulnerable to these ground-disturbing activities and associated habitat loss. The timber harvest projects and a number of the other timber-related projects could result in the long-term loss of forested habitat which supports a variety of wildlife, including MAMU and NSO. Timber sales projects could also result in the loss of forested habitat and affect wildlife. For the purposes of this analysis, we consider timber harvest and timber sales collectively as potential impacts on mature wildlife habitat; however, we recognize that some of these projects could be beneficial for forest health and wildlife. Furthermore, some timber management activities would affect mature wildlife habitat, but would generally result in temporary impacts with a goal of promoting the long-term enhancement of mature habitat. As discussed previously, wildlife would generally avoid or be displaced by disturbance. As a result, wildlife would experience increased rates of stress, injury, and mortality. Additionally, when wildlife is displaced or behaviors change in response to disturbance and habitat loss, competition and predation pressures from other wildlife that move to occupy abandoned habitats or are occupying habitats that displaced wildlife is trying to use can increase which can result in a decrease in overall fitness (including reduced rates of reproduction) for some species.

Impacts on wildlife (and threatened and endangered species) would vary depending on the amount and quality of habitat, and the duration of impacts, the fitness of an individual(s), and the concentration of individuals within affected habitats. As stated previously, the Project and the other projects would affect about 65,000 acres of land (and associated wildlife habitats) which represents about 2.5 percent of the total amount of land within the watersheds crossed by the Project. However, some habitat types may be more sensitive to disturbance that others, such as those defined as “irreplaceable, essential, or limited” by the ODFW (see section 4.5); information on the extent of impacts that would occur to these sensitive habitat types as a result of the reasonable foreseeable projects is not available or quantifiable at this time. Therefore, we conclude that the resulting cumulative impact of the Project and the other projects would not be significant because of the total amount of land and habitat affected relative to the amounts available within the watersheds crossed and wildlife’s general ability to avoid construction activities and adapt to disturbance.

In Section 4.06, we address the Project’s extensive impacts on federally listed threatened and endangered species. In the forthcoming biological assessment, we address cumulative effects on federally listed threatened and endangered species. However, acknowledging that many federally-protected species in the Project area depend on LSOG habitat for one or more life stages and due to their particular sensitivity, we discuss further cumulative impacts on two of those species MAMU and NSO. The projects identified in table 4.14-12 include timber sales and forest management projects involving timber harvest on about 694 acres within watersheds where MAMU occur and about 10,439 acres within watersheds where NSO occur. The majority of these harvests are of regenerating stands rather than LSOG, so they are more likely to prevent forested habitat from becoming LSOG (and thus suitable for LSOG-associated species) than remove existing LSOG that is currently suitable for MAMU and NSO. As a result, the Project-related habitat loss described in section 4.6 would contribute to a cumulative impact on MAMU and NSO habitat. Furthermore, of the projects considered in this analysis, this Project would have the largest incremental impact to these species.

COE permits and mitigation projects, minor federal agency projects (instream and aquatic restoration projects), timber-related activities, and livestock grazing would occur in the watersheds affected by the Project and would impact aquatic resources, including threatened and endangered species and other species of concern. Additionally, LNG carriers, the Port's Channel Modification Project, the regular maintenance of the channel, other projects in Coos Bay, and the removal of dams along the Klamath River would also impact aquatic resources including fish, marine mammals, and other aquatic organisms. In-water work and ground-disturbing activities associated with these projects would affect aquatic habitats, fish, marine mammals, and other aquatic organisms in a manner similar to that described for the Project (see sections 4.5 and 4.6). Aquatic habitats would be both temporarily and permanently affected; and fish and water-dependent wildlife would experience increased rates of stress, injury, and mortality.

Concerns about the importance of fish to communities affected by the Project and the potential for cumulative impacts on fish were expressed in numerous comments to the Commission. Comments provided by several tribes specifically identified Coos Bay and the Klamath River as fisheries that could be subject to adverse cumulative impacts. With the exception of the Port's Channel Modification Project, the COE's North Jetty Maintenance Project, LNG carriers, and channel maintenance activities, the other projects affecting Coos Bay are temporary in nature resulting in temporary impacts on aquatic habitats, fish, marine mammals and other aquatic organisms primarily from dredging activities that result in the loss of habitat and increase rates of turbidity and sedimentation. LNG carriers and other marine vessel traffic in Coos Bay would occur regularly; however, the disturbance caused by ships (increased wave action, underwater noise, and water withdrawal/discharge) in Coos Bay is not expected to adversely impact fish and other aquatic resources including crabbing. Channel maintenance activities would occur periodically, but the impacts of these activities on fisheries and aquatic resources would be temporary. The impacts of these projects when combined with the impacts of the Project would not result in a significant cumulative impact on fish, marine mammals, and other aquatic organisms in Coos Bay.

Along the pipeline route, in-water work, ground-disturbing activities, and vegetation clearing related to other projects can affect aquatic habitats, fish, and water-dependent wildlife. Aquatic habitat disturbance would affect fish behavior, migration, feeding, and reproduction, and would increase rates of stress, injury, and mortality experienced by fish and other wildlife. Threatened, endangered, and other special status fish species may be particularly vulnerable to these ground-disturbing activities and the associated aquatic habitat disturbance. As described previously, the details of the other projects are not well known, so we cannot quantify the specific impacts of these projects or determine if these impacts would overlap with the impacts of the Project. Turbidity generated by the various projects is generally not additive because the generation of plumes is uncommonly synchronized and spatially overlapping. Sedimentation, however, would be additive at common settling points. Settling points within each stream are largely determined by flow dynamics within short stream segments. Consequently, the common deposition points are likely to be past and ongoing points where sediments accumulate. Additional sediment accumulation at these points is clearly an impact, but likely not a conversion of habitat type. Based on the Project's impacts on aquatic resources and the impacts of the other projects which are expected to be similar to those of the Project, we conclude that the resulting cumulative impact would not be significant.

Pacific Connector would cross the Klamath River using an HDD. As described previously, the use of an HDD significantly reduces the potential for impacts on a waterbody and any aquatic resources within or dependent on that waterbody. Should an inadvertent release of drilling fluid occur into the Klamath River, aquatic habitat and fish would be temporarily affected. The removal of the four dams along the Klamath River would temporarily and permanently significantly affect fish and other aquatic resources in the river. Short-term impacts on aquatic resources would result from increases in turbidity and long-term beneficial impacts would result from the permanent modification of (and access to) stream reaches due to changes in flow. The closest dam removal planned to the Project's crossing of the Klamath River would occur about 20 miles downstream. Because the dam is 20 miles downstream, the impacts of its removal would not be additive with the impacts of the Project; therefore, we conclude that the Project would not significantly contribute to an adverse cumulative impact.

4.14.1.5 Land Use

There are no other projects in Coos Bay whose impacts when combined with those of the LNG terminal would result in a significant cumulative impact on land use. As described previously, the Project and the other projects identified in table 4.14-2 would cumulatively affect about 65,000 acres of land (about 2.5 percent of the total amount of land within the watersheds crossed by the Project). Affected lands support a number of uses including natural forest, silviculture, residential, grazing, commercial, agricultural, and industrial activities. Timber and forest management are commonplace in the region and are not, with the exception of growth of trees and installation of permanent aboveground facilities over the pipeline, prohibited or restricted by the Project. Clearing of forested areas for construction of the Pacific Connector pipeline would amount to less than nine percent of the acreage of timberlands affected by the BLM and Forest Service vegetation management projects listed in table 4.14-2. The acreage of forested land affected by the pipeline that would not be reforested (i.e., the permanent operational right-of-way and aboveground facilities) would constitute less than two percent of the timberlands affected by the BLM and Forest Service vegetation management projects listed in table 4.14-2. Overall, the impacts of the Project when combined with the impacts of the other projects would not result in a significant cumulative impact on land use.

4.14.1.6 Visual Resources and Recreation

The only projects listed in table 4.14-2 that involve new permanent aboveground facilities within the viewshed of the LNG terminal is the City of North Bend's Department of Human Services Building and the CTCLUSI Hollering Place. The non-jurisdictional SORSC would be located within the footprint of the LNG terminal site and is considered from a visual perspective as part of the LNG terminal site. Also, although not a permanent aboveground facility, the regular use of the Federal Navigational Channel by LNG carriers and associated project-related marine vessel traffic would also constitute an impact on the visual character of Coos Bay. The Department of Human Services Building is located less than a mile from the LNG terminal and may be visible from the same vantage points (viewpoints 6-10 as shown on figure 4.8-2); however, it is located on the developed Southwest Oregon Regional Airport property and is visually consistent with the existing industrial/commercial visual character. When complete, the CTCLUSI's Hollering Place would be located just over 2 miles southwest of the LNG terminal site along the community of Empire's shoreline. The LNG carries would occur frequently in Coos Bay and would be distinguishable from other marine traffic where the navigation channel is visible from vantage points in Charleston, Barview, Empire, and North Bend. As described in section 4.8.2, we conclude that the LNG terminal would have a significant impact on a limited number of viewers and locations around Coos Bay. Therefore, because the Project's impact on Coos Bay's visual character would be significant, a significant cumulative impact would result; however, we conclude that the impacts of the Human Services building, CTCLUSI's Hollering Place, and the increased marine traffic would not contribute to a greater impact on the visual character of Coos Bay.

As described previously, at least six timber sale projects affecting a total of over 5,000 acres of land have or would cross/overlap about six miles of pipeline construction right-of-way and workspace. It is also likely that an undeterminable amount of other timber-related activities; maintenance, commercial thinning, and timber management have or would cross/overlap pipeline construction right-of-way and workspace. A cumulative impact on visual resources would occur if visible impacts of these projects and the Project are observable from one or more shared vantage points. Numerous commenters including the Klamath Indian Tribe have expressed concern about an adverse cumulative impact on the visual character of the Project area. Commenters cited the spiritual and intrinsic value of potentially affected viewsheds. Timber-related activities, sales, and forest management are common practices in Oregon and their visual impacts can be observed across the landscape. The impact of the pipeline operational easement would resemble other utilities and forest access roads, and would not generally be out of character for the region. There would, however, be locations where the pipeline route would be in less developed and managed areas and its visual impact would be less common; but because of the remote siting, the number of possible viewpoints and receptors would be small. According to the Forest Service, the majority of the timber-related activities involve thinning younger stands to speed the development of late successional old-growth habitat in LSRs and on the Matrix lands. These thinning prescriptions would generally not result in large new openings in the forest canopy. Additionally, where the pipeline would cross remote and steep topography, locations where the permanently cleared operational easement would be visible would be limited. Therefore, we conclude that a cumulative impact would occur, but that this impact would not be significant.

Two projects - the Turkey Hill Solar Project and the transmission line associated with the Swan Lake Hydroelectric Pumped Storage Project - are located in the vicinity of the proposed Klamath Compressor Station. The compressor station would be painted with a color that blends with the hues of the surrounding landscape and the grounds would be landscaped to reduce visual impacts on area residents. Given the distance to the Turkey Hill Solar Project and Swan Lake Hydroelectric Pumped Storage Project transmission line (2.2 miles and 1.9 miles, respectively), and existing topography, we conclude that the impacts of these projects would not contribute to a significant cumulative impact on visual resources.

As described in comments to the Commission about the Project, Coos Bay provides numerous recreational opportunities including boating, fishing, crabbing, hiking, bird watching, and scenic viewing. The cumulative impacts of the Project and the other projects in Coos Bay on water quality, aquatic resources, and transportation, all of which affect recreational use of the bay would not be significant, so the cumulative impact on recreation in Coos Bay would not be significant. Recreational users of Coos Bay may be inconvenienced by delays associated with the increased use of the channel by LNG carriers and other Project-related marine traffic; however, no other additional long-term marine traffic has been identified as occurring in the bay. Dredging activities associated with the other projects in Coos Bay would temporarily increase traffic in the channel, but any cumulative impact would not be significant as the dredging activities would be temporary and periodic. These inconveniences when added to existing marine traffic would contribute to a cumulative impact; but this impact would not significantly impair a user's ability to participate in recreation activities in the bay.

Southern and West-central Oregon provide the public a large number of diverse recreational opportunities including camping, hiking, off-road vehicle trails, hunting, fishing, boating, and wildlife watching. Cumulative impacts along the pipeline route could occur if the Project and one or more other projects affect the same recreational resource (trail, natural area, etc.). However, none of the other projects identified along the pipeline route are expected to significantly reduce overall recreational opportunities for the public. As described previously, the Project would not significantly affect recreation. Based on the impacts of the Project and other projects, we conclude that there would not be a significant cumulative impact on recreation occurring along the pipeline route.

4.14.1.7 Socioeconomics

Constructing the Project would temporarily impact the socioeconomic character of the region as described in section 4.9. The socioeconomic impacts of the Project would occur because of the introduction of a new construction workforce, which would affect total population, available housing, and tax revenue during the period of construction; and would draw on existing public services such as police, fire, and healthcare. We do not anticipate that the other projects occurring in the watersheds affected by the Project would require a significant influx of non-local labor because these projects are common to the region. Therefore, we conclude that the other projects would not meaningfully contribute to a cumulative impact on the socioeconomic character of the region. However, as described in section 4.9, the Project would result in a significant impact on housing in Coos County during construction; therefore, a significant cumulative impact would result.

4.14.1.8 Transportation

The proposed modification of the Coos Bay Federal Navigational Channel as well as other projects in Coos Bay would require the use of marine vessels. As described in section 4.10.1, constructing and operating the Project would increase the number of vessels in Coos Bay as a result of the addition of approximately 70 water deliveries via a mix of ocean-going vessels and barges during the two-year construction period and 120 LNG carriers per year transiting to and from the Jordan Cove LNG terminal during its operation. This increase in marine traffic combined with current deep-draft vessel traffic would be less than historic ship traffic through the channel. In addition, in a Letter of Recommendation for the Project the Coast Guard considers that the Coos Bay channel to be suitable for the proposed type and frequency of LNG carriers traffic (see appendix B). Therefore, we conclude that while some marine traffic might be temporarily inconvenienced, the passage of construction-related and LNG carriers through the channel would not have significant or long-term impacts on other boats in Coos Bay. Numerous commenters have expressed concern that a modified navigational channel would induce additional marine vessel traffic. To our knowledge, additional marine vessel traffic utilizing the modified channel has not been proposed; therefore, we cannot speculate on unknown future impacts. However, the Coast Guard and other authorities would continue to regulate any future marine traffic within the channel.

Of the projects identified in table 4.14-2, timber-related activities may result in use of large, heavy equipment and log trucks on local and regional roadways. Other projects planned for the area are road improvements or other relatively small-scale projects not requiring a significant workforce. As described in section 4.10, the Project would contribute vehicle trips to Project-area roads during construction, and would affect these roads and their users. Together, the Project and other projects would result in a cumulative impact on area roads and traffic; however, the degree of impact would depend on the extent of overlap in time and space during active construction of the projects.

4.14.1.9 Cultural Resources

Cumulative impacts on cultural resources would only occur if other projects were to share (and impact) the same APE as the Project. Several forest- and timber-management projects listed in table 4.14-2 would share the same APE as the Project and could contribute to a cumulative impact on cultural resources. The federal agencies managing these projects would be required to follow the regulatory requirements of 36 CFR Part 800 and/or other implementing regulations. Under these regulations, the lead federal agency, in consultation with the SHPO, would identify historic properties in the project APE, assess potential effects, and resolve adverse effects through an agreement document that outlines a treatment plan.

We received numerous and detailed comments from Indian tribes, particularly the CTCLUSI, expressing and reiterating concern about the Project's contribution to a cumulative impact on cultural resources. In their comments, the CTCLUSI state that the extensive geotechnical work (e.g., drilling and core sampling) that has occurred at the LNG terminal site over the three iterations of this Project has adversely affected cultural resources. We acknowledge that a considerable amount of geotechnical work has occurred at the LNG terminal site, but we are not aware of any documented impacts on cultural resources resulting from geotechnical work at this site. Ingram Yard and the South Dunes areas were surveyed by archeologists and no historic properties were identified. As described previously, we consider the impacts of past projects as part of the environmental baseline, but are addressing these comments because of the sensitive nature of cultural resources and the significance attributed to them by the CTCLUSI. Once construction of the LNG terminal is complete, the site would be permanently transformed into an industrial facility and would not be subject to impacts from other projects; therefore, a cumulative impact on cultural resources would not occur.

As described previously, the Project would have adverse impacts on historic properties. Further, surveys of both the LNG terminal facilities and pipeline are incomplete and may result in the identification of additional historic properties. Also, an ethnographic study of the Project and the identification of traditional cultural resources is incomplete. One known TCP is present in Coos Bay and overlies the Project facilities. Once evaluations are complete, adverse effects on historic properties would be resolved by implementing the procedures outlined in a Project-specific MOA following completion of the Section 106 process pursuant to the NHPA. The MOA would also include provisions for inventorying areas not yet surveyed to identify historic properties that may be affected by the Project. Although the required review processes are not complete, we conclude, given state and federal laws and regulations protecting cultural resources and the other projects affecting the Project's APE, that any cumulative impact on cultural resources would not be significant.

4.14.1.10 Air Quality, Climate Change, and Noise

Air Quality

Constructing the Project, as well as the other projects listed in table 4.14.2, would temporarily affect air quality due to emissions from the combustion engines used to power construction equipment, vehicle emissions traveling to and from the project sites, deliveries of construction materials, and from fugitive dust emissions resulting from earth-disturbing activities and equipment movement on dirt roads. The potential for cumulative construction emissions impacts would be greatest during site preparation when fugitive dust production would likely be at its peak. Emissions from equipment engines and vehicles operating concurrently would also result in cumulative air quality impacts in the local area. Most of the reasonably foreseeable projects are located outside of the geographic scope for cumulative construction emissions. The only projects that would potentially overlap with the geographic scope for cumulative construction emissions are associated with the non-jurisdictional Project facilities, COE Coos Bay Federal Navigation Channel Maintenance Dredging, the Port's Channel Modification Project, Southwest Oregon Regional Airport Expansion, and various BLM and Forest Service vegetation maintenance projects.

The primary projects in the construction air emissions geographic scope of the Jordan Cove LNG Project with the potential to be constructed in a similar timeframe are the COE Coos Bay Navigation Channel Maintenance Dredging Project and the Southwest Oregon Regional Airport Extension. The COE Maintenance Dredging Project would result in the short-term release of criteria pollutants from the operation of dredges. Estimated emissions of criteria pollutants would not result in exceedances of the NAAQS in the Project area. Furthermore, the cumulative impact analysis conducted as part of the 2015 COE EA (which included the Southwest Oregon Regional Airport Extension and the originally proposed Jordan Cove Project) found that no substantial cumulative effects would occur. Based on this information, and the implementation of mitigation measures discussed above, cumulative air quality impacts during construction of the Jordan Cove LNG Project would not be significant.

The majority of the pipeline would be located in an attainment area for the NAAQS. However, a small portion of the pipeline would be located in a PM10 maintenance area and a PM2.5 nonattainment area. Due to the de minimis construction emissions that would not exceed General Conformity thresholds, and the limited scope of Project construction in the nonattainment area, the Project is not expected to contribute discernable cumulative impacts on the nearby nonattainment areas or maintenance areas. To minimize impacts due to construction emissions during pipeline construction, Pacific Connector would implement mitigation measures to minimize construction impacts on air quality, including implementing a fugitive dust control plan, compliance with applicable EPA mobile source emission performance standards, and use of equipment manufactured to meet air quality standards.

The projects identified within the construction geographic scope of the pipeline include various BLM and Forest Service vegetation maintenance projects and the Klamath Dam Removal. While these projects would likely cause minor short-term air quality impacts, it is unlikely that they would cause significant cumulative impacts when combined with the pipeline.

Operation of the LNG facilities would have long-term effects on air quality due to operational emissions associated with the facilities. Jordan Cove would be required to obtain a Title V Operating Permit for Project operation, and would be required to comply with any operating conditions of this permit, including measures to reduce emissions.

A cumulative ambient air quality analysis was conducted that showed that operation of the LNG facilities, when considered along with existing sources and background air quality, would not result in an exceedance of the NAAQSs. The only project identified within the 50 km geographic scope for cumulative operational air quality impacts is the non-jurisdictional LNG carriers. Emissions and exhaust parameters from the LNG carriers were included in the cumulative modeling analysis starting from the process of transit, berthing, to hoteling and LNG loading, and finally to connecting the towlines and de-berthing. Based on our air quality analysis, operational cumulative impacts associated with the Jordan Cove LNG Project are expected to be minor.

Operation of the Pacific Connector Pipeline Project would have long-term effects on air quality due to emissions from the Klamath Compressor Station. The compressor station would be located in an attainment area for the NAAQS. The compressor station emissions would be below the General Conformity *de minimis* thresholds; therefore, the compressor station would not significantly impact nonattainment or maintenance areas.

Pacific Connector would require an Air Contaminant Discharge Permit from the ODEQ to construct the Klamath Compressor Station and a Title V Operating Permit to operate the compressor station. The permits for this facility would include mitigation measures and operational requirements to ensure that air emissions do not exceed the permit requirements and that the facilities would be operated in compliance with applicable air quality regulations.

Pacific Connector completed air quality modeling for the operational emissions of the Klamath Compressor Station. The results of the air quality modeling are summarized in section 4.12 and provide the estimated facility air quality impacts combined with background air quality concentrations for NO_2, CO_2, PM_{10}, $PM_{2.5}$, and SO_2, and include existing operating air emission sources. Based on this analysis, the operation of Klamath Compressor Station would not result in an exceedance of any of the NAAQS. No projects were identified within the geographic scope of the Klamath Compressor Station that would result in operational air quality impacts. Therefore, the Project would not result in cumulative impacts on air quality from the operation of the Pacific Connector Pipeline Project.

Climate Change and Greenhouse Gas Emissions

Climate change is the variation in climate (including temperature, precipitation, humidity, wind, and other meteorological variables) over time, whether due to natural variability, human activities, or a combination of both, and cannot be characterized by an individual event or anomalous weather pattern. For example, a severe drought or abnormally hot summer in a particular region is not a certain indication of climate change. However, a series of severe droughts or hot summers that statistically alter the trend in average precipitation or temperature over decades may indicate climate change. Recent research has begun to attribute certain extreme weather events to climate change (USGCRP 2018).

The leading U.S. scientific body on climate change is the U.S. Global Change Research Program (USGCRP), composed of representatives from thirteen federal departments and agencies.[231] The Global Change Research Act of 1990 requires the USGCRP to submit a report to the President and Congress no less than every four years that "1) integrates, evaluates, and interprets the findings of the Program; 2) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and 3) analyzes current trends in global change, both human induced and natural, and projects major trends for the subsequent 25 to 100 years." These reports describe the state of the science relating to climate change and the effects of climate change on different regions of the U.S. and on various societal and environmental sectors, such as water resources, agriculture, energy use, and human health.

In 2017 and 2018, the USGCRP issued its *Climate Science Special Report: Fourth National Climate Assessment*, Volumes I and II (Fourth Assessment Report) (USGCRP, 2017; and USGCRP, 2018, respectively). The Fourth Assessment Report states that climate change has resulted in a wide range of impacts across every region of the country. Those impacts extend beyond atmospheric climate change alone and include changes to water resources, transportation, agriculture, ecosystems, and human health. The U.S. and the world are warming; global sea level is rising and acidifying; and certain weather events are becoming more frequent and more severe. These changes are driven by accumulation of GHG in the atmosphere through combustion of fossil fuels (coal, petroleum, and natural gas), combined with agriculture, clearing of forests, and other natural sources. These impacts have accelerated throughout the end 20th and into the 21st century (USGCRP 2018).

Climate change is a global phenomenon; however, for this analysis, we will focus on the existing and potential cumulative climate change impacts in the Project area. The USGCRP's Fourth Assessment Report notes the following observations of environmental impacts are attributed to climate change in the Northwest region (USGCRP, 2017; USGCRP, 2018):

- the region has warmed nearly 2°F since 1900;
- warmer winters have led to reductions in mountain snowpack, resulting in drought, water scarcity, and large wildfires;
- declines in dissolved oxygen in streams and lakes have caused fish kills and loss of aquatic species diversity; and
- moderate to severe spring and summer drought areas have increased 12 percent to 14 percent.

[231] The USGCRP member agencies are: Department of Agriculture, Department of Commerce, Department of Defense, Department of Energy, Department of Health and Human Services, Department of the Interior, Department of State, Department of Transportation, Environmental Protection Agency, National Aeronautics and Space Administration, National Science Foundation, Smithsonian Institution, and U.S. Agency for International Development.

The USGCRP's Fourth Assessment Report notes the following projections of climate change impacts in the Project region with a high or very high level of confidence[232] (USGCRP, 2018):

- increases in stream temperature indicate a 22 percent reduction in salmon habitat by the late 20th century;
- more frequent severe winter storms, which may contribute to storm surge, large waves, coastal erosion, and flooding in low-lying coastal areas;
- the warming trend is projected to be accentuated in certain mountain areas in the Northwest in late winter and spring, further exacerbating snowpack loss and increasing the risk for insect infestations and wildfires;
- longer periods of time between rainfall events may lead to declines in recharge of groundwater and decreased water availability, and responses to decreased water availability, such as increased groundwater pumping, may lead to stress or depletion of aquifers and strain on surface water sources; and
- increases in evaporation and plant water loss rates may alter the balance of runoff and groundwater recharge, which would likely to lead to saltwater intrusion into shallow aquifers.

It should be noted that while the impacts described above taken individually may be manageable for certain communities, the impacts of compound extreme events (such as simultaneous heat and drought, wildfires associated with hot and dry conditions, or flooding associated with high precipitation on top of saturated soils) can be greater than the sum of the parts (USGCRP 2018).

The GHG emissions associated with construction and operation of the Project are identified in section 4.12.1.1 for the Jordan Cove LNG Project and section 4.12.1.2 for the Pacific Connector Klamath Compressor Station and pipeline. Both the Jordan Cove LNG Project and the Pacific Connector Klamath Compressor Station and pipeline would remain below PSD major source thresholds and are therefore not required to conduct a Best Available Control Technology analysis for mitigating GHG emissions. The construction and operation of the Project would increase the atmospheric concentration of GHGs, in combination with past, current, and future emissions from all other sources globally and contribute incrementally to future climate change impacts. Project emissions would contribute incrementally to future climate change impacts.

Currently, there is no universally accepted methodology to attribute discrete, quantifiable, physical effects on the environment to the Project's incremental contribution to GHGs. We have looked at atmospheric modeling used by the EPA, National Aeronautics and Space Administration, the Intergovernmental Panel on Climate Change, and others and we found that these models are not reasonable for project-level analysis for a number of reasons. For example, these global models are not suited to determine the incremental impact of individual projects, due to both scale and

[232] The report authors assessed current scientific understanding of climate change based on available scientific literature. Each "Key Finding" listed in the report is accompanied by a confidence statement indicating the consistency of evidence or the consistency of model projections. A high level of confidence results from "moderate evidence (several sources, some consistency, methods vary and/or documentation limited, etc.), medium consensus." A *very* high level of confidence results from "strong evidence (established theory, multiple sources, consistent results, well documented and accepted methods, etc.), high consensus." https://science2017.globalchange.gov/chapter/front-matter-guide/

overwhelming complexity. We also reviewed simpler models and mathematical techniques to determine global physical effects caused by GHG emissions, such as increases in global atmospheric CO_2 concentrations, atmospheric forcing, or ocean CO_2 absorption. We could not identify a reliable, less complex model for this task and we are not aware of a tool to meaningfully attribute specific increases in global CO_2 concentrations, heat forcing, or similar global impacts to project-specific GHG emissions. Similarly, it is not currently possible to determine localized or regional impacts from GHG emissions from the Project. Absent such a method for relating GHG emissions to specific resource impacts, we are not able to assess potential GHG-related impacts attributable to this project. Without the ability to determine discrete resource impacts, we are unable to determine the significance of the Project's contribution to climate change.

We have not been able to find any GHG emission reduction goals established at the federal level.[233] The State of Oregon has set GHG reduction goals with a state-wide target of 51 million metric tons of CO_2e by 2020 (a 10 percent reduction from 1990 levels), and 14 million metric tons of CO_2e by 2050 (a 75 percent reduction from 1990 levels) (Oregon Global Warming Commission 2017). The Oregon Global Warming Commission projects that Oregon will fall short of these goals without additional legislative action. Direct emissions from the Jordan Cove LNG and Pacific Connector Pipeline Projects would result in annual CO_2e emissions of about 2.14 million metric tons of CO_2e, which would represent 4.2 percent and 15.3 percent of Oregon's 2020 and 2050 GHG goals, respectively.

Noise

the Project would involve various types of equipment and activities, including pile driving, dredging, and drilling. These activities would temporarily increase noise in the surrounding areas. Projects listed in table 4.14-2 that are located within the geographic scope that could contribute to a cumulative noise impact include non-jurisdictional Project facilities, COE Coos Bay Federal Navigation Channel Maintenance Dredging, the Port's Channel Modification Project, Southwest Oregon Regional Airport Expansion, various BLM and Forest Service vegetation maintenance projects, and the Klamath Dam Removal. Based on the schedule and proximity of the other projects, there may be some cumulative construction noise impacts. The exact level of noise impacts that would occur from the projects identified in table 4.14-2 is not known; however, most construction is expected to take place during daytime hours and would be intermittent rather than continuous. Construction noise would primarily last for short periods and would vary as the equipment moves along the construction spread.

To minimize the Project's contribution to a cumulative impact, Jordan Cove would implement mitigation measures including selecting low-noise alternative equipment, restricting time of day for construction, installing temporary noise barriers, enclosing equipment, and preparing site-specific noise management plans. The HDD or DP crossing method would be used to cross under six waterbodies and a powerline/steep slope location along the BPA Powerline Corridor. Per our recommendation in section 4.12.2, Pacific Connector would be required to ensure that noise attributable to drilling operations does not exceed an 55 L_{dn} dBA. Because construction noise is temporary and would dissipate with distance, and the applicants would implement BMPs and noise

[233] The national emissions reduction targets expressed in the EPA's Clean Power Plan and the Paris climate accord are pending repeal and withdrawal, respectively.

mitigation as well as adhere to our recommendations, we conclude cumulative impacts on noise levels would not be significant.

Operation of the Jordan Cove LNG Project and Pacific Connector's Klamath Compressor Station would result in long-term increases in noise levels in the vicinity of these aboveground facilities. Noise at the Jordan Cove LNG Project would be associated with refrigerant gas turbines/compressors, boil-off gas compressors/motors, various pumps/motors, steam turbine generators, air-cooled condensers, and blow-down events. Operational noise was modeled at four NSAs near the Jordan Cove LNG terminal as discussed in section 4.12. This modeling indicated noise attributable to the LNG terminal at the NSAs would be within the FERC's limit of L_{dn} 55 dBA. Overall predicted noise increases at one of the NSAs would be noticeable but are not likely to be significant. Noise increases at the remaining three NSAs are unlikely to be perceptible. None of the other projects located within 1 mile of the Jordan Cove LNG Project are expected to have any operational noise impacts; therefore, operation of the Project would not contribute to broader cumulative noise impacts.

Underwater noise levels from large commercial ships are fairly consistent, ranging from about 177 to 188 dB re 1 µPA at 1 meter. Considering peak noise levels and cumulative sound exposure, vessel noise is not expected to exceed the NMFS guideline thresholds for the onset of permanent threshold shift for cetaceans and pinnipeds. Total underwater noise from maintenance dredging, LNG carriers, tugs, and other marine vessels would increase during operation of the Project; however this cumulative impact would not be significantly greater than existing underwater noise levels in Coos Bay.

Noise at the Klamath Compressor Station would be associated with gas turbines, compressors, pumps, cooling fans, and blowdown events. Operational noise was modeled at five NSAs near the Klamath Compressor Station. This modeling indicated noise attributable to the compressor station at the NSAs would be within FERC's limit of L_{dn} 55 dBA. Pacific Connector would adopt the acoustic design recommendations for the Klamath Compressor Station outlined in the noise study report. Overall predicted noise increases at NSAs #5 and #6 are unlikely to be perceptible based upon the existing background noise. The predicted noise increases at the remaining NSAs would be noticeable but are not likely to be significant. None of the known existing or future projects located within 1 mile of the Klamath Compressor Station are expected to have any operational noise impacts; therefore, operation of the Pacific Connector Pipeline Project would not contribute to broader cumulative noise impacts.

4.14.2 Cumulative Impact Conclusions

The impacts of the Project when added to those of the other projects would result in cumulative impacts on the environment. For the federal projects, existing laws and regulations protect waterbodies and wetlands, threatened and endangered species, and historic properties, and limit impacts on air and noise. In addition, Federal land-managing agencies, such as the BLM and Forest Service, have requirements in their LRMPs and RMPs to protect resources on their lands. Given the BMPs and impact avoidance, minimization, and mitigation measures that would be implemented; and federal and state laws and regulations protecting the environment; we conclude that with the exception of significant impacts on visual resources and available housing in the Coos Bay area, cumulative impacts on the environment would not be significant.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS OF THE ENVIRONMENTAL ANALYSIS

The conclusions and recommendations presented below are those of the FERC environmental staff. They were prepared in cooperation with the BLM, Forest Service, Reclamation, DOE, COE, EPA, FWS, NOAA, Coast Guard, USDOT, and Coquille Tribe. However, these agencies may present their own conclusions and recommendations in their respective and applicable records of decision. The cooperating agencies can adopt this final EIS consistent with 40 CFR 1501.3 if, after an independent review of the document, they conclude that their requirements have been satisfied. Otherwise, they may elect to conduct their own supplemental environmental analyses.

Based on our review as described in the preceding sections, we conclude that constructing and operating the Project would result in temporary, long-term, and permanent impacts on the environment and a number of significant environmental impacts; however, a majority of impacts would be less than significant due to the implementation of proposed and recommended impact avoidance, minimization, and mitigation measures. As part of our review we developed measures that would appropriately and reasonably further avoid, minimize, or mitigate environmental impacts resulting from construction and operation of the proposed Project. Therefore, we recommend that these measures be attached as conditions to any authorizations issued by the Commission.

5.1.1 Geology

The LNG terminal would be located in Coos Bay within the seismically active CSZ. Numerous comments were received by the Commission about the potential affects to the LNG terminal from a tsunami. Recognizing the concern, and as described in the LNG safety and reliability section, Jordan Cove designed the terminal facilities consistent with maximum tsunami run-up elevations and considered tsunami wave heights and inundation elevations; therefore, FERC staff agrees that the equipment elevations that Jordan Cove provided are suitable for the proposed LNG terminal site. We also conclude that the LNG terminal would be able to withstand without damage a storm surge during a 500-year storm event. Although much of the pipeline would be located in the CSZ, we conclude, based on a review of potential impacts, historical data, seismic hazard mapping, peak horizontal ground acceleration values, pipeline tolerances, and Pacific Connector's proposed impact avoidance and minimization measures, that construction and operation the Project would not be significantly affected by potential geological hazards including ground shaking, surface ruptures, soil liquefaction and lateral spreading, landslides, and slope failures. Additionally, about 90 miles of pipeline would cross the Cascade and Klamath mountain ranges, which increases concerns for erosion, landslides, and slope failures. However, we conclude, based on our evaluation of the Project and Pacific Connector's proposed construction methods including its implementation of erosion control devices and other impact avoidance and minimization measures, that construction and operation of the pipeline would not be significantly affected. To ensure landslides in six moderate risk areas are further minimized, we are recommending that Pacific Connector file final monitoring protocols and mitigation measures. Furthermore, due to the absence of mining and other mineral extraction activities along the pipeline route, we conclude that these activities would also not be affected.

5.1.2 Soils and Sediments

Constructing and operating the LNG terminal would permanently impact underlying soils, including sands, fine sands, silt loams, and dune lands. Erosions control measures compliant with our Plan and Procedures would be implemented to control and minimize erosion and sedimentation. The pipeline would be located across numerous soil types including soils prone to erosion and compaction. The pipeline would also be located across about 149 miles of soils that have been rated as having reclamation sensitivity or poor revegetation potential. Impacts on soils would be reduced by Pacific Connector's implementation of erosion control measures and its use of best management practices including spill prevention and response procedures. Furthermore, Pacific Connector would install permanent erosion control measures and, if necessary, decompact soils (ripping) and implement other soil remediation measures.

To address contaminated soils at the terminal site, Jordan Cove would develop a disposal plan consistent with state requirements. An assessment of these soils concluded that residual contaminants did not exceed ODEQ screening levels for worker exposure. To ensure potential contamination is fully addressed, we are also recommending that Jordan Cove consult with the ODEQ regarding existing soil and groundwater contamination at affected sites.

The marine loading facilities and LNG carrier berth would permanently modify the Coos Bay shoreline and access to the navigational channel. A study of vessel wakes concludes that operating the LNG terminal (and LNG carriers) would not increase shoreline impacts. The marine berth would be constructed to account for concerns about LNG carrier propeller wash affecting the operational ability of the terminal.

Based on our review, we conclude that constructing and operating the Project would temporarily and permanently impact soils; however, based on the proposed construction and operations procedures and methods and the impact avoidance, minimization, and mitigation measures that would be implemented, these impacts would not be significant.

5.1.3 Water Resources and Wetlands

5.1.3.1 Groundwater

Based on the characteristics of groundwater underlying the LNG terminal site, our determination that the Project would not affect nearby (about 3,500 feet north of the terminal) CBNBWB water withdrawal wells, and Jordan Cove's implementation of BMPs and impact avoidance, minimization, and mitigation measures to address potential inadvertent releases of equipment related fluids, we conclude that impacts on groundwater resources at the LNG terminal site may occur, but would be minimized to the extent practicable, and would not be significant. Constructing and operating the pipeline could temporarily and/or permanently affect springs, seeps, and wells. These resources could experience changes in quantity (flow and volume) and quality (contamination due to the inadvertent release of equipment related fluids). To minimize impacts on these resources, Pacific Connector would implement measures described in its *Groundwater Supply Monitoring and Mitigation, SPCC Plan,* and *Contaminated Substances Discovery Plans.* Therefore, we conclude that constructing and operating the Project would not significantly affect groundwater resources.

5.1.3.2 Surface Water

Creating the LNG marine berth and access channel, as well as modifying the navigation channel would temporarily increase turbidity and sedimentation in Coos Bay, affecting overall water quality. The increased turbidity and sedimentation would occur as a result of initial dredging activities over varying distances depending on hydrological conditions and then again periodically in association with maintenance dredging. LNG carriers traversing the navigational channel and operating in the marine berth would not have a measurable effect on water quality other than a minor increase in turbidity along the bottom of the berth due to propeller wash. LNG carrier water withdrawals and discharges associated with ballast and normal engine operations during LNG loading would recirculate over 3 million gallons of water per hour. LNG carrier operations are not expected to significantly affect water quality (e.g., temperature, salinity, or dissolved oxygen levels) in Coos Bay.

The pipeline would be constructed across or in close proximity to 352 waterbodies; 270 intermittent streams and ditches, 69 perennial waterbodies, and several ponds and other surface water features. Pacific Connector developed a *Stream Crossing Risk Analysis* that, in conjunction with following their *Procedures*, would avoid and minimize impacts on waterbodies. Waterbodies would be crossed during low-flow periods whenever possible and within ODFW recommended in-water construction windows.

Pacific Connector would cross five major waterbodies (defined as those over 100 feet wide) including two crossings of Coos Bay and one at the Coos River using HDD methods and two locations on the South Umpqua River using DP and diverted open-cut methods. The Rogue River and Klamath River would also be crossed via HDD methods. Pacific Connector prepared an *HDD Contingency Plan and Failure Procedures* that describes measures to deal with HDD failure and contain an inadvertent release of drilling mud during the HDD process.

Other than the limited number of HDD, DP, bores, and one diverted open cut, all other crossings would use dry open-cut methods (including dam-and-pump and fluming). These methods would reduce the potential for turbidity from flowing water disturbance during active flow construction. Impacts from dry crossings would be temporary and localized, with most construction occurring at a single crossing within a 48-hour period.

The pipeline would cross three rivers listed on the Nationwide Rivers Inventory: the North Fork of the Coquille River, the East Fork of the Coquille River, and the South Umpqua River. The pipeline would cross the North Fork of the Coquille River (at about MP 23) and the East Fork of the Coquille River (at about MP 30) using a dry open-cut method. Pacific Connector proposes to use a DP and diverted open cut, respectively, at the two crossings of the South Umpqua River (at about MPs 71 and 95).

During construction, Pacific Connector would use a total of about 75,000 gallons per day of water for dust control. All required permits would be obtained prior to water use from both private and public water sources, which would stipulate allowable flow rates of withdrawal and discharge. Based on Jordan Cove's proposed dredging and vessel operation methods, Pacific Connector's proposed waterbody crossing and restoration methods, as well as the required impact avoidance and minimization measures (including implementation of erosion controls, water management plans, hazardous substance management procedure, and construction timing), we conclude that the Project would not result in significant impacts on surface water resources.

5.1.3.3 Wetlands

Constructing and operating the LNG terminal would affect about 86.1 acres of wetlands and result in the loss of about 22.3 acres of wetlands. Constructing and operating the pipeline would temporarily affect about 112.2 acres of wetlands and result in long-term impacts on about 5.8 acres of wetlands.

Jordan Cove and Pacific Connector developed a *Compensatory Wetland Mitigation Plan* to address unavoidable impacts on wetlands. Impacts on freshwater wetland resources would be mitigated via the Kentuck project site, and impacts on estuarine wetland resources would be mitigated via the Eelgrass Mitigation site and Kentuck project site (see Jordan Cove and Pacific Connector's *Compensatory Wetland Mitigation Plan*). These mitigation plans are still being reviewed by the COE, ODSL, and applicable federal and state agencies. Approval of these mitigation plans by these agencies would be required prior to the issuance of federal and state wetland permits.

Based on our review of the Project and Jordan Cove and Pacific Connector's implementation of measures to reduce impacts on wetlands, we conclude that constructing and operating the Project would not significantly affect wetlands.

5.1.4 Vegetation

Constructing and operating the Project would affect over 4,000 acres of vegetation. Over 2,000 acres of forested vegetation including about 773 acres of LSOG forest would be cleared and experience long-term and permanent impacts. However, most of the vegetation types affected by the Project are common and widespread in the region. The temporary and permanent clearing of vegetation would affect soils, wildlife, and water resources; would result in the creation of forest "edges"; and could increase the introduction and spread of exotic and invasive species. To reduce the impacts of clearing vegetation along the pipeline route, Pacific Connector would implement erosion control devices and numerous other measures as described in its *ECRP*, *Fire Prevention and Suppression Plan*, and its *Integrated Pest Management Plan.* Based on the types and amounts of vegetation that would be affected by the Project, the measures that would be implemented to avoid, minimize, and mitigate the resulting impacts, our recommendation for Pacific Connector to develop a final *Integrated Pest Management Plan*, and the abundance of similar vegetation in the affected watersheds, we conclude that constructing and operating the Project would have permanent but not significant impacts on vegetation.

5.1.5 Wildlife and Aquatic Resources

Over 600 species of terrestrial and aquatic wildlife including amphibians, reptiles, birds, fish, and mammals occur in the Project area. Constructing and operating the Project would temporarily and permanently affect these species. Wildlife would avoid and be displaced by construction activities and changes to habitat caused by the Project. Avoidance, displacement, and impacts on other behaviors as well as the loss of habitat would increase the rates of stress, injury, and mortality experienced by wildlife. Additionally, we concluded that operational noise from the LNG terminal may affect terrestrial and aquatic wildlife depending on their proximity to the terminal and each species' tolerance for increased noise. We also conclude that the LNG terminal would not significantly affect mammals currently occupying the North Spit. To further minimize impacts on wildlife and aquatic resources from terminal lighting, we are recommending that Jordan Cove document consultations with appropriate resource agencies and develop a final lighting plan, as well as develop a final *Fish Salvage Plan* and a *Hydrostatic Test Plan* that requires that any water withdrawal from a flowing stream does not exceed an instantaneous flow reduction of more than 10 percent of stream flow. Regarding potential impacts on wildlife and aquatic species due to increased marine traffic (and potential fuel and/or equipment fluid releases), we conclude that impacts on migratory birds and aquatic species would be low and not significant. We also conclude that entrainment and impingement from LNG carrier water intakes at the terminal would not have substantial adverse effects on any marine phase of aquatic resources (e.g., the juvenile stage of salmonids) or their food sources. With the exception of forested habitats and associated wildlife, impacts on wildlife and aquatic resources would generally be temporary. To minimize impacts on wildlife and aquatic resources, the applicants would implement numerous best management practices and impact avoidance and minimization measures. Therefore, based on the implementation of these measures, the characteristics of wildlife and aquatic species in the Project area, and the applicant's proposed construction and operation procedures and methods, we conclude that the Project would not significantly impact wildlife and aquatic resources.

5.1.6 Threatened, Endangered, and Other Special Status Species

The Project would be located across lands with habitats supporting 34 federally-listed and proposed threatened and endangered species. Based on surveys conducted by the applicants, our assessment of these species and impacts on them resulting from construction and operation of the Project, and in consultation with the FWS and NMFS, we have determined that the Project is not likely to adversely affect 21 of the 34 identified threatened and endangered species; and is likely to adversely affect 13 of the 34 identified threatened and endangered species. The threatened species MAMU, NSO, green sturgeon (Southern DPS), Pacific eulachon (Southern DPS), coho salmon (SONCC), coho salmon (Oregon Coast ESU), vernal pool fairy shrimp, and Kincaid's lupine are likely to be adversely affected. The endangered species Lost River sucker, shortnose sucker, Applegate's milk-vetch, and Gentner's fritillary are also likely to be adversely affected. The proposed threatened Pacific fisher (West Coast DPS) is also likely to be adversely affected. At this time, the applicants have not proposed measures to mitigate these impacts.

To ensure impacts on federally listed threatened and endangered species are sufficiently minimized, we are making several recommendations concerning noise, construction methods, and workspace. Whales may be affected by construction-related noise; therefore, we are recommending that Jordan Cove prepare a Marine Mammal Monitoring Plan that identifies the measures that would be implemented to reduce noise impacts and to ensure compliance with NMFS underwater noise criteria pertaining to listed whales. We are also recommending that Pacific Connector adhere to FWS-recommended timing restrictions concerning MAMU stands and NSO activity centers. Lastly, we are recommending that Pacific Connector prepare a Klamath Basin suckers fish salvage plan, and that workspace be eliminated to avoid impacts on Gentner's fritillary.

In compliance with Section 7 of the ESA, we are preparing a BA. This BA will be submitted to the FWS and the NMFS prior to the issuance of the final EIS. Along with the BA, we will request the initiation of formal consultation with the FWS and NMFS. The BA will be appended to the final EIS. The BA will request formal consultation with the FWS and NMFS. In response to our BA, the FWS and NMFS would then issue biological opinions where they will determine if the Project would likely jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. To ensure compliance with the ESA, we are recommending that construction not occur until consultation is complete. Concerning state-listed species and other species of concern, we conclude that constructing and operating the Project would not significantly affect these species.

5.1.7 Land Use

The Project would temporarily and permanently affect numerous land uses including managed and unmanaged forest, industrial/commercial (including utility), unmanaged (open), residential, agricultural (pasture, row crop, and other), recreational, timber, transportation (roads and highways), and range. The Project would also cross lands managed by the COE, Forest Service, BLM, and Reclamation. The LNG terminal site comprises primarily privately controlled land consisting of a combination of brownfield decommissioned industrial facilities, an existing landfill requiring closure, and open land. With the exception of a COE easement and BLM land crossed by the industrial wastewater pipeline (within an existing utility corridor), no federal lands would be affected at the LNG terminal site. The nearest residence to the LNG terminal is about 1.1 miles away. The pipeline would cross a mix of private and public lands, with privately owned lands making up about two-thirds and federal lands accounting for about one-third, with some state lands also crossed. The pipeline and/or associated workspaces would be located within 50 feet of seven residences. Impacts on residences would be minimized by the implementation of residential best management practices. Following construction, lands temporarily affected would be able to resume previous land uses. Some permanently affected lands would also be able to resume previous land uses (agriculture, unmanaged, and range), and other lands would be permanently converted to industrial/commercial use, precluding the resumption of previous land uses. Based on the impacts on land uses, we conclude that constructing and operating the Project would not significantly affect land use.

The Jordan Cove LNG Project as well as approximately 50 miles of the pipeline route would be within Oregon’s Designated Coastal Zone. The Project would need to obtain a finding from the ODLCD that the Project components within the coastal zone are consistent with the CZMA. To ensure compliance with the CZMA, we are recommending that construction not occur until the Project receives a consistency determination.

5.1.8 Recreation and Visual Resources

5.1.8.1 Recreation

Constructing and operating the Project could temporarily affect recreational use of areas located near the LNG terminal and pipeline. The Project could also affect nearby recreational services. Recreational areas near the LNG terminal could experience a temporary increase in noise. Some views from these areas would now include the LNG terminal and carriers. Individuals using recreational resources in the area could experience increased traffic and greater travel times. Visitors could also find that temporary accommodations (e.g., hotels, camp sites, and RV parks) in the Coos Bay area have less vacancy. During operation, recreational boaters may experience delays due to LNG carriers transiting to and from the LNG terminal; otherwise, no significant impacts are expected to occur to water-based recreation.

Visitors to recreation areas crossed by the pipeline would likely find construction to be an annoyance and an inconvenience; but this impact would be temporary. Recreational service providers may be affected if visitors avoid construction areas. However, due to the assembly line nature of pipeline construction, impacts on a specific area would generally be temporary as pipeline work in an area is completed and activities then move onto another area. Based on the expected impacts to recreation areas and services, we conclude that constructing and operating the Project would affect recreation; however, this effect would not be significant.

5.1.8.2 Visual Resources

The LNG terminal would be visible from numerous viewpoints within the North Bend/Coos Bay area. The most visible components of the LNG terminal would be the LNG storage tanks (180 feet tall) and nighttime lighting. Although adjacent properties have been developed and are currently being used for commercial purposes, the LNG terminal would be a major industrial facility considerably different from adjacent uses, and would permanently and significantly affect the visual character of Coos Bay's northern shoreline. Construction of the pipeline (use of heavy equipment and ground disturbance) and its impact on the viewshed would be temporary. Operation of the pipeline and the maintenance of an easement would permanently affect the viewshed; however, due to the remoteness of the Project area and the presence of other linear infrastructure, powerlines, highways, and roads, which have a similar impact on the viewshed, we conclude that construction and operation of the pipeline would not significantly affect visual resources.

5.1.9 Socioeconomics

Constructing and operating the Project would generate tax revenues for local and state governments. The Project would also create considerable temporary employment opportunities many of which may be filled by local workers. In addition, the purchasing of supplies and materials as well as use of other services would result in a temporary positive impact for local businesses. Constructing the Project would temporarily impact demand for housing (rental housing, hotel and motel rooms, and RV spaces) in the Project area. In the Coos Bay area, constructing both the LNG terminal and the pipeline would significantly impact demand for housing and could result in rent increases and displacement. To reduce this impact, Jordan Cove is constructing a temporary housing facility for contractors. However, we conclude that housing impacts in Coos Bay would experience a temporary significant impact. In other Project areas, housing would also be affected, but this effect would not be significant. The influx of an outside workforce into the Project area during construction would temporarily increase pressure on law enforcement (by increasing crime rates), fire protection, and medical services. Based on the temporary nature of the Project's impacts, we conclude that constructing and operating the Project would not significantly affect the socioeconomic character of the Project area.

With the applicant's proposed construction and operations procedures and mitigation measures in place, we conclude that constructing and operating the LNG and pipeline facilities are not expected to result in significant impacts on socioeconomic resources or services, with the exception of temporary housing availability during construction.

5.1.10 Transportation

Constructing the LNG terminal would require delivery vessels over a 2-year period via a mix of ocean-going vessels and barges. Once construction is complete, LNG carriers would transit to and from the terminal, increasing the total number of deep-draft vessels calling at Coos Bay. The anticipated increases in marine traffic combined with current deep-draft vessel traffic would be less than historic ship traffic through the channel and are, therefore, not expected to significantly affect other marine traffic in Coos Bay. During construction, motor vehicle traffic in the Coos Bay area would increase and, as a result, traffic and commute times in the area would also likely increase. To reduce these increases, Jordan Cove conducted a traffic study of the Coos Bay area and would implement numerous measures to reduce impacts on roadways and facilitate an efficient flow of vehicles. Additionally, during construction, work shifts would be staggered, permanent improvements to a key intersection would be made, manual flagging would be used, and off-site parking lots would be utilized (with workers transported to the site by bus). We have recommended that Jordan Cove entered into traffic development agreements with ODOT, Coos County, and the City of North Bend, as recommended in the *Traffic Impact Analysis* report Furthermore, the use of existing roads along the pipeline route to access construction work areas and to move construction equipment, materials, and personnel would temporarily affect these roadways; however, we conclude that, with mitigation measures in place to reduce impacts on roads and users, constructing and operating the Project would not result in significant impacts on transportation.

5.1.11 Cultural Resources

Cultural resource investigations for the Project are currently incomplete. Surveys that have been completed have identified sites in the vicinity that require monitoring during construction. Additionally, further testing has been recommended for some sites if avoidance cannot be achieved by the Project.

The FERC staff and the applicants have contacted Indian tribes that may attach religious or cultural importance to sites in the APE. We received comments from the CTCLUSI, Coquille, Cow Creek, Grand Ronde, Karuk, Klamath, and Yurok Tribes. The Coquille Tribe is a cooperating agency, while the others have filed motions to intervene. For both Projects (i.e., the Jordan Cove LNG Project and Pacific Connector Pipeline Project), a finalized ethnographic study is in the process of being completed by the applicants.

We have not yet completed the process of complying with Sections 101 and 106 of the NHPA. Additional cultural resource inventories, evaluations, and associated reports are yet to be completed. Consultations with tribes, SHPO, and applicable federal land-managing agencies have also not been concluded. We are recommending that Jordan Cove and Pacific Connector not construct or use any of their proposed facilities, including related ancillary areas for staging, storage, temporary work areas, and new or to-be-improved access roads, until all studies and consultations necessary to complete compliance with the NHPA have been completed. It is expected that the resolution of adverse effects through an MOA and implementation of treatment plans would mitigate impacts at affected historic properties to a less-than-significant finding, should the Project be approved by the Commission.

5.1.12 Air Quality and Noise

5.1.12.1 Air Quality

Air pollutants would be emitted as a result of both construction and operation of LNG marine traffic, the LNG terminal, the Pacific Connector pipeline, and aboveground facilities. During construction, a temporary reduction in ambient air quality may result from emissions and fugitive dust generated by construction equipment. Emissions from construction equipment would be temporary and would not result in a significant impact on regional air quality or result in any exceedance of applicable ambient air quality standards.

The Jordan Cove LNG Project is located in an air attainment area for federal air quality standards. In September 2017, Jordan Cove submitted an air quality permit application to the ODEQ. The Project's Type B state-only NSR permit application demonstrates that applicable requirements have been met. For all pollutants, the impacts at the points of highest concentration during operation of the Jordan Cove facilities are well below the applicable NAAQS and the PSD increments when combined with ambient air quality concentrations.

The Klamath Compressor Station and most of the pipeline route would be located in areas designated as attainment for all federal air quality standards, except for approximately 325 feet of pipeline route that would be located within the Klamath Falls PM_{10} maintenance area. Pacific Connector submitted a standard ACDP initial application to the ODEQ in May 2015, and submitted a revised application in September 2017. For all pollutants, the combined impacts at the points of highest concentration during operation of the Klamath Compressor Station are less than the applicable NAAQS.

Constructing and operating the Project would result in impacts on air quality; however, with implementation of BMPs, we conclude that these impacts would not be significant.

5.1.12.2 Noise

Noise would be generated as a result of both construction and operation of the LNG terminal and aboveground facilities associated with the Pacific Connector pipeline. The NSAs closest to the Jordan Cove LNG terminal are single-family homes in the city of North Bend (NSA1) about 1.3 miles south and directly across Coos Bay from the center of the proposed LNG terminal site and the Horsfall campground located approximately 1.2 miles northeast of the LNG terminal. Based on the large number of residents who live across Coos Bay, the impulsive (i.e., short and intense) noise impacts associated with pile-driving activities, the predicted and perceptible noise impacts on nearby NSAs, the duration of pile-driving activities, as well as the lack of noise mitigation measures proposed by Jordan Cove, we have recommended that Jordan Cove implement additional measures to minimize the noise impacts of pile driving on NSAs. With the implementation of the mitigation measures proposed, in addition to our recommendation, effects resulting from construction of the Jordan Cove LNG terminal would be temporary and would not result in significant impacts on nearby communities.

Operational noise from operating the LNG terminal is predicted to have a sound level below the FERC requirement of 55 dBA L_{dn}. However, we are recommending that Jordan Cove document that its facilities meet our noise standards by filing the results of a noise survey during operation that shows compliance with our noise requirement.

During the construction of the Pacific Connector Project, construction noise would be audible to NSAs near the construction right-of-way. Pipeline construction activities generally would be limited to daytime hours. Due to the assembly-line nature of pipeline construction, activities in any area could occur intermittently over a period lasting from several weeks to a few months. Noise from HDD drilling activities may be above our requirement of 55 dBA L_{dn} at some NSAs without mitigation. To make certain that the mitigation measures implemented at the HDD locations minimize noise at nearby NSAs, we recommend that Pacific Connector file a noise mitigation plan, monitor noise levels, and file weekly noise reports documenting compliance with our noise standard during the drilling activities.

Operation of the Klamath Compressor Station would result in noise impacts on nearby NSAs. In order to reduce these impacts, Pacific Connector would implement mitigation measures to reduce noise from the compressor station to meet our requirement of 55 dBA L_{dn} at nearby NSAs. To ensure that actual operational noise is at or below the predicted noise, and that there would be no significant impact to noise quality at the nearest NSAs, we are recommending that Pacific Connector file the results of a noise survey no later than 60 days after the compressor station is placed in service to demonstrate that noise at nearby NSAs does not exceed our standards. If that level is exceeded, Pacific Connector would need to install additional noise controls to meet that level.

Constructing and operating the Project would result in noise-related impacts; however, with implementation of mitigation measures as well as inclusion of the recommendations made in this EIS, we conclude that the Project would not result in significant noise-related impacts.

5.1.13 Reliability and Safety

As part of the NEPA review, Commission staff must assess whether the proposed facilities would be able to operate safely and securely. As a result of our technical review of the preliminary engineering design and our recommended mitigation, we believe that the facility design proposed by Jordan Cove includes acceptable layers of protection or safeguards that would reduce the risk of a potentially hazardous scenario from developing into an event that could impact the off-site public.

As a cooperating agency, the USDOT assists the FERC by determining whether Jordan Cove's proposed design would meet the USDOT's 49 CFR 193 Subpart B siting requirements. USDOT will provide a Letter of Determination on the Project's compliance with 49 CFR 193 Subpart B. This determination will be provided to the Commission as further consideration to the Commission on its decision to authorize or deny the Project. If the Project is authorized and constructed, the facility would be subject to the USDOT's inspection and enforcement program and final determination of whether a facility is in compliance with the requirements of 49 CFR 193 would be made by the USDOT staff.

As a cooperating agency, the Coast Guard analyzed the suitability of the waterway for LNG marine traffic. Based on its review and its own independent risk assessment, the Coast Guard has determined that the waterway could be made suitable for the type and frequency of LNG marine traffic associated with the proposed Jordan Cove LNG facility. This opinion was contingent upon the availability of additional measures necessary to responsibly manage the maritime safety and security risks. If appropriate resources are not in place prior to LNG carrier movement along the waterway, then the Coast Guard would consider at that time what, if any, vessel traffic and/or facility control measures would be appropriate to adequately address navigational safety and maritime security considerations.

Pacific Connector's pipeline would be built and inspected according to USDOT standards. These standards ensure pipeline safety.

5.1.14 Cumulative Impacts

Construction of the Project, in addition to other projects within the same geographic scopes crossed by the pipeline, would have cumulative impacts on a range of environmental resources, as discussed in section 4.14. We provided information about Project-related impacts and mitigation measures for specific environmental resources and were able to make some general assumptions about other federal projects identified in table 4.14.2.3-1. For the federal projects, there are laws and regulations in place that protect waterbodies and wetlands, threatened and endangered species, and historic properties, and limit impacts from air and noise pollution. Federal land-managing agencies, such as the BLM and Forest Service, have requirements in their LMPs to protect resources on the lands they manage. We have limited information about potential or foreseeable private projects in the region. For some resources, there are also state laws and regulations that apply to private projects. While there would be cumulative impacts on resources when all of the foreseeable projects are combined, the magnitude of that impact would be minimal at the landscape scale. Given the Project BMPs and design features, mitigation measures that would be implemented, federal and state laws and regulations protecting resources, and permitting requirements, we conclude that when added to other past, present, and reasonably foreseeable future actions, the Project, with two exceptions, would not result in significant cumulative impacts on environmental resources. Constructing the Project would result in a temporary significant cumulative impact on housing availability in Coos County and would also result in a permanent significant cumulative impact on the visual character of Coos Bay.

5.2 FERC STAFF'S RECOMMENDED MITIGATION

If the Commission authorizes the Project, we are recommending that the following measures be included as specific conditions in the Commission's Order. These measures would further mitigate the environmental impacts associated with the construction and operation of the proposed Project. The section number in parentheses at the end of a condition corresponds to the section number in which the measure and related resource impact analysis appears in the EIS.

1. Jordan Cove and Pacific Connector shall follow the construction procedures and mitigation measures described in its applications and supplemental filings (including responses to staff data requests), and as identified in the EIS, unless modified by the Order. Jordan Cove and Pacific Connector must:
    a. request any modification to these procedures, measures, or conditions in a filing with the Secretary;
    b. justify each modification relative to site-specific conditions;
    c. explain how that modification provides an equal or greater level of environmental protection than the original measure; and
    d. receive approval in writing from the Director of OEP **before using that modification**.

2. For the LNG terminal, the Director of OEP, or the Director's designee, has delegated authority to address any requests for approvals or authorizations necessary to carry out the conditions of the Order, and take whatever steps are necessary to ensure the protection of life, health, property, and the environment during construction and operation of the Jordan Cove LNG Project. This authority shall include:
    a. the modification of conditions of the Order;
    b. stop-work authority and authority to cease operation; and
    c. the imposition of any additional measures deemed necessary to ensure continued compliance with the intent of the conditions of the Order as well as the avoidance or mitigation of unforeseen adverse environmental impact resulting from project construction and operation.

3. For the pipeline facilities, the Director of OEP, or the Director's designee, has delegated authority to address any requests for approvals or authorizations necessary to carry out the conditions of the Order, and take whatever steps are necessary to ensure the protection of environmental resources during construction and operation of the Pacific Connector Pipeline Project. This authority shall allow:
    a. the modification of conditions of the Order;
    b. stop-work authority; and
    c. the imposition of any additional measures deemed necessary to ensure continued compliance with the intent of the conditions of the Order as well as the avoidance or mitigation of unforeseen adverse environmental impact resulting from project construction and operation activities.

4. **Prior to any construction,** Jordan Cove and Pacific Connector shall file an affirmative statement with the Secretary, certified by a senior company official, that all company personnel, EIs, and contractor personnel will be informed of the EI's authority and have been or will be trained on the implementation of the environmental mitigation measures appropriate to their jobs **before** becoming involved with construction and restoration activities.

5. The authorized facility locations shall be as shown in the EIS, as supplemented by filed site plans and alignment sheets, and shall include the route variations identified in conditions 16-19 below. **As soon as they are available, and before the start of construction,** Jordan Cove and Pacific Connector shall file with the Secretary any revised detailed site plan drawings and survey alignment maps/sheets at a scale not smaller than 1:6,000 with station positions for all facilities approved by the Order. All requests for modifications of environmental conditions of the Order or site-specific clearances must be written and must reference locations designated on these site plan drawings.

   For the pipeline, Pacific Connector's exercise of eminent domain authority granted under NGA Section 7(h) in any condemnation proceedings related to the Order must be consistent with these authorized facilities and locations. Pacific Connector's right of eminent domain granted under NGA Section 7(h) does not authorize it to increase the size of its natural gas pipeline or facilities to accommodate future needs or to acquire a right-of-way for a pipeline to transport a commodity other than natural gas.

6. Jordan Cove and Pacific Connector shall file with the Secretary detailed site plan drawings, alignment maps/sheets, or aerial photographs at a scale not smaller than 1:6,000, identifying all route realignments, facility relocations, changes in site plan layout, staging areas, pipe storage yards, new access roads and other areas that would be used or disturbed and have not been previously identified in filings with the Secretary. Approval for each of these areas must be explicitly requested in writing. For each area, the request must include a description of the existing land use/cover type, documentation of landowner approval, whether any cultural resources or federally listed threatened or endangered species would be affected, and whether any other environmentally sensitive areas are within or abutting the area. All areas shall be clearly identified on the maps/sheets/aerial photographs. Each area must be approved in writing by the Director of OEP **before construction in or near that area.**

   This requirement does not apply to route variations required by the Order, extra workspace allowed by the Commission's *Upland Erosion Control, Revegetation, and Maintenance Plan* and/or minor field realignments per landowner needs and requirements which do not affect other landowners or sensitive environmental areas such as wetlands.

   Examples of alterations requiring approval include all route realignments and facility location changes resulting from:

   a. implementation of cultural resources mitigation measures;

   b. implementation of endangered, threatened, or special concern species mitigation measures;

   c. recommendations by state regulatory authorities; and

d. agreements with individual landowners that affect other landowners or could affect sensitive environmental areas.

7. **Within 60 days of the acceptance of the Authorization/Certificate and before construction begins**, Jordan Cove and Pacific Connector shall each file an Implementation Plan with the Secretary for review and written approval by the Director of OEP. Jordan Cove and Pacific Connector must file revisions to the plan as schedules change. The plan shall identify:

   a. how Jordan Cove and Pacific Connector will implement the construction procedures and mitigation measures described in its application and supplements (including responses to staff data requests), identified in the EIS, and required by the Order;

   b. how Jordan Cove and Pacific Connector will incorporate these requirements into the contract bid documents, construction contracts (especially penalty clauses and specifications), and construction drawings so that the mitigation required at each site is clear to onsite construction and inspection personnel;

   c. the number of EIs assigned, and how the company will ensure that sufficient personnel are available to implement the environmental mitigation;

   d. company personnel, including EIs and contractors, who will receive copies of the appropriate material;

   e. the location and dates of the environmental compliance training and instructions Jordan Cove and Pacific Connector will give to all personnel involved with construction and restoration (initial and refresher training as the Project progresses and personnel change), with the opportunity for OEP staff to participate in the training session(s);

   f. the company personnel (if known) and specific portion of Jordan Cove's and Pacific Connector's organization having responsibility for compliance;

   g. the procedures (including use of contract penalties) Jordan Cove and Pacific Connector will follow if noncompliance occurs; and

   h. for each discrete facility, a Gantt or PERT chart (or similar Project scheduling diagram), and dates for:

      1. the completion of all required surveys and reports;

      2. the environmental compliance training of onsite personnel;

      3. the start of construction; and

      4. the start and completion of restoration.

8. Jordan Cove shall employ at least one EI for the LNG terminal and Pacific Connector shall employ a team of EIs for the pipeline facilities (i.e., at least one per construction spread or as may be established by the Director of OEP). The EIs shall be:

   a. responsible for monitoring and ensuring compliance with all mitigation measures required by the Order and other grants, permits, certificates, or authorizing documents;

b. responsible for evaluating the construction contractor's implementation of the environmental mitigation measures required in the contract (see condition 7 above) and any other authorizing document;

c. empowered to order correction of acts that violate the environmental conditions of the Order, and any other authorizing document;

d. a full-time position separate from all other activity inspectors;

e. responsible for documenting compliance with the environmental conditions of the Order, as well as any environmental conditions/permit requirements imposed by other federal, state, or local agencies; and

f. responsible for maintaining status reports.

9. Beginning with the filing of its Implementation Plan, Jordan Cove shall file updated status reports with the Secretary on a **monthly** basis for the LNG terminal and Pacific Connector shall file updated status reports with the Secretary on a **biweekly** basis for the pipeline facilities until all construction and restoration activities are complete. Problems of a significant magnitude shall be reported to the FERC **within 24 hours.** On request, these status reports will also be provided to other federal and state agencies with permitting responsibilities. Status reports shall include:

a. an update on Jordan Cove's and Pacific Connector's efforts to obtain the necessary federal authorizations;

b. Project schedule, including current construction status of the LNG terminal/each pipeline spread, work planned for the following reporting period, and any schedule changes for stream crossings or work in other environmentally-sensitive areas;

c. a listing of all problems encountered, contractor nonconformance/deficiency logs, and each instance of noncompliance observed by the EI during the reporting period (both for the conditions imposed by the Commission and any environmental conditions/permit requirements imposed by other federal, state, or local agencies);

d. a description of the corrective and remedial actions implemented in response to all instances of noncompliance, nonconformance, or deficiency;

e. the effectiveness of all corrective and remedial actions implemented;

f. a description of any landowner/resident complaints which may relate to compliance with the requirements of the order, and the measures taken to satisfy their concerns; and

g. copies of any correspondence received by Jordan Cove and Pacific Connector from other federal, state, or local permitting agencies concerning instances of noncompliance, and Jordan Cove's and Pacific Connector's response.

10. Pacific Connector shall develop and implement an environmental complaint resolution procedure, and file such procedure with the Secretary, for review and approval by the Director of OEP. The procedure shall provide landowners with clear and simple

directions for identifying and resolving their environmental mitigation problems/concerns during construction of the Project and restoration of the right-of-way. This procedure shall be in effect throughout the construction and restoration periods and two years thereafter. Prior to construction, Pacific Connector shall mail the complaint procedures to each landowner whose property will be crossed by the Project.

a. In its letter to affected landowners, Pacific Connector shall:

    1. provide a local contact that the landowners should call first with their concerns; the letter should indicate how soon a landowner should expect a response;

    2. instruct the landowners that if they are not satisfied with the response, they should call Pacific Connector's Hotline; the letter should indicate how soon to expect a response; and

    3. instruct the landowners that if they are still not satisfied with the response from Pacific Connector's Hotline, they should contact the Commission's Landowner Helpline at 877-337-2237 or at LandownerHelp@ferc.gov.

b. In addition, Pacific Connector shall include in its status report a copy of a table that contains the following information for each problem/concern:

    1. the identity of the caller and date of the call;

    2. the location by milepost and identification number from the authorized alignment sheet(s) of the affected property;

    3. a description of the problem/concern; and

    4. an explanation of how and when the problem was resolved, will be resolved, or why it has not been resolved.

11. Jordan Cove and Pacific Connector must receive written authorization from the Director of OEP before commencing construction of any Project facilities. To obtain such authorization, Jordan Cove and Pacific Connector must file with the Secretary documentation that it has received all applicable authorizations required under federal law (or evidence of waiver thereof).

12. Jordan Cove must receive written authorization from the Director of OEP **prior to introducing hazardous fluids into the Project facilities**. Instrumentation and controls, hazard detection, hazard control, and security components/systems necessary for the safe introduction of such fluids shall be installed and functional.

13. Jordan Cove must receive written authorization from the Director of OEP **before placing into service** the LNG terminal and other components of the Jordan Cove LNG Project. Such authorization will only be granted following a determination that the facilities have been constructed in accordance with the FERC approval, can be expected to operate safely as designed, and the rehabilitation and restoration of the areas affected by the Project are proceeding satisfactorily.

14. Pacific Connector must receive written authorization from the Director of OEP **before placing the pipeline into service.** Such authorization will only be granted following a

determination that rehabilitation and restoration of the right-of-way and other areas affected by the Pacific Connector Gas Pipeline Project are proceeding satisfactorily.

15. **Within 30 days of placing the authorized facilities in service**, Jordan Cove and Pacific Connector shall each file an affirmative statement with the Secretary, certified by a senior company official:

    a. that the facilities have been constructed in compliance with all applicable conditions, and that continuing activities will be consistent with all applicable conditions; or

    b. identifying which of the conditions of the Order Jordan Cove and Pacific Connector have complied with or will comply with. This statement shall also identify any areas affected by the Project where compliance measures were not properly implemented, if not previously identified in filed status reports, and the reason for noncompliance.

16. **Prior to construction,** Pacific Connector shall file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the Blue Ridge Variation into its proposed route between MP 11 and 25. (*section 3.4.2.2*)

17. **Prior to construction,** Pacific Connector shall file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the Survey and Manage Species Variation into the proposed route between MPs 111.5 and 111.6, and provide documentation of consultation with the Forest Service. (*section 3.4.2.7)*

18. **Prior to construction,** Pacific Connector shall file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the East Fork Cow Creek Variation into its proposed route between MPs 109.6 and 109.9, and provide documentation of consultation with the Forest Service. (*section 3.4.2.8)*

19. **Prior to construction,** Pacific Connector shall file with the Secretary, for review and written approval by the Director of OEP, revised alignment sheets that incorporate the Pacific Crest Trail Variation into the proposed route between MPs 166.4 and 168.1, and provide documentation of consultation with the Forest Service. (*section 3.4.2.9)*

20. **Prior to construction,** Pacific Connector shall file with the Secretary, for review and written approval by the Director of OEP, the final monitoring protocols and/or mitigation measures for all landslide areas that were not accessible during previous studies. (*section 4.1.2.4*)

21. **Prior to the end of the draft EIS comment period,** Pacific Connector shall consult with the ODEQ regarding existing soil and groundwater contamination at the sites listed in appendix G, and file the results of this consultation, along with any proposed site-specific soil or groundwater handling, management, and disposal procedures. *(section 4.2.2.2)*

22. **Prior to construction,** Pacific Connector shall file a revised *Integrated Pest Management Plan* with the Secretary, for review and written approval by the Director of

the OEP, that specifies that construction equipment will be cleaned after leaving areas of noxious weed infestations and prior to entering BLM-managed lands regardless of contiguous land owner. The revised plan shall also address BLM and Forest Service requirements related to monitoring of invasive plant species on federally managed lands, and documentation that the revised plan was found acceptable by the BLM and Forest Service. (*section 4.4.3.4*)

23. **Prior to construction,** Jordan Cove shall file with the Secretary, for review and written approval by the Director of OEP, its lighting plan. The plan shall include measures that will reduce lighting to the minimal levels necessary to ensure safe operation of the LNG facilities and any other measures that will be implemented to minimize lighting impacts on fish and wildlife. Along with its lighting plan, Jordan Cove shall file documentation that the plan was developed in consultation with the FWS, NMFS, and ODFW. This lighting plan shall also be in compliance with recommendation 59. (*section 4.5.1.1)*

24. **Prior to construction,** Pacific Connector shall file with the Secretary, for review and written approval by the Director of OEP, its final *Fish Salvage Plan*, that addresses methods suitable to collect and salvage all lamprey life stages, to the extent practical, together with documentation that the final *Fish Salvage Plan* was developed in consultations with interested tribes, ODFW, FWS and NMFS. The revised *Fish Salvage Plan* shall also incorporate the applicable measures of the Handling Guidelines for Klamath Basin Suckers. (*section 4.5.2.3*)

25. **Prior to construction**, Pacific Connector shall file with the Secretary, for review and written approval by the Director of OEP, a revised *Hydrostatic Test Plan* that requires that any water withdrawal from a flowing stream does not exceed an instantaneous flow reduction of more than 10 percent of stream flow. (*section 4.5.2.3*)

26. **Prior to construction**, Jordan Cove shall file with the Secretary, for review and written approval by the Director of OEP, a *Marine Mammal Monitoring Plan* that identifies how the presence of listed whales will be determined during construction, and measures Jordan Cove will take to minimize potential noise effects on whales and other marine mammals, and ensure compliance with NMFS underwater noise criteria for the protection of listed whales. *(section 4.6.1.1)*

27. **Prior to construction,** Pacific Connector shall file with the Secretary its commitment to adhere to FWS-recommended timing restrictions within threshold distances of MAMU and NSO stands **during construction, operations, and maintenance** of the pipeline facilities. *(section 4.6.1.2)*

28. **Prior to end of the draft EIS comment period,** Pacific Connector shall file with the Secretary revised alignment sheets that eliminate or relocate TEWA 128.01-W, TEWA 128.96-N, TEWA 142.07-N, and EAR-128.05. *(section 4.6.1.6)*

29. Jordan Cove and Pacific Connector **shall not begin construction until**:

    a. the Commission staff completes formal ESA consultations with the NMFS and FWS; and

b. Jordan Cove and Pacific Connector have received written notification from the Director of OEP that construction and/or implementation of conservation measures may begin. (*section 4.6.1.7*)

30. Jordan Cove and Pacific Connector **shall not begin construction** of the Project **until** they file with the Secretary a copy of the determination of consistency with the Coastal Zone Management Plan issued by the State of Oregon. (*section 4.7.1.2*)

31. **Prior to construction,** Jordan Cove shall file documentation that it has entered into development agreements with ODOT, Coos County, and the City of North Bend, as recommended in the *Traffic Impact Analysis* report. (*section 4.10.1.2*)

32. **Prior to construction of facilities and/or use of any staging, storage, temporary work areas, or new or to-be-improved access roads,** Jordan Cove and Pacific Connector shall file with the Secretary a revised Ethnographic Report describing sites of religious and cultural significance to Indian Tribes and other tribal information as outlined in the FERC staff's October 23, 2018 environmental information request #14, for the review of interested Indian tribes and the FERC staff, and for written approval by the Director of OEP. *(section 4.11.3.1)*

33. Jordan Cove and Pacific Connector shall **not begin construction of facilities and/or use** any staging, storage, or temporary work areas and new or to-be-improved access roads **until**:

    a. Jordan Cove and Pacific Connector each file with the Secretary:

        1. remaining cultural resources inventory reports for areas not previously surveyed;

        2. site evaluations and monitoring reports, as necessary;

        3. final HPMP with avoidance plans;

        4. final UDP; and

        5. comments on the cultural resources reports and plans from the SHPO, applicable federal land managing agencies, and interested Indian tribes.

    b. FERC affords the ACHP an opportunity to comment on the undertaking; and

    c. FERC staff reviews and the Director of OEP approves all cultural resources reports and plans, and notifies Jordan Cove and Pacific Connector in writing that treatment plans may be implemented and/or construction may proceed.

    All materials filed with the Commission containing location, character, and ownership information about cultural resources must have the cover and any relevant pages therein clearly labeled in bold lettering: "**CUI//PRIV - DO NOT RELEASE**." *(section 4.11.5*)

34. **Following the start of pile-driving activities,** Jordan Cove shall monitor daytime pile-driving and file **weekly** noise data reports with the Secretary that identify the noise impact on the nearest NSAs. If any measured daytime noise impacts (L_{max}) at the nearest NSAs are greater than 10 dBA over the L_{eq} ambient levels, Jordan Cove shall:

a. cease pile-driving activities and implement noise mitigation measures; and

b. file with the Secretary evidence of noise mitigation installation and request written notification from the Director of OEP that pile driving may resume. *(section 4.12.2.3)*

35. Jordan Cove shall conduct all pile-driving activities between the hours of 7 a.m. and 7 p.m. **throughout the duration of construction**. *(section 4.12.2.3)*

36. Jordan Cove shall file a full power load noise survey with the Secretary for the LNG terminal **no later than 60 days after** each liquefaction train is placed into service. If the noise attributable to operation of the equipment at the LNG terminal exceeds an L_{dn} of 55 dBA at the nearest NSA, **within 60 days** Jordan Cove shall modify operation of the liquefaction facilities or install additional noise controls until a noise level below an L_{dn} of 55 dBA at the NSA is achieved. Jordan Cove shall confirm compliance with the above requirement by filing a second noise survey with the Secretary **no later than 60 days** after it installs the additional noise controls. *(section 4.12.2.3)*

37. Jordan Cove shall file a full power load noise survey with the Secretary **no later than 60 days after placing the entire LNG terminal into service**. If a full load noise survey is not possible, Jordan Cove shall file an interim survey at the maximum possible horsepower load **within 60 days** of placing the LNG terminal into service and file the full operational surveys **within 6 months**. If the noise attributable to the operation of all the equipment of the LNG terminal exceeds 55 dBA L_{dn} at any nearby NSAs, under interim or full load conditions, Jordan Cove shall file a report on what changes are needed and install additional noise controls to meet the level **within 1 year** of the in-service date. Jordan Cove shall confirm compliance with this requirement by filing a second full power noise survey with the Secretary **no later than 60 days** after it installs the additional noise controls. *(section 4.12.2.3)*

38. **Prior to drilling activities at HDD sites,** Pacific Connector shall file a site-specific noise mitigation plan with the Secretary, for review and written approval by the Director of OEP. During any drilling operations, Pacific Connector shall implement the approved plan, monitor noise levels, and file in its biweekly reports documentation that the noise levels attributable to the drilling operations at NSAs does not exceed 55 L_{dn} dBA. (*section 4.12.2.4*)

39. Pacific Connector shall file a noise survey with the Secretary **no later than 60 days after placing the Klamath Compressor Station in service**. If a full load condition noise survey is not possible, Pacific Connector shall provide an interim survey at the maximum possible horsepower load and provide the full load survey **within six months**. If the noise attributable to the operation of all of the equipment at the Klamath Compressor Station under interim or full horsepower load conditions exceeds an L_{dn} of 55 dBA at any nearby NSAs, Pacific Connector shall file a report on what changes are needed and shall install the additional noise controls to meet the level **within one year** of the in-service date. Pacific Connector shall confirm compliance with the above requirement by filing a second noise survey with the Secretary **no later than 60 days** after it installs the additional noise controls. *(section 4.12.2.4)*

40. **Prior to end of the draft EIS comment period**, Jordan Cove shall file with the Secretary documentation of consultation with USDOT PHMSA staff as to whether the design wind speed for other non-hazardous buildings and structures would be subject USDOT PHMSA requirements. *(section 4.13.1.6)*

41. **Prior to the end draft EIS comment period**, Jordan Cove shall file with the Secretary an analysis that demonstrates the flammable vapor dispersion from design spills would be prevented from dispersing underneath the elevated LNG storage tanks, or the LNG storage tanks would be able to withstand an overpressure due to ignition of the flammable vapor dispersion cloud that disperses underneath the elevated LNG storage tanks. *(section 4.13.1.6)*

42. **Prior to initial site preparation**, Jordan Cove shall file with the Secretary documentation demonstrating it has received a determination of no hazard (with or without conditions) by USDOT FAA for all permanent structures, temporary construction equipment, and mobile objects that exceed the height requirements in 14 CFR 77.9. *(section 4.13.1.6)*

43. **Prior to construction of final design**, Jordan Cove shall file with the Secretary the following information, stamped and sealed by the professional engineer-of-record, registered in Oregon:

    a. site preparation drawings and specifications;

    b. LNG terminal structures, LNG storage tank, and foundation design drawings and calculations (including prefabricated and field constructed structures);

    c. seismic specifications for procured Seismic Category I equipment prior to the issuing of request for quotations;

    d. quality control procedures to be used for civil/structural design and construction; and

    e. a determination of whether soil improvement is necessary to counteract soil liquefaction.

    In addition, Jordan Cove shall file, in its Implementation Plan, the schedule for producing this information. *(section 4.13.1.6)*

44. **Prior to construction of final design,** Jordan Cove shall file with the Secretary consultation with USDOT PHMSA staff as to whether the use of normally closed valves to remove stormwater from curbed areas would meet USDOT PHMSA requirements. *(section 4.13.1.6)*

45. **Prior to commencement of service**, Jordan Cove shall file with the Secretary a monitoring and maintenance plan, stamped and sealed by the professional engineer-of-record registered in Oregon, which ensures the facilities are protected for the life of the LNG terminal considering settlement, subsidence, and sea level rise. *(section 4.13.1.6)*

Conditions 46 through 133 shall apply to the Jordan Cove LNG terminal. Information pertaining to these specific conditions shall be filed with the Secretary for review and written approval by the Director of OEP either: <u>prior to initial site preparation</u>; <u>prior to</u>

construction of final design; prior to commissioning; prior to introduction of hazardous fluids; or prior to commencement of service, as indicated by each specific condition. Specific engineering, vulnerability, or detailed design information meeting the criteria specified in Order No. 683 (Docket No. RM06-24-000), including security information, shall be submitted as critical energy infrastructure information (CEII) pursuant to 18 CFR 388.112. See Critical Energy Infrastructure Information, Order No. 683, 71 Fed. Reg. 58,273 (October 3, 2006), FERC Stats. & Regs. ¶ 31,228 (2006). Information pertaining to items such as offsite emergency response; procedures for public notification and evacuation; and construction and operating reporting requirements will be subject to public disclosure. All information shall be filed a minimum of 30 days before approval to proceed is required.

46. **Prior to initial site preparation**, Jordan Cove shall file an overall Project schedule, which includes the proposed stages of the commissioning plan. *(section 4.13.1.6)*

47. **Prior to initial site preparation**, Jordan Cove shall file procedures for controlling access during construction. *(section 4.13.1.6)*

48. **Prior to initial site preparation**, Jordan Cove shall file quality assurance and quality control procedures for construction activities for both the Engineering Procurement Contractor and Jordan Cove to monitor construction activities. *(section 4.13.1.6)*

49. **Prior to initial site preparation**, Jordan Cove shall specify a spill containment system around the Warm Flare Knockout Drum. *(section 4.13.1.6)*

50. **Prior to initial site preparation**, Jordan Cove shall develop an ERP (including evacuation) and coordinate procedures with the Coast Guard; state, county, and local emergency planning groups; fire departments; state and local law enforcement; and appropriate federal agencies. This plan shall include at a minimum:

    a. designated contacts with state and local emergency response agencies;

    b. scalable procedures for the prompt notification of appropriate local officials and emergency response agencies based on the level and severity of potential incidents;

    c. procedures for notifying residents and recreational users within areas of potential hazard;

    d. evacuation routes/methods for residents and public use areas that are within any transient hazard areas along the route of the LNG marine transit;

    e. locations of permanent sirens and other warning devices; and

    f. an "emergency coordinator" on each LNG marine vessel to activate sirens and other warning devices.

    Jordan Cove shall notify the FERC staff of all planning meetings in advance and shall report progress on the development of its ERP **at 3-month intervals**. *(section 4.13.1.6)*

51. **Prior to initial site preparation**, Jordan Cove shall file a Cost-Sharing Plan identifying the mechanisms for funding all Project-specific security/emergency management costs

that would be imposed on state and local agencies. This comprehensive plan shall include funding mechanisms for the capital costs associated with any necessary security/emergency management equipment and personnel base. Jordan Cove shall notify FERC staff of all planning meetings in advance and shall report progress on the development of its Cost Sharing Plan at **3-month intervals**. *(section 4.13.1.6)*

52. **Prior to construction of final design**, Jordan Cove shall file change logs that list and explain any changes made from the FEED provided in Jordan Cove LNG Project's application and filings. A list of all changes with an explanation for the design alteration shall be provided and all changes shall be clearly indicated on all diagrams and drawings. *(section 4.13.1.6)*

53. **Prior to construction of final design**, Jordan Cove shall file information/revisions pertaining to Jordan Cove's response numbers 8c, 13, 15, 21, 22, 23, 24, 26, 27, 28, and 31 of its December 20, 2018 filing and 6, 9, 10, 11, 17, 19, 32, 34, and 36 of its February 6, 2019 filing which indicated features to be included or considered in the final design. *(section 4.13.1.6)*

54. **Prior to construction of final design**, Jordan Cove shall file drawings and specifications for crash rated vehicle barriers at each facility entrance for access control. *(section 4.13.1.6)*

55. **Prior to construction of final design**, Jordan Cove shall file drawings of the security fence. The fencing drawings shall provide details of fencing that demonstrates it would restrict and deter access around the entire facility and has a setback from exterior features (e.g., power lines, trees, etc.) and from interior features (e.g., piping, equipment, buildings, etc.) that does not allow the fence to be overcome. *(section 4.13.1.6)*

56. **Prior to construction of final design**, Jordan Cove shall file drawings of internal road vehicle protections, such as guard rails, barriers, and bollards to protect transfer piping, pumps, compressors, hydrants, monitors, etc. to ensure that they are located away from roadway or protected from inadvertent damage from vehicles. *(section 4.13.1.6)*

57. **Prior to construction of final design**, Jordan Cove shall file security camera and intrusion detection drawings. The security camera drawings shall show the locations, areas covered, and features of each camera (e.g., fixed, tilt/pan/zoom, motion detection alerts, low light, mounting height, etc.) to verify camera coverage of the entire perimeter with redundancies for cameras interior to the facility to enable rapid monitoring of the facility, including a camera at the top of each LNG storage tank, and coverage within pretreatment areas, within liquefaction areas, within truck transfer areas, within marine transfer areas, and buildings. The drawings shall show or note the location of the intrusion detection to verify it covers the entire perimeter of the facility. *(section 4.13.1.6)*

58. **Prior to construction of final design**, Jordan Cove shall file lighting drawings. The lighting drawings shall show the location, elevation, type of light fixture, and lux levels of the lighting system and shall be in accordance with API 540 and provide illumination along the perimeter of the facility, process equipment, mooring points, and along

paths/roads of access and egress to facilitate security monitoring and emergency response operations. *(section 4.13.1.6)*

59. **Prior to construction of final design**, Jordan Cove shall file a plot plan of the final design showing all major equipment, structures, buildings, and impoundment systems. This lighting plan shall also be in compliance with recommendation 23. *(section 4.13.1.6)*

60. **Prior to construction of final design**, Jordan Cove shall file three-dimensional plant drawings to confirm plant layout for maintenance, access, egress, and congestion. *(section 4.13.1.6)*

61. **Prior to construction of final design**, Jordan Cove shall file up-to-date process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) including vendor P&IDs. The PFDs shall include heat and material balances. The P&IDs shall include the following information:

    a. equipment tag number, name, size, duty, capacity, and design conditions;

    b. equipment insulation type and thickness;

    c. storage tank pipe penetration size and nozzle schedule;

    d. valve high pressure side and internal and external vent locations;

    e. piping with line number, piping class specification, size, and insulation type and thickness;

    f. piping specification breaks and insulation limits;

    g. all control and manual valves numbered;

    h. relief valves with size and set points; and

    i. drawing revision number and date. *(section 4.13.1.6)*

62. **Prior to construction of final design**, Jordan Cove shall file P&IDs, specifications, and procedures that clearly show and specify the tie-in details required to safely connect subsequently constructed facilities with the operational facilities. *(section 4.13.1.6)*

63. **Prior to construction of final design**, Jordan Cove shall file a car seal philosophy and a list of all car-sealed and locked valves consistent with the P&IDs. *(section 4.13.1.6)*

64. **Prior to construction of final design**, Jordan Cove shall file information to demonstrate the EPC contractor has verified that all FEED HAZOP and LOPA recommendations have been addressed. *(section 4.13.1.6)*

65. **Prior to construction of final design**, Jordan Cove shall file a hazard and operability review prior to issuing the P&IDs for construction. A copy of the review, a list of the recommendations, and actions taken on the recommendations shall be filed. *(section 4.13.1.6)*

66. **Prior to construction of final design**, Jordan Cove shall provide a check valve upstream of the amine contractor column to prevent backflow or provide a a dynamic simulation that shows that upon plant shutdown, the swan neck would be sufficient for this purpose. *(section 4.13.1.6)*

67. **Prior to construction of final design**, Jordan Cove shall specify how Mole Sieve Gas Dehydrator support and sieve material would be prevented from migrating to the piping system. *(section 4.13.1.6)*

68. **Prior to construction of final design**, Jordan Cove shall specify how the regeneration gas heater tube design temperature would be consistent with the higher shell side steam temperatures. *(section 4.13.1.6)*

69. **Prior to construction of final design**, Jordan Cove shall specify a cold gas bypass around the defrost gas heater to prevent defrost gas heater high temperature shutdown during low flow and startup conditions. *(section 4.13.1.6)*

70. **Prior to construction of final design**, Jordan Cove shall demonstrate that the differential pressure (dp) level transmitters on the LNG flash drum would not result in an excess number of false high-high-high level shutdowns. *(section 4.13.1.6)*

71. **Prior to construction of final design**, Jordan Cove shall specify a means to stop LNG flows to the BOG suction drum when the BOG compressor is shutdown to prevent filling the BOG suction drum with LNG. *(section 4.13.1.6)*

72. **Prior to construction of final design**, Jordan Cove shall specify a low instrument air pressure shutdown to prevent loss of control to air operated valves. *(section 4.13.1.6)*

73. **Prior to construction of final design**, Jordan Cove shall evaluate and, if applicable, address the potential for cryogenic feed gas back flow in the event relief valve 30-PSV-01002A/B is open. *(section 4.13.1.6)*

74. **Prior to construction of final design**, Jordan Cove shall include LNG tank fill flow measurement with high flow alarm. *(section 4.13.1.6)*

75. **Prior to construction of final design**, Jordan Cove shall specify a discretionary vent valve on each LNG storage tank that is operable through the Distributed Control System (DCS). In addition, a car sealed open manual block valve shall be provided upstream of the discretionary vent valve. *(section 4.13.1.6)*

76. **Prior to construction of final design**, Jordan Cove shall file the safe operating limits (upper and lower), alarm and shutdown set points for all instrumentation (e.g., temperature, pressures, flows, and compositions). *(section 4.13.1.6)*

77. **Prior to construction of final design**, Jordan Cove shall file cause-and-effect matrices for the process instrumentation, fire and gas detection system, and emergency shutdown system. The cause-and-effect matrices shall include alarms and shutdown functions, details of the voting and shutdown logic, and set points. *(section 4.13.1.6)*

78. **Prior to construction of final design**, Jordan Cove shall file an up-to-date equipment list, process and mechanical data sheets, and specifications. The specifications shall include:

    a. building specifications (e.g., control buildings, electrical buildings, compressor buildings, storage buildings, pressurized buildings, ventilated buildings, blast resistant buildings);
    b. mechanical specifications (e.g., piping, valve, insulation, rotating equipment, heat exchanger, storage tank and vessel, other specialized equipment);
    c. electrical and instrumentation specifications (e.g., power system, control system, safety instrument system [SIS], cable specifications, other electrical and instrumentation); and
    d. security and fire safety specifications (e.g., security, passive protection, hazard detection, hazard control, firewater). *(section 4.13.1.6)*

79. **Prior to construction of final design**, Jordan Cove shall file a list of all codes and standards and the final specification document number where they are referenced. *(section 4.13.1.6)*

80. **Prior to construction of final design**, Jordan Cove shall file complete specifications and drawings of the proposed LNG tank design and installation. *(section 4.13.1.6)*

81. **Prior to construction of final design**, Jordan Cove shall file an evaluation of emergency shutdown valve closure times. The evaluation shall account for the time to detect an upset or hazardous condition, notify plant personnel, and close the emergency shutdown valve(s). *(section 4.13.1.6)*

82. **Prior to construction of final design**, Jordan Cove shall file an evaluation of dynamic pressure surge effects from valve opening and closure times and pump startup and shutdown operations. *(section 4.13.1.6)*

83. **Prior to construction of final design**, Jordan Cove shall demonstrate that, for hazardous fluids, piping and piping nipples 2 inches or less in diameter are designed to withstand external loads, including vibrational loads in the vicinity of rotating equipment and operator live loads in areas accessible by operators. *(section 4.13.1.6)*

84. **Prior to construction of final design**, Jordan Cove shall clearly specify the responsibilities of the LNG tank contractor and the EPC contractor for the piping associated with the LNG storage tank. *(section 4.13.1.6)*

85. **Prior to construction of final design**, Jordan Cove shall file the sizing basis and capacity for the final design of the flares and/or vent stacks as well as the pressure and vacuum relief valves for major process equipment, vessels, and storage tanks. *(section 4.13.1.6)*

86. **Prior to construction of final design**, Jordan Cove shall file an updated fire protection evaluation of the proposed facilities. A copy of the evaluation, a list of recommendations and supporting justifications, and actions taken on the recommendations shall be filed. The evaluation shall justify the type, quantity, and location of hazard detection and

hazard control, passive fire protection, emergency shutdown and depressurizing systems, firewater, and emergency response equipment, training, and qualifications in accordance with NFPA 59A (2001). The justification for the flammable and combustible gas detection and flame and heat detection systems shall be in accordance with ISA 84.00.07 or equivalent methodologies and would need to demonstrate 90 percent or more of releases (unignited and ignited) that could result in an off-site or cascading impact would be detected by two or more detectors and result in isolation and de inventory within 10 minutes. The analysis shall take into account the set points, voting logic, wind speeds, and wind directions. The justification for firewater shall provide calculations for all firewater demands based on design densities, surface area, and throw distance as well as specifications for the corresponding hydrant and monitors needed to reach and cool equipment. *(section 4.13.1.6)*

87. **Prior to construction of final design**, Jordan Cove shall file spill containment system drawings with dimensions and slopes of curbing, trenches, impoundments, and capacity calculations considering any foundations and equipment within impoundments, as well as the sizing and design of the down-comers. The spill containment drawings shall show containment for all hazardous fluids including all liquids handled above their flashpoint, from the largest flow from a single line for 10 minutes, including de-inventory, or the maximum liquid from the largest vessel (or total of impounded vessels) or otherwise demonstrate that providing spill containment would not significantly reduce the flammable vapor dispersion or radiant heat consequences of a spill. *(section 4.13.1.6)*

88. **Prior to construction of final design**, Jordan Cove shall file electrical area classification drawings. *(section 4.13.1.6)*

89. **Prior to construction of final design**, Jordan Cove shall provide documentation demonstrating adequate ventilation, detection, and electrical area classification based on the final selection of the batteries, and associated hydrogen off-gassing rates. *(section 4.13.1.6)*

90. **Prior to construction of final design**, Jordan Cove shall file drawings and details of how process seals or isolations installed at the interface between a flammable fluid system and an electrical conduit or wiring system meet the requirements of NFPA 59A (2001). *(section 4.13.1.6)*

91. **Prior to construction of final design**, Jordan Cove shall file details of an air gap or vent installed downstream of process seals or isolations installed at the interface between a flammable fluid system and an electrical conduit or wiring system. Each air gap shall vent to a safe location and be equipped with a leak detection device that shall continuously monitor for the presence of a flammable fluid, alarm the hazardous condition, and shut down the appropriate systems. *(section 4.13.1.6)*

92. **Prior to construction of final design**, Jordan Cove shall file complete drawings and a list of the hazard detection equipment. The drawings shall clearly show the location and elevation of all detection equipment. The list shall include the instrument tag number, type and location, alarm indication locations, and shutdown functions of the hazard detection equipment. *(section 4.13.1.6)*

93. **Prior to construction of final design**, Jordan Cove shall file a technical review of facility design that:

    a. identifies all combustion/ventilation air intake equipment and the distances to any possible flammable gas or toxic release; and

    b. demonstrates that these areas are adequately covered by hazard detection devices and indicates how these devices would isolate or shutdown any combustion or heating ventilation and air conditioning equipment whose continued operation could add to or sustain an emergency. *(section 4.13.1.6)*

94. **Prior to construction of final design**, Jordan Cove shall file a design that includes hazard detection suitable to detect high temperatures and smoldering combustion products in electrical buildings and control room buildings. *(section 4.13.1.6)*

95. **Prior to construction of final design**, Jordan Cove shall file an evaluation of the voting logic and voting degradation for hazard detectors. *(section 4.13.1.6)*

96. **Prior to construction of final design**, Jordan Cove shall file a list of alarm and shutdown set points for all hazard detectors that account for the calibration gas of the hazard detectors when determining the lower flammable limit set points for methane, ethylene, propane, isopentane, and condensate. *(section 4.13.1.6)*

97. **Prior to construction of final design**, Jordan Cove shall file a list of alarm and shutdown set points for all hazard detectors that account for the calibration gas of hazard detectors when determining the set points for toxic components such as condensate and hydrogen sulfide. *(section 4.13.1.6)*

98. **Prior to construction of final design**, Jordan Cove shall file a drawing showing the location of the emergency shutdown buttons. Emergency shutdown buttons shall be easily accessible, conspicuously labeled, and located in an area which would be accessible during an emergency. *(section 4.13.1.6)*

99. **Prior to construction of final design**, Jordan Cove shall file facility plan drawings and a list of the fixed and wheeled dry-chemical, hand-held fire extinguishers, and other hazard control equipment. Plan drawings shall clearly show the location by tag number of all fixed, wheeled, and hand-held extinguishers and shall demonstrate the spacing of extinguishers meet prescribed NFPA 10 travel distances. The list shall include the equipment tag number, type, capacity, equipment covered, discharge rate, and automatic and manual remote signals initiating discharge of the units and shall demonstrate they meet NFPA 59A. *(section 4.13.1.6)*

100. **Prior to construction of final design**, Jordan Cove shall file drawings and specifications for the structural passive protection systems to protect equipment and supports from cryogenic releases. *(section 4.13.1.6)*

101. **Prior to construction of final design**, Jordan Cove shall file calculations or test results for the structural passive protection systems to protect equipment and supports from cryogenic releases. *(section 4.13.1.6)*

102. **Prior to construction of final design**, Jordan Cove shall file drawings and calculations that demonstrate passive protection is provided in areas where jet fires may result in failure of structural supports. *(section 4.13.1.6)*

103. **Prior to construction of final design**, Jordan Cove shall file a detailed quantitative analysis to demonstrate that adequate thermal mitigation would be provided for each significant component within the 4,000 Btu/ft^2-hr zone from an impoundment, or provide an analysis that assesses the consequence of pressure vessel bursts and boiling liquid expanding vapor explosions. Trucks at the truck transfer station shall be included in the analysis. A combination of passive and active protection shall be provided and demonstrate the effectiveness and reliability. Effectiveness of passive mitigation shall be supported by calculations for the thickness limiting temperature rise and effectiveness of active mitigation shall be justified with calculations demonstrating flow rates and durations of any cooling water would mitigate the heat absorbed by the vessel. *(section 4.13.1.6)*

104. **Prior to construction of final design**, Jordan Cove shall file an evaluation and associated specifications and drawings of how they would prevent cascading damage of transformers (e.g., fire walls or spacing) in accordance with NFPA 850 or equivalent. *(section 4.13.1.6)*

105. **Prior to construction of final design**, Jordan Cove shall file facility plan drawings showing the proposed location of the firewater and any foam systems. Plan drawings shall clearly show the location of firewater and foam piping, post indicator valves, and the location and area covered by, each monitor, hydrant, hose, water curtain, deluge system, foam system, water-mist system, and sprinkler. All areas of the pretreatment area shall have adequate coverage. The drawings shall also include piping and instrumentation diagrams of the firewater and foam systems. *(section 4.13.1.6)*

106. **Prior to construction of final design**, Jordan Cove shall specify that the firewater pump shelter is designed to allow removal of the largest firewater pump or other component for maintenance with an overhead or external crane. *(section 4.13.1.6)*

107. **Prior to construction of final design**, Jordan Cove shall demonstrate that the firewater storage tanks are in compliance with NFPA 22 or demonstrate how API Standard 650 provides an equivalent or better level of safety. *(section 4.13.1.6)*

108. **Prior to construction of final design**, Jordan Cove shall specify that the firewater flow test meter is equipped with a transmitter and that a pressure transmitter is installed upstream of the flow transmitter. The flow transmitter and pressure transmitter shall be connected to the DCS and recorded. *(section 4.13.1.6)*

109. **Prior to construction of final design**, Jordan Cove shall file the settlement results during hydrostatic tests of the LNG storage containers and periodically thereafter to verify settlement is as expected and does not exceed the applicable criteria in API 620, API 625, API 653, and ACI 376. *(section 4.13.1.6)*

110. **Prior to construction of final design**, Jordan Cove shall file drawings of the storage tank piping support structure and support of horizontal piping at grade including pump columns, relief valves, pipe penetrations, instrumentation, and appurtenances. *(section 4.13.1.6)*

111. **Prior to construction of final design**, Jordan Cove shall file the structural analysis of the LNG storage tank and outer containment demonstrating they are designed to withstand all loads and combinations. *(section 4.13.1.6)*

112. **Prior to construction of final design**, Jordan Cove shall file an analysis of the structural integrity of the outer containment of the full containment LNG storage tank demonstrating it can withstand the radiant heat from a roof tank top fire or adjacent tank roof fire. *(section 4.13.1.6)*

113. **Prior to construction of final design**, Jordan Cove shall file a projectile analysis to demonstrate that the outer concrete impoundment wall of a full-containment LNG storage tank could withstand projectiles from explosions and high winds. The analysis shall detail the projectile speeds and characteristics and method used to determine penetration or perforation depths. *(section 4.13.1.6)*

114. **Prior to commissioning**, Jordan Cove shall file a detailed schedule for commissioning through equipment startup. The schedule shall include milestones for all procedures and tests to be completed: prior to introduction of hazardous fluids and during commissioning and startup. Jordan Cove shall file documentation certifying that each of these milestones has been completed before authorization to commence the next phase of commissioning and startup will be issued. *(section 4.13.1.6)*

115. **Prior to commissioning**, Jordan Cove shall file detailed plans and procedures for: testing the integrity of onsite mechanical installation; functional tests; introduction of hazardous fluids; operational tests; and placing the equipment into service. *(section 4.13.1.6)*

116. **Prior to commissioning**, Jordan Cove shall file settlement results from the hydrostatic tests of the LNG storage containers and shall file a plan to periodically verify settlement is as expected and does not exceed the applicable criteria set forth in API 620, API 625, API 653, and ACI 376. The program shall specify what actions would be taken after various levels of seismic events. *(section 4.13.1.6)*

117. **Prior to commissioning**, Jordan Cove shall file the operation and maintenance procedures and manuals, as well as safety procedures, hot work procedures and permits, abnormal operating conditions reporting procedures, simultaneous operations procedures, and management of change procedures and forms. *(section 4.13.1.6)*

118. **Prior to commissioning**, Jordan Cove shall file a plan for clean-out, dry-out, purging, and tightness testing. This plan shall address the requirements of the American Gas Association's Purging Principles and Practice, and shall provide justification if not using an inert or non-flammable gas for clean-out, dry-out, purging, and tightness testing. *(section 4.13.1.6)*

119. **Prior to commissioning**, Jordan Cove shall tag all equipment, instrumentation, and valves in the field, including drain valves, vent valves, main valves, and car-sealed or locked valves. *(section 4.13.1.6)*

120. **Prior to commissioning**, Jordan Cove shall file a plan to maintain a detailed training log to demonstrate that operating, maintenance, and emergency response staff have completed the required training. *(section 4.13.1.6)*

121. **Prior to commissioning**, Jordan Cove shall file the procedures for pressure/leak tests which address the requirements of ASME VIII and ASME B31.3. The procedures shall include a line list of pneumatic and hydrostatic test pressures. *(section 4.13.1.6)*

122. **Prior to introduction of hazardous fluids**, Jordan Cove shall complete and document a pre-startup safety review to ensure that installed equipment meets the design and operating intent of the facility. The pre-startup safety review shall include any changes since the last hazard review, operating procedures, and operator training. A copy of the review with a list of recommendations, and actions taken on each recommendation, shall be filed. *(section 4.13.1.6)*

123. **Prior to introduction of hazardous fluids**, Jordan Cove shall complete and document all pertinent tests (Factory Acceptance Tests, Site Acceptance Tests, Site Integration Tests) associated with the DCS and SIS that demonstrates full functionality and operability of the system. *(section 4.13.1.6)*

124. **Prior to introduction of hazardous fluids**, Jordan Cove shall develop and implement an alarm management program to reduce alarm complacency and maximize the effectiveness of operator response to alarms. *(section 4.13.1.6)*

125. **Prior to introduction of hazardous fluids**, Jordan Cove shall complete and document clean agent acceptance tests. *(section 4.13.1.6)*

126. **Prior to introduction of hazardous fluids**, Jordan Cove shall complete and document a firewater pump acceptance test and firewater monitor and hydrant coverage test. The actual coverage area from each monitor and hydrant shall be shown on facility plot plan(s). *(section 4.13.1.6)*

127. **Prior to introduction of hazardous fluids**, Jordan Cove shall complete and document foam system and sprinkler system acceptance tests. *(section 4.13.1.6)*

128. Jordan Cove shall file a request for written authorization from the Director of OEP **prior to unloading or loading the first LNG commissioning cargo**. After production of first LNG, Jordan Cove shall file weekly reports on the commissioning of the proposed systems that detail the progress toward demonstrating the facilities can safely and reliably operate at or near the design production rate. The reports shall include a summary of activities, problems encountered, and remedial actions taken. The weekly reports shall also include the latest commissioning schedule, including projected and actual LNG production by each liquefaction train, LNG storage inventories in each storage tank, and the number of anticipated and actual LNG commissioning cargoes, along with the

associated volumes loaded or unloaded. Further, the weekly reports shall include a status and list of all planned and completed safety and reliability tests, work authorizations, and punch list items. Problems of significant magnitude shall be reported to the FERC within 24 hours. *(section 4.13.1.6)*

129. **Prior to commencement of service**, Jordan Cove shall file a request for written authorization from the Director of OEP. Such authorization will only be granted following a determination by the Coast Guard, under its authorities under the Ports and Waterways Safety Act, the Magnuson Act, the MTSA of 2002, and the Security and Accountability For Every Port Act, that appropriate measures to ensure the safety and security of the facility and the waterway have been put into place by Jordan Cove or other appropriate parties. *(section 4.13.1.6)*

130. **Prior to commencement of service**, Jordan Cove shall notify the FERC staff of any proposed revisions to the security plan and physical security of the plant. *(section 4.13.1.6)*

131. **Prior to commencement of service**, Jordan Cove shall label piping with fluid service and direction of flow in the field, in addition to the pipe labeling requirements of NFPA 59A (2001). *(section 4.13.1.6)*

132. **Prior to commencement of service**, Jordan Cove shall provide plans for any preventative and predictive maintenance program that performs periodic or continuous equipment condition monitoring. *(section 4.13.1.6)*

133. **Prior to commencement of service**, Jordan Cove shall develop procedures for offsite contractors' responsibilities, restrictions, and limitations and for supervision of these contractors by Jordan Cove staff. *(section 4.13.1.6)*

In addition, conditions 134 through 137 shall apply throughout the life of the Jordan Cove LNG Project.

134. The facility shall be subject to regular FERC staff technical reviews and site inspections on at least an **annual** basis or more frequently as circumstances indicate. Prior to each FERC staff technical review and site inspection, Jordan Cove shall respond to a specific data request including information relating to possible design and operating conditions that may have been imposed by other agencies or organizations. Up-to-date detailed P&IDs reflecting facility modifications and provision of other pertinent information not included in the semi-annual reports described below, including facility events that have taken place since the previously submitted semi-annual report, shall be submitted. *(section 4.13.1.6)*

135. **Semi-annual** operational reports shall be filed with the Secretary to identify changes in facility design and operating conditions; abnormal operating experiences; activities (e.g., ship arrivals, quantity and composition of imported and exported LNG, liquefied and vaporized quantities, boil off/flash gas); and plant modifications, including future plans and progress thereof. Abnormalities shall include, but not be limited to, unloading/loading/shipping problems, potential hazardous conditions from offsite vessels, storage tank stratification or rollover, geysering, storage tank pressure

excursions, cold spots on the storage tank, storage tank vibrations and/or vibrations in associated cryogenic piping, storage tank settlement, significant equipment or instrumentation malfunctions or failures, non-scheduled maintenance or repair (and reasons therefore), relative movement of storage tank inner vessels, hazardous fluids releases, fires involving hazardous fluids and/or from other sources, negative pressure (vacuum) within a storage tank, and higher than predicted boil off rates. Adverse weather conditions and the effect on the facility also shall be reported. Reports shall be submitted **within 45 days after each period ending June 30 and December 31**. In addition to the above items, a section entitled "Significant Plant Modifications Proposed for the Next 12 Months (dates)" shall be included in the semi-annual operational reports. Such information would provide the FERC staff with early notice of anticipated future construction/maintenance at the LNG facilities. *(section 4.13.1.6)*

136. In the event the temperature of any region of the LNG storage container, including any secondary containment and imbedded pipe supports, becomes less than the minimum specified operating temperature for the material, the Commission shall be notified **within 24 hours** and procedures for corrective action shall be specified. *(section 4.13.1.6)*

137. Significant non-scheduled events, including safety-related incidents (e.g., LNG, condensate, refrigerant, or natural gas releases; fires; explosions; mechanical failures; unusual over pressurization; and major injuries) and security-related incidents (e.., attempts to enter site, suspicious activities) shall be reported to the FERC staff. In the event that an abnormality is of significant magnitude to threaten public or employee safety, cause significant property damage, or interrupt service, notification shall be made **immediately**, without unduly interfering with any necessary or appropriate emergency repair, alarm, or other emergency procedure. In all instances, notification shall be made to the FERC staff **within 24 hours**. This notification practice shall be incorporated into the liquefaction facility's emergency plan. Examples of reportable hazardous fluids-related incidents include:

a. fire;

b. explosion;

c. estimated property damage of $50,000 or more;

d. death or personal injury necessitating in-patient hospitalization;

e. release of hazardous fluids for 5 minutes or more;

f. unintended movement or abnormal loading by environmental causes, such as an earthquake, landslide, or flood, that impairs the serviceability, structural integrity, or reliability of an LNG facility that contains, controls, or processes hazardous fluids;

g. any crack or other material defect that impairs the structural integrity or reliability of an LNG facility that contains, controls, or processes hazardous fluids;

h. any malfunction or operating error that causes the pressure of a pipeline or LNG facility that contains or processes hazardous fluids to rise above its maximum allowable operating pressure (or working pressure for LNG facilities) plus the build-up allowed for operation of pressure-limiting or control devices;

i. a leak in an LNG facility that contains or processes hazardous fluids that constitutes an emergency;

j. inner tank leakage, ineffective insulation, or frost heave that impairs the structural integrity of an LNG storage tank;

k. any safety-related condition that could lead to an imminent hazard and cause (either directly or indirectly by remedial action of the operator), for purposes other than abandonment, a 20 percent reduction in operating pressure or shutdown of operation of a pipeline or an LNG facility that contains or processes hazardous fluids;

l. safety-related incidents from hazardous fluids transportation occurring at or en route to and from the LNG facility; or

m. an event that is significant in the judgment of the operator and/or management even though it did not meet the above criteria or the guidelines set forth in an LNG facility's incident management plan.

In the event of an incident, the Director of OEP has delegated authority to take whatever steps are necessary to ensure operational reliability and to protect human life, health, property, or the environment, including authority to direct the LNG facility to cease operations. Following the initial company notification, the FERC staff would determine the need for a separate follow-up report or follow up in the upcoming semi-annual operational report. All company follow-up reports shall include investigation results and recommendations to minimize a reoccurrence of the incident. *(section 4.13.1.6)*

Jordan Cove Energy Project, L.P.

Pacific Connector GAS PIPELINE

September 3, 2019

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: *Pacific Connector Gas Pipeline, LP* and *Jordan Cove Energy Project L.P.*
Docket Nos. CP17-494-000 and CP17-495-000
Supplemental Response to Comments on Draft Environmental Impact Statement

Dear Ms. Bose:

On September 21, 2017, Jordan Cove Energy Project L.P. ("JCEP") filed an application pursuant to Section 3(a) of the Natural Gas Act, as amended,[1] and Parts 153 and 380 of the regulations of the Federal Energy Regulatory Commission ("Commission"),[2] for authorization to site, construct, and operate certain liquefied natural gas facilities ("LNG Terminal"). On the same day, Pacific Connector Gas Pipeline, LP ("PCGP", and together with JCEP, "Applicants") filed an application pursuant to Section 7(c) of the NGA,[3] and Parts 157 and 284 of the Commission's regulations,[4] for a certificate of public convenience and necessity authorizing PCGP to construct, install, own, and operate a new natural gas pipeline ("Pipeline"). On March 29, 2019, the Commission Staff issued its Draft Environmental Impact Statement ("DEIS") for the Project, establishing a deadline for comments on the DEIS of July 5, 2019.

On July 22, 2019 Applicants submitted their initial response to certain of the comments regarding the DEIS. Applicants are submitting this supplemental response to assist the Commission in its review of all comments filed during the DEIS comment period as part of the preparation of the Final Environmental Impact Statement.

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[1] 15 U.S.C. § 717b(a) (2012).
[2] 18 C.F.R. Pts. 153 and 380 (2019).
[3] 15 U.S.C. § 717f.
[4] 18 C.F.R. Pts. 157 and 284.

Should you have any questions, please contact me at neades@pembina.com or 832-255-3841.

Sincerely,

/s/ Natalie Eades

Natalie Eades
Jordan Cove Energy Project L.P.
Pacific Connector Gas Pipeline, LP

Enclosures

cc: John Peconom (FERC)
John Crookston (Tetra Tech)

CERTIFICATE OF SERVICE

I hereby certify that I have this 3rd day of September, 2019, served the foregoing document upon each person designated on the official service lists compiled by the Secretary in these proceedings.

/s/ Victoria R. Galvez
Victoria R. Galvez
Attorney for
Jordan Cove Energy Project L.P.
Pacific Connector Gas Pipeline, LP

Attachment A

Supplemental Response to Comments on DEIS

Table of Contents

I. *Earthquakes and Tsunamis*

In the Applicants' response to certain of the comments on the DEIS on July 22, 2019, Applicants acknowledged numerous technical comments submitted by the Oregon Department of Geology and Mineral Industries ("DOGAMI") that merited a supplemental response to refute DOGAMI's claims.[5] As the following subsections demonstrate, the analysis reflected in the DEIS is based on current standards and methods and is appropriate and reasonable. DOGAMI's claims to the contrary are incorrect and misinformed. Other state agencies, such as the Oregon Department of Energy,[6] the Oregon Department of Environmental Quality,[7] and the Oregon Department of Land Conservation and Development,[8] have relied on DOGAMI's review and have included issues raised in many of DOGAMI's comments as a concern for permits being granted by each respective agency. Through this response, Applicants explain why the scope of the studies and the designs performed for the Project are accurate and appropriate.

The DEIS contains a comprehensive analysis of earthquake and tsunami risks, and it presents ample support for its main conclusions and recommendations—that (1) identified faults are not likely to cause offset at the LNG Terminal,[9] (2) the LNG Terminal's final design must include consideration of earthquake ground movement,[10] (3) tsunami design elevations are suitable for the LNG Terminal site,[11] and (4) the final Pipeline design must include final monitoring protocols and measures for all landslide areas that were not accessible during previous studies.[12]

In its general comments, DOGAMI claims that key portions of the DEIS were insufficiently prepared, and in some cases were wrong or inadequate, and that this raises questions about FERC's process in developing the DEIS.[13] DOGAMI attacks the DEIS's analysis, conclusions, and recommendations, claiming that the analysis is based on faulty data, faulty engineering, and faulty science. To the contrary, the studies and information that form the base of the analysis presented in the DEIS were prepared by professional engineers using the best modeling techniques available. Tsunami modelling was carried out by two separate engineering firms (Coast & Harbor Engineering and Moffatt & Nichol) using two independently developed, state-of-the-art models that analyzed multiple scenarios. These scenarios were then compared with DOGAMI and NOAA data to further verify results and conclusions for the design of the Project. GeoEngineers preformed the analysis for the Pipeline to develop its landslide analysis using LiDAR mapping and field verification methods that DOGAMI has accepted for other projects.

We strongly disagree with DOGAMI's numerous comments alleging a "lack of familiarity with seismic hazard assessment" and its disparagement of the licensed and qualified professionals

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[5] JCEP-PCGP Response to Comments on Draft Environmental Impact Statement at p. 49, Accession Number 20190722-5109 (Jul. 22, 2019) ("Response to Comments").
[6] Comments of Oregon State Agencies at p. 17-19, Accession No. 20190703-5209 (July 3, 2019) ("Oregon State Agencies Comments").
[7] Oregon State Agencies Comments at pp. 21-22.
[8] Oregon State Agencies Comments at pp. 196-197.
[9] DEIS at p. 4-735.
[10] DEIS at p. 5-21 (condition 45).
[11] DEIS at p. 4-740.
[12] DEIS at p. 5-17 (condition 21).
[13] Oregon State Agencies Comments at p. 156.

who contributed to the geohazard assessment and prepared the DEIS. FERC Staff reviewed the Applicants' data and analysis, and then used its own expertise and the expertise of other agencies to reasonably, and correctly, reach its conclusions and document those analyses and conclusions in the DEIS.

Many of these concerns rest on DOGAMI's uninformed presumption that JCEP and PCGP failed to address certain comments DOGAMI made on draft versions of the Applicants' resource reports, and not the actual final versions filed with FERC in September 2017. Furthermore, many of DOGAMI's specific comments on the DEIS simply repeat previously provided comments without any diligence to confirm whether the comments remain valid or necessary. For example, DOGAMI repeatedly attacks the DEIS and its underlying analysis for failing to employ LiDAR as a first step in characterizing hazards, but this ignores repeated references to the actual aerial photograph review, LiDAR interpretation, aerial reconnaissance, and ground-based reconnaissance that occurred. DOGAMI questions the design criteria, standards, and referenced studies used in the DEIS and its underlying analysis, but in many instances, DOGAMI fails to verify what standards actually apply, and what studies the DEIS actually uses in its analysis. And unfortunately, many of DOGAMI's comments are focused on isolated words and phrases, taken out of context and characterized as beneath the standard of care that would be employed by qualified professionals. The specific comments addressed below highlight several of these and explain why the DEIS and its underlying analysis contain a thorough review of potential hazards associated with the Project.

Moreover, it appears that DOGAMI has not actually reviewed the final resource reports provided to FERC. Thus, DOGAMI questions the scientific and engineering analyses relating to geologic hazards, but the Applicants understand that DOGAMI has not actually reviewed the underlying scientific and engineering analysis upon which the summaries in the DEIS were based. DOGAMI is aware that its comments were based on outdated reports. In November 2017, DOGAMI provided Applicants with its comments on the April and May 2017 draft versions of the resource reports, and these comments were filed to the FERC docket on December 4, 2017.[14] On December 20, 2017, the Applicants directed DOGAMI to the correct version of the resource reports.[15] Because certain of the scientific and engineering analysis appendices were filed under the FERC guidelines as Critical Energy Infrastructure Information and Controlled Unclassified Information that must be handled as privileged, the Applicants offered DOGAMI the opportunity to enter into a protective agreement to allow DOGAMI access to review the seismic hazard study and geotechnical investigation appendices. These appendices provide additional context to the public resource reports and answered many of the concerns that DOGAMI had raised. DOGAMI never entered into any protective agreement and, to Applicants' knowledge, has not reviewed the underlying studies and investigations that addressed DOGAMI's concerns. In preparing the DEIS, FERC based its analysis on the complete set of resource reports and appendices, and its conclusions are adequately documented.

[14] Comments of DOGAMI, Accession No. 20171204-5022 (Dec. 1, 2017).
[15] Response to DOGAMI Comment Letter of JCEP and PCGP, Accession No. 20171220-5157 (Dec. 20, 2017).

The following subsections address numerous of DOGAMI's specific comments and demonstrate the adequacy of the DEIS's analysis.

A. **Pipeline Seismic Hazard Evaluation**

DOGAMI claims that the pipeline seismic hazard evaluation presented in the DEIS is not sufficiently accurate or detailed.[16] For example, DOGAMI states that the assessment of major earthquake source zones should include intraplate earthquakes.[17] It is correct that the Cascadia subduction zone ("CSZ") is capable of generating both interplate and intraplate earthquakes. Since both originate from the CSZ, and since the DEIS discusses regional earthquakes from the CSZ, there is no deficiency in the analysis.[18] Section 3.2 of PCGP Resource Report 6 contains a more technical discussion of regional seismicity.

DOGAMI notes that major historic earthquakes are not described properly, citing a minor error in the number of events in the year 1873, and requesting a discussion of the completeness and length of record.[19] The DEIS reference to two large earthquakes in 1873 was based on a 2013 version of Resource Report 6, and the final resource report submitted in 2017 correctly reflected the most current data in Section 4.1.1.1, including reference to only one earthquake in the area in 1873. This Section 4.1.1.1 also covers historical seismicity. Magnitude ranges above 4 are of potential engineering significance to a buried pipeline, and the DEIS should be updated to include the current information provided in Section 4.1.1.1 of Resource Report 6.

DOGAMI claims that the assessment is based on an outdated statewide geologic map from 1991, and suggests that OGDC-6 should be used at a minimum.[20] The reference to this 1991 map in the DEIS is immediately followed by a sentence discussing 2009 and 2010 maps from the U.S. Geological Survey, making it plain that GeoEngineers did not base its assessment of geologically mapped faults on an outdated and very small scale statewide geologic map from 1991. The citations included in Section 4.1.2 in Resource Report 6 comprise the accurate and complete set of map references. Sources cited in the DEIS include the USGS Faults and Folds Database (USGS, 2014) DOGAMI mapping including Black and Madin 1995, Personius 2002, Mertzman et al 2007, Mertzman 2008, Hladky and Mertzman 2002, and GeoEngineers interpretation of route specific LiDAR (2015) and DOGAMI LiDAR (as of August 2017).[21] OGDC-6, which DOGAMI suggests, is not cited in the seismic hazards parts of the DEIS or in the underlying analysis in Resource Report 6 because it is not particularly helpful for locating faults. The USGS US Quaternary Fault Map offers the same traces, with more complete information, than DOGAMI's online product OregonHazVu.

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[16] Oregon State Agencies Comments at pp. 163-165.
[17] Oregon State Agencies Comments at p. 163.
[18] DEIS at p. 4-11.
[19] Oregon State Agencies Comments at p. 164.
[20] Oregon State Agencies Comments at p. 164.
[21] DEIS at p. 4-14.

DOGAMI states that faults should be mapped by study of the high-resolution LiDAR for the entire pipeline route.[22] PCGP agrees and commissioned GeoEngineers to complete a LiDAR fault evaluation of the USGS/DOGAMI Klamath area faults in 2017. Section 4.1.2 of Resource Report 6 describes the accurate and complete review of LiDAR data that supplements the USGS Quaternary fault database. Review of the LiDAR data available from DOGAMI is referenced in Section 4.1.2.3 of the DEIS.[23]

DOGAMI claims that historical seismicity in the Klamath Falls area is not accurately described.[24] Section 4.1.1.1 of Resource Report 6 provides an accurate and complete description of Klamath Basin seismicity. The DEIS narrative[25] is intended for a less technical audience and deliberately focuses on issues that are pertinent to pipeline design and construction.

DOGAMI alleges a lack of in-depth quantitative evaluation of the potential for earthquake induced landslides where expected ground shaking is high enough to potentially trigger such events.[26] Any of the areas identified as known or potential landslide hazard areas on the Geologic Hazards maps in Resource Report 6, Appendix F, could have the potential for being activated by earthquake induced ground shaking, but the potential hazard to the pipeline would not be substantially different than other significant landslide triggers, such as an intense rainfall event. The requested in-depth, quantitative evaluation for every slope along the Pipeline route that can experience strong ground shaking would be an extensive effort requiring subsurface data collection, soil and rock testing, and stability analyses throughout most of the 230-mile pipeline alignment. Subsurface data collection throughout the entire Pipeline alignment is not possible due to the physical limitations of accessing boring equipment to undeveloped right of way on timber covered slopes. The evaluations and mitigation plans provided are consistent with current engineering practice and FERC guidance.

DOGAMI claims that the DEIS overstates the conclusion that welded steel pipelines are not prone to failure during earthquakes.[27] This comment incorrectly characterizes the DEIS. The sentence DOGAMI attacks appears in a discussion on ground shaking,[28] with risks from permanent ground deformation being addressed in subsequent paragraphs. The DEIS clearly indicated potential hazards from seismically induced permanent ground deformation resulting from fault rupture and liquefaction. In particular, the DEIS identified and evaluated the locations of these seismic hazards in Section 4.1.2.3, and included recommendations to mitigate these hazards.[29]

[22] Oregon State Agencies Comments at p. 164.
[23] DEIS at p. 4-14.
[24] Oregon State Agencies Comments at p. 164-65.
[25] DEIS at pp. 4-14, 4-21
[26] Oregon State Agencies Comments at p. 165.
[27] Oregon State Agencies Comments at p. 165.
[28] DEIS at p. 4-12.
[29] DEIS at pp. 4-16, 4-18.

B. **Ground Motion Issues**

DOGAMI submits numerous comments related to ground motion and requests a probabilistic ground motion study for the entire Pipeline using accurate up to date methods and data.[30] The DEIS analysis is already robust and informed on this topic. For example, DOGAMI questions inclusion of a discussion of the distinction between earthquake magnitude and ground motion, claiming that the concept is too basic to be included in an engineering seismology discussion for a major project.[31] Peak horizontal ground acceleration ("PGA") is addressed in Section 4.1.2.3 of the DEIS.[32] This discussion in the DEIS appears specifically intended to be accessible to a lay audience. As such, it includes statements that DOGAMI acknowledges to be correct to illuminate basic distinctions. The Pipeline, like all embedded structures, has Period T=0 seconds, which on an acceleration response spectrum corresponds to the PGA. No other spectral ordinates are important to the Pipeline.

Regarding probabilistic ground motion studies, this section of the DEIS also describes PGAs that have different probabilities of exceedance over different intervals and how they were used in the Probabilistic Seismic Hazard Assessment ("PSHA") for the Project. The second paragraph of this section explicitly cites the probabilistic seismic hazard mapping that the USGS performed and made available for use in building codes and non-building projects that have specific needs like this one.[33] The USGS National Seismic Hazard Maps, and specifically the PGA values, are the results of the USGS PSHA, which responds to DOGAMI's comment.

DOGAMI requests that the DEIS be modified to present the most current recurrence and probability data for Cascadia earthquakes.[34] Section 4.1.1.2 of Resource Report 6 discusses the Cascadia recurrence intervals from current sources. In addition, as discussed therein, Goldfinger et al 2013, 2017 provide the most recent estimates based on paleoseismology offshore. The USGS National Seismic Hazard Maps are the result of a probabilistic seismic hazard assessment that provides coverage for the entire Pipeline, thus meeting DOGAMI's request. Furthermore, the CSZ magnitude cited in DOGAMI's comment is, in fact, the range of magnitudes considered in the source model for seismic hazard curves for the different return periods described in the subsequent paragraph. They are obtained through de-aggregation of the USGS's probabilistic analyses. The large range of magnitude that DOGAMI comments on is inextricably linked to the range of considered recurrence intervals and the nature of probabilistic seismic hazard assessments. It would be incorrect to separate CSZ recurrence or probability from other seismic sources when computing probabilistic PGAs used as input to subsequent ground deformation analyses. DOGAMI requests analysis that is already described in this section of the DEIS and, with further detail, in Resource Report 6. DOGAMI's requests are superfluous. Moreover, DOGAMI's request to consider CSZ-related PGA separately from crustal-related PGA is incorrect.

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[30] Oregon State Agencies Comments at pp. 165-167.
[31] Oregon State Agencies Comments at p. 165.
[32] DEIS at p. 4-13 (see paragraph 1).
[33] DEIS at p. 4-13 (see paragraph 2).
[34] Oregon State Agencies Comments at pp. 165-66.

DOGAMI claims that the USGS PSHA mapping for the Pipeline area is not applicable for the Project and that the citation to USGS National Seismic Hazard Map is wrong.[35] For the first claim, the published PSHA is appropriately applicable to this Project, as there is no need to duplicate the national standard PSHA for a pipeline. Regarding the citation, the citation to USGS 2009a (referring to a Quaternary fault and fold database) appears to be in error in the DEIS and in Resource Report 6, and this error should be corrected. However, this error does not support DOGAMI's overall claim that the authors of the analysis have an "apparent lack of familiarity with seismic hazard assessment procedures" and thus "may not be relied on to ensure public safety."

DOGAMI also cites other minor errors and typos to support its claim that the DEIS indicates a lack of familiarity with seismic hazard procedures. For example, DOGAMI notes that the site-specific PGA of 0.5g "does not make sense."[36] DOGAMI is correct that there is a typo in the referenced sentence, one that is easily clarified by referring to Table 2 in Section 4.1.1.4 of the cited Resource Report 6. We concur in recommending that this typo be corrected. The PGA values described in the DEIS and explicitly stated in Table 2 of Resource Report 6 are probabilistic values, as stated in the text.

DOGAMI also claims that the USGS NSHM 2014 PGA data should be used for the ground motion assessment.[37] DOGAMI's referenced USGS probabilistic hazard maps that have not yet been adopted into the Oregon building code. The value stated in the DEIS is based on USGS maps that were in effect at the time the report was prepared and that remain in effect as these responses are being written. The current Oregon Structural Specialty Code is considered an up-to-date method.

DOGAMI cites to a sentence discussing probabilistic ground motion and seismic intensity, claiming that there is no place in modern PSHA discussion for the conflation of the two concepts.[38] Rather than conflating the two concepts, the DEIS text simply creates a relatable point of access to a lay audience in its description of ground shaking and peak horizontal ground acceleration in Section 4.1.2.3.[39] Indeed, in the introductory sentence for this section, the DEIS specifically identifies that "earthquake magnitude and ground motion are two different parameters discussed in relation to CSZ events,"[40] and the DEIS does not conflate the two. With a 1,120-page DEIS, Applicants posit that there is abundant place in this modern PSHA to improve widespread comprehension.

DOGAMI claims that the probabilistic ground motion assessment of the LNG Terminal does not consider certain ground motion parameters that are essential to ensure public safety.[41] DOGAMI states that the DEIS lacks any discussion of structure performance issues in the event

[35] Oregon State Agencies Comments at p. 166.
[36] Oregon State Agencies Comments at p. 166.
[37] Oregon State Agencies Comments at p. 166.
[38] Oregon State Agencies Comments at p. 167.
[39] DEIS at p. 4-13.
[40] DEIS at p. 4-13.
[41] Oregon State Agencies Comments at p. 169.

of a 3 to 5 minute duration of shaking. JCEP completed a site-specific fault and seismic hazard analysis for the LNG Terminal in accordance with 18 CFR 380.12(h)(5). The LNG Terminal is designed to comply with, for example, the most stringent requirements given in ASCE7-05 and ASCE7-10. The LNG Storage Tanks must also satisfy Section 7.2.2 of NFPA 59A (2006).[42] Final design of the soil treatment and foundation design will be in accordance with the latest adopted codes and provided to FERC per recommendations 43 and 45 in Section 5.3 of the DEIS.[43]

DOGAMI questions the credibility of the analysis given a discussion in the DEIS on the correlation between PGA, Mercalli Intensity and Richter magnitude.[44] The DEIS clearly states in its discussion regarding PGA, Mercalli Intensity and Richter magnitude that it is not a direct comparison, but rather relies on an empirical correlation between the accelerations and scales.[45] The next paragraph of the DIES follows with FERC's identification of the seismic design category determination based on ASCE 7-10 and ASCE 7-16.

C. **Fault Identification**

DOGAMI claims that the DEIS's reliance on literature for identifying active faults is itself faulty, and DOGAMI requests that Applicants prepare a detailed evaluation of LiDAR along the Pipeline route for evidence of Quaternary fault followed by field investigation.[46] DOGAMI ignores language in the exact same sentence describing how LiDAR data from DOGAMI was reviewed and interpreted as part of the analysis[47]

DOGAMI also claims that the DEIS overlooks or ignores published information in a way that fails to ensure public safety because it fails to properly evaluate hazard associated with a particular fault near milepost 213 called the Adams Point fault.[48] First, the DEIS is not intended to represent an exhaustive account of the entirety of analysis performed for the geologic hazard evaluation for the Project as presented in Resource Report 6. Second, DOGAMI's claims about the Adams Point fault are incorrect, as it terminates east of the pipeline route as mapped by DOGAMI Open File Report 03-03 (2003). The nearby DOGAMI-mapped, inferred (buried) fault that crosses the route is the southeastern extension of the Stukel Mountain fault, the assessment of which is described in Section 4.1.2.1 of Resource Report 6 and summarized on the same page of the DEIS that DOGAMI cites in its comment.[49] Regarding the alleged oversight of the Adams Point fault near milepost 215, DOGAMI should review that section in Resource Report 6 and further find in Appendix J a summary of the site specific Seismic Reflection Survey of the fault crossing and in Appendix K the fault crossing pipe stress analysis and design. The site-specific geophysical study identified the fault crossing at milepost 212.8-212.9 consistent with the USGS interpreted trace (see Appendix F Geologic Hazards map 44 of 47). This is in contrast to the

[42] DEIS at p. 4-733, 4-734.
[43] DEIS at p. 5-21.
[44] Oregon State Agencies Comments at p. 169.
[45] DEIS at p. 4-738.
[46] Oregon State Agencies Comments at p. 167.
[47] DEIS at p. 4-14.
[48] Oregon State Agencies Comments at p. 167.
[49] DEIS at p. 4-14, 4-15.

DOGAMI (2003) buried fault trace that crosses the route at approximately milepost 213.8 to 213.9, which was not identified by the geophysical.[50]

DOGAMI claims that the evaluation of potentially active faults near the LNG Terminal is inaccurate and incomplete.[51] To the contrary, Section 4.13.1.5 of the DEIS refers to the design requirements of ASCE7-05, ASCE7-10 and NFPA 59A (2001 and 2006), which require site-specific investigation to account for seismicity of "known faults and sources" and "incorporate current seismic interpretations."[52] Applicants used the latest data (2014 USGS Seismic Hazard Maps) available at the time of design. DOGAMI further claims that the DEIS ignores the Charleston Fault.[53] DOGAMI is again incorrect, as the Charleston Fault is included in the 2014 USGS Seismic Hazard Maps and was not ignored in the PHSA. Additionally, no faults were found within the site during field investigations. Results of the site-specific fault and seismic analysis performed for the Project are discussed in Section 4.13.1.5 of the DEIS.[54] These site-specific investigations support the DEIS conclusion that identified faults are not likely to cause offset at the site.

D. **Liquefaction Issues**

DOGAMI claims there are scope-limiting assumptions that cause the liquefactions assessment of the Pipeline route to not adequately ensure public safety.[55] DOGAMI cites a phrase in the DEIS discussing water-saturated soils within the pipeline depth, and then claims that the analysis fails to address liquefaction at depths below the Pipeline trench. However, a plain language reading of the sentence reveals no scope-limiting assumption.[56] DOGAMI requests an analysis of liquefaction potential where the alignment crosses susceptible soils.[57] This precise analysis is discussed in the next paragraph in the DEIS, which describes the liquefaction susceptibility and lateral spreading analysis.[58] This part of the DEIS and Section 4.1.3 of Resource Report 6 present the results of the liquefaction hazards analysis for the entire pipeline alignment.

DOGAMI next claims the lack of references or supporting borehole, geotechnical, or geologic data for analysis of liquefaction potential at stream crossings.[59] GeoEngineers' liquefaction susceptibility evaluation used topography and soil conditions obtained from geological maps, NRCS soil surveys, and, at some sites, geotechnical boring data.[60] This level of detail is adequate for the DEIS to maintain accessibility to a lay audience. The detailed information that DOGAMI claims is missing is more fully provided in Section 4.1.3.2 of Resource Report 6.

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[50] DEIS at p. 4-14.
[51] Oregon State Agencies Comments at p. 168.
[52] DEIS at p. 4-733, 4-734.
[53] Oregon State Agencies Comments at p. 169.
[54] DEIS at p. 4-735.
[55] Oregon State Agencies Comments at pp. 167-168.
[56] DEIS at p. 4-16.
[57] Oregon State Agencies Comments at p. 167.
[58] DEIS at p. 4-16, 4-17.
[59] Oregon State Agencies Comments at p. 168.
[60] DEIS at p. 4-16.

DOGAMI incorrectly claims that it is impossible to determine whether liquefaction potential assessments are adequate,[61] since the data DOGAMI seeks is provided in the resource report. Resource Report 6 includes a detailed, accurate, and comprehensive liquefaction hazard analysis and mitigation design. Appendix H includes supporting data. Data collection was designed using a multistage screening process. The initial desktop review identified 29 sites, which was winnowed to 20 for site-specific surface and subsurface data collection. Site-specific analyses that conform to the best practices outlined in the National Academies compilation were completed at 8 sites, and 4 of those were evaluated using fully coupled, time-domain, 2D dynamic nonlinear numerical simulation (Atlas Geotechnical 2018).[62] The liquefaction hazard analyses completed for this Project equals or exceeds the standard requested by DOGAMI.

DOGAMI claims that liquefaction hazards at the LNG Terminal receive only cursory treatment.[63] The DEIS specifically recognizes consideration of liquefaction as a key design element for the LNG Terminal[64] and includes a recommendation to specifically require the final design for soil stabilization and foundation design be submitted to the Commission prior to construction.[65] A detailed description of the liquefaction triggering analysis and the methods used in the analysis are provided in Appendix J13.4 of Resource Report 13. The liquefaction triggering analysis applies the recommendations of the National Academies Liquefaction Study Report (NALSR 2016). The final terminal soil stabilization and foundation design will be provided as noted in Staff recommendation 45 in Section 5.2 of the DEIS.[66] This design will be compliant with current codes. As of this date, the 2017 FERC Guidelines require compliance with ASCE 7-05, and the 2014 Oregon Structural Specialty Code (OSSC) requires compliance with ASCE 7-10. Therefore, ASCE 7-05 and ASCE 7-10 are the most current standards required for compliance with the FERC guidelines and applicable building codes in the State of Oregon.

E. **Tsunami Issues**

DOGAMI is concerned that the tsunami analysis and modeling assumptions, results, and mitigation are not clearly documented for runup elevations or subsidence.[67] The DEIS discussion summarizes FERC Staff's evaluation of the modeling provided by JCEP and its independent verification with NOAA and others to confirm the validity of the design.[68] JCEP's modeling was performed by professional engineers recognized as industry experts. The initial Project tsunami modeling was performed by Coast & Harbor Engineering using the SELFE hydrodynamic model. This model is the same model used by DOGAMI. Additionally, JCEP retained Moffatt & Nichol to perform an independent analysis that incorporates the newly available ASCE 7-16 chapter regarding tsunami design. Moffatt & Nichol selected the Mike 21 model suite developed by the

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[61] Oregon State Agencies Comments at p. 168.
[62] Supplemental Response to January 3, 2018 Data Request of Jordan Cove Energy Project L.P. and Pacific Connector Gas Pipeline, LP at Attachment FERC-PCGP-RR6-1 at p. 5-7 p. 160, Accession 20180831-5054 (Aug. 31, 2018).
[63] Oregon State Agencies Comments at p. 170.
[64] DEIS at p. 4-732.
[65] DEIS at p. 4-733.
[66] DEIS at p. 5-21.
[67] Oregon State Agencies Comments at p. 171.
[68] DEIS at pp. 4-734 to 4-740.

Danish Hydraulic Institute. Data from each of the models plus the DOGAMI published inundation data and the NOAA data provided in the ASCE Tsunami Design Geodatabase were compared and found to show correlation of the design elevation for the site.[69] FERC Staff worked with NOAA, who helped developed Tsunami maps for ASCE 7-16, and NOAA determined that inundation elevations from the MCT event for the LNG Terminal site were consistent with those determined by JCEP. Therefore, FERC Staff correctly agreed in the DEIS that the tsunami elevations that JCEP provided are suitable for the Project site.[70]

Furthermore, the initial modeling methodology and assumptions were coordinated with DOGAMI and FERC.[71] These design assumptions and design factors were used in the SELFE Model[72] and the Mike 21 Model:[73]

- 2,475-year event consistent with a DOGAMI fault scenario L1
- Ground elevations modeled from C-Map, USACE, USGS, site topography surveys, and the proposed ground elevation design of the site[74]
- Initial water surface elevation, MHW Charleston, OR NOAA station +6.46' NAVD88[75]
- Subsidence 7.6' (obtained from DOGAMI deformation grids)[76]
- Modeled wave height increased by factor of 1.3[77]
- Added 1' of freeboard to the adjusted surface elevation

The DEIS notes the assertion that tsunami protection berms, safety critical elements of the facility, point of support elevations, invert levels and underside of essential equipment, would be at least 1 foot above the estimated maximum run-up elevation and most will be far above that elevation.[78] The elevations of the major equipment and areas are clearly detailed and summarized

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[69] JCEP Resource Report 13, Appendix I.13.2, Moffatt & Nichol Tsunami Wave Runup Comparison, Appendix A, Accession No. 20170921-5142 (Sept. 21, 2017).
[70] DEIS at p. 4-740.
[71] JCEP Resource Report 13, Appendix I.13.2, CHE Technical Memorandum - Jordan Cove LNG Facility Tsunami Hydrodynamic Modeling at p. 3, Accession No. 20170921-5142 (Sept. 21, 2017).
[72] JCEP Resource Report 13, Appendix I.13.2, CHE Technical Memorandum - Jordan Cove LNG Facility Tsunami Hydrodynamic Modeling at p. 15, Accession No. 20170921-5142 (Sept. 21, 2017).
[73] JCEP Resource Report 13, Appendix I.13.2, Moffatt & Nichol Tsunami Modeling at pp. 20, 22-24, Accession No. 20170921-5142 (Sept. 21, 2017).
[74] JCEP Resource Report 13, Appendix I.13.2, Moffatt & Nichol Tsunami Modeling at pp. 22-23, Accession No. 20170921-5142 (Sept. 21, 2017).
[75] JCEP Resource Report 13, Appendix I.13.2, Moffatt & Nichol Tsunami Modeling at p. 16, 23, Accession No. 20170921-5142 (Sept. 21, 2017).
[76] JCEP Resource Report 13, Appendix I.13.2, Moffatt & Nichol Tsunami Modeling at p. 23, Accession No. 20170921-5142 (Sept. 21, 2017).
[77] JCEP Resource Report 13, Appendix I.13.2, Moffatt & Nichol Tsunami Modeling at p. 16, Accession No. 20170921-5142 (Sept. 21, 2017).
[78] DEIS at p. 4-739.

for the marine facilities, LNG tanks, process areas, impoundment floors, utilities, and building in JCEP Resource Report 13, Table 13.2-1 through Table 13.2-6. Furthermore, provisions for life safety are described in Section 13.39.1.7 of Resource Report 13, describing tsunami evacuation muster points (TEMPs) within the bounds of the LNG Terminal and South Dunes. The elevation of each muster point was determined to maintain an elevation at least equal to the inundation due to a 2,475-year event + 10ft or a 10,000-year event, whichever is greater. The 2,475 year and 10,000-year events are based upon the DOGAMI rupture scenarios L1 and XXL1.

F. **Landslide Issues**

DOGAMI attacks the DEIS statement that landslides can usually be identified on topographical maps or aerial photos based on distinctive contour or vegetative patterns.[79] DOGAMI claims that LIDAR is the only definitive method for finding deep slides in western Oregon.[80] DOGAMI ignores that the cited DEIS reference explicitly states that "topographic maps" was defined as including LiDAR.[81] Furthermore, Section 4.5 of Resource Report 6 provides a detailed description of the landslide mapping process for the entire proposed Pipeline alignment using LiDAR hillshade imagery. Section 4.5.3.4 of Resource Report 6 confirms this, explaining that LiDAR was the primary tool for identifying topographic indicators of landsliding because it can reveal fine details of the landscape. DOGAMI refers to comparison of remote sensitive datasets,[82] but multiple data sets of LiDAR for comparison purposes were not available as of the submittal of Resource Report 6. Moreover, DOGAMI's statement that LiDAR is the only definitive method is itself a misstatement of the conclusions drawn from the Oregon LiDAR pilot study. As stated in SP42 (2009), the conclusion of the LiDAR pilot study was that LiDAR was overwhelmingly better than other available remote sensing data sets. LiDAR is not the only method, nor is it definitive. It is, however, appropriate for use in this analysis, and indeed was used in this hazard assessment.

DOGAMI questions the DEIS analysis of shallow-rapid landslides, where the DEIS states that shallow-rapid landslides are more likely to expose the pipe and result in a loss of support where it crosses a debris slide source area. DOGAMI claims that if the pipe is at the surface, a shallow slide could run into the pipe, and DOGAMI asks that situations where this occurs be defined.[83] DOGAMI appears to misunderstand the issue presented. The statement in the DEIS indicates that shallow-rapid landslides are unlikely to induce long-term strain to a pipeline. As the name of these types of landslides indicates, they are characterized as "rapid." As such, their movement occurs rapidly and typically does not induce strain "long-term." The DEIS discussion goes on to explain that once mobilized into a debris flow, shallow-rapid landslides often have tremendous erosional potential, and that debris flows that originate upslope of the pipeline also have the potential to scour, expose and damage the pipeline by impact.[84] DOGAMI's proposed resolution of this issue—defining situations where shallow slides could run into the pipe, is nonsensical. Pipelines are buried specifically to reduce their exposure to mechanical damage

[79] Oregon State Agencies Comments at p. 182.
[80] Oregon State Agencies Comments at p. 182.
[81] DEIS at p. 4-20.
[82] Oregon State Agencies Comments at p. 182.
[83] Oregon State Agencies Comments at p. 182.
[84] DEIS at p. 4-19.

including from landslides. Although it is technically true that an above-grade pipeline would be susceptible to impact, PCGP has not proposed to install an above-grade pipeline. Surface facilities, where they exist, are sited away from or protected against debris flows.

DOGAMI attacks the DEIS for relying on the Statewide Information Database for Oregon ("SLIDO"), a compilation of published data, claiming that the compilation ranges from very poor older data from decades ago to the best available modern LiDAR-based data, and DOGAMI requests site-specific evaluations using LiDAR data in order to complete Phase 1 landslide identification.[85] However, the section of the DEIS that DOGAMI references makes no mention of SLIDO data being used.[86] As indicated in the referenced sentence, LiDAR hillshade imagery was used in conjunction with aerial imagery for Phase 1 landslide identification. This is confirmed in Section 4.5.3.4 of Resource Report 6, noting that LiDAR was the primary tool for identifying topographic indicators of landsliding because it can reveal fine details of the landscape.

Similarly, DOGAMI attacks the DEIS analysis, which mentions using the Potential Rapidly Moving Landslide Hazards in Western Oregon (Hofmeister et al. 2002) in PCGP's initial risk assessment.[87] DOGAMI notes that this resource is a preliminary screening tool and, because it is based on outdated datasets, site-specific evaluations including modern methods should be completed using LiDAR data in order to evaluate areas that have potential for shallow landslides.[88] As reflected in the DEIS and the supporting data, the resource DOGAMI suggests should only be used as a preliminary screening tool was indeed only used as a preliminary screening tool. And the modern LiDAR based methods that DOGAMI says should be used were indeed used. Section 4.5.3.4 of Resource Report 6 explains that LiDAR was the primary tool for identifying topographic indicators of landsliding because it can reveal fine details of the landscape. Potential RML hazards were further evaluated based on aerial and ground-based reconnaissance as described in Section 4.1.2.4 of the DEIS and Section 4.5.5 of Resource Report 6.[89]

In other locations, DOGAMI similarly attacks the DEIS analysis, asserting that its conclusions should be supported by modern references and that site-specific evaluations should be completed using LiDAR data to evaluate areas that have potential for shallow landslides.[90] The language that DOGAMI attacks, a discussion of PCGP's analysis along the proposed route, is based on "modern" LiDAR data. Moreover, site specific evaluations were completed based on aerial and ground-based reconnaissance as described in Section 4.5.5 of Resource Report 6.

DOGAMI claims that discussion of areas of potential ground-shaking that might initiate landslides is too limited in scope because it only mentions the Klamath Falls region and the Coos Bay region.[91] DOGAMI states that ground motion maps predict effects much further inland than just the Coos Bay region., and because the entire pipeline route is in a high seismic zone, the

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[85] Oregon State Agencies Comments at p. 182.
[86] DEIS at p. 4-19.
[87] Oregon State Agencies Comments at p. 183.
[88] Oregon State Agencies Comments at p. 183.
[89] DEIS at p. 4-19, 4-20; PCGP Resource Report 6 at p. 34, Accession No. 20170921-5142 (Sept. 21, 2017).
[90] Oregon State Agencies Comments at p. 182.
[91] Oregon State Agencies Comments at p. 184.

analysis should be revised to reflect that.[92] Table 2 in the main body of Resource Report 6 summarizes ground shaking amplitude along the entire alignment. The term "Coos Bay region" correctly describes the part of the alignment susceptible to ground shaking sufficiently intense to initiate landslides or rockfalls. This statement is consistent with the statement in the opening paragraph of this DEIS section noting that strong ground shaking associated with an earthquake may induce landslide failures at great distances from the earthquake source.[93]

DOGAMI isolates one sentence in the DEIS's landslide discussion—noting that six landslides were identified as posing a moderate to high potential risk and were evaluated further in the field—and claims that this number of landslides is very low compared to what has been recently mapped in areas just north of the pipeline route using LiDAR based mapping.[94] DOGAMI then recommends that the landslide analysis be based on LiDAR data.[95] DOGAMI takes the statement out of context and fails to acknowledge the full breadth of the landslide hazard assessment described in Section 4.5 of Resource Report 6. GeoEngineers identified hundreds of deep-seated landslides and shallow rapid landslide hazards along the PCGP alignment using LiDAR data as well as other published sources, including data from DOGAMI. This is clearly presented in the DEIS, which states that Appendix B, Table B-2 from GeoEngineers (2017a) identified where PCGP's initial proposed route was changed to avoid identified landslides and landslide hazard areas.[96] Table B-2 lists 128 deep-seated landslides identified along the PCGP study corridor. After an iterative routing process to avoid the vast majority of the identified landslides, six landslides were identified as potentially posing a moderate to high risk to the proposed pipeline and were evaluated further in the field. DOGAMI's implication that mapped landslides are ignored in the analysis, and that LiDAR data was not appropriately used, is baseless.

In more than one instance, DOGAMI questions the DEIS's use of qualifiers, such as "generally" and "infrequently," and requests citations to support the statements. In one instance, DOGAMI focuses on an assertion that the mass-movement of rapid-shallow landslides is typically triggered by large, infrequent storm events.[97] DOGAMI notes that "infrequent" is a relative term and asks that it be defined, and the conclusion referenced. DOGAMI similarly attacks the DEIS statement that ridgetops are generally considered to be stable, noting that recent mapping in the coast range has found landslides propagating to and over the ridges.[98] Not all statements that are based on professional judgment and experience require substantiation with peer reviewed citations. In the first instance, because the concept of exceedance intervals is uncommon outside of risk assessment discussions, the word "infrequent" was selected to increase the narrative's accessibility to a lay audience. Quite simply, light rain occurs more frequently than potentially damaging heavy rain. In the second instance, the word "generally" was selected to express the sentiment that this statement is not a rule, and as is the case with all general statements, exceptions may occur.

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[92] Oregon State Agencies Comments at p. 184.
[93] DEIS at p. 4-21.
[94] Oregon State Agencies Comments at pp. 184 and 185.
[95] Oregon State Agencies Comments at pp. 184 and 185.
[96] DEIS at p. 4-22.
[97] Oregon State Agencies Comments at p. 182.
[98] Oregon State Agencies Comments at pp. 185 and 186.

DOGAMI questions the DEIS statements that all of the moderate- and high-hazard deep-seated landslides identified along the alignment, and all known hazardous landslides thought to pose a risk to the pipeline, were avoided.[99] DOGAMI asserts that if LiDAR and site-specific landslide hazard mapping was not performed to locate these areas, there are likely many areas missed, and therefore not "all" are identified or avoided.[100] DOGAMI cites an example in the LiDAR image of the route from MP 89 to 90, where the PCGP mapping in Appendix F identified one landslide on the northeast side of the route ridge. DOGAMI asserts that a qualified professional could see on the LiDAR image that landslides are located along both sides of the ridge and on the slope down to the valley towards the northwest.[101]

In rebuttal to this DOGAMI comment, first, Section 4.1.2.4 of the DEIS clearly states that LiDAR was utilized to map and evaluate landslide hazards along the PCGP alignment,[102] and DOGAMI's repeated implications that it was not are baseless. Furthermore, site-specific mapping and site-specific ground-based reconnaissance were also completed. Second, it is unclear what features in the clipped LiDAR image DOGAMI is referring to as landslides. Interpretation of LiDAR imagery requires professional judgment and experience, and landslides mapped using LiDAR interpretation should be ground-truthed. The landslides here were mapped following a comprehensive assessment based on aerial photograph review, LiDAR interpretation, aerial reconnaissance, and ground-based reconnaissance. DOGAMI's comment reflects a preference for relying on interpretation of landslide presence based solely on remote sensing LiDAR imagery, presented as fact, without any additional confirmation in the field. A qualified professional would qualify such interpretations and conclusions with appropriate limitations.

DOGAMI commented on the DEIS statement regarding PCGP's proposed use of Best Management Practices ("BMPs") like well-drained structural fill to limit potential adverse impacts on slope stability for those side slopes segments that are less than 30 percent gradient.[103] DOGAMI claims that focusing on slope gradient alone is insufficient since many deep landslides are on slopes with very low gradients. DOGAMI instead suggests that existing landslides and hazards be located and addressed individually, regardless of slope gradient. DOGAMI misunderstands the discussion regarding the use of slope gradients.[104] The use of slope gradients is not to identify where landslides occur but is used to guide the implementation of BMPs like structural fill to restore the construction corridor to original site grades. Section 4.6 of Resource Report 6 provides a list of the proposed methods for Landslide Hazard Avoidance and minimization of adverse effects. The DEIS appropriately incorporated the landslide hazard avoidance and minimization measures in Section 4.1.2.4 of the DEIS.[105] Additional details regarding specific construction methods across existing low-risk landslides will be provided in the final design package.

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[99] Oregon State Agencies Comments at pp. 185 and 186.
[100] Oregon State Agencies Comments at pp. 185 and 186.
[101] Oregon State Agencies Comments at p. 185.
[102] DEIS at pp. 4-19, 4-20, and 4-22.
[103] Oregon State Agencies Comments at p. 186.
[104] DEIS at p. 4-22.
[105] DEIS at pp. 4-21 through 4-23.

II. *Conditional Coastal Zone Management Act Consistency Determination*

Oregon Department of Land Conservation and Development (ODLCD) submitted a comment concerning FERC's longstanding practice of issuing project certificates conditioned on subsequently obtaining CZMA consistency determinations from the relevant states. ODLCD asserts that FERC must know the outcome of the state's consistency review before issuing a certificate order. This is not correct. The D.C. Circuit has held that the CZMA does not prohibit FERC from issuing a certificate conditioned on the applicant receiving a state concurrence before construction may begin:

> "[P]etitioners contend that FERC violated the Coastal Zone Management Act, which provides that a federal permit 'to conduct an activity . . . affecting . . . the coastal zone' shall not be granted 'until the state . . . has concurred with the applicant's certification.' 16 U.S.C. § 1456(c)(3)(A). But FERC's certificate order allows Algonquin to begin construction only after obtaining approval from Massachusetts. Accordingly, it does not authorize the "activity" to which petitioners objected before FERC until after the state 'has concurred.'"[106]

Here, the DEIS recommends a condition that Applicants not begin construction until each files with the Secretary a copy of ODLCD's determination of consistency with the CZMA. Notwithstanding the DEIS's use of the word "should" install of "shall" in the recommended condition, Applicants anticipate that this condition would be binding and prohibit commencement of construction until the CZMA consistency determinations are issued, consistent with FERC's longstanding practice. In sum, because the FERC's approval would be conditioned on the Applicants first obtaining the requisite consistency determinations, the issuance of such a conditional order is consistent with the requirements of the CZMA.

III. *Aquatic and Upland Habitat*

A. **Shade Tree Removal Effects**

Commenters raised concerns that removal of shade trees will have a negative impact on fish, and stated that the DEIS does not address how this impact will be mitigated.[107] They also raised concerns that removal of trees will increase stream temperatures and negatively affect salmon species.[108] Shade tree removal and effects on stream temperatures and fish are addressed in Section 4.3.2.2 of the DEIS.[109] The DEIS analyzes the impacts of the Project on stream temperatures and finds construction and operation of the Pipeline would have no discernable effect on stream temperature.[110] The DEIS also discusses multiple strategies that PCGP would

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[106] *Town of Weymouth, Mass. v. FERC*, 2018 WL 6921213 at *2 (D.C. Cir. Dec. 27. 2018).
[107] Comment of Timothy Cate at p. 1, Accession No. 20190405-5101 (Apr. 5, 2019).
[108] Comments of Western Environmental Law Center, et al. at p. 137, Accession No. 20190703-5020 (July 3, 2019) ("WELC Comments").
[109] DEIS at pp. 4-114 to 4-116; *see also* Biological Assessment for JCEP and PCGP at Section 3.5.3.3, Accession No. 20190730-3071 (July 30, 2019) ("Biological Assessment").
[110] DEIS at pp. 4-114 through 4-115.

implement to minimize potential impacts, such as reducing the construction right-of-way at waterbody crossings where feasible, locating temporary extra workspace areas 50 feet back from waterbody crossings where feasible, replanting streambanks after construction in accordance with the ECRP, implementing the Large Woody Debris Plan.[111] Additionally, PCGP will use the results of its thermal impact analysis[112] to develop and implement a thermal mitigation plan, replanting riparian areas equal to 1:1 ratio to temporary riparian shading vegetation losses and 2:1 ratio for permanent riparian losses from the 30-foot operational easement clearing. Based on employing the above noted measures, the DEIS appropriately discusses the potential impacts of removing shade trees and provides ample support for its conclusion that impacts from construction and operation of the Pipeline would not result in discernible effects on stream temperature.[113]

B. **Loss of Forested Habitat**

Commenters expressed concerns regarding impacts on forests, specifically "old-growth" and late successional reserve forests/trees.[114] The concerns raised by commenters are already considered in Section 4.4 of the DEIS.[115] Additionally, the DEIS discusses Applicant's Comprehensive Mitigation Plan (CMP),[116] in which Applicants have developed a suite of onsite and offsite strategies to offset removal of forest habitat. These will cover impacts at the LNG Terminal and along the Pipeline. As mentioned in the DEIS, measures include those found in the ECRP,[117] the Leave Tree Protection Plan,[118] the Integrated Pest Management Plan,[119] the Fire Prevention and Suppression Plan,[120] and the SPCC Plan.[121] Approximately 1,400 acres (the area outside of the 30-feet wide permanent easement in forestland) of the construction corridor will be re-planted to trees following construction. PCGP will be committing to voluntarily fund U.S. Forest Service Projects (Appendix F2 of the DEIS) and Bureau of Land Management projects that are designed to enhance wildlife habitat such as fuel reduction projects to minimize risks from wildfires, snag creation, and re-allocation of matrix lands (subject to timber harvest) to protection as late-successional reserves. Based on employing the above noted measures, the DEIS sufficiently considers impacts on forests and contains ample support for its conclusion that constructing and operating the Pipeline would not significantly affect vegetation.[122]

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[111] DEIS at p. 4-294. *See also* Plan of Development of PCGP at Appendix I, Accession No. 20180123-5100 (Jan. 23, 2018) ("Plan of Development"); Biological Assessment at Appendix O, Accession No. 20180917-5000 (Sept. 17, 2018).
[112] Appendix Q.2 of PCGP Resource Report 2, Accession No. 20170921-4011 (Sept. 21, 2017).
[113] DEIS at p. 4-116.
[114] Comment of Francis Eatherington at pp. 1 to 2, Accession No. 20190705-5077 (Jul. 4, 2019) ("Eatherington Comments"); Comments of League of Women Voters at p. 66, Accession No. 20190705-5052 (Jul. 4, 2019) ("League of Women Voters Comments"); Comment of Ann Turner at pp. 4 to 5, Accession No. 20190627-5025 (Jun. 26, 2019).
[115] *See* DEIS at pp. 4-165 to 4-167.
[116] *See* DEIS at p. 4-186.
[117] DEIS at 4-208. *See also* Appendix I to the Plan of Development.
[118] DEIS at 4-208. *See also* Appendix P to the Plan of Development.
[119] DEIS at 4-208. *See also* Appendix N to the Plan of Development.
[120] DEIS at 4-208. *See also* Appendix K to the Plan of Development.
[121] DEIS at 4-208. *See also* Appendix X to the Plan of Development.
[122] DEIS at p. 4-178.

Comments also expressed concerns regarding impacts on habitat to certain protected or endangered species, such as the marbled murrelet.[123] The DEIS discusses impacts to protected species in Section 4.6.[124] The DEIS also notes that additional habitat mitigation would be completed as part of the project.[125] The DEIS also includes a recommended condition to any FERC order that JCEP and PCGP not begin construction until they receive written notification from the Director of the OEP that construction or implementation of conservation measures may begin.[126] Furthermore, Applicants recently entered into an option agreement with a private timber company to acquire and preserve commercial forestland that would otherwise be subject to harvest under rules of the Oregon Forest Practices Act. Applicants will also be committing to funding programs related to barred owl and marbled murrelet management, programs recommended by the U.S. Fish and Wildlife Service that would aid the recovery of these two species. In sum, PCGP will be committing to habitat mitigation on over 12,000 acres (management and acquisitions), over double the total acreage of habitat removal (all types) over the length of the Pipeline (about 4,500 acres) and more than 5 times the forested acreage along the Pipeline (approximately 2,100 acres) that would be removed.

C. **Impacts to Upland Habitat on the North Spit**

ODFW comments that the Project will likely cause deleterious ecological and have legacy implications for upland habitats on the North Spit.[127] The Comprehensive Mitigation Plan discussed in the DEIS contemplates a Wildlife Habitat Mitigation Plan for the project.[128] JCEP will work with ODFW on appropriate mitigation for the North Spit to be included in the final plan.

IV. ***Wildlife and Aquatic Resources***

A. **Impacts on Fish and Shellfish**

1. Loss of salmon and oyster habitat

Many commenters expressed concern that salmon and oyster habitat in Coos Bay would be degraded as a result of the Project.[129] Potential impacts to salmon and oyster habitat, as well as corresponding mitigation measures, are addressed in Sections 4.5.2.2, 4.5.2.3, and 4.5.2.4 of the DEIS. The DEIS discusses loss of oyster habitat associated with construction of the LNG Terminal and channel improvements, as well as development of the Kentuck project, which is anticipated to replace this habitat since existing oyster and shrimp habitat is present near Kentuck Slough.[130] The DEIS also discusses the impacts of dredging the access channel on the quality of habitat available

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[123] Eatherington Comments at p. 1.
[124] *See, e.g.*, DEIS at pp. 4-310 to 4-358, 4-359 to 4-368.
[125] *See, e.g.*, DEIS at pp. 2-1, 4-186.
[126] DEIS at 4-359.
[127] Oregon State Agencies Comments at p. 68.
[128] DEIS at p. 4-186.
[129] Comment of Karen Saxton at p. 1, Accession No. 20190408-5117 (Apr. 8, 2019); Comment of James Neu at p. 5, Accession No. 20190627-0203 (Jun. 26, 2019).
[130] DEIS at pp. 2-17, 4-245.

for juvenile salmonids, and mitigation for loss of intertidal and subtidal habitat from dredging.[131] Additionally, 2.7 acres of floodplain habitat would be re-established adjacent to Kentuck Creek and would include stream enhancements including re-alignment of Kentuck Creek through the site. This area is close to the main Coos Bay river channel, which would benefit early marine-rearing juvenile salmonids. The DEIS also discusses the Applicants' Compensatory Wetland Mitigation Plan,[132] is currently under review by the resource agencies, and the Applicants will continue to consult with the ODSL, ODFW, USACE and NMFS in the development of a final Compensatory Wetland Mitigation Plan. Additional BMPs are described in Sections 4.5.2.2 through 4.5.2.4 of the DEIS. Therefore, the DEIS adequately considers impacts to fish and oyster habitat.

a. Effects on fish and shellfish in Coos Bay from dredging

Commenters allege that the DEIS does not sufficiently consider the negative effects of dredging on fish and shellfish from the Project.[133] Effects on fish and shellfish in Coos Bay from dredging is addressed in Section 4.3.2.2 of the DEIS.[134] Overall, the adverse impacts from these activities, to the extent they may occur, are not expected to be substantial and will generally be short-term in duration.[135]

A commenter expressed concern regarding impacts on Dungeness crab (*Metacarcinus magister*) and its habitat in Coos Bay, including impacts from turbidity during construction and maintenance dredging.[136] Effects on aquatic habitat from construction and operation of the LNG Terminal are addressed in Section 4.5.2.2 of the DEIS.[137] The DEIS discusses the Dungeness crabs' extensive use of eelgrass beds,[138] which are not affected by NRI construction. Effects on aquatic habitat, including Dungeness crab, would be minimized by the current in-water work windows (October 1 to February 15) and by maintaining the cutterhead near the bottom if a hydraulic dredge is used.[139] As with all dredging, there would be an initial loss of benthic resources from the dredging of the floor of the bay that would recover over time. Overall habitat structure of the bay would remain essentially unchanged following channel modifications in these areas. Through appropriate BMPs and mitigation, the impacts from turbidity at the NRIs and therefore

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[131] DEIS at pp. 4-243 to 4-245.
[132] DEIS at p. 4-130; *see also* Supplemental Information of Jordan Cove Energy Project L.P. and Pacific Connector Gas Pipeline, LP, Accession No. 20190129-5158 (Jan. 29, 2019).
[133] Oregon State Agencies Comments at pp. 69-70; Eatherington Comments at pp. 13-14; Comment of Stephanie Walker-Masson at p. 1, Accession No. 20190703-0068 (July 3, 2019).
[134] DEIS at pp. 4-243 to 4-249; *see also* Biological Assessment at Section 3.5.1.3.
[135] DEIS at pp. 4-243, 4-234.
[136] Comment of Patricia Kullberg at p. 7, Accession No. 20190702-5015 (July 1, 2019).
[137] *See* DEIS at pp. 4-232, 4-241.
[138] DEIS at p. 4-241.
[139] DEIS at p. 4-247.

to crabs and shellfish will be limited, and the benthic community is expected to recover within a short period after dredging events.[140] The DEIS considers these impacts.

Commenters also expressed concern regarding impacts on Olympia oyster (*Ostrea lurida*) and claimed that the DEIS did not include an Olympia oyster mitigation plan.[141] Effects on shellfish and Olympia oyster from construction of the Pipeline are addressed in Section 4.5.2.3 of the DEIS. In addition to discussing a survey for the Olympia oysters,[142] the DEIS discusses the impact of construction on the oysters as well as other benthic species.[143] Moreover, the DEIS discusses that typical habitat for the Olympia oyster is not common in the bay due to the composition of the bottom areas of the bay.[144] Thus, a specific mitigation plan is not called for. Nevertheless, the DEIS discusses the impact of Project activities as well contingency plans to address potential impacts.[145] Given the above, the DEIS appropriately considers impacts to the Olympia oyster.

b. Changes in channel flow and effects on oysters and oyster farms

Regarding dredging in the Coos Estuary for the Project, a commenter asserts that the DEIS fails to consider the impact of changes to channel flow from the Project, and the resulting impact to oysters, particularly due to harmful algal bacteria on the incoming tide and the sweeping out to sea of larval oysters on the outgoing tide.[146] Project-related effects on tidal flow, tidal range, current velocity, and circulation in Coos Bay are addressed in Section 4.3.2.1 of the DEIS.[147] The DEIS also references modeling completed to determine the extent of these effects, from which it concludes effects would be localized and negligible.[148] Based on results of a two-dimensional hydrodynamic simulation model developed to assess "Without Project" and "With Project" scenarios, it was concluded that the mean tidal range (MHHW – MLLW) remained unchanged by the Project. Tidal currents were determined to remain unchanged for most areas except for a small increase (<0.3 knots) near the Access Channel and <0.7 knot increase in the localized areas around pile dike CB-7.3 and at the eastern and western slopes of the Access Channel. The results of this modeling do not suggest that the Project would alter the existing reach of harmful algal bacteria, or the distribution patterns of larval stages of marine life. The DEIS appropriately addresses the potential impact of changes to channel flow and its impact to oysters.

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140 These BMPs are describes in Appendix B of the Dredge Pollution Control Plan for the NRIs. Supplemental Information of Jordan Cove Energy Project L.P. at Attachment B Dredging Pollution Control Plans, Accession No. 20190827-5086 (Aug. 27, 2019).
141 Eatherington Comments at pp. 13 and 14; Oregon State Agencies Comments at p. 68.
142 DEIS at pp. 4-265 to 4-266.
143 DEIS at pp. 4-268 to 4-269.
144 DEIS at p. 4-269.
145 DEIS at pp. 4-268 to 4-270.
146 Comment of James Fereday at pp. 8 and 9, Accession No. 20190624-5027 (June 23, 2019); Oregon State Agencies Comments at p. 69.
147 DEIS at p. 4-85.
148 *Id.*

c. Impacts on benthic community

Commenters allege that the DEIS does not properly consider Project impacts to the benthic community, and particularly the lack of a definition for benthic recovery.[149] Although no single definition is given for benthic recovery, the DEIS discusses potential impacts to the benthic community in several locations throughout the DEIS. The DEIS considers impacts to benthic community diversity and health,[150] the potential for permanent displacement of some benthic organisms,[151] as well as conditions under which benthic organism re-establishment could occur.[152] The DEIS further considers impacts to the benthic community from sources such as bottom erosion and turbidity,[153] disturbance of habitat,[154] burial,[155] increased suspended sediment,[156] and dredging.[157] Moreover, the DEIS cites several studies and reviews that evaluated effects of dredging on benthic communities in Coos Bay, Yaquina Bay, the lower Columbia River, and elsewhere are cited.[158]

Recovery of affected benthic communities would be cyclic given periodic maintenance dredging that would occur in the channel over decades. The DEIS discusses this maintenance dredging, including frequency, amount of material affected, and disposal of such material.[159] Moreover, the DEIS cites modeling conducted to evaluate the extent of impacts from this maintenance dredging, including impacts to benthic organisms.[160] Given the above, the DEIS appropriately considers impacts to the benthic community, despite providing no explicit definition of recovery.

2. Updated DEIS figure of spatial distribution of shellfish habitat

ODFW comments that the DEIS incorrectly illustrates the major known oyster and shrimp habitat and clamming and crabbing areas in the bay relative to the Project activities in figure 4.5-2, particularly in the mixed communities of bay clams in the area immediately west and north-west of the airport runway.[161] JCEP has updated the DEIS figure 4.5-2 (see below) to incorporate the ODFW 2014 clamming and crabbing areas and the addition of ODFW 1997 primary native oyster habitat in Coos Bay. The data does not identify any crab pots/rings in the four NRI areas. Crabbing areas are depicted in the NRI area 1 and 2 locations because there are crab pots/rings immediately adjacent to those NRI areas. The ODFW 2014 crabbing area within NRI 1 is 2.8 acres and the ODFW 2014 crabbing area within NRI 2 is 4.1 acres.

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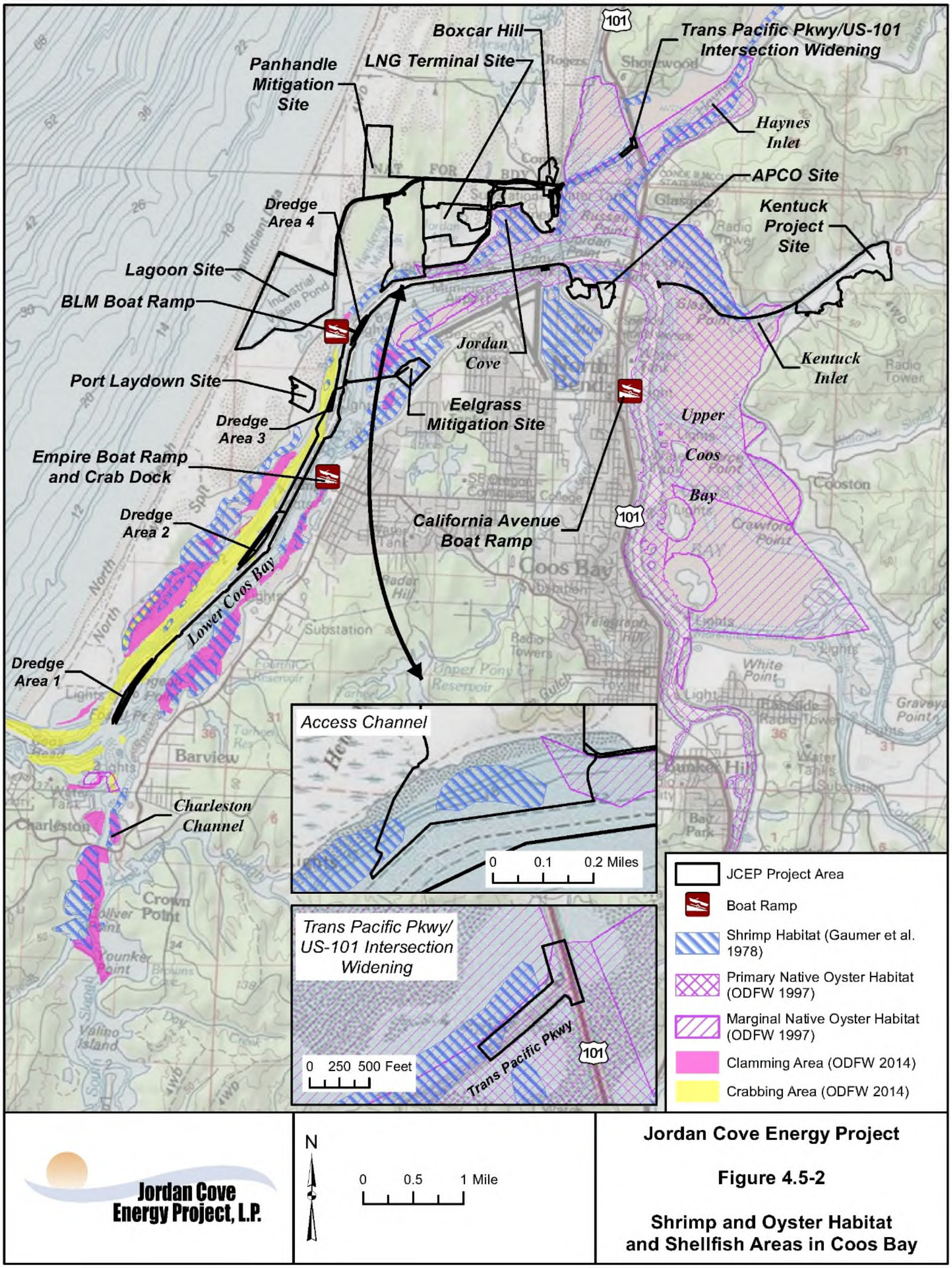
[149] Comment of James Fereday at pp. 7 and 8, Accession No. 20190624-5027 (June 23, 2019); Comment of Oregon Shores at pp. 2 and 3, Accession No. 20190705-5176 (July 5, 2019).
[150] DEIS at p. 4-234.
[151] DEIS at p. 4-235.
[152] DEIS at p. 4-129.
[153] DEIS at pp. 4-235, 4-244.
[154] DEIS at p. 4-244.
[155] DEIS at p. 4-244.
[156] DEIS at p. 4-245.
[157] DEIS at p. 4-247.
[158] DEIS at p. 4-248.
[159] DEIS at p. 4-262.
[160] DEIS at pp. 4-262 to 4-263.
[161] Oregon State Agencies Comments at pp. 69-70.



Jordan Cove Energy Project

Figure 4.5-2

Shrimp and Oyster Habitat and Shellfish Areas in Coos Bay

B. Cooling Water Discharge on Marine Life

Commenters raised concerns that discharge of ballast or cooling water will affect water temperatures in the bay and negatively affect salmon and other marine life.[162] Thermal impacts from LNG carrier ballast water discharge are addressed in Section 4.3.2.1 of the DEIS.[163] The DEIS also discusses modeling by Moffat and Nichols (2017)[164] regarding impacts to water temperature of the slip from the release of engine cooling water. The DEIS adequately evaluates discharge of ballast and cooling water.

C. Impacts on Marine Mammals

Certain commenters expressed concern that the Project could threaten protected marine mammals through ship strikes and shipping noise.[165] Potential Project-related effects on marine mammals, including (but not limited to) ship strikes and underwater noise are addressed in Sections 4.5.2.1 and 4.6.1.1 of the DEIS.[166] The DEIS also discusses mitigation measures for these impacts.[167] Finally, the DEIS references the required Section 7 consultations with FWS and NMFS, which will also consider measures to minimize the risk of adverse impacts, including vessel strikes, to marine mammals.[168] To further increase the awareness of local species and risk factors, the DEIS notes that JCEP would provide a "Ship Strike Avoidance Measures Package" to shippers calling on the LNG Terminal.[169] The DEIS appropriately considers impacts to threatened marine mammals.

D. Impacts on Waterbodies

ODFW comments that variations exist across documents (such as the DEIS, mitigation planning documents, the Applicants' resource reports, and the Applicant-Prepared Draft Biological Assessment), and that inconsistent numbers and differing definitions of "waterbody" make it difficult to assess impacts.[170]

The various documents cited contain minor differences in numbers related to waterbodies for several reasons. As the Applicants obtain landowner permission to conduct wetland and waterbody surveys, and as PCGP incorporates minor route deviations into the pipeline alignment, wetland acreage impacts and waterbody crossing numbers are refined. This accounts for the minor differences in numbers between the documents. The DEIS's analysis of impacts considers the appropriate scope of environmental impacts at these locations, including the implementation of

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[162] *See, e.g.*, Comment of Nancy Shinn at p. 1, Accession No. 20190514-5058 (May 14, 2019).
[163] DEIS at pp. 4-88 to 4-92; *see also* Biological Assessment at p. 3-343.
[164] DEIS at p. 4-85.
[165] Comment of Whale and Dolphin Conservation, Accession No. 20190703-5199 (July 3, 2019); Oregon State Agencies Comments at pp. 73-74; Comment of Emma Marris, Accession No. 20190621-5008 (June 21, 2019) ("Marris Comments").
[166] DEIS at pp. 4-233 to 4-234, 4-250 to 2-254, 4-319 to 4-320; *see also* Biological Assessment at Section 3.2.
[167] *See, e.g.*, DEIS at p. 4-319.
[168] DEIS at pp. 1-26 to 1-27, 4-309.
[169] DEIS at p. 4-319.
[170] Oregon State Agencies Comments at pp. 82-84.

various BMPs detailed in the environmental documents and applications to protect all wetlands and waterbodies. Moreover, the DEIS discusses the Applicants' statement that construction across waterbodies will occur within the ODFW-recommended in-water work windows (excepting waterbodies where trenchless crossing methods have been proposed).[171] The DEIS's analysis of these impacts is not rendered deficient as a result of minor, insignificant variations in the documents, many of which arise as a result of greater precision over time, particularly given the avoidance, minimization, and mitigation plans discussed in the DEIS.

E. **Wetland Mitigation**

ODFW contends that wetland impacts were underestimated for the Project because Applicants did not consider temporary impacts in its calculations.[172] However, the DEIS appropriately addresses wetland impacts and mitigation. The DEIS discusses both temporary and permanent impacts to wetlands; impacts considered include conversion of wetlands, introduction of non-native species, changes in hydrogeological conditions, vegetation loss, and reduction in hydroregulatory abilities.[173] The DEIS analyzes impacts based not only on wetland type but also on the timeframe of impacts.[174] Additionally, the DEIS references Applicant's Compensatory Wetland Mitigation Plan (CWMP), which addresses both temporary and permanent impacts.[175]

The DEIS acknowledges that USACE and ODSL may require additional mitigation (beyond what is required in the DEIS), and that the adequacy of wetland mitigation for federally jurisdictional wetlands, including the scope and location of mitigation, would ultimately be determined by the USACE.[176] Further, the DEIS executive summary notes that the conclusions in the DEIS are based on several factors, including that the Applicants' CWMP would satisfy the USACE's regulatory requirements to mitigate unavoidable impacts on wetlands and waters of the United States.[177] The DEIS acknowledges that the CWMP is still being reviewed by USACE, ODSL, and other applicable federal and state agencies and that approval of the plan would be prerequisite to issuance of federal and state wetland permits.[178] The DEIS appropriately considers wetland impacts and mitigation.

F. **Eelgrass Mitigation**

ODFW comments that eelgrass avoidance alternatives are not fully investigated and that the eelgrass mitigation plan is incomplete.[179] The DEIS references Applicants' CWMP in discussing eelgrass mitigation.[180] The CWMP discusses details regarding mitigation measures of success and contingencies; however, ODSL and other resource agencies will ultimately determine

[171] DEIS at p. 2-65, 4-273.
[172] Oregon State Agencies Comments at p. 82.
[173] DEIS at pp. 4-127 to 4-134.
[174] *See, e.g.*, DEIS at p. 4-132.
[175] DEIS at pp. 4-130, 4-134.
[176] DEIS at p. 4-134.
[177] DEIS at p. ES-5.
[178] DEIS at p. 4-130.
[179] Oregon State Agencies Comments at pp. 71-72.
[180] *See, e.g.*, DEIS at p. 4-130.

the adequacy of the mitigation plan, the contents of which may change depending on agency consultations. The DEIS acknowledges that the CWMP is still being reviewed by USACE, ODSL, and other applicable federal and state agencies and that approval of the plan would be prerequisite to issuance of federal and state wetland permits.[181] The Applicants will continue to consult with the COE, NMFS, ODSL, and ODFW and other appropriate resource agencies to develop a final wetland mitigation plan. Given the above, the DEIS adequately considers impacts to eelgrass.

V. *Threatened, Endangered, and Other Special Status Species.*

A. **Compliance with Section 7 and Section 10 of the Endangered Species Act**

ODFW claims that the DEIS fails to explain how consultation for impacts from the Project on non-federal lands will occur under Section 10 of the Endangered Species Act ("ESA").[182] ODFW erroneously asserts that consultation under Section 7 of the ESA would be for the federal action and for federal lands only, leaving impacts on non-federal lands for a separate consultation under Section 10.[183] ODFW's comments represent a misunderstanding of the scope of consultation under Section 7 of the ESA for the Project.

Section 7 consultation provides the mechanism by which federal agencies ensure the actions they authorize, fund, or undertake do not jeopardize the existence of any listed species or result in the destruction or adverse modification of designated critical habitat. Section 7(a)(2) of the ESA requires federal agencies to consult with the U.S. Fish and Wildlife Service ("FWS") and the National Marine Fisheries Service ("NMFS"), as appropriate, before taking any action (e.g., permitting) that may affect federally-listed endangered or threatened species or designated critical habitat.[184] Here, the entirety of the LNG Terminal and Pipeline is subject to FERC jurisdiction and authorization, regardless of whether it is located on federal or non-federal lands. As a result, the entire Project is subject to Section 7 consultation. As described in the DEIS, the federal agencies are consulting with FWS and NMFS regarding any federally listed species or critical habitat that may be affected by the Project. There is no qualifier that this Section 7 consultation only reaches federal lands. Indeed, any biological opinion issued for the Project would include an Incidental Take Statement, which would apply to the take of any listed species, regardless of where that take occurred.

Despite ODFW's claim, no Section 10 consultation is required here. Section 10 of the ESA authorizes the FWS and NMFS to issue permits authorizing the take of listed species incidental to otherwise lawful *non-federal* activities upon submission of a habitat conservation plan.[185] The Applicants do not need a Section 10 incidental take permit, and Section 10 of the ESA does not impose any "consultation" obligation on the part of the Applicants or the federal agencies. The ongoing Section 7 consultation with FWS and NMFS will encompass all potential effects to federally-protected species as a result of the Project.

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[181] DEIS at p. 4-130.
[182] Oregon State Agencies Comments at p. 75.
[183] Oregon State Agencies Comments at p. 75.
[184] 16 U.S.C. § 1536(a)(2).
[185] 16 U.S.C. § 1539(a)(1)(A)-(B).

B. **Impacts on Endangered Species**

1. Shortnose sucker (*Chasmistes brevirostris*)

A commenter raised concern that potential mortality to shortnose sucker from electrofishing may occur, and that Project-related erosion would impact the shortnose sucker, such as effects of fertilizer used during revegetation.[186] Impacts from electrofishing are addressed in Section 4.6.1.3 of the DEIS, as are other impacts, such as entrainment and entrapment, acoustic shock and underwater noise, streambank erosion, and herbicide application.[187] The DEIS also references PCGP's Fish Salvage Plan,[188] which details methods to minimize negative impacts from salvage operations.[189] The impacts of fertilizer runoff are discussed in Section 4.3.2.2 of the DEIS.[190] Although the discussion in the DEIS does not directly discuss the shortnose sucker, the application plans discussed in the DEIS address this through the broader minimization of fertilizer runoff.[191]

2. Coho salmon (*Oncorhynchus kisutch*)

Many commenters expressed concern that the Project would harm important habitat, including for species protected under the Endangered Species Act such as Oregon Coast Coho Salmon.[192] Potential Project-related effects on protected species' habitat, including Coho salmon (Oregon Coast Evolutionary Significant Unit [ESU]) are summarized in Section 4.6.1.3 of the DEIS.[193] For example, the DEIS discusses impacts to Coho Salmon and its habitat from pile driving, dredging, increased turbidity, impacts on the benthic community and food sources, entrainment and impingement from engine cooling water operations, blasting, reduced recruitment of large woody debris, and other riparian habitat alterations.[194]

3. Marbled murrelet (*Brachyramphus marmoratus*) and northern spotted owl (*Strix occidentalis caurina*)

Commenters expressed concern regarding clearing of old-growth forest and impacts on spotted owl (NSO) and marbled murrelet (MAMU), their habitat, and the sufficiency of mitigation.[195] Impacts on these species from construction of the Project are addressed in Sections

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[186] Marris Comments at p. 7.
[187] DEIS at p. 4-341; *see also* Biological Assessment at Section 3.5.6.3.
[188] *Id.*
[189] *See, e.g.*, DEIS at p. 4-340.
[190] DEIS at p. 4-117.
[191] *See id.*
[192] Center for Biological Diversity Comments, Accession No. 20190703-5157 (July 3, 2019).
[193] *See, e.g.*, DEIS at pp. 4-332 to 4-335. The biological assessment has since been issued, and this species is further discussed there in Section 3.5.4.5.
[194] DEIS at pp. 4-334 to 4-335.
[195] *See, e.g.*, Comment of Ronald Crete at p. 3, Accession No. 20190701-5065 (June 28, 2019); Comment of Kristine Cooper Cates at p. 2, Accession No. 20190606-5009 (June 5, 2019).

4.5 and 4.6 of the DEIS.[196] The DEIS discusses impacts to MAMU and NSO habitat, noise impacts, impacts to prey species, and behavioral impacts.[197] Additionally, the DEIS recommends that the Project comply with FWS-recommended timing restrictions concerning MAMU stands and NSO activity centers.[198] The DEIS further recommends that construction not start until consultations with the FWS and NMFS are complete,[199] and notes that these consultations may require further avoidance, reduction, or mitigation measures.[200] Therefore, the DEIS properly discusses impacts to MAMU and NSO, their habitat, and the sufficiency of mitigation.

In addition to the impact minimization measures identified in the DEIS, PCGP is proposing mitigation for permanent impacts to Late Successional Old Growth (LSOG) forest and MAMU habitat.[201] In sum, PCGP is committed to providing habitat mitigation equivalent to approximately 11,500 acres. Of this, approximately 9,000 acres would be management actions on federal lands to accelerate the development of old-growth forests, conversion of matrix land to late-successional reserves, fuel reduction and fire breaks to reduce the threat of habitat loss from wildfires, and snag creation. As stated above in Section III.B, Applicants have made recent commitments for additional forestland preservation and program funding. Based on the additional commitments, over the life of the Project, there would be a net-benefit to obligate LSOG species because the mitigation package would create and preserve far more LSOG habitat than would be removed.[202]

4. Protected Plant Species

Commenters expressed concern regarding Project-related impacts on threatened and endangered plant species, including the sufficiency of mitigation measures.[203] These concerns are addressed in Section 4.6.1.6 of the DEIS.[204] The DEIS discusses impacts to habitat, potential changes in hydrology and soil characteristics, changes to species composition, impacts from invasive species, and fugitive dust.[205] Moreover, the DEIS references PCGP's Federally-listed Plant Conservation Plan, which details avoidance, minimization, and mitigation measures to protect listed plant species.[206] PCGP contracted with local biologist/botanists with expertise in identifying federal and state listed threatened, endangered plants, sensitive flora species, and noxious weeds to conduct surveys for the Pipeline. Given the above, the DEIS appropriately

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[196] DEIS at pp. 4-197 to 4-200, 4-217 to 4-221, 4-323 to 4-330; *see also* Biological Assessment Sections 3.3.3 and 3.3.4.
[197] DEIS at pp. 4-323 to 4-330.
[198] DEIS at pp. 4-326, 5-5.
[199] DEIS at pp. 5-6.
[200] DEIS at pp. 1-25 to 1-26.
[201] Comments on Draft Environmental Impact Statement of Jordan Cove Energy Project L.P. and Pacific Connector Gas Pipeline, LP, Accession No. 20190705-5092 (July 5, 2019).
[202] DEIS at pp. 2-34 and 2-35 (Table 2.1.5-1 summarizing mitigation projects on National Forest Service Lands); DEIS at Appendix F.2.
[203] Comment of SL McLaughlin at p. 2, Accession No. 20190703-5206 (July 3, 2019) ("McLaughlin Comments"); Comment of Kristine Cooper Cates at p. 2, Accession No. 20190606-5009 (June 6, 2019).
[204] DEIS at pp. 4-347 to 4-359. *See also* Biological Assessment at Section 3.7.
[205] DEIS at pp. 4-350 to 4-359.
[206] *See, e.g.*, p. DEIS at 4-348.

considers impacts on threatened and endangered plant species, including the sufficiency of mitigation measures.

5. Killer whales (*Orcinus orca*)

Commenters expressed concern regarding the assessment of Project-related effects on killer whale (Eastern Northern Pacific Southern Resident Stock).[207] Project-related effects on killer whale are included in Section 4.6 of the DEIS.[208] The DEIS discusses impacts to the whales from ship strikes, increased carrier traffic, noise, and impacts to critical habitat.[209] Additionally, the DEIS discusses references the 2016 NMFS *Technical Guidance for Assessing the Effect of Anthropogenic Sound on Marine Mammals*,[210] and discusses the impacts of anthropogenic sound not only on marine mammals but also on fish.[211] Moreover, the DEIS recommends that JCEP file a Marine Mammal Monitoring Plan prior to construction.[212] Additionally, JCEP filed an Application for Incidental Harassment Authorization for the Taking of Marine Mammals (IHA) Under Section 101(a)(5)(A) of the Marine Mammal Protection Act, with the NMFS on April 23, 2019.[213] The IHA addresses Project activities expected to result in Take, the type of Incidental Take authorization requested, estimated Take, anticipated impacts, proposed mitigation measures, and proposed monitoring and reporting. JCEP's IHA is under review by NMFS and construction and operation of the Project would be subject NMFS' Incidental Take Authorization and conditions of the Incidental Take Authorization for the protection of marine mammals, including the killer whale.

6. Green sturgeon (*Acipenser medirostris*)

Certain commenters express concern regarding impacts to Green Sturgeon (Southern Distinct Population Segment).[214] Impacts to Green Sturgeon are discussed in Section 4.6 of the DEIS.[215] The DEIS discusses impacts from noise, spills, sedimentation, dredging, construction techniques, and impacts to habitat and concludes most effects would be short-term or localized in nature.[216]

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[207] Motion to Intervene and Comments of the Natural Resources Defense Council at pp. 94-99, Accession No. 20190705-5164 (July 5, 2019); WELC Comments at pp. 82-83, 87-90.
[208] DEIS at pp. 4-319 to 4-321. *See also* Biological Assessment at Section 3.2.3.
[209] DEIS at pp. 4-319 to 4-320.
[210] DEIS at pp. 4-251.
[211] DEIS at pp. 4-250 to 4-254.
[212] DEIS at pp. 4-320 to 4-321.
[213] Incidental Harassment Authorization Application of Jordan Cove Energy Project L.P., Accession No. 20190423-5121 (Apr. 23, 2019).
[214] League of Women Voters Comments at p. 59.
[215] DEIS at pp. 4-335 to 4-337. *See also* Biological Assessment at Section 3.5.1.
[216] DEIS at pp. 4-335 to 4-337.

7. Western snowy plover (*Charadrius alexandrinus nivosus*)

ODFW expresses concern regarding the Project's impacts to western snowy plover (Pacific Coast Population) nesting and foraging habitat.[217] Impacts to western snowy plover are discussed in Section 4.6.1.2 of the DEIS.[218] The DEIS discusses impacts to habitat from construction, noise, dredging, and increased human presence.[219] As noted in the DEIS, consultation with FWS is required,[220] and the Applicants are working with the agencies to mitigate potential impacts to western snowy plovers and critical habitat.

8. Pacific marten (*Martes caurina*)

ODFW expresses concern about Project impacts to Pacific marten and their habitat.[221] These concerns are addressed in Section 4.6.1.1 of the DEIS[222] The DEIS discusses impacts related to noise, vehicle traffic, impacts to habitat, and increased human presence.[223]

VI. *Reliability and Safety*

Many commenters assert that Project activities would present significant potential safety risks.[224] Concerns regarding public safety are discussed in Sections 4.13 of the DEIS.[225] As described extensively in the DEIS, Applicants will construct and operate their respective facilities in compliance with the requirements of the U.S. Department of Transportation (USDOT) and the Pipeline and Hazardous Materials Safety Administration (PHMSA).[226]

As noted in the DEIS, the Project would be subject to safety standards under both USDOT and the USCG,[227] which would govern the design, construction, and operation of the facilities.[228] The DEIS also references the USCG's May 2018 Letter of Recommendation, which recommended that the Coos Bay Channel is suitable for accommodating the type and frequency of LNG marine traffic associated with this project from a maritime and navigational safety standpoint.[229] Likewise, the DEIS indicates that USDOT monitors the construction and operation of natural gas facilities to determine compliance with USDOT standards.[230] The DEIS further explains that USDOT will issue a Letter of Determination (LOD) regarding whether the proposed LNG facility

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[217] Oregon State Agencies Comments at pp. 75-76.
[218] DEIS at pp. 4-321 to 4-323. *See also* Biological Assessment at Section 3.3.2.
[219] DEIS at pp. 4-322 to 4-323.
[220] DEIS at pp. 1-25 to 1-26, 4-309.
[221] Oregon State Agencies Comments at p. 76.
[222] DEIS at 4-314 to 4-318. *See also* Biological Assessment at Section 3.2.10.
[223] DEIS at 4-316 to 4-318.
[224] Comments of Shannon Mangan, Accession No. 20190513-0013 (May 13, 2019).
[225] DEIS at pp. 4-698 to 4-780.
[226] DEIS at pp. 2-19, 2-21, 2-45, 2-55, 2-56, 2-69, 2-71, 3-14, 4-66, 4-302 - 303, 4-611, 4-626, 4-660, 4-698 - 4-701, 4-720- 4-722, 4-724, 4-729, 4-733, 4-734, 4-736, 4-741, 4-745, 4-748 – 4-750, 4-752, 4-753, 4-769 – 4-776, 4-780, 4-781, 5-10, 5-11
[227] DEIS at pp. 4-703 to 4-706, 4-780.
[228] DEIS at pp. 4-780 to 4-781.
[229] DEIS at pp. 4-709 to 4-710, 4-780.
[230] DEIS at p. 1-15.

will be capable of complying with USDOT's siting regulations.[231] The Commission may rely on the conclusions of USDOT, the Coast Guard, and PHMSA in conducting its independent assessments.[232] Further, the Commission may rely on future coordination between the Applicants and other federal agencies in its NEPA assessment.[233] Moreover, the DEIS contains multiple recommendations to enhance the reliability and safety of, and minimize risk from, the Projects.[234] Given the above, the DEIS appropriately discusses safety risks. Specific safety concerns are addressed in more detail below.

A. **LNG Terminal**

1. Safety hazards

One commenter asserts that the DEIS did not disclose what would happen if risks occurred, beyond vague descriptions, and the DEIS did not describe any safety hazard; only that safety hazards are mitigated; and the commenter asserted that conclusions in the DEIS regarding the safety to the public from the LNG Terminal are vague, incorrect, and misleading.[235] Section 4.13.1 of the DEIS assesses safety hazards associated with the LNG Terminal. The DEIS discusses a range of hazards, including vessel hazards,[236] potential releases,[237] fires,[238] seismic events (including earthquakes and tsunamis),[239] meteorological events (including hurricanes and tornadoes),[240] landslides and other natural hazards,[241] and potential transportation impacts.[242] Additionally, the DEIS identifies and describes historical records of both LNG marine vessel transport and LNG facility operations.[243] The DEIS's analysis includes a discussion of regulatory oversight, USDOT siting requirements, security requirements, preliminary engineering review of the facility design, and recommended mitigation measures.[244] As such, the DEIS adequately identifies safety hazards associated with the LNG Terminal.[245]

2. Unconfined vapor clouds

Commenters raise questions regarding the adequacy of modeling used to measure vapor cloud dispersion at the LNG Terminal and assert that the risks of unconfined vapor cloud

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[231] DEIS at p. 1-15.
[232] *Sierra Club v. Clinton*, 746 F. Supp. 2d 1025, 1038 (D. Minn. 2010) (agency utilizing another agency's assessment of particular impacts as support for its independent NEPA assessment).
[233] *See* Response to Comments on DEIS of JCEP and PCGP at Section II(A)(5), Accession No. 20190722-5109 (July 22, 2019) ("Applicants Response to DEIS Comments").
[234] DEIS at pp. 4-755 to 4-768.
[235] WELC Comments at pp. 12, 13.
[236] DEIS at p. 4-707.
[237] DEIS at p. 4-719.
[238] DEIS at pp. 4-725, 4-727 to 4-728.
[239] DEIS at pp. 4-734 to 4-740.
[240] DEIS at pp. 4-740 to 4-744.
[241] DEIS at pp. 4-744 to 4-745.
[242] DEIS at pp. 4-745 to 4-752.
[243] DEIS pp. 4-702, 4-703, 4-712, 4-713.
[244] DEIS at pp. 4-698 to 4-755.
[245] DEIS at p. 4-781.

explosions are not adequately accounted for.[246] The DEIS addresses these vapor cloud issues and notes that potential incidents, such as vapor cloud explosions, are considered in determining compliance with USDOT requirements.[247] The DEIS's analysis recognizes that JCEP will have to demonstrate to USDOT that the LNG Terminal will meet the USDOT siting standards and the USDOT's LOD will serve as one of the considerations for the Commission to deliberate in its decision to authorize or deny any application.[248]

The DEIS discusses JCEP's facility siting hazard analysis,[249] and impacts from flammable vapors are included in that analysis. That analysis also includes overpressure analysis for the ignition of flammable refrigerant vapors from design spills, which JCEP completed using USDOT-approved modeling tools that are used consistently among LNG applicants to demonstrate siting compliance with 49 CFR Part 193 requirements.

As noted above, USDOT reviews LNG applications to determine whether a proposed LNG facility complies with the safety standards contained in 49 CFR Part 193, Subpart B.[250] JCEP has submitted the information required by USDOT for this review and anticipates receiving an LOD 30 days prior to FERC's issuance of the Final EIS confirming that the LNG Terminal meets the siting requirements of 49 CFR Part 193. As such, the DEIS appropriately concludes that the USDOT will assist FERC by determining whether the Jordan Cove LNG Project's proposed design would meet USDOT siting requirements,[251] and based on adherence to USDOT standards, the Project would not significantly affect public safety.[252]

3. Leaks and fires

Commenters expressed concerns regarding potential leaks of combustible gases from the Project and fires resulting from releases of LNG.[253] These concerns are addressed in Sections 4.13.1 and 4.13.2 of the DEIS. As discussed above, USDOT will assist FERC in determining if safety standards are met prior to issuance of any Certificate Authorization for the Project. These standards include provisions to minimize the risk from spills of any flammable mixture of vapors,[254] and Section 4.13.1.1 of the DEIS provides a discussion of the LNG safety regulations followed in the design of the Project and the regulatory review and approval framework.[255]

Additionally, Section 4.13.1.5 of the DEIS describes LNG Terminal design, monitoring systems, and emergency response measures to minimize the risk of such potentially hazardous

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[246] Comment of Jerry Havens at pp. 1-8, Accession No. 20190402-5029 (Apr. 1, 2019); WELC Comments at p. 22; League of Women Voters Comments at p. 17.
[247] DEIS p. 4-701.
[248] DEIS p. 4-702.
[249] *See* DEIS at 4-698.
[250] *Supra* Section V.
[251] DEIS p. 4-780.
[252] DEIS p. 4-781.
[253] Collected public comments of Oregon Wild, Accession No. 20190620-5088 (Jun. 20, 2019) ("Comments of Oregon Wild"); WELC Comments at pp. 17, 35, and 36.
[254] DEIS at p. 4-700 to 4-701.
[255] DEIS at pp. 4-698, 4-699.

scenarios at the LNG Terminal. The DEIS discusses spill containment, spacing and plant layout, ignition controls, hazard detection, emergency shutdown, depressurization systems, hazard controls, passive cryogenic and fire protection, and firewater systems incorporated into the LNG Terminal design.[256] The DEIS includes a review of JCEP's proposed hazard mitigation systems included in its Certificate Application and discusses how the measures would meet NFPA 72, ISA Standard 12.13, and other recommended and generally accepted good engineering practices.[257] Moreover, the DEIS recommends in Section 4.13.1.6 additional requirements that are anticipated to be conditions of any Certificate Authorization issued for the Project, subjecting Project design of hazard detection and monitoring systems to further study and final design review and approval by FERC.[258]

Additionally, the DEIS discusses the Project's Emergency Response Plans (ERPs).[259] The DEIS explains that the Energy Policy Act of 2005 requires an ERP be prepared in consultation with the USCG, as well as state and local agencies, and be approved by the FERC prior to any approval to begin construction of an LNG terminal.[260] Moreover, the ERP establishes the procedures for responding to specific emergencies that could occur at the LNG Terminal as well as procedures for emergencies that could affect the public.[261] Section 4.13.1.5 summarizes the required contents of the ERP and elements included in JCEP's draft ERP submitted with its Certificate Application to address emergency events and potential release scenarios. For PCGP, the DEIS discusses the requirements of the pipeline ERP and references the ERP previously submitted by PCGP.[262] The DEIS further discusses safety measures associated with PCGP in Section 4.13.2.1. This includes a review of pipeline burial depth, compliance with USDOT regulations, as well as PCGP's Fire Prevention and Suppression Plan.[263]

4. Emergency response

Commenters express concern about the Project's impact on emergency response capabilities, including concerns regarding response capacity and the adequacy of access to, and escape from, the LNG Terminal site and workforce housing area.[264] These concerns are adequately addressed in the DEIS. As noted above, the DEIS explains that prior to construction, JCEP must develop an ERP (including evacuation) and coordinate procedures with the USCG and other appropriate federal, state, county, and local agencies. The DEIS discusses that this plan will include at a minimum: a) designated contacts; b) scalable notification procedures; c) evacuation

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[256] DEIS at pp. 4-174 to 4-729.
[257] DEIS at p. 4-725.
[258] DEIS at pp. 4-756 to 758, 4-761, 4-762.
[259] DEIS at pp. 4-753 to 4-756.
[260] DEIS at p. 4-754.
[261] DEIS at pp. 4-753 to 4-754.
[262] DEIS at 4-775.
[263] DEIS at pp. 4-774 to 4-776.
[264] McLaughlin Comments at p. 4; WELC Comments at p. 53

routes/methods; d) locations of permanent sirens and other warning devices; and e) emergency coordinators.[265]

Additionally, the DEIS includes several recommendations to further account for the sufficiency of emergency response measures, including notifications for all planning meetings reports on progress on the development of the ERP at 3-month intervals.[266] The DEIS also explains that JCEP would also be required to develop a cost-sharing plan that discusses resources and reimbursements provided by JCEP to cover state and local safety and emergency management and that must include the LNG Terminal operator's letter of commitment with agency acknowledgement for each state and local agency designated to receive resources.[267]

ODOE raised concern that funding to the Coos County Sheriff's Office has been suspended, preventing its participating in emergency planning activities.[268] JCEP is re-engaging with the Sheriff's Office for the exclusive purposes of emergency planning. In addition, meetings with ODOE are being held to develop an engagement plan to meet with the other County planning groups and to address the issues raised by ODOE that include ERP and security plans for Project construction, operation, blasting, and for the temporary worker housing.[269]

Based on employing all of the above noted measures, the DEIS contains ample support for its conclusion that the Project would not significantly affect public safety.

5. Hazard zones

Commenters raise concerns regarding inadequate analysis of impacts in hazard zones, especially to schools and residential areas.[270] These impacts are appropriately addressed in the DEIS. The DEIS explains that the Project must comply with USDOT siting requirements;[271] as stated therein, USDOT will issue a LOD to the Commission after USDOT completes its analysis of whether the proposed facilities would meet the USDOT siting standards.[272] The DEIS describes the evaluation in the LOD, including hazard modeling results and endpoints used to establish exclusion zones, as well as JCEP's evaluation on potential incidents and safety measures incorporated in the design or operation of the facility specific to the site that have a bearing on the safety of plant personnel and surrounding public. The LOD will serve as one of the considerations for the Commission to deliberate in its decision to authorize or deny an application.[273]

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[265] DEIS at pp. 4-753 through 4-754.
[266] DEIS at 4-757.
[267] DEIS at p. 4-754.
[268] Oregon State Agencies Comments at p. 11.
[269] Oregon State Agencies Comments at p. 11-17.
[270] Comment of Wim de Vriend at pp. 5, 27 to 37, Accession No. 20190419-5008 (Apr. 18, 2019) ("de Vriend April Comments"); Comment of Janet Lea at p. 1, Accession No. 20190708-5011 (Jul. 5, 2019); Comment of Martha Neuringer at p. 1, Accession No. 20190708-5033 (Jul. 5, 2019).
[271] DEIS at 4-699 to 4-701.
[272] DEIS at 4-702.
[273] DEIS at p. 4-702.

The DEIS also discusses the siting standards of the USCG. In the DEIS, FERC Staff conduct a hazard analysis for zones of concern for potential impacts from LNG vessel traffic, including to schools and other areas.[274] Additionally, the DEIS references the Coast Guard's May 2018 LOR, which recommended that the Coos Bay Channel is suitable for accommodating the type and frequency of LNG marine traffic associated with this project from a maritime and navigational safety standpoint.[275] The DEIS further discusses that the May 2018 LOR was based on implementation of strategies and risk management measures identified by the USCG in its Waterway Suitability Assessment.[276] The Commission may rely on the conclusions of USDOT and USCG in conducting its independent assessments.[277] Further, the Commission can rely on future coordination between the Applicants and other federal agencies in its NEPA assessment.[278] Therefore, the DEIS appropriately considers impacts in hazard zones, including to school and residential areas.

6. Industry Standards.

Commenters allege that JCEP does not meet certain Society of International Gas Tanker and Terminal Operators (SIGTTO) standards relating to safe distances from populated areas, timely escape routes for LNG carriers in emergencies, avoiding moorage on the outside of a channel curve, and avoiding long inshore channels.[279] The SIGTTO Information Paper 14 (Information Paper) referenced by commenters was prepared and published more than 20 years ago, and it is not an industry or regulatory standard, as suggested by commenters; rather, it is an "information paper" with "views on risks, navigation and cargo operations." JCEP is a member of SIGTTO and adheres to its principles. The Information Paper concentrates on issues when a port is being designed where ports do not yet exist and are being developed.[280] The Port of Coos Bay is not within this category. However, JCEP, a member of SIGTTO, used the paper's concepts in addressing risk.

In the United States, regulatory and agency oversight of LNG facilities far exceeds the views in the Information Paper. Federal and state authorities have established regulatory requirements and standards for LNG facilities in the United States based on extensive studies, risk evaluation, and analysis. The DEIS's analysis of the Project's compliance with these standards has been discussed above; however, specific responses to issues raised by commenters are provided below:

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[274] DEIS at pp. 4-707 to 4-709.
[275] DEIS at pp. 4-709 to 4-710, 4-780.
[276] DEIS at pp. 4-705 to 4-709. *See also* DEIS at pp. 1-13 to 1-14.
[277] *Sierra Club v. Clinton*, 746 F. Supp. 2d at 1038 (agency utilizing another agency's assessment of particular impacts as support for its independent NEPA assessment).
[278] *Supra* n.233.
[279] de Vriend April Comments at pp. 4, 7 to 11; Comments of Jean and John Culp at pp. 1 to 2, Accession No. 20190429-5156 (Apr. 29, 2019); Comment of Kelley Argenta at pp. 1 to 2, Accession No. 20190620-5002 (Jun. 19, 2019).
[280] Site selection and design for LNG ports and jetties: With views on risk limitation during port navigation and cargo operations. 1997. Society of International Gas Tanker and Terminal Operators.

Safe distances from populated areas

In Section 4.13.1, the DEIS explains that the Project must comply with the siting requirements of both USDOT and USCG.[281] The DEIS further explains that USDOT will issue a LOD to the Commission after USDOT completes its analysis of whether the proposed facilities would meet the USDOT siting standards.[282] The DEIS describes the evaluation in the LOD, including hazard modeling results and endpoints used to establish exclusion zones, as well as JCEP's evaluation on potential incidents and safety measures incorporated in the design or operation of the facility specific to the site that have a bearing on the safety of plant personnel and surrounding public; the LOD will serve as one of the considerations for the Commission to deliberate in its decision to authorize or deny an application.[283] Additionally, the DEIS discusses a hazard analysis for zones of concern for potential impacts from LNG vessel traffic, including for populated areas.[284] Therefore, the DEIS adequately considers safety impacts to populated areas.

Timely escape routes for LNG carriers in emergencies including earthquakes

As noted above, the DEIS explains that prior to construction, JCEP must develop an ERP (including evacuation) and coordinate procedures with the USCG and other appropriate federal, state, county, and local agencies. The DEIS discusses that this plan must include evacuation routes/methods.[285] The DEIS adequately considers escape routes for LNG carriers.

Channel design, including avoiding long inshore channels and avoiding moorage on the outside of a channel curve

Section 4.13.1.3 of the DEIS explains that USCG has regulatory authority over navigational safety, LNG marine vessel engineering and safety standards, and marine transfer areas.[286] The DEIS references the Coast Guard's May 2018 LOR, which recommended that the Coos Bay Channel is suitable for accommodating the type and frequency of LNG marine traffic associated with this project from a maritime and navigational safety standpoint.[287] The DEIS also discusses that the May 2018 LOR was based on implementation of strategies and risk management measures identified by the USCG in its Waterway Suitability Assessment, which would help ensure the waterway is suitable for LNG carrier traffic.[288] Moreover, the DEIS discusses modifications to the channel in order to reduce risks from vessel passage.[289] Therefore, the DEIS properly considers impacts of channel design.

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[281] DEIS at pp. 4-699 to 4-710.
[282] DEIS at pp. 4-702.
[283] DEIS at p. 4-702.
[284] DEIS at pp. 4-707 to 4-709.
[285] DEIS at pp. 4-753 to 4-754, 4-756 to 4-757.
[286] DEIS at pp. 4-702 to 4-710.
[287] DEIS at pp. 4-709 to 4-710, 4-780.
[288] DEIS at pp. 4-705 to 4-710. *See also* DEIS at pp. 1-13 to 1-14.
[289] *See, e.g.*, DEIS at p. 2-10.

Based on FERC Staff's consideration of the USDOT's LOD and the USCG's LOR in the Commission's decision to authorize or deny an application, the DEIS contains ample support for its conclusion that the Project would not significantly affect public safety.

B. **LNG Vessels**

1. Navigation conflicts and safety

Commenters raised concerns regarding the effects of LNG vessels on navigation safety, and conflicts with other boats/vessels navigating the channel.[290] These concerns are addressed in Section 4.13.1 of the DEIS. The DEIS discusses JCEP's WSA, which analyzes the public safety and security implications of the Project from LNG marine traffic both in the waterway and when in port, as well as USCG's approval of JCEP's WSA.[291] Additionally, Section 4.13.1.3 of the DEIS explains that USCG has regulatory authority over navigational safety, LNG marine vessel engineering and safety standards, and marine transfer areas.[292] The DEIS references the USCG's May 2018 LOR, which recommended that the Coos Bay Channel is suitable for accommodating the type and frequency of LNG marine traffic associated with this project from a maritime and navigational safety standpoint.[293] In sum, the DEIS adequately considers potential impacts from LNG vessel traffic on navigational safety and use of Coos Bay.

2. Airport safety

Commenters express concern regarding the LNG Terminal's proximity to the Southwest Oregon Regional Airport in North Bend and assert that the LNG Terminal would threaten aviation safety.[294] These concerns are addressed in Section 4.13.1.5 of the DEIS.[295] The DEIS describes applicable FAA regulations, JCEP's notice to the FAA of the Project, structures associated with the LNG Terminal exceeding 200 feet, JCEP's commitment to continue to investigate measures to eliminate or mitigate presumed hazards, and potential mitigation measures.[296] Additionally, the DEIS includes a recommendation that JCEP should file documentation of receipt of no hazard determinations from the FAA prior to initial site preparation, without which the Project will not proceed as currently envisioned.[297] Given the above, the DEIS appropriately considers impacts to aviation safety.

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[290] Comments of Oregon Wild at pp. 8 to 9; Comment of Janet Hodder at p. 7, Accession No. 20190701-5371 (Jul. 1, 2019).
[291] DEIS at pp. 1-14, 4-705 to 4-707.
[292] DEIS at pp. 4-702 to 4-710.
[293] DEIS at pp. 4-709 to 4-710, 4-780.
[294] Comments of Marilyn Costamagna at pp. 3, 8, 9, Accession No. 20190617-0034 (Jun. 17, 2019); Comments of Cindy Oqier at p. 2, Accession No. 20190703-0055 (Jul. 3, 2019); Comments of Suzanne Church at p. 1, Accession No. 20190625-5041 (Jun. 25, 2019).
[295] DEIS at pp. 4-749 to 4-752.
[296] DEIS at pp. 4-749 to 4-752.
[297] DEIS at pp. 4-751, 4-755.

3. Security Zones and Exclusion Zones

A commenter expresses concern regarding the implementation of security zones for vessels in the channel and of exclusion zones applicable to the LNG Terminal under 49 CFR Subpart B.[298] These issues are already addressed in the DEIS. The DEIS discusses JCEP's WSA, which analyzes the public safety and security implications of the Project from LNG marine traffic both in the waterway and when in port, as well as USCG's approval of JCEP's WSA.[299] As identified in the WSA, a moving Safety/Security zone shall be established around the LNG vessel extending 500-yards around the vessel but ending at the shoreline; vessels are not excluded from entering the security zone but may not enter the Safety/Security zone without first obtaining permission from the USCG Captain of the Port (COTP).[300] Additionally, the WSA discusses how escort resources will be used to contact and control vessel movements such that the LNG carrier is protected.[301] Moreover, Section 4.13.1.3 of the DEIS explains that USCG has regulatory authority over navigational safety, LNG marine vessel engineering and safety standards, and marine transfer areas.[302] The DEIS references the USCG's May 2018 LOR, which recommended that the Coos Bay Channel is suitable for accommodating the type and frequency of LNG marine traffic associated with this Project from a maritime and navigational safety standpoint.[303]

To assist with vessel traffic management, JCEP would provide a Vessel Traffic Information System (VTIS) that will cover Coos Bay. The VTIS would be able to deconflict the waterway for all waterway users. Because the LNG carriers would be able to provide long-term forecasts of their entry and exit times, the VTIS would coordinate with all waterway users to avoid conflicts and emergency conditions. Inbound LNG carriers would have fewer entry limits than loaded LNG carriers and are more flexible as to entry conditions. The LNG carrier crossing of the sand bar during high tides is only in the case of the departing laden LNG carrier. Arriving vessels have no such tidal restrictions and hence are more flexible. The VTIS operator would be able to communicate directly with fishing vessels, the USCG, and deep-draft shipping to ensure a smooth and coordinated waterway. This system currently does not exist in Coos Bay. Similar systems are in other ports, and they operate effectively to coordinate and deconflict vessel traffic in a waterway. The Coos Bay Pilots, who have been piloting ships into Coos Bay for years, do not anticipate any impact to the current recreational and commercial fishing fleet in Coos Bay with the additional LNG vessel traffic.

The DEIS considers exclusion zones among the siting requirements discussed in Section 4.13.1.2. The DEIS explains that the Project must comply with the siting requirements of USDOT.[304] Additionally, the DEIS explains that USDOT will issue a LOD to the Commission after USDOT completes its analysis of whether the proposed facilities would meet these USDOT

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[298] WELC Comments at pp. 20 to 21.
[299] DEIS at pp. 1-14, 4-705 to 4-707.
[300] Letter of Recommendation for JCEP, Accession No. 20180601-3051 p. 22 (Jun. 1, 2018).
[301] *Id*.
[302] DEIS at pp. 4-702 to 4-710.
[303] DEIS at pp. 4-709 to 4-710, 4-780.
[304] DEIS at pp. 4-699 to 4-702.

siting standards.[305] The DEIS describes the evaluation in the LOD, including hazard modeling results and endpoints used to establish exclusion zones, as well as JCEP's evaluation on potential incidents and safety measures incorporated in the design or operation of the facility specific to the site that have a bearing on the safety of plant personnel and surrounding public; the LOD will serve as one of the considerations for the Commission to deliberate in its decision to authorize or deny an application.[306] Therefore, the DEIS adequately assesses security zones and exclusion zones.

In addition, on August 2, 2019, JCEP filed with FERC documentation of its continued efforts toward a landowner agreement to address the exclusion zone beyond the LNG Terminal western property line and over the Henderson Property.[307] JCEP is committed to ongoing negotiations with the landowner for legal control over the LNG Terminal exclusion zone, and will provide FERC with a copy of the final agreement.

4. Regulatory Oversight

One commenter expressed concern regarding regulatory oversight of LNG vessels.[308] Regulatory oversight of LNG vessels is addressed in Section 4.13.1.3 of the DEIS.[309] The DEIS identifies USCG regulatory authority over LNG marine vessels, and applicable United States and international security requirements.[310] Additionally, the DEIS discusses JCEP's WSA, which analyzes vessel route, port characterization, and risk management strategies, as well as USCG's review and approval of JCEP's WSA.[311] The DEIS adequately addresses regulatory oversight of LNG vessels in transit and at berth in the DEIS.

C. **Pipeline Safety**

1. Pipeline leaks and rupture

Commenters express concern regarding natural gas leaks from the Pipeline and pipeline rupture.[312] These concerns are addressed in Section 4.13.2 of the DEIS. As described in the DEIS, Applicants must construct and operate their respective facilities to comply with the requirements of the USDOT and PHMSA.[313] Additionally, the DEIS discusses how USDOT has the exclusive authority to promulgate federal safety standards for the transportation of natural gas.[314] The DEIS further discusses safety standards for the Pipeline, such as maximum allowable operating pressures based on nearby population density, pipeline burial depth requirements, and development of

305 DEIS at p. 4-702.
306 DEIS at p. 4-702.
307 Supplemental Response to July 8, 2019 Data Request of JCEP at Request 3, Accession No. 20190802-5108 (Aug. 2, 2019).
308 WELC Comments at p. 25.
309 DEIS at pp. 4-702 to 4-707.
310 DEIS at pp. 4-703 to 4-705.
311 DEIS at pp. 1-14, 4-705 to 4-707.
312 Comments of Patricia Kullberg at pp. 10-11, Accession No. 20190702-5015 (Jul. 1, 2019); Comments of Marilyn Costamagna at pp. 4-5, Accession No. 20190610-0011 (Jun. 10, 2019); McLaughlin Comments at pp. 3 and 4.
313 *See, e.g.*, DEIS at pp. 4-752, 4-769, and 4-779 to 4-780.
314 DEIS at p. 4-769.

emergency response plans.[315] Additionally, in Sections 4.13.2.2 and 4.13.2.3, the DEIS examines pipeline accident data.[316] As stated therein, the available data show that natural gas transmission pipelines continue to be a safe, reliable means of energy transportation.[317]

The DEIS also discusses various protective measures that the PCGP will implement to mitigate the risk of leaks or rupture. To prevent natural gas leaks along the Pipeline, PCGP would conduct periodic corrosion/leak surveys along a corridor centered on the Pipeline, which will be up to 10 feet wide and will be maintained in an herbaceous state. Trees that are located within 15 feet of the Pipeline will be cut and removed from the right-of-way.[318] In addition, the Pipeline would be protected from corrosion using a cathodic protection (CP) system, which would be installed following construction. The CP system would generally consist of a number of sites where a rectifier/anode bed is installed and electrically connected by a conductor to the Pipeline.[319] The Project Corrosion Control Plan[320] contains additional information on PCGP's corrosion control methods and cathodic protection system.[321] Monitoring and maintenance of the cathodic protection system would be accomplished in compliance with the appropriate regulations at least once per calendar year but with intervals not to exceed 15 months. Problems detected through the monitoring program would be corrected promptly and checked in a follow-up survey no later than 12 months after the initial discovery. Recording and transmitting pressure and temperature data would be controlled and/or monitored by the gas control monitoring system.

In addition, in-line inspection tools, known as smart pigs, would be launched/received by equipment located at each end of the Pipeline (i.e., the Jordan Cove Meter Station and the Klamath Compressor Station).[322] There would also be pig launcher/receiver equipment co-located at Block Valve Assemblies to facilitate periodic in-line inspections using smart pigs. Use of pigs, the cathodic protection system, and periodic aboveground inspections would reduce the remote possibility of unintentional natural gas releases.

Based on employing all of the above noted measures, the DEIS contains ample support for its conclusion that the Project would not significantly affect public safety.

2. Valve Assemblies

Commenters raise concern regarding USDOT pipeline safety regulations and distances between block valve assemblies and mainline block valves.[323] These requirements are already considered in the DEIS. A mainline valve (MLV) is a block valve installed in-line (as part) of the pipeline. A block valve assembly (BVA) includes the MLV and appurtenances such as the valve

[315] DEIS at pp. 4-770 to 4-771, 4-774 to 4-775.
[316] DEIS at pp. 4-776 to 4-780.
[317] DEIS at p. 4-780.
[318] DEIS at p. 2-71.
[319] DEIS at pp. 2-42, 4-426.
[320] Plan of Development at Appendix F.
[321] DEIS at p. 2-69.
[322] DEIS at p. 2-21.
[323] Comment of Clarence and Stephany Adams at pp. 3 to 4, Accession No. 20190703-5053 (July 3, 2019).

operator, bypass and blowdown valves and piping, and instrumentation. Pipe class and MLV locations must comply with the 49 CFR Section 192, in particular 49 CFR Section 192.5 Class Locations and 49 CFR Section 192.179 Transmission line valves.[324] PCGP agrees with commenters who cite the required maximum distances that a sectionalizing block valve (MLV) must be placed, as stated in 49 CFR Section 192.179. For example, 49 CFR Section 192.179 (a)(3) states "Each point on the pipeline in a Class 2 location must be within 7-1⁄2 miles (12 kilometers) of a valve." The DEIS explains that the Pipeline would be constructed in accordance with such USDOT regulations.[325]

To perform the compliance assessment, the beginning and ending location of each class segment is compared to the location of both the upstream and downstream MLV, to assure that every point within a class segment is within the maximum allowed distance to at least either the upstream or downstream MLV. If the distance is greater than the maximum allowed, then the MLV location must be revised or additional MLV added until all points are within the maximum allowed distance of an MLV. PCGP notes that due to the incorporation of re-routes into the originally proposed Pipeline alignment, and preservation of original mileposting as reference points, using milepost designations to determine miles of pipeline is inaccurate. Rather, a measured method for determining mileage should be used to obtain a linear distance between valve locations. Additionally, the Applicants filed a proposed list of modifications to the Project which included relocations of four MLV's (see Applicant Response to DEIS date July 5, 2019, Attachment A, Appendix 3).[326] These revisions have been reviewed to ensure the design complies with the requirement of 49 CFR Section 192.179.

3. Wildfire and Extreme Fire Danger Concerns

Commenters raise concerns related to wildfires and extreme fire dangers generally in the Project area.[327] The DEIS adequately evaluated these concerns and determined that PCGP would, among other things, meet or exceed USDOT pipeline burial depth requirements, develop an ERP including procedures to minimizes hazards in the event of an emergency, and would have facilities along the Pipeline to aid in protecting the Pipeline from wildfires.[328] Concerns regarding drought and wildfire are addressed through PCGP's implementation of the procedures detailed in its Fire Prevention and Suppression Plan[329] and the Prescribed Burning Plan[330], which follow Oregon Department of Forestry requirements, and which were analyzed in the DEIS.[331] In addition, many landowner agreements, especially those with timber companies, contain requirements for fire plans.

[324] DEIS at pp. 4-769 to 4-771.
[325] DEIS at p. 2-45.
[326] Comments of PCGP and JCEP, Accession No. 20190705-5092 (July 5, 2019).
[327] Comment of Regna Merritt on behalf of 978 petition signees, Accession No. 20190627-5082 (June 27, 2019).
[328] DEIS at pp. 4-774 to 4-776.
[329] Plan of Development at Appendix K.
[330] Plan of Development at Appendix R.
[331] DEIS at pp. 2-70, 4-776.

Another commenter asserts that by creating a continuous corridor of early seral vegetation and by facilitating additional fire exclusion and fire suppression through LSRs, the Pipeline will increase fire hazards and wildfires in the area that inhibit the retention of late-successional habitat characteristics; further, the commenter claims that the Umpqua National Forest is the only land management area that presents mitigation measures that would lower the risk of loss of forest stands to high intensity fire with proposed thinning and off-site pine removal.[332] These concerns are already addressed in the DEIS. PCGP is unaware of any scientific support indicating that the Pipeline route through LSRs would increase fire hazards. In descriptions for the proposed mitigation projects on the Umpqua National Forest, the DEIS notes that the Forest Service states that the Pipeline corridor would increase fire suppression complexity, but that it would also provide a fuel break.[333] Additionally, some of the proposed mitigation projects identify that fuels reduction adjacent to the Pipeline would increase the effectiveness of the Pipeline corridor as a fuel break. Commenter is correct that the Umpqua National Forest is the only National Forest that has provided mitigation specifically for fuels reduction and/or a fuel break.[334]

Further, the DEIS discusses Applicants' voluntary compensatory mitigation proposals for BLM lands.[335] Within the list of voluntary mitigation projects, there are several focused on fire suppression and fuels reduction, and they are spread across the Coos Bay, Roseburg and Medford BLM districts.

Commenters raise concern of pipeline failures leading to fires, and fire response time in remote areas and areas of steep terrain[336]. Additionally, commenters expressed concern regarding the impacts of a wildfire over the buried pipeline and block valves.[337] The DEIS already addresses these concerns. See the above discussion for a description of leak detection, corrosion control, and inspection measures to be implemented by PCGP during operation of the Pipeline to minimize the potential for pipeline leaks. In addition, block valves are protected because the site ground cover is crushed rock (gravel) and is free of vegetation, which provides separation between a possible wildfire and the main piping arrangement that exists above ground."

The DEIS recognizes that the Pipeline would be in areas where forest fires could occur.[338] The DEIS further discusses PCGP's proposal to meet or exceed USDOT pipeline burial depth requirements (found in 49 CFR Part 192), installing the Pipeline with at least 36 inches of cover in Class I locations with normal soils and at least 24 inches of cover in consolidated rock areas.[339] In the event a fire was to occur on the surface in the vicinity of the Pipeline, the presence of the Pipeline would not increase fire hazards.

[332] Comment of Klamath Siskiyou Wildlands Center at p. 9, Accession No. 20190611-5153 (July 11, 2019).
[333] DEIS at p. 4-450.
[334] Other National Forests have proposed projects that would thin forest, but not specifically to manage or control fires; typically proposed to increase late successional characteristics in a stand
[335] DEIS at p. 1-8.
[336] Marris Comments at 7.
[337] Oregon Women's Land Trust at pp. 4-5, Accession No. 20190702-5054 (July 2, 2019).
[338] DEIS at p. 4-774.
[339] DEIS at p. 4-774.

The DEIS explains how fires on the surface are not a direct threat to underground natural gas pipelines because of the insulating effects of soil cover over the pipeline; soil is a poor conductor of heat with thermal conductivity values ranging from 0.44 to 1.44 Btu/ft-hr-°F, and the heat capacity of most soils is 0.20 to 0.25 Btu/lb-°F.[340] Additionally, the 30-foot wide operational corridor would be maintained with a low fuel, low shrub canopy to allow aerial inspection and ground-based inspection. The operational/maintained corridor would be planted in native grasses, low growing plants, and shrubs and would closely approximate the bio regime and fuel load condition of a dense chaparral forest (California, Chaparral Institute 2017). According to Figure 2.5(C) in "Wildland Fire in Ecosystems Effects of Fire on Soil and Water," soil temperatures during a High Severity chaparral wild fire typically do not exceed ~175° F at a depth of 2 inches (Forest Service 2005). The amount of moisture present in the soil along the maintained corridor would have no effect on the deeper (>2 inches) soil temperature profiles due to the short-duration burn time and fast moving characteristics of a wildfire in the low canopy environment within the operational/maintained corridor. Given the above, the DEIS sufficiently considers fire risk to pipeline integrity.

VII. *Engineering and Design*

1. LNG Terminal Design

One commenter expresses concerns regarding the safety implications of the mechanical design of the LNG facility, particularly the reliability of the mechanical design.[341] These concerns are already adequately addressed in the DEIS. Section 4.13.1.5 of the DEIS contains a review of the preliminary engineering designs and discusses public information related to reliability and mechanical design of the LNG Terminal[342] Moreover, the DEIS refers to industry codes and standards for the design, fabrication, construction, and installation of piping and equipment and specifications for the facility and includes recommendations not only to ensure industry codes and standards are incorporated in the facility design but also to verify that the equipment is being properly maintained during the life of the facility.[343] Given the above, the DEIS adequately assesses the reliability of the mechanical design and makes provisions to assure use of the proper design and technology throughout the life of the Project.

One commenter expressed concern regarding the LNG Terminal's ability to shut down in an emergency, and any relevant safety implications.[344] These concerns are sufficiently addressed in the DEIS. In Section 4.13.1.5, the DEIS addresses the LNG Terminal's emergency shutdown and depressurization systems.[345] The emergency shutdown system is subject to 49 CFR Part 193 compliance and FERC Staff's recommendations in the DEIS[346] detail further review of final design requirements. JCEP anticipates that the Staff Recommendations in Section 4.13.1.6 of the DEIS would be conditions of any Certificate issued for the LNG Terminal. JCEP would comply with

[340] DEIS at p. 4-755.
[341] WELC Comments at p. 17.
[342] DEIS at pp. 4-713 to 4-719.
[343] DEIS at pp. 4-715 to 4-719.
[344] WELC Comments at p. 20.
[345] DEIS at pp. 4-719 to 4-720.
[346] DEIS at p. 4-762.

the conditions of the Certificate to enhance the reliability and safety of the facility and to mitigate the risk of impact on the public. Therefore, the DEIS sufficiently analyzes the Project's emergency shutdown system.

2. Shipping Channel Modifications

One commenter asserts that there is no evidence to suggest that the four modifications to the shipping channel are necessary or would serve to enhance the channel.[347] These modifications are appropriately considered in the DEIS. As stated in the DEIS, JCEP proposes to excavate four submerged areas in Coos Bay along the vessel access route to improve navigational reliability.[348] Section 4.13.1.3 of the DEIS explains that USCG has regulatory authority over navigational safety, LNG marine vessel engineering and safety standards, and marine transfer areas.[349] The DEIS references the USCG's May 2018 LOR, which recommended that the Coos Bay Channel is suitable for accommodating the type and frequency of LNG marine traffic associated with this project from a maritime and navigational safety standpoint.[350] The DEIS notes that the LNG Terminal would be able to produce up to 7.8 million metric tons per annum of LNG.[351] In order to export this volume using the size of vessels anticipated to call on the LNG Terminal, JCEP identified the need to expand the weather window in which these LNG vessels could transit Coos Bay.[352]

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[347] Comment of Oregon Shores at p. 4, Accession No. 20190705-5176 (July 5, 2019).
[348] DEIS at pp. 2-10, 4-244
[349] DEIS at pp. 4-702 to 4-710.
[350] DEIS at pp. 4-709 to 4-710, 4-780.
[351] DEIS at p. 1-1.
[352] *See* JCEP Resource Report 1 at p. 26, Accession No. 20170921-5142 (Sept. 21, 2017).

Document Content(s)

PROPERTY OWNER CERTIFICATION AND CONSENT

I hereby certify that the Oregon Department of State Lands is the manager of those submerged and submersible non-trust lands in Coos Bay owned by the State of Oregon. I hereby approve Jordan Cove LNG, LLC to file land use applications with the City of Coos Bay ("City"), the City of North Bend, and Coos County ("County") for the following land use authorizations for uses and activities to be located and/or undertaken within our area of ownership, as depicted on attached Exhibit 1:

(1) Post-acknowledgment amendments to the Coos Bay Estuary Management Plan ("CBEMP") map at three Coos Bay locations in the City of Coos Bay and unincorporated Coos County depicted in Exhibit 1 to these Applications ("Navigation Reliability Improvement Sites" or "NRI Sites") to change the zoning designation of 59-CA, 2-NA, and 3-DA, to DDNC-DA;

(2) A post-acknowledgment amendment of the CBEMP, which is part of the Coos County Comprehensive Plan ("CCCP"), to take a reasons exception to Statewide Planning Goal ("Goal") 16 text amendment adopted of the CBEMP, which is part of the Coos County Comprehensive Plan ("CCCP"), in the form of a reasons exception to Statewide Planning Goal ("Goal") 16 to authorize the rezone of the NRI Sites to DDNC-DA;

(3) An amendment of the text of the Coos County Zoning and Land Development Ordinance ("CCZLDO") to clarify that the DDNC-DA designation is appropriate for application to area adjacent to, and not only within, the designated federal navigation channel;

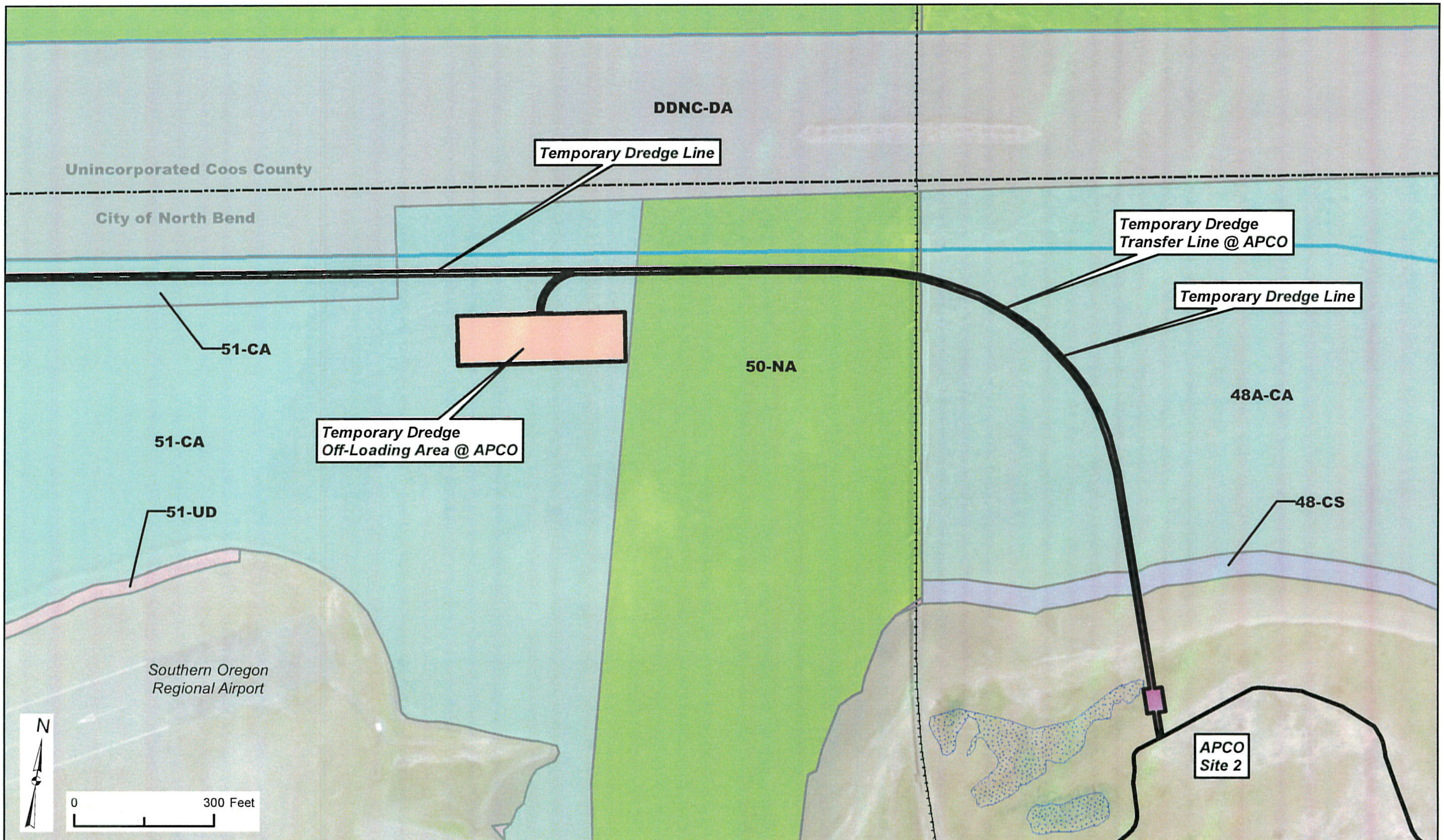
(4) Administrative conditional use permit to authorize new and maintenance dredging at the NRI Sites in the DDNC-DA zone, as this Application proposes to amend those sites.

(5) Administrative authorization from the City of North Bend for the installation of temporary dredge material transport lines, an off-loading facility, and the placement of dredged material in an Industrial zone designation.

By: Vicki L Walker

Print Name and Title: Vicki L. Walker, Director, Oregon Department of State Lands

Date: 11/1/18



JCEP Project Area
Temporary Dredge Off-Loading Area @ APCO
Temporary Dredge Transfer Line @ APCO

CBEMP Aquatic Management Units
Conservation Aquatic (CA)
Deep Draft Navigation Channel (DDNC)
Development Aquatic (DA)
Natural Aquatic (NA)
CBEMP Shoreland Management Units
Urban Development Area (UD)
Conservation Shorelands (CS)

Wetland
Federal Navigation Channel
City Limits

Jordan Cove Energy Project

JCEP Project Area Update - August 2018

CBEMP Zoning
Temporary Dredge Transfer Line @ APCO

Jordan Cove LNG℠

8/6/2018

FIGURE NO. 3

\\deainc.com\files\PROJECTS\JLNG00000001\0600INFO\GS\Maps\Design\APCO Temporary Dredge Transfer Line\APCO Temporary Dredge Transfer Line_CBEMP.mxd

J1-000-CIV-MAP-DEA-00001-01 Rev. C

Exhibit 1
Page 1 of 3

Exhibit 29
Page 2 of 6

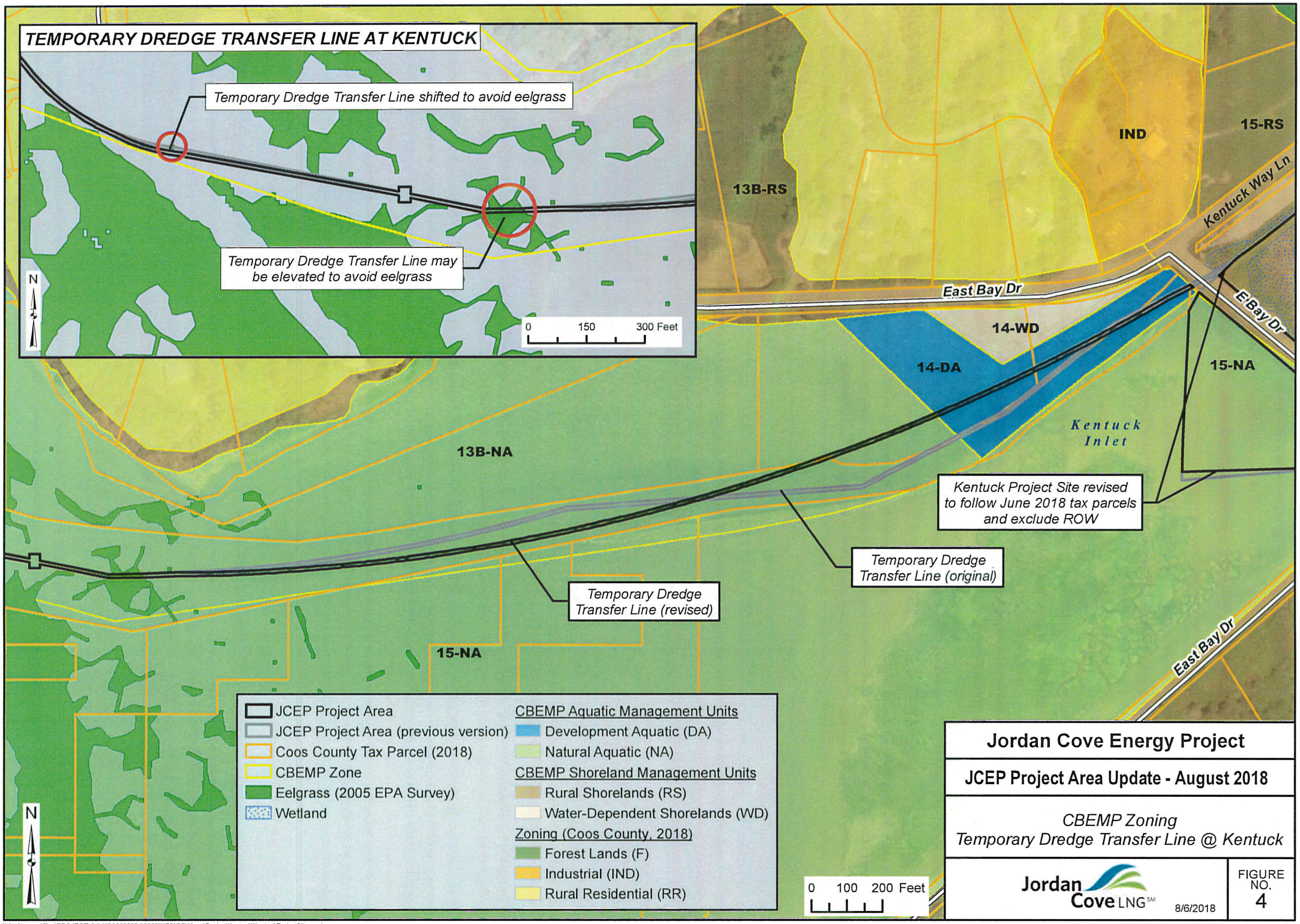
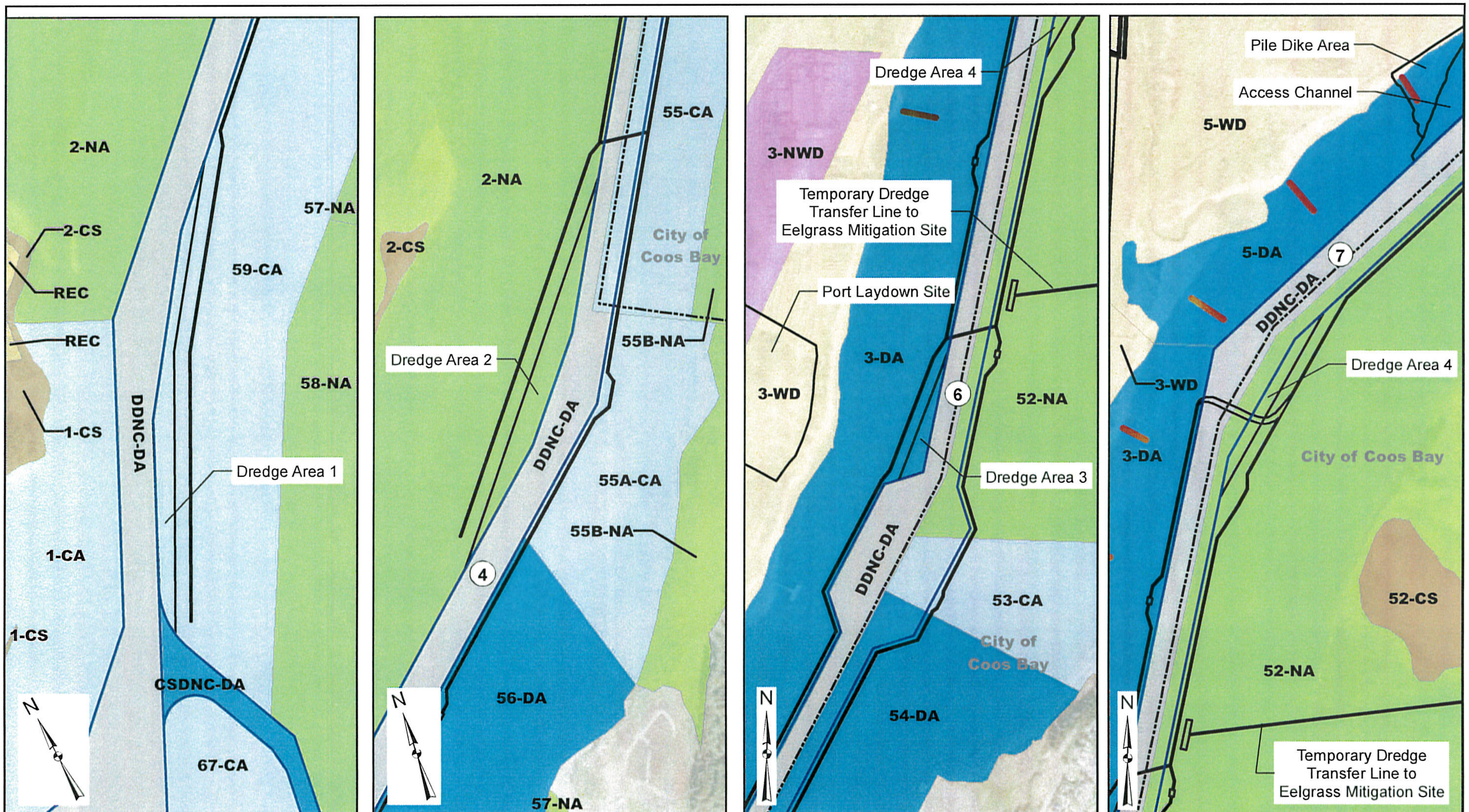


Exhibit 29
Page 3 of 6

J1-000-CIV-MAP-DEA-00001-01 Rev. C

Exhibit 1
Page 2 of 3



JCEP Project Area
Existing Pile Dike
City Limits
(#) Channel Mile
Federal Navigation Channel

CBEMP Aquatic Management Units
Conservation Aquatic (CA)
Deep Draft Navigation Channel (DDNC)
Development Aquatic (DA)
Natural Aquatic (NA)

CBEMP Shoreland Management Units
Conservation Shorelands (CS)
Water-Dependent Shorelands (WD)

Zoning (Coos County, 2018)
Recreation (REC)

0 0.15 0.3 Miles

Jordan Cove Energy Project

JCEP Project Area Update - July 2018

CBEMP Zoning Navigational Reliability Improvement (NRI) Areas

Jordan Cove LNG℠ 7/10/2018

FIGURE NO. 5

\\deainc.com\files\PROJECTS\JLNG\00000001\0600INFO\GS\Maps\Land Use\Perkins Cove CBEMP Zoning by Facility\Fig 4 CBEMP Zoning Temporary Dredge Line.mxd

J1-000-CIV-MAP-DEA-00001-01 Rev. C

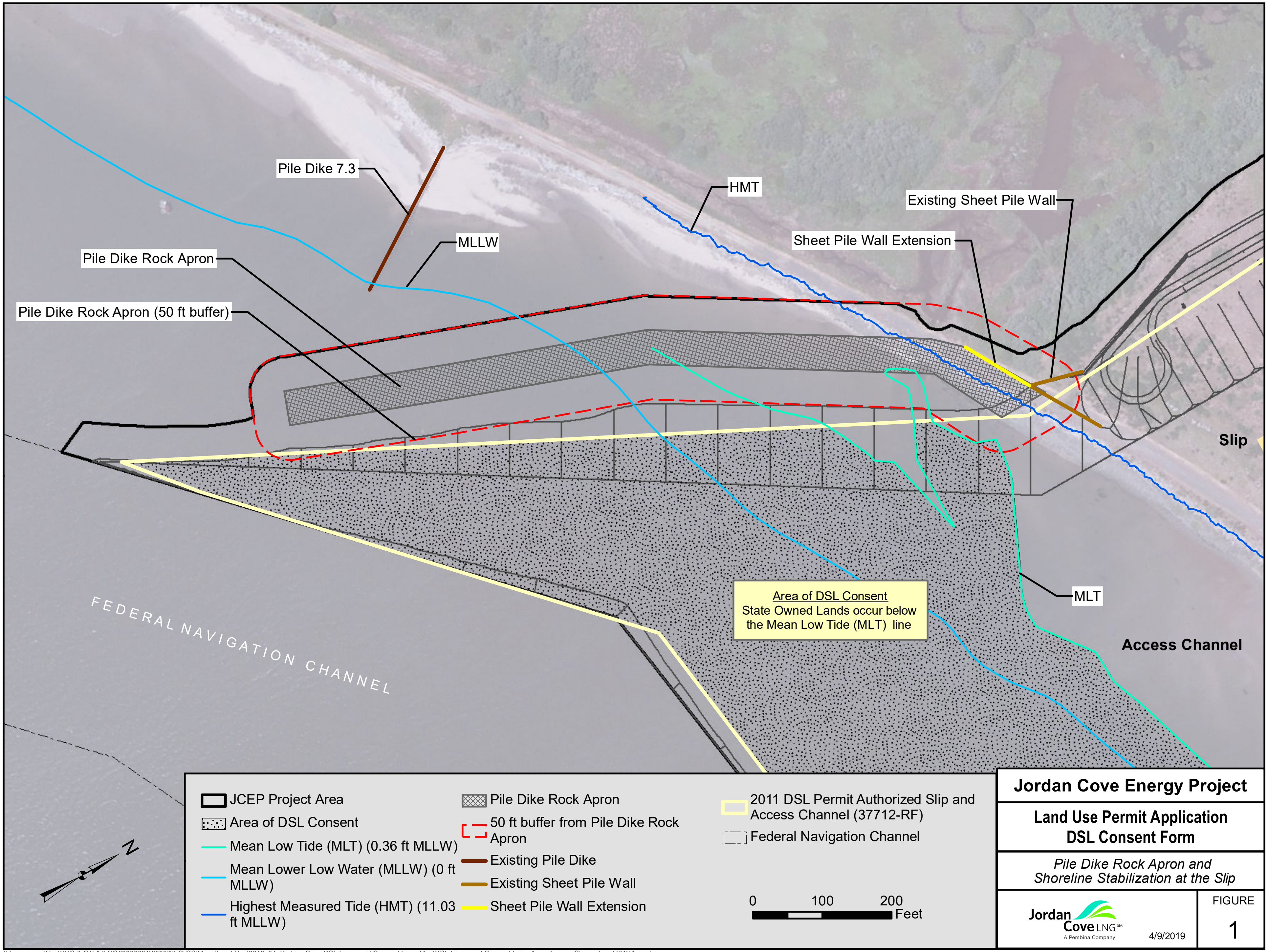
PROPERTY OWNER CERTIFICATION AND CONSENT

I hereby certify that the Oregon Department of State Lands is the manager of the submerged and submersible non-trust lands in Coos Bay owned by the State of Oregon. I hereby approve Jordan Cove Energy Project L.P. to file land use applications with Coos County ("County") for approval under applicable land use regulations of in-water rock apron and shoreline stabilization improvements to be located within our area of ownership, as depicted on attached Exhibit A.

By: ______________________ [signature]
Vicki Walker, Director

Date: 4/30/15

59892-0025/144042917.1



Jordan Cove Energy Project

Land Use Permit Application
DSL Consent Form

Pile Dike Rock Apron and Shoreline Stabilization at the Slip

Jordan Cove LNG
A Pembina Company

4/9/2019

FIGURE 1

\\deainc.com\files\PROJECT\J\JLNG00000001\0600INFO\GS\Maps\Land Use\2019_04_Perkins Coie_DSL Easement Consent Form Map\DSL Easement Consent Form App - Access Channel and PDRA.mxd

Jordan Cove Energy Project, L.P.

October 11, 2019

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, D.C. 20426

Re: OEP/DG2E/Gas Branch 3
Jordan Cove Energy Project L.P.
Docket No. CP17-495-000
Response to October 4, 2019 Data Request

Dear Ms. Bose:

On September 21, 2017, Jordan Cove Energy Project L.P. ("JCEP") filed an application pursuant to Section 3(a) of the Natural Gas Act, as amended,[1] and Parts 153 and 380 of the regulations of the Federal Energy Regulatory Commission ("Commission"),[2] for authorization to site, construct, and operate certain liquefied natural gas facilities.

On October 4, 2019, the Commission issued an Environmental Information Request ("October 4 Data Request"). JCEP is submitting a complete response to the October 4 Data Request in the narrative and attachments included herewith.

Should you have any questions, please contact me at neades@pembina.com or 832-255-3841.

Sincerely,

/s/ Natalie Eades
Natalie Eades
Jordan Cove Energy Project L.P.

Enclosures

cc: John Peconom (FERC)
John Crookston (Tetra Tech)

[1] 15 U.S.C. § 717b(a) (2012).
[2] 18 C.F.R. Pts. 153 and 380 (2019).

JORDAN COVE ENERGY PROJECT L.P.

DOCKET NO. CP17-495-000

Verification

VERIFICATION

THE STATE OF TEXAS)
)
COUNTY OF HARRIS)

Natalie Eades, being first duly sworn, states that she is Manager, Environment & Regulatory for Jordan Cove Energy Project L.P.; that she is authorized to execute this Verification; that she has read the foregoing document and is familiar with the contents thereof; and that all allegations of fact therein contained are true and correct to the best of her knowledge and belief.

JORDAN COVE ENERGY PROJECT L.P.

Natalie Eades
Natalie Eades
Manager, Environment & Regulatory
Jordan Cove Energy Project L.P.

Subscribed and sworn to before me this 4th day of October, 2019.

Notary Public, State of Texas

My Commission Expires:

August 18, 2020

LATANYA HAMILTON
Notary ID # 130784481
My Commission Expires
August 18, 2020

CERTIFICATE OF SERVICE

I hereby certify that I have this 11th day of October, 2019, served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding.

*/s/Abigail M. Meredith*________________
Abigail M. Meredith
Attorney for
Jordan Cove Energy Project L.P.

Request

In order to address concerns expressed by the Bureau of Land Management (BLM) regarding the feasibility of installing the proposed industrial waste water pipeline (IWWP) along the Trans-Pacific Parkway, please provide a map of the proposed IWWP at a horizontal scale of 1" = 200'. This map should indicate landownership and illustrate topographic features, such as sand dunes and wetlands. This map should also depict the adjacent Trans-Pacific Parkway and North Spit rail spur as well as all existing utilities (water, power, fiber optics, etc.). Confirm sufficient space is present within the existing easement to successfully accommodate construction and operation of the IWWP by indicating on the aforementioned map (or other drawing) all required workspaces. Also, in an accompaniment to the map, describe IWWP construction methods (general and special). If sufficient space is unavailable within the existing easement, describe facility/route alternatives, including any impact on BLM or U.S. Department of Agriculture Forest Service (Forest Service) administered lands. Specifically, at a minimum, describe the feasibility of an alternative pipeline route that would avoid the BLM parcel located north of the terminal site and would locate a portion of the IWWP within the proposed Access and Utility Corridor. Lastly, document consultation with the BLM and Forest Service regarding the proposed IWWP location, construction feasibility, and any potential alternative facilities/routes.

Response:

Please see Attachment 1 for details regarding construction of the industrial wastewater pipeline ("IWWP" or "IWP" on the attachments). The horizontal scale provided in Attachment 1 is greater than 1" = 200'. Attachment 1 also shows topographic features, the Trans-Pacific Parkway, the rail line and utilities. Please see Attachment 2 for land ownership with existing and proposed easement information. JCEP has confirmed that there is sufficient space for construction, operation and maintenance of the IWWP within the existing 100-foot wide Trans-Pacific Parkway right-of-way easement created and established for transportation and utility purposes. Therefore this response does not include plans for future work nor potential facility/route alternatives. No feasible alternative routes have been identified. Attachment 1 will be updated prior to construction to include the latest wetland delineations and construction requirements; no centerline changes are anticipated, however. JCEP discussed the permitting of the proposed IWWP with BLM through teleconferences in August and September 2019.

JCEP anticipates using typical municipal utility construction techniques, including trenching, pipe placement, and backfill. Construction and major maintenance activities would utilize the width between the railroad tracks and up to one lane of Trans-Pacific Parkway. Minor maintenance would utilize the proposed 20-foot wide IWWP easement within the existing 100-foot easement shown on Attachment 2. The trench width for the IWWP is expected to be 36 inches to 48 inches with a minimum burial depth of 36 inches, as on in sheet D-1 included in Attachment 1. JCEP notes that some traffic flagging and signaling will be necessary, but this is not depicted on the plan sheets in Attachment 1.

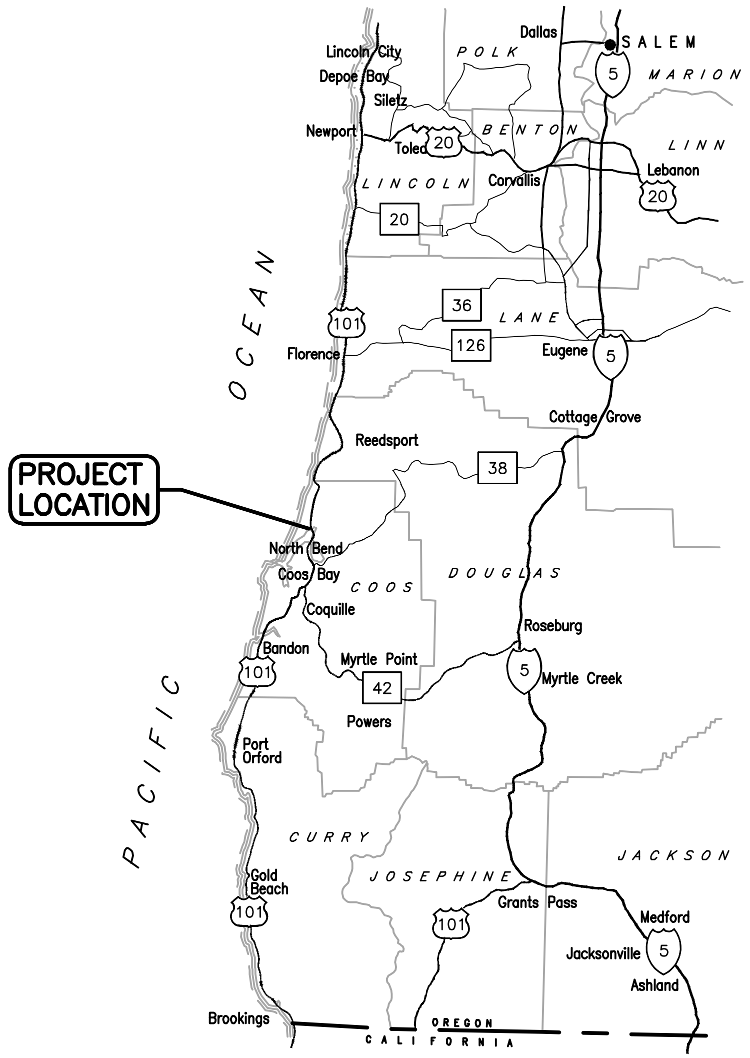
JCEP ATTACHMENT 1

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
PHASE 2
COOS COUNTY, OR

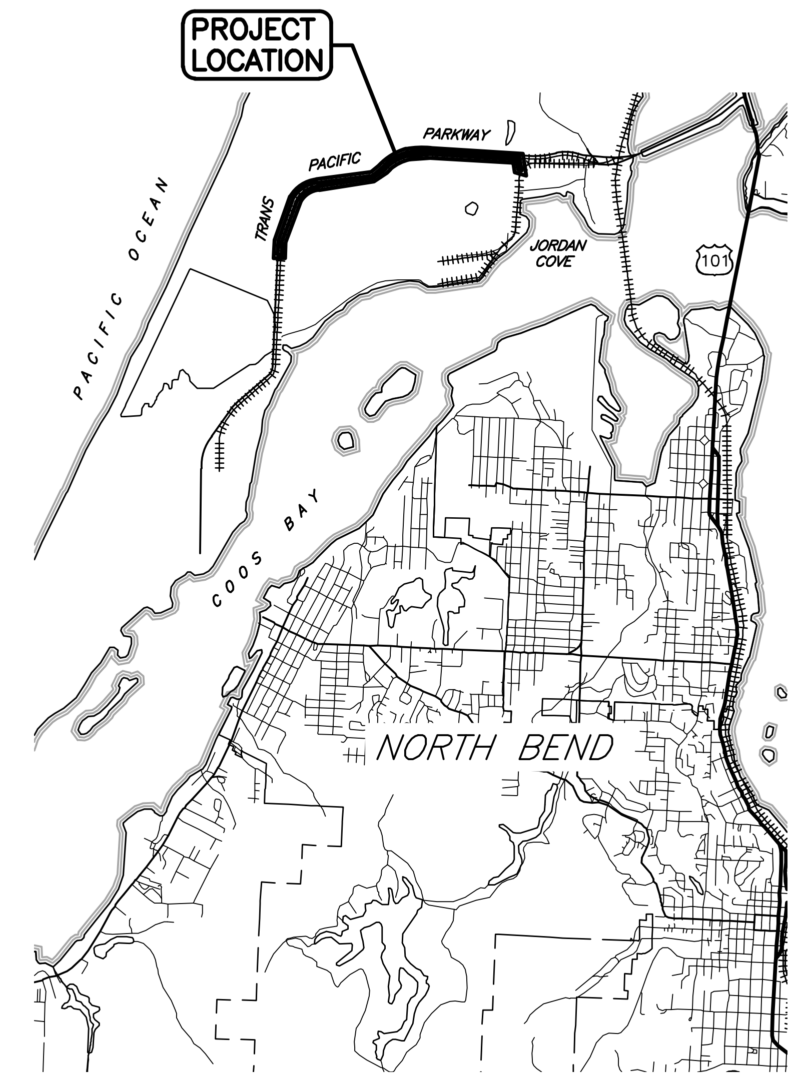
PREPARED BY:

SHN

MARCH 2015



LOCATION MAP
NTS



VICINITY MAP
NTS

APPROVALS

JCEP: ______________________ DATE

INDEX OF SHEETS

SHT	DWG	TITLE
1	G-1	COVER
2	G-2	STANDARD ABBREVIATIONS AND LEGENDS
3	G-3	GENERAL NOTES
4	G-4	EROSION & SEDIMENT CONTROL PLAN
5	C-1	IWP PHASE 2 PLAN & PROFILE
6	C-2	IWP PHASE 2 PLAN & PROFILE
7	C-3	IWP PHASE 2 PLAN & PROFILE
8	C-4	IWP PHASE 2 PLAN & PROFILE
9	C-5	IWP PHASE 2 PLAN & PROFILE
10	C-6	IWP PHASE 2 PLAN & PROFILE
11	C-7	IWP PHASE 2 PLAN & PROFILE
12	C-8	IWP PHASE 2 PLAN & PROFILE
13	C-9	IWP PHASE 2 PLAN & PROFILE
14	C-10	IWP PHASE 2 PLAN & PROFILE
15	C-11	IWP PHASE 2 PLAN & PROFILE
16	C-12	IWP PHASE 2 PLAN & PROFILE
17	C-13	IWP PHASE 2 PLAN & PROFILE
18	C-14	IWP PHASE 2 PLAN & PROFILE
19	C-15	IWP PHASE 2 PLAN & PROFILE
20	C-16	IWP PHASE 2 PLAN & PROFILE
21	C-17	IWP PHASE 2 PLAN & PROFILE
22	C-18	IWP PHASE 2 PLAN & PROFILE
23	C-19	IWP PHASE 2 PLAN & PROFILE
24	C-20	IWP PHASE 2 PLAN & PROFILE
25	C-21	IWP PHASE 2 PLAN & PROFILE
26	C-22	IWP PHASE 2 PLAN & PROFILE
27	C-23	IWP PHASE 2 PLAN & PROFILE
28	C-24	IWP PHASE 2 PLAN & PROFILE
29	C-25	LATERALS PLAN & PROFILE
30	D-1	DETAILS
31	D-2	DETAILS
32	D-3	DETAILS

Oregon law requires you to follow rules adopted by the Oregon Utility Notification Center. Those rules are set forth in OAR 952-001-0010 through OAR 952-001-0090. You may obtain copies of the rules by calling the center (503) 232-1987.

All underground Utilities and substructures shown hereon were obtained from the best available sources, and are presumed to be accurate, and complete. It shall be the contractor's sole responsibility to verify, locate, and protect all utilities and substructures shown or not shown.

CALL THE STATEWIDE UTILITIES LOCATING SERVICE AT: 1-(800) 332-2344 W/ YOUR SCHEDULE AT LEAST TWO DAYS PRIOR TO BEGINNING WORK.

SAVED: 3/23/2016 2:46 PM DREED, PLOTTED: 3/28/2016 3:10 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-COVER.dwg

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
275 MARKET AVENUE
COOS BAY, OR. 97420
WWW.SHN-ENGR.COM
541-266-9890

REV Description:
Doc No:
REV: REV Date:
DSGN DPG CHK SKD
DR NN/NR APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

COVER

SHEET G-1
SEQ 1
DATE 03/2015
PROJ. NO. 614029.500

ABBREVIATIONS

A
ABN — ABANDON
ABS — ACRYLONITRILE–BUTADIENE–STYRENE
AB — ANCHOR BOLT, AGGREGATE BASE
AC — ASPHALTIC CONCRETE
ACP — ASBESTOS CEMENT PIPE
ACI — AMERICAN CONCRETE INSTITUTE
ADJ — ADJUSTABLE
AGGR — AGGREGATE
AISC — AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AL — ALUMINUM
ALT — ALTERNATE
AP — ANGLE POINT
APPROX — APPROXIMATELY
ARCH — ARCHITECTURAL
ASTM — AMERICAN SOCIETY FOR TESTING & MATERIALS
AUTO — AUTOMATIC
AUX — AUXILIARY
@ — AT

B
BC — BEGIN CURVE
BCR — BEGIN CURB RETURN
BD — BOARD
BF — BLIND FLANGE
BFV — BUTTERFLY VALVE
BK — BOOK OR BACK
BLDG — BUILDING
BM — BENCH MARK, BEAM
BMP — BEST MANAGEMENT PRACTICE
BO — BLOW OFF
BOT — BOTTOM
BRG — BEARING
BTWN — BETWEEN
BV — BALL VALVE
BVC — BEGINNING OF VERTICAL CURVE
BW — BACK OF WALK
BWV — BACKWATER VALVE

C
C — CHANNEL (STRUCTURAL SHAPE)
CARV — COMBINATION AIR AND VACUUM RELEASE VALVE
CATV — CABLE TELEVISION
CB — CATCH BASIN
CEIL — CEILING
CFM — CUBIC FEET PER MINUTE
CFS — CUBIC FEET PER SECOND
CHEM — CHEMICAL
CI — CAST IRON
CIP — CAST IRON PIPE
C.I.P. — CAST IN PLACE
CJ — CONSTRUCTION JOINT
CLR — CLEAR
℄ — CENTERLINE
CMP — CORRUGATED METAL PIPE
CMU — CONCRETE MASONRY UNIT
CTSK — COUNTERSINK
CO — CLEANOUT
COL — COLUMN
CONC — CONCRETE
CONT — CONTINUOUS OR CONTINUED
COORD — COORDINATE
CPLG — COUPLING
CRS — COLD ROLLED STEEL
CTR — CENTER
CTS — COPPER TUBE SIZE
CU — CUBIC
CU FT — CUBIC FEET
CV — CHECK VALVE
CW — COLD WATER
CY — CUBIC YARD

D
° — DEGREE (ANGLE)
d — PENNY (NAIL SIZE)
D — STORM DRAIN
DB — DISTRIBUTION BOX
DBL — DOUBLE
DF — DOUGLAS FIR
DI — DROP INLET OR DUCTILE IRON
DIA — DIAMETER
DIAG — DIAGONAL
DIM — DIMENSION
DIMJ — DUCTILE IRON MECHANICAL JOINT
DIP — DUCTILE IRON PIPE
DET — DETAIL
DWG — DRAWING
DW — DRIVEWAY

E
(E) — EXISTING
E — EASTING OR EAST
EA — EACH
EC — END CURVE
ECR — END CURB RETURN
EF — EACH FACE
EFL — EFFLUENT
EG — EXISTING GRADE/GROUND
EL — ELBOW
ELEC — ELECTRIC OR ELECTRICAL
ELEV — ELEVATION
ENGR — ENGINEER
EP — EDGE OF PAVING
EQ — EQUAL
EQUIP — EQUIPMENT
ER — EDGE OF ROAD
EVC — END OF VERTICAL CURVE
EW — EACH WAY
EWEF — EACH WAY, EACH FACE
EXC — EXCAVATE
EXP — EXPOSED OR EXPANSION
EXP JT — EXPANSION JOINT
EXST — EXISTING
EXT — EXTERIOR

F
F — FLANGE
FC — FLEXIBLE COUPLING OR FACE OF CURB
FCA — FLANGED COUPLING ADAPTER
FD — FLOOR DRAIN
FDC — FIRE DEPARTMENT CONNECTION
FDN — FOUNDATION
FF — FINISH FLOOR
FG — FINISHED GRADE
FH — FIRE HYDRANT
FIG — FIGURE
FIN — FINISH
FIP — FEMALE IRON PIPE
FL — FLOW LINE
FLG — FLANGE
FLR — FLOOR
FLTR — FILTER
FO — FIBER OPTIC
FOC — FACE OF CONCRETE
FT — FOOT OR FEET
FT^2 — SQUARE FEET
FT^3 — CUBIC FEET
FTG — FOOTING
FUT — FUTURE

G
G — GAS
GA — GAGE
GALV — GALVANIZED
GIP — GALVANIZED IRON PIPE
GM — GAS METER
GPD — GALLONS PER DAY
GPH — GALLONS PER HOUR
GPM — GALLONS PER MINUTE
GRD — GRADE OR GROUND
GSP — GALVANIZED STEEL PIPE
GV — GATE VALVE
GYP — GYPSUM

H
HB — HOSE BIBB
HDPE — HIGH DENSITY POLYETHYLENE
HDR — HEADER
HDW — HARDWARE
HMA — HOT MIX ASPHALT
HOR — HORIZONTAL
HP — HORSEPOWER, HIGH POINT
HR — HOUR
HT — HEIGHT
HW — HOT WATER
HWR — HOT WATER RETURN
HWS — HOT WATER SUPPLY

I
ID — INSIDE DIAMETER
IN — INCH
INFL — INFLUENT
INSUL — INSULATE OR INSULATION
INT — INTERIOR
INV — INVERT
IPS — IRON PIPE SIZE

J
JT — JOINT
JP — JOINT POLE

K
KIP — THOUSAND POUNDS
KW — KILOWATT

L
∠ — ANGLE (DEGREES)
L — ANGLE (STRUCTURAL SHAPE)
LAT — LATERAL
LB — POUND
LF — LINEAR FEET
LG — LONG
LH — LEFT HAND
LONG — LONGITUDINAL
LP — LOW POINT
LPG — LIQUIFIED PETROLEUM GAS
LRP — LEGALLY RESPONSIBLE PARTY
LR — LONG RADIUS
LT — LEFT
LVC — LENGTH OF VERTICAL CURVE

M
MATL — MATERIAL
MAX — MAXIMUM
MECH — MECHANICAL
MF — MEGA–FLANGE PIPE JOINT
MFR — MANUFACTURER
MGD — MILLION GALLONS PER DAY
MH — MANHOLE
MHMAC — MINOR HOT MIX ASPHALT CONCRETE
MIN — MINIMUM OR MINUTE
MIP — MALE IRON PIPE
MISC — MISCELLANEOUS
MJ — MECHANICAL JOINT
MNPT — MALE NATIONAL PIPE THREAD
MTL — METAL
MWS — MAXIMUM WATER SURFACE

N
(N) — NEW
N — NORTHING OR NORTH
NC — NORMALLY CLOSED
NIC — NOT IN CONTRACT
NF — NON–FREEZE
NO — NUMBER OR NORMALLY OPEN
NOM — NOMINAL
NP — NEW PAVEMENT
NPT — NATIONAL PIPE THREAD
NTS — NOT TO SCALE
— NUMBER

O
OC — ON CENTER
OD — OUTSIDE DIAMETER
OG — ORIGINAL GROUND
OVFL — OVERFLOW
OZ — OUNCE
OH — OVERHEAD

P
PC — POINT OF CURVE
PCC — PORTLAND CEMENT CONCRETE
PCF — POUNDS PER CUBIC FOOT
PE — PLAIN END
PERF — PERFORATED
PEP — POLYETHELENE PIPE
PI — POINT OF INTERSECTION
PL — PLATE
℗ — PROPERTY LINE
PLCS — PLACES
PLYWD — PLYWOOD
PMP — PERFORATED METAL PIPE
POC — POINT ON CURVE
POT — POINT OF TANGENT
PP — POWER POLE
PRC — POINT OF REVERSE CURVE
PREFAB — PREFABRICATED
PRELIM — PRELIMINARY
PRESS — PRESSURE
PROP — PROPERTY
PSF — POUNDS PER SQUARE FOOT
PSI — POUNDS PER SQUARE INCH
PSIG — POUNDS PER SQUARE INCH, GAUGE
PT — POINT OF TANGENCY, POINT
PUE — PUBLIC UTILITY EASEMENT
PV — PLUG VALVE
PVC — POLYVINYL CHLORIDE PLASTIC
PVI — POINT OF VERTICAL INTERSECTION
PVMT — PAVEMENT

Q
QTY — QUANTITY

R
R — RADIUS
RC — RELATIVE COMPACTION
RCP — REINFORCED CONCRETE PIPE
RD — ROAD
RDCR — REDUCER
RWD — REDWOOD
REF — REFER OR REFERENCE
REINF — REINFORCED, REINFORCING OR REINFORCE
REQD — REQUIRED
RET — RETURN
RH — RIGHT HAND
RM — ROOM
RO — ROUGH OPENING
RSP — ROCK SLOPE PROTECTION
RT — RIGHT OR RING TIGHT
R/W — RIGHT OF WAY
RWL — RAIN WATER LEADER

S
S — SEWER
SL — SLOPE
SCHED — SCHEDULE
SCSD — SCOTIA COMMUNITY SERVICES DISTRICT
SD — STORM DRAIN
SDMH — STORM DRAIN MANHOLE
SECT — SECTION
SF — SQUARE FOOT/FEET
SHT — SHEET
SIM — SIMILAR
SP — SPACE OR SPACES
SPEC — SPECIFICATIONS
SQ — SQUARE
SQ FT — SQUARE FOOT
SQ IN — SQUARE INCH
SS — SANITARY SEWER
SSCO — SANITARY SEWER CLEAN OUT
SSMH — SANITARY SEWER MANHOLE
SST — STAINLESS STEEL
STA — STATION
STD — STANDARD
STL — STEEL
STR — STRUCTURAL
STRUCT — STRUCTURE
SUSP — SUSPENDED
SW — SIDEWALK
SWPPP — STORM WATER POLLUTION PREVENTION PLAN
SYMM — SYMMETRICAL

T
TAN — TANGENT
T&B — TOP AND BOTTOM
T&G — TONGUE AND GROOVE
TBC — TOP BACK CURB
TBM — TEMPORARY BENCH MARK
TBW — TOP BACK WALK
TC — TOP OF CURB
TCE — TEMPORARY CONSTRUCTION EASEMENT
TEL — TELEPHONE
TELEM — TELEMETRY
TEMP — TEMPERATURE OR TEMPORARY
TFC — TOP FACE CURB
THD — THREAD
TOC — TOP OF CONCRETE
TOG — TOP OF GRATE
TOS — TOWN OF SCOTIA
TOW — TOP OF WALL
TP — TURNING POINT, TOP OF PAVEMENT OR TELEPHONE POLE
TRANSV — TRANSVERSE
TS — TUBE, STRUCTURAL
TYP — TYPICAL

U
UBC — UNIFORM BUILDING CODE
UOS — UNLESS OTHERWISE SPECIFIED
UG — UNDERGROUND
UTIL — UTILITY

V
V — VOLT
VAC — VACUUM
VAR — VARIES
VC — VERTICAL CURVE
VCP — VITRIFIED CLAY PIPE
VERT — VERTICAL
VG — VALLEY GUTTER
VPI — VERTICAL POINT OF INTERSECTION

W
W — WATER OR WIDE FLANGE
W/ — WITH
W/O — WITHOUT
WM — WATER METER
WP — WORK POINT
WS — WATER SURFACE, WATER STOP
WWF — WELDED WIRE FABRIC

X
XFMR — TRANSFORMER

Y
YD — YARD
YD^2 — SQUARE YARD
YD^3 — CUBIC YARD

CURVE DATA

R (RADIUS)
L (LENGTH)
△ (DELTA)
T (TANGENT)

UTILITIES LEGEND

PROPOSED | EXISTING

GATE VALVE
PLUG VALVE (PV)
BALL VALVE (BV)
BUTTERFLY VALVE (BFV)
AUTOMATICALLY OPERATED VALVE (P= PNEUMATIC, E= ELECTRIC, S= SOLENOID, H= HYDRAULIC, D= DIAPHRAGM ACTUATOR)
3–WAY VALVE
GLOBE VALVE
ANGLE VALVE
PRESSURE REGULATING VALVE
PRESSURE RELIEF VALVE
CHECK VALVE
AIR OR VACUUM RELEASE VALVE
AIR AND VACUUM VALVE (AV)
COMBINATION AIR VALVE (CA)
FLOW METER
HOSE BIBB (NF= NON–FREEZE)
REDUCER
FIRE HYDRANT
DROP INLET
MANHOLE
SEWER CLEAN OUT OR SEWER LATERAL
UNDERGROUND ELECTRICAL (E)
OVERHEAD ELECTRICAL (OH E)
FIBER OPTIC LINE (FO)
CABLE TELEVISION (TV)
JOINT UTILITIES (J)
UNDERGROUND TELEMETRY LINE (TM)
OVERHEAD TELEMETRY LINE (OH TM)
UNDERGROUND TELEPHONE LINE (T)
OVERHEAD TELEPHONE LINE (OH T)
FIRE WATER LINE (FW)
STEAM LINE (ST)
WATER LINE (W)
RAW WATER LINE (RW)
SANITARY SEWER LINE (SS)
STORM DRAIN LINE (SD)
GAS LINE (G)
FORCE MAIN AND DIRECTION OF FLOW (FM)

SIZE AND MATERIAL OF EXISTING PIPING MAY BE SHOWN WHEN KNOWN.
SIZE AND MATERIAL OF NEW PIPING MAY BE SHOWN ON PLAN OR IN PROFILE.

EDGE OF PAVEMENT (EP)
EDGE OF GRAVEL (GR)
CULVERT
POLE MOUNTED ROADWAY LUMINAIRE
ITEM TO BE REMOVED — EXISTING: NOT USED
ITEM TO BE ABANDONED IN PLACE
WATER SERVICE– WM–1= SINGLE, WM–2= DUAL (3)
PULL BOX AND DESIGNATION (PB)
SIGN AND DESIGNATION (R4–4)

NOTES

1. CONTACT THE ENGINEER FOR SYMBOLS NOT LISTED.
2. THIS IS A STANDARD SHEET, THEREFORE, SOME SYMBOLS OR ABBREVIATIONS MAY APPEAR ON THIS SHEET WHICH DO NOT APPEAR ON THE PLANS.
3. SITE AND UTILITY SYMBOLS SHOWN ON THIS SHEET ARE NOT INTENDED TO REPRESENT THE PHYSICAL SCALE OR SHAPE OF ANY ITEMS. WHERE LARGE–SCALE PLANS ARE PRESENTED, THE SYMBOLS SHOWN HEREON MAY BE REPLACED BY DETAILS MORE SUITED TO THE DRAWING SCALE.

TOPOGRAPHIC LEGEND

PROPOSED | EXISTING

P.I. (POINT OF INTERSECTION)
TEMPORARY BENCH MARK — PROPOSED: NOT USED
FINISH GRADE ELEVATON (47.55) — EXISTING: NOT USED
ELEVATION OF ORIGINAL GROUND (42.6) — PROPOSED: NOT USED
RADIAL POINT
FLOW LINE AND DIRECTION
TOP OF CUT
TOP OF FILL
TOE OF CUT OR FILL
CONTOUR LINE (200 / 180)
CONCRETE (IN PLAN)
CONCRETE (IN SECTION)
PAVEMENT
ROCKS — PROPOSED: NOT USED
STUMPS — PROPOSED: NOT USED
TREES
ROADS
UTILITY POLE (PP=POWER POLE, TP= TEL POLE, JP=JOINT POLE)
GUY WIRE
FENCE
BOUNDARY LIMITS, W/DESIGNATION
RIGHT OF WAY
CENTERLINE
MARSH — PROPOSED: NOT USED
WETLAND
SPRING — PROPOSED: NOT USED
TEST PIT AND DESIGNATION (TP–4)
EXPLORATION BORE HOLE
PROPERTY CORNER
SURVEY MONUMENT
CONTROL POINT
DRIVEWAY
RAILROAD — PROPOSED: NOT USED

DETAIL AND SECTION DESIGNATION

SECTION (LETTER) OR DETAIL (NUMERAL) DESIGNATION (A)
INDICATES SECTION OR DETAIL TAKEN AND SHOWN ON SAME SHEET (C–5)
ON DRAWING WHERE SECTION OR DETAIL IS TAKEN: SHEET NUMBER WHERE SHOWN
ON DRAWING WHERE SECTION OR DETAIL IS SHOWN: SHEET NUMBER WHERE TAKEN
STANDARD DETAIL NUMBER (DETAIL MAY BE SHOWN ON ANY SHEET WITHIN THE DRAWING SET) (006)

REGISTERED PROFESSIONAL ENGINEER 15,479 Daniel P. Graber OREGON JULY 25, 1991 DANIEL P. GRABER
RENEWS: 6/30/17

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING 0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

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WWW.SHN–ENGR.COM
541–266–9890

REV Description: | Doc. No: | REV: | REV Date:
DSGN DPG | DR NN/NR | CHK | APVD | SKD

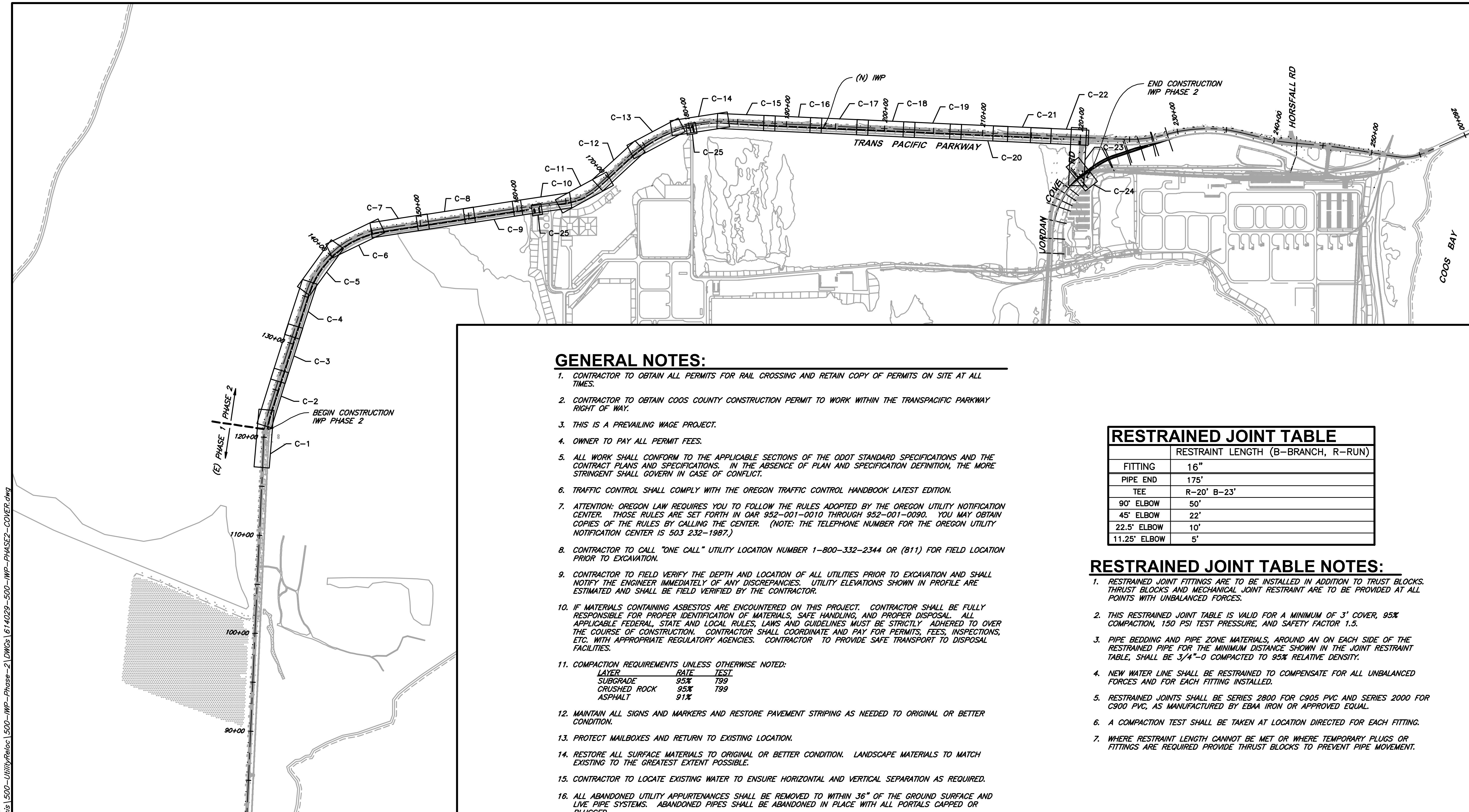
Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

LEGEND

SHEET G–2
SEQ 2
DATE 03/2015
PROJ. NO. 614029.500

SAVED: 3/23/2016 2:46 PM DREED, PLOTTED: 3/28/2016 3:10 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029–JCEOwnerAssis\500–UtilityReloc\500–IWP–Phase–2\DWGs\614029–500–IWP–PHASE2–COVER.dwg



OVERVIEW MAP
NTS

GENERAL NOTES:

1. CONTRACTOR TO OBTAIN ALL PERMITS FOR RAIL CROSSING AND RETAIN COPY OF PERMITS ON SITE AT ALL TIMES.
2. CONTRACTOR TO OBTAIN COOS COUNTY CONSTRUCTION PERMIT TO WORK WITHIN THE TRANSPACIFIC PARKWAY RIGHT OF WAY.
3. THIS IS A PREVAILING WAGE PROJECT.
4. OWNER TO PAY ALL PERMIT FEES.
5. ALL WORK SHALL CONFORM TO THE APPLICABLE SECTIONS OF THE ODOT STANDARD SPECIFICATIONS AND THE CONTRACT PLANS AND SPECIFICATIONS. IN THE ABSENCE OF PLAN AND SPECIFICATION DEFINITION, THE MORE STRINGENT SHALL GOVERN IN CASE OF CONFLICT.
6. TRAFFIC CONTROL SHALL COMPLY WITH THE OREGON TRAFFIC CONTROL HANDBOOK LATEST EDITION.
7. ATTENTION: OREGON LAW REQUIRES YOU TO FOLLOW THE RULES ADOPTED BY THE OREGON UTILITY NOTIFICATION CENTER. THOSE RULES ARE SET FORTH IN OAR 952-001-0010 THROUGH 952-001-0090. YOU MAY OBTAIN COPIES OF THE RULES BY CALLING THE CENTER. (NOTE: THE TELEPHONE NUMBER FOR THE OREGON UTILITY NOTIFICATION CENTER IS 503 232-1987.)
8. CONTRACTOR TO CALL "ONE CALL" UTILITY LOCATION NUMBER 1-800-332-2344 OR (811) FOR FIELD LOCATION PRIOR TO EXCAVATION.
9. CONTRACTOR TO FIELD VERIFY THE DEPTH AND LOCATION OF ALL UTILITIES PRIOR TO EXCAVATION AND SHALL NOTIFY THE ENGINEER IMMEDIATELY OF ANY DISCREPANCIES. UTILITY ELEVATIONS SHOWN IN PROFILE ARE ESTIMATED AND SHALL BE FIELD VERIFIED BY THE CONTRACTOR.
10. IF MATERIALS CONTAINING ASBESTOS ARE ENCOUNTERED ON THIS PROJECT. CONTRACTOR SHALL BE FULLY RESPONSIBLE FOR PROPER IDENTIFICATION OF MATERIALS, SAFE HANDLING, AND PROPER DISPOSAL. ALL APPLICABLE FEDERAL, STATE AND LOCAL RULES, LAWS AND GUIDELINES MUST BE STRICTLY ADHERED TO OVER THE COURSE OF CONSTRUCTION. CONTRACTOR SHALL COORDINATE AND PAY FOR PERMITS, FEES, INSPECTIONS, ETC. WITH APPROPRIATE REGULATORY AGENCIES. CONTRACTOR TO PROVIDE SAFE TRANSPORT TO DISPOSAL FACILITIES.
11. COMPACTION REQUIREMENTS UNLESS OTHERWISE NOTED:

LAYER	RATE	TEST
SUBGRADE	95%	T99
CRUSHED ROCK	95%	T99
ASPHALT	91%	

12. MAINTAIN ALL SIGNS AND MARKERS AND RESTORE PAVEMENT STRIPING AS NEEDED TO ORIGINAL OR BETTER CONDITION.
13. PROTECT MAILBOXES AND RETURN TO EXISTING LOCATION.
14. RESTORE ALL SURFACE MATERIALS TO ORIGINAL OR BETTER CONDITION. LANDSCAPE MATERIALS TO MATCH EXISTING TO THE GREATEST EXTENT POSSIBLE.
15. CONTRACTOR TO LOCATE EXISTING WATER TO ENSURE HORIZONTAL AND VERTICAL SEPARATION AS REQUIRED.
16. ALL ABANDONED UTILITY APPURTENANCES SHALL BE REMOVED TO WITHIN 36" OF THE GROUND SURFACE AND LIVE PIPE SYSTEMS. ABANDONED PIPES SHALL BE ABANDONED IN PLACE WITH ALL PORTALS CAPPED OR PLUGGED.
17. CONTRACTOR SHALL PROTECT ALL STORM SEWERS WITH INLET SEDIMENT BARRIERS, AND INSTALL OR PROVIDE EROSION AND SEDIMENT CONTROL MEASURES IN ACCORDANCE WITH BEST MANAGEMENT PRACTICES.
18. ROADWAY MATERIALS SHALL BE RESTORED TO MATCH OR EXCEED EXITING DIMENSIONS WITH MATERIALS MEETING ODOT SPECIFICATIONS. MATERIAL GRADATIONS AND TEST DATA SHALL BE SUBMITTED AND APPROVED PRIOR TO CONSTRUCTION.
19. CONTRACTOR TO PRESSURE TEST ALL NEW PIPE AT 150 LBS.
20. INSTALL THRUST BLOCKS, TOGETHER WITH JOINT RESTRAINT SYSTEMS, ON ALL FITTINGS OR PRESSURE POINTS PRIOR TO TESTING PIPE. FOLLOW RESTRAINED JOINT TABLE FOR PIPE LENGTH TO BE RESTRAINED FROM EACH FITTING. ON TEMPORARY OR EXISTING FITTINGS, ONLY THRUST BLOCKS WILL BE REQUIRED. ALLOW THRUST BLOCKS 5 DAYS TO CURE PRIOR TO TESTING. INSTALL PORTS AND VALVES AS NEEDED FOR TESTING PURPOSES.
21. THE CONTRACTOR SHALL MAKE HIS OWN ARRANGEMENTS FOR STAGING AREAS.
22. THE CONTRACTOR SHALL MAKE HIS OWN ARRANGEMENTS FOR DISPOSAL OF EXCESS MATERIALS. MATERIALS TO BE DISPOSED OF OFFSITE SHALL BE BY WRITTEN AGREEMENT BETWEEN PARTIES AND/OR PERMITS FROM APPROPRIATE AGENCIES, AND THE CONTRACTOR SHALL PROVIDE A COPY OF THE AGREEMENT/PERMITS TO THE ENGINEER.

RESTRAINED JOINT TABLE

	RESTRAINT LENGTH (B-BRANCH, R-RUN)
FITTING	16"
PIPE END	175'
TEE	R-20' B-23'
90° ELBOW	50'
45° ELBOW	22'
22.5° ELBOW	10'
11.25° ELBOW	5'

RESTRAINED JOINT TABLE NOTES:

1. RESTRAINED JOINT FITTINGS ARE TO BE INSTALLED IN ADDITION TO TRUST BLOCKS. THRUST BLOCKS AND MECHANICAL JOINT RESTRAINT ARE TO BE PROVIDED AT ALL POINTS WITH UNBALANCED FORCES.
2. THIS RESTRAINED JOINT TABLE IS VALID FOR A MINIMUM OF 3' COVER, 95% COMPACTION, 150 PSI TEST PRESSURE, AND SAFETY FACTOR 1.5.
3. PIPE BEDDING AND PIPE ZONE MATERIALS, AROUND AN ON EACH SIDE OF THE RESTRAINED PIPE FOR THE MINIMUM DISTANCE SHOWN IN THE JOINT RESTRAINT TABLE, SHALL BE 3/4"-0 COMPACTED TO 95% RELATIVE DENSITY.
4. NEW WATER LINE SHALL BE RESTRAINED TO COMPENSATE FOR ALL UNBALANCED FORCES AND FOR EACH FITTING INSTALLED.
5. RESTRAINED JOINTS SHALL BE SERIES 2800 FOR C905 PVC AND SERIES 2000 FOR C900 PVC, AS MANUFACTURED BY EBAA IRON OR APPROVED EQUAL.
6. A COMPACTION TEST SHALL BE TAKEN AT LOCATION DIRECTED FOR EACH FITTING.
7. WHERE RESTRAINT LENGTH CANNOT BE MET OR WHERE TEMPORARY PLUGS OR FITTINGS ARE REQUIRED PROVIDE THRUST BLOCKS TO PREVENT PIPE MOVEMENT.

REGISTERED PROFESSIONAL ENGINEER 15,479 Daniel P. Graber OREGON JULY 25, 1991 DANIEL P. GRABER
RENEWS: 6/30/17

VERIFY SCALES
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0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

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COOS BAY, OR. 97420
WWW.SHN-ENGR.COM
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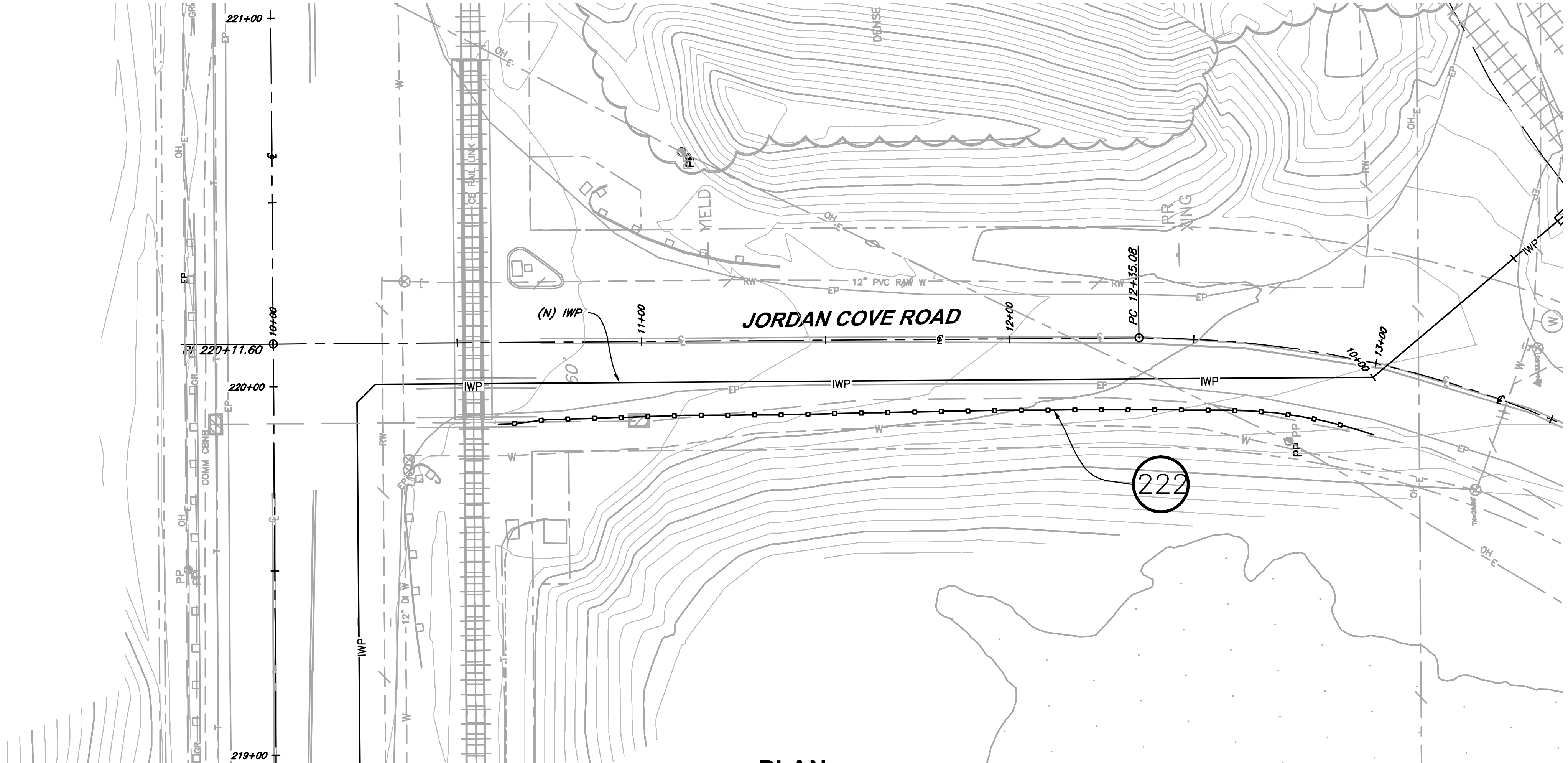
REV Description: | Doc No: | REV: | REV Date:
DSGN DPG | CHK SKD | DR NN/NR | APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
GENERAL NOTES

SHEET G-3
SEQ 3
DATE 03/2015
PROJ. NO. 614029.500

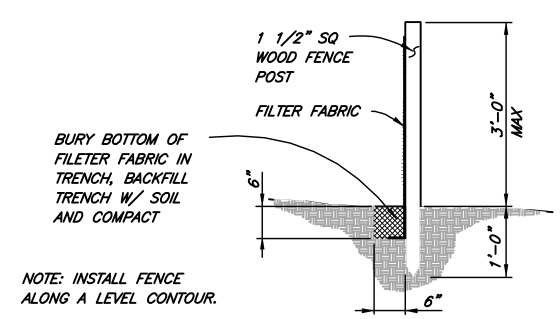
SAVED: 3/23/2016 2:46 PM DREED, PLOTTED: 3/28/2016 3:10 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-COVER.dwg



PLAN
1"=20'

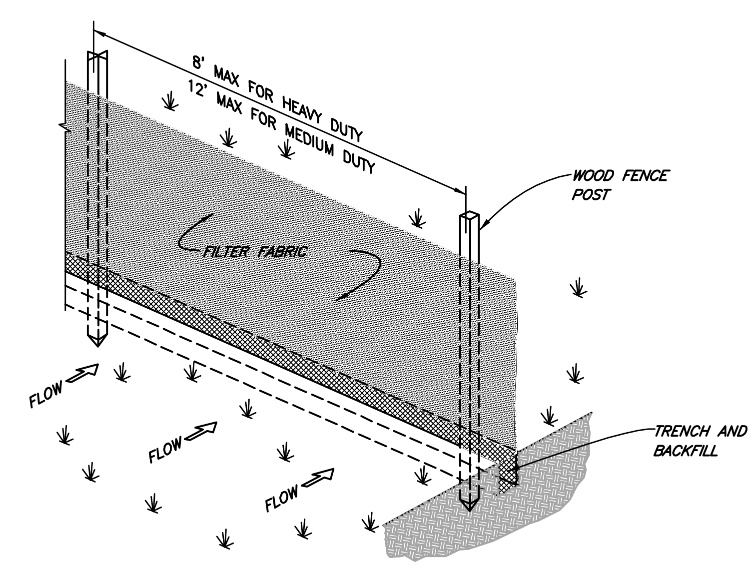
NOTES:

1. ALL EROSION & SEDIMENT CONTROL WORKMANSHIP AND MATERIALS SHALL BE IN ACCORDANCE WITH COOS COUNTY STANDARDS AND THE MOST CURRENT COPY OF THE STATE OF OREGON STANDARD SPECIFICATIONS FOR CONSTRUCTION AND AS AMENDED BY THE COUNTY OR THE STATE.
2. ATTENTION: OREGON LAW REQUIRES YOU TO FOLLOW THE RULES ADOPTED BY THE OREGON UTILITY NOTIFICATION CENTER. THOSE RULES ARE SET FORTH IN OAR 952-001-0010 THROUGH 952-001-0090. YOU MAY OBTAIN COPIES OF THE RULES BY CALLING THE CENTER. (NOTE: THE TELEPHONE NUMBER FOR THE OREGON UTILITY NOTIFICATION CENTER IS 503 232-1987.)
3. CONTRACTOR TO CALL "ONE CALL" UTILITY LOCATION NUMBER 1-800-322-3244 FOR FIELD LOCATION PRIOR TO EXCAVATION.
4. ALL EROSION AND SEDIMENT CONTROL FACILITIES SHALL BE REGULARLY INSPECTED AND MAINTAINED DURING CONSTRUCTION.
5. CONTRACTOR TO RESTORE SITE TO ORIGINAL CONDITIONS UPON COMPLETION OF THE WORK.
6. SILT FENCING SHALL BE PROVIDED AT THE LOCATIONS SHOWN OR AS DIRECTED BY THE ENGINEER.



NOTE: INSTALL FENCE ALONG A LEVEL CONTOUR.

TYPICAL SECTION



ISOMETRIC ELEVATION

DETAIL 222
NTS

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

VERIFY SCALES
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541-266-9890

REV Description:
Doc. No:
REV: REV Date:
DSGN DPG CHK SKD
DR NN/NR APVD

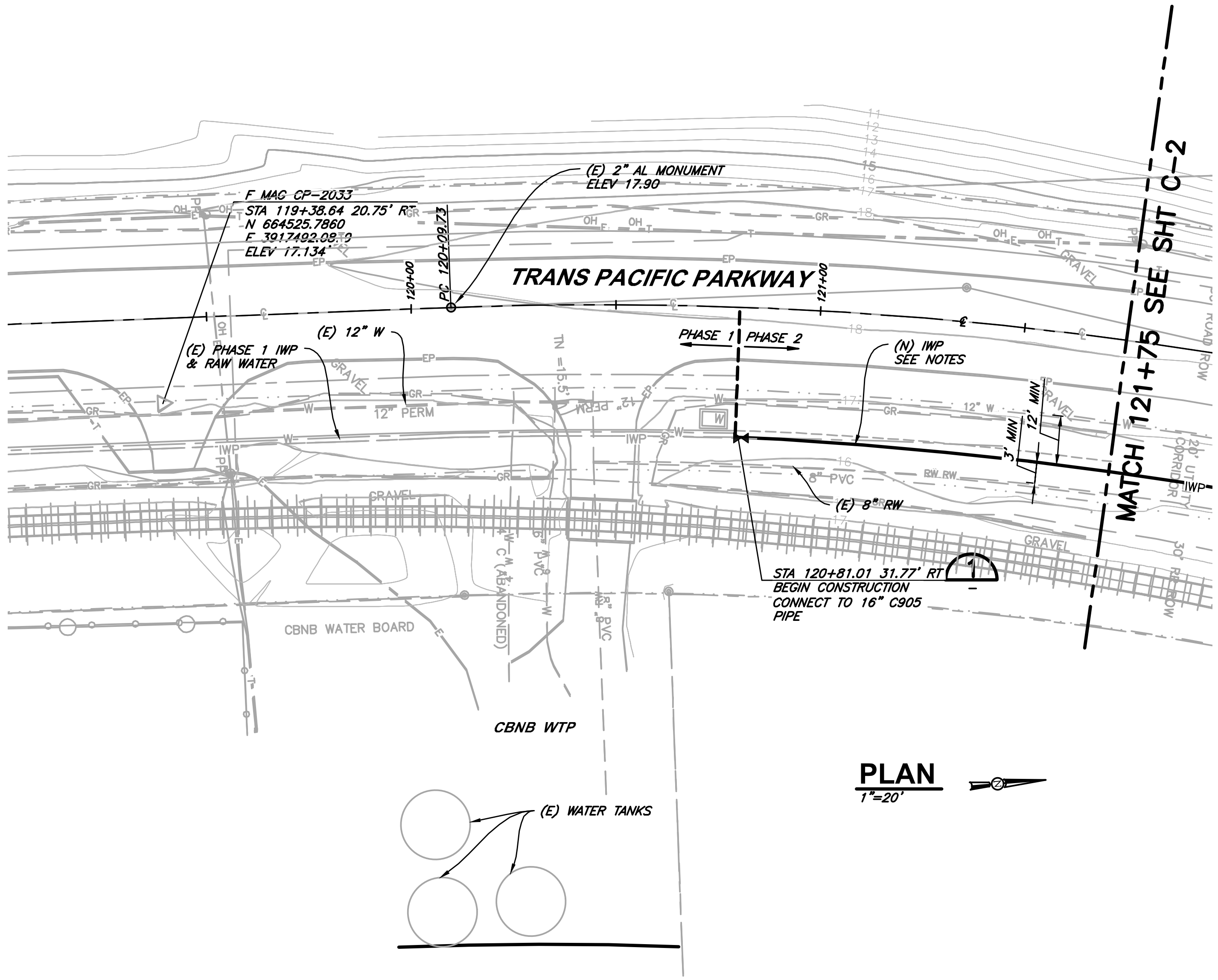
Jordan Cove LNG

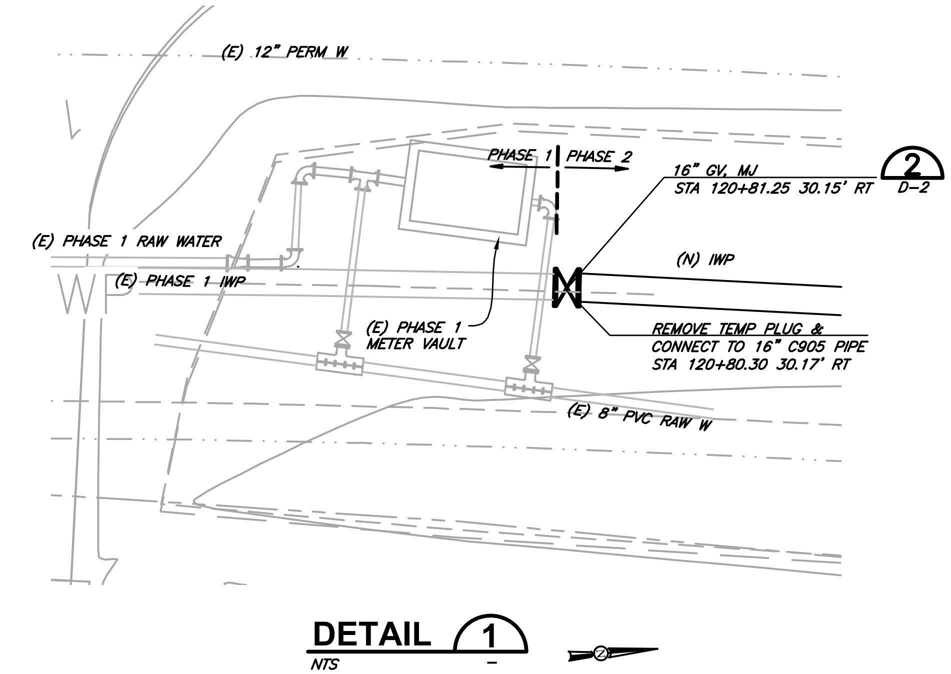
JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

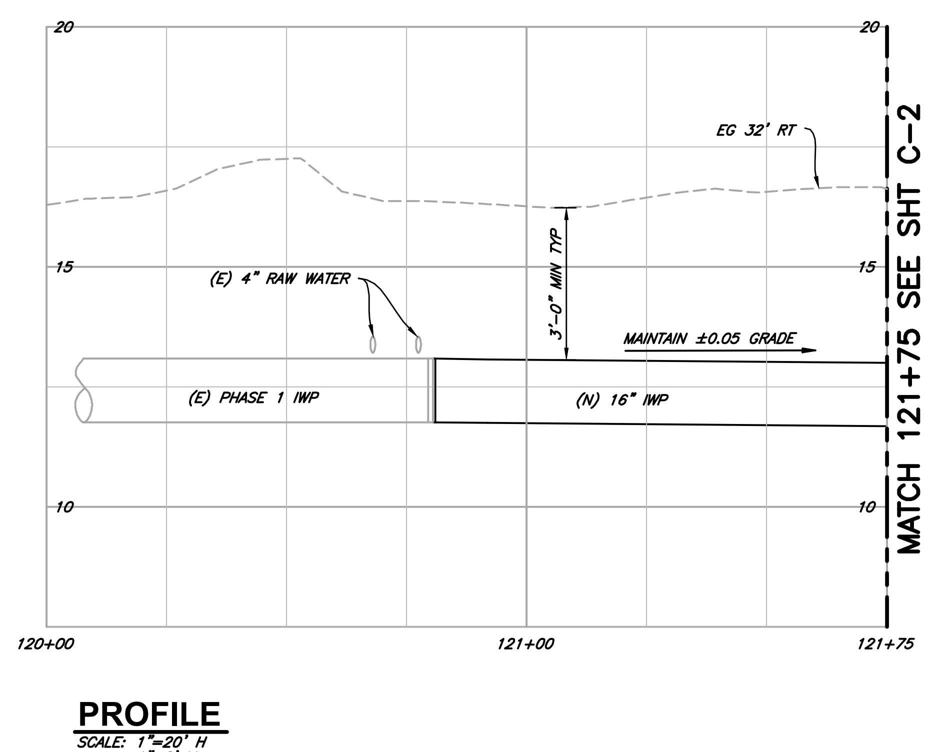
EROSION & SEDIMENT CONTROL PLAN

SHEET G-4
SEQ 4
DATE 03/2015
PROJ. NO. 614029.500

SAVED: 3/28/2016 2:27 PM DREED, PLOTTED: 3/28/2016 3:12 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg







NOTES:

1. MAINTAIN 12' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL WATER PIPE. IF LESS THAN 10' OUTSIDE TO OUTSIDE OF PIPES IWP MUST BE BELOW PARALLEL WATER PIPE.
2. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL RAW WATER PIPE.
3. POTHOLE & VERIFY WATER PIPE LOCATION & DEPTH EVERY 1000' ON TANGENTS AND 500' ON CURVES OR AS DIRECTED.
4. MAXIMUM 3" DEFLECTION PER 20' PIPE SECTION.
5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

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\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
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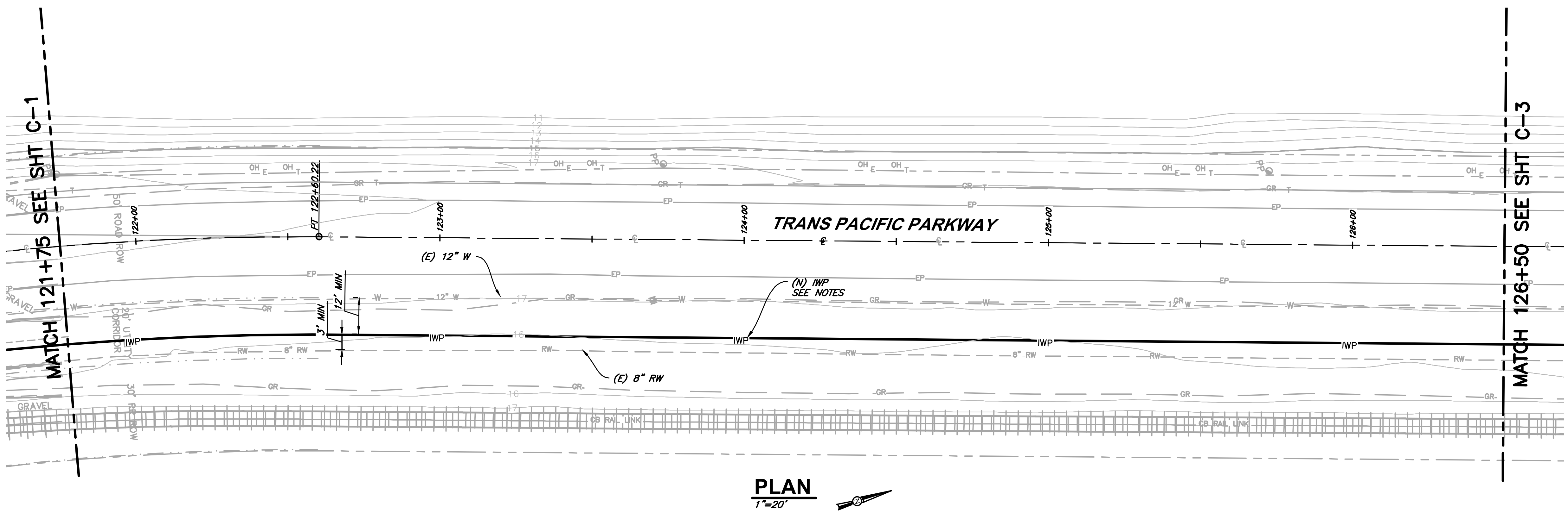
REV Description:	
Doc No:	
REV:	REV Date:
DSGN DPG	CHK SKD
DR NN/NR	APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-1
SEQ 5
DATE 03/2015
PROJ. NO. 614029.500



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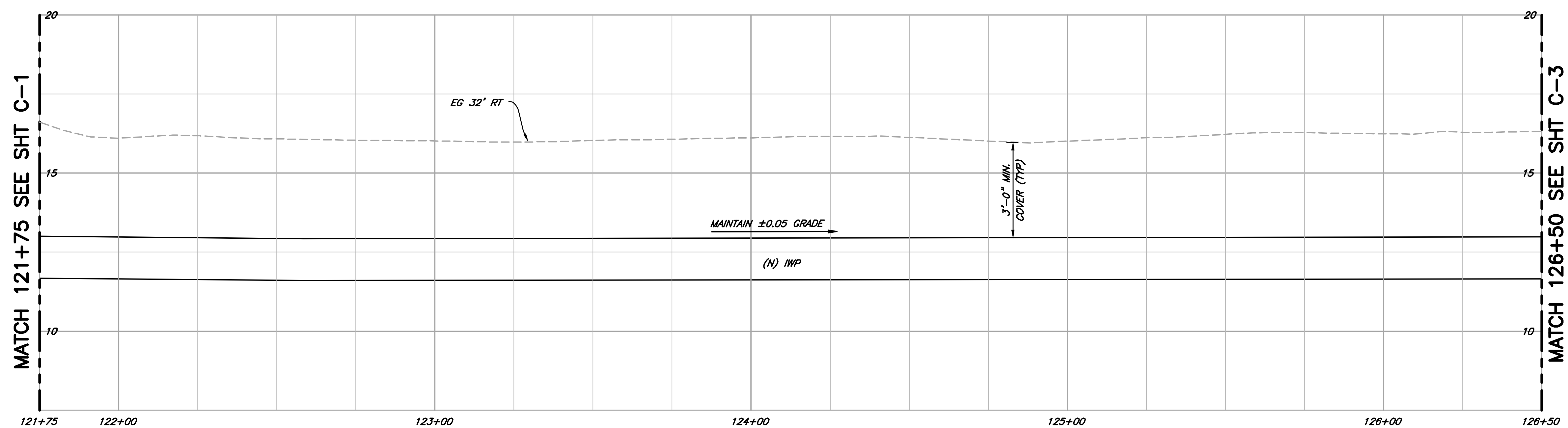


PROFILE
SCALE: 1"=20' H
1"=2' V

NOTES:

1. MAINTAIN 12' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL WATER PIPE. IF LESS THAN 10' OUTSIDE TO OUTSIDE OF PIPES IWP MUST BE BELOW PARALLEL WATER PIPE.
2. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL RAW WATER PIPE.
3. POTHOLE & VERIFY WATER PIPE LOCATION & DEPTH EVERY 1000' ON TANGENTS AND 500' ON CURVES OR AS DIRECTED.
4. MAXIMUM 3° DEFLECTION PER 20' PIPE SECTION.
5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

SAVED: 3/28/2016 2:27 PM DREED, PLOTTED: 3/28/2016 3:12 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
275 MARKET AVENUE
COOS BAY, OR. 97420
WWW.SHN-ENGR.COM
541-266-9890

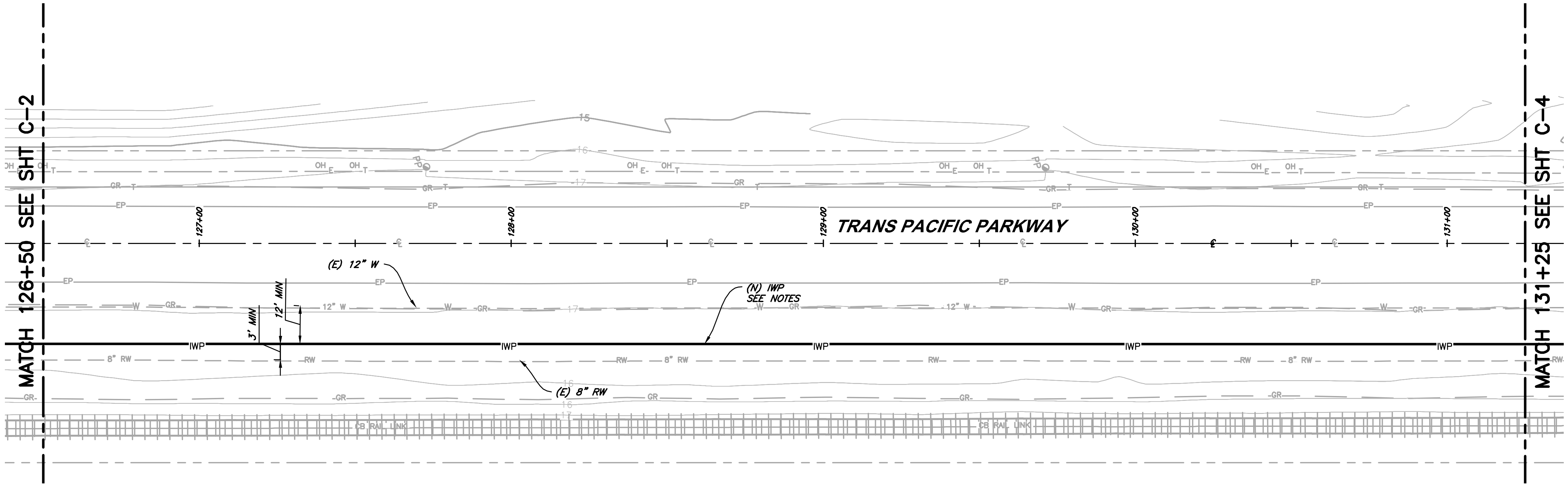
REV Description:	
Doc No:	
REV:	REV Date:
DSGN DPG	CHK SKD
DR NN/NR	APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-2
SEQ 6
DATE 03/2015
PROJ. NO. 614029.500



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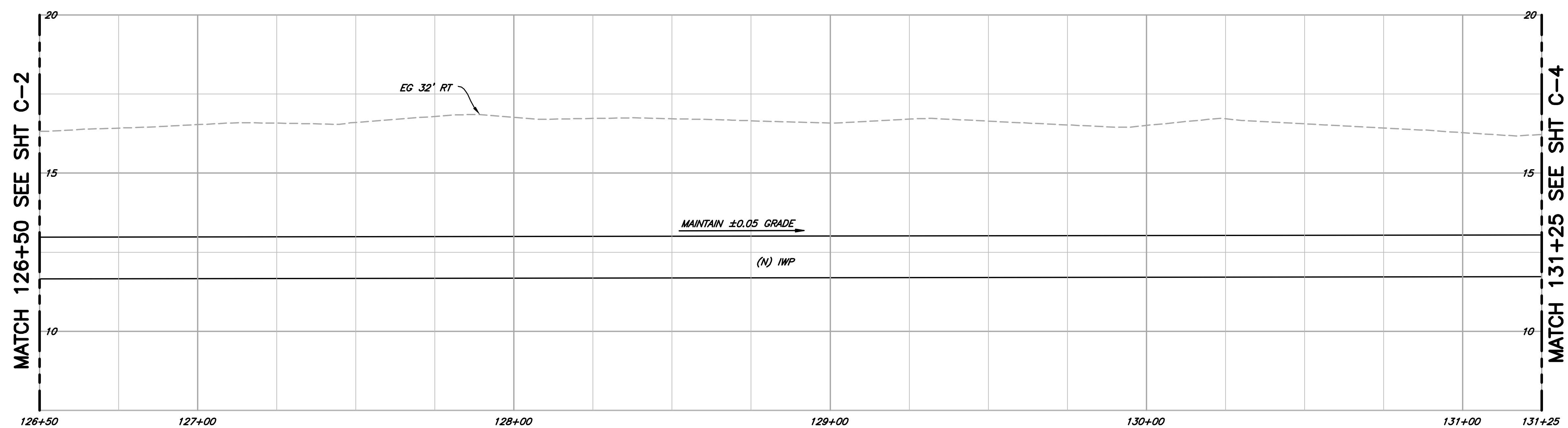

PROFILE
SCALE: 1"=20' H
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5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

SAVED: 3/28/2016 2:27 PM DREED, PLOTTED: 3/28/2016 3:13 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg

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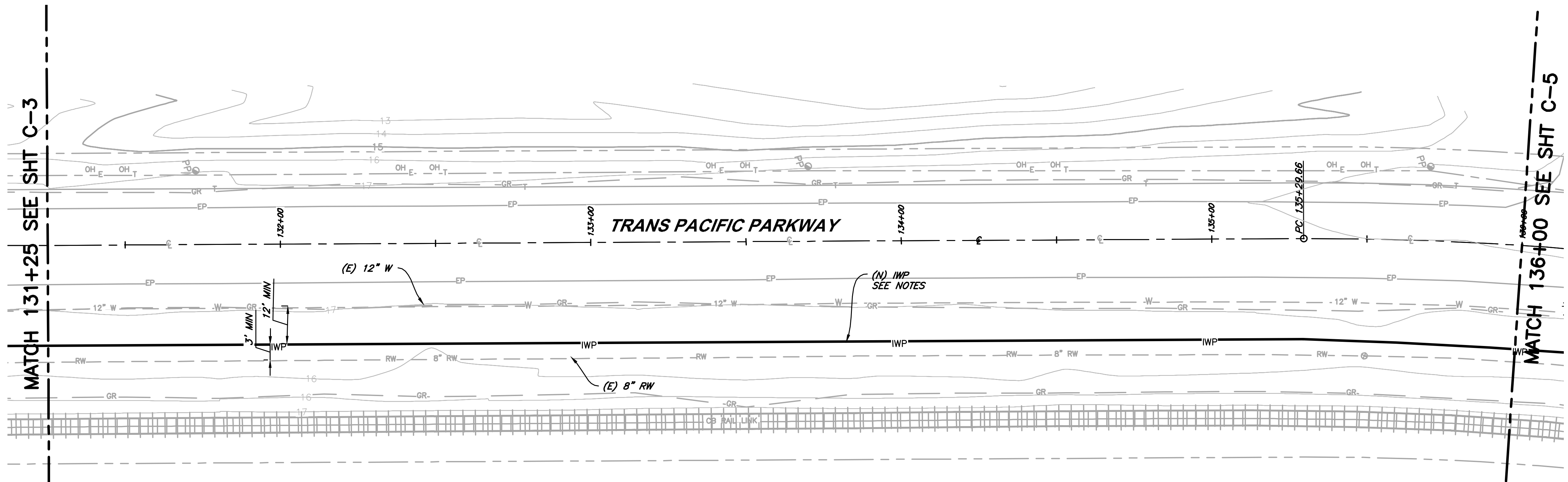
REV	Description:		
Doc. No:			
REV:	REV Date:		
DSGN	DPG	CHK	SKD
DR	NN/NR	APVD	

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-3
SEQ 7
DATE 03/2015
PROJ. NO. 614029.500



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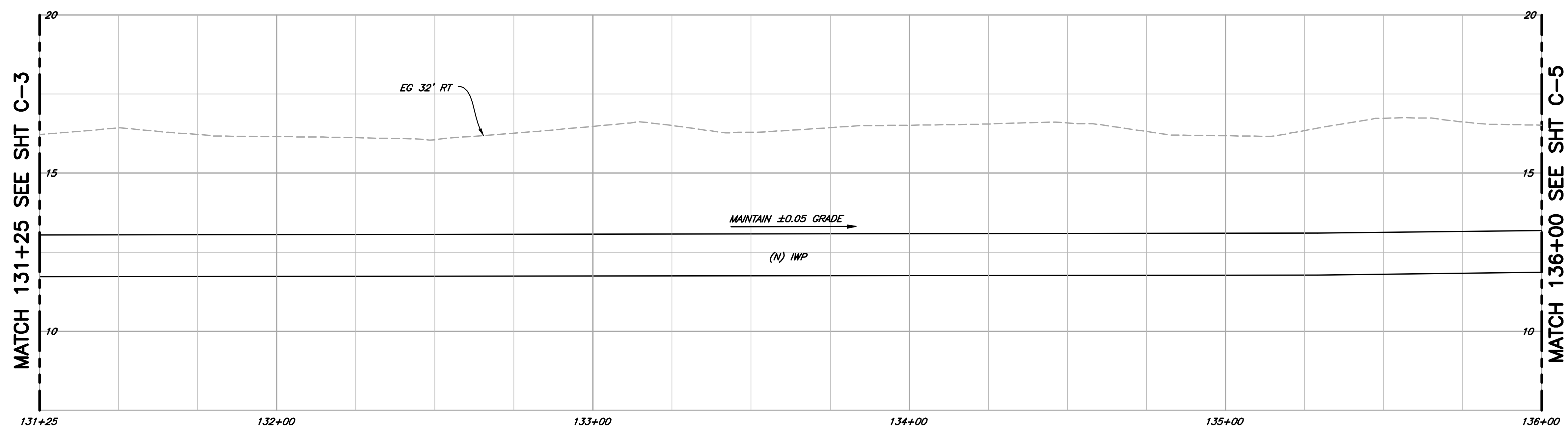

PROFILE
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DR NN/NR	APVD

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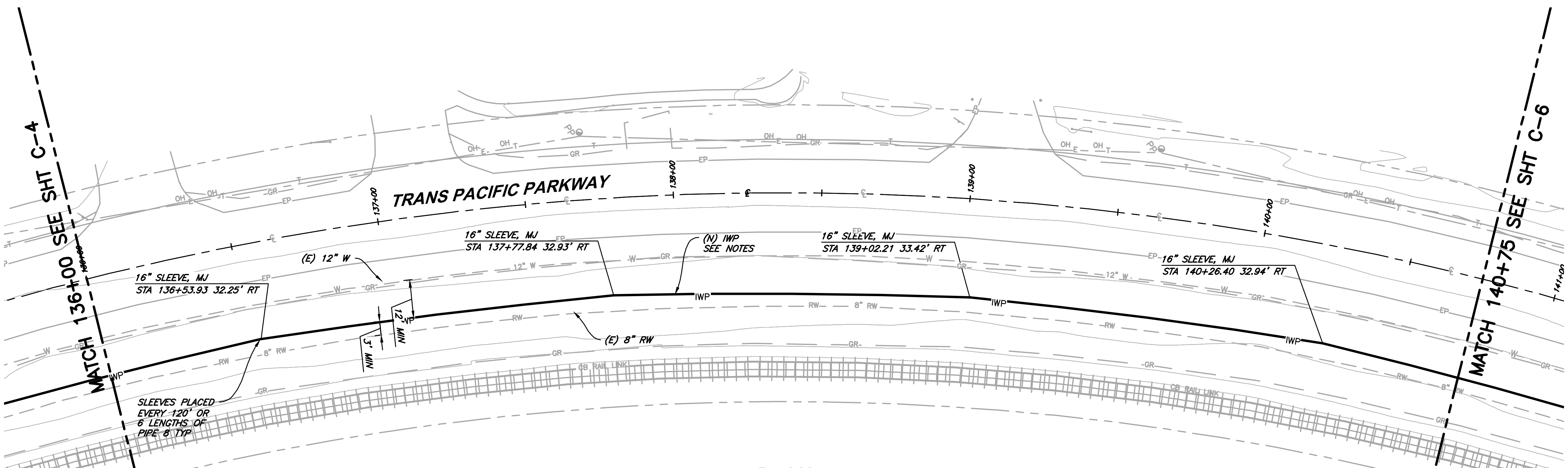
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-4
SEQ 8
DATE 03/2015
PROJ. NO. 614029.500



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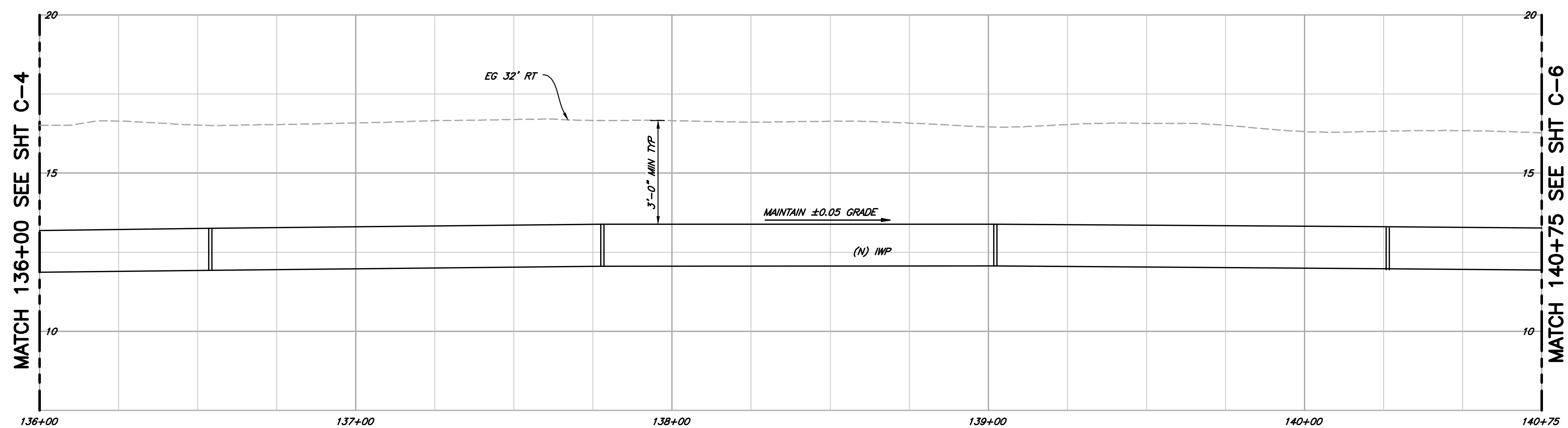

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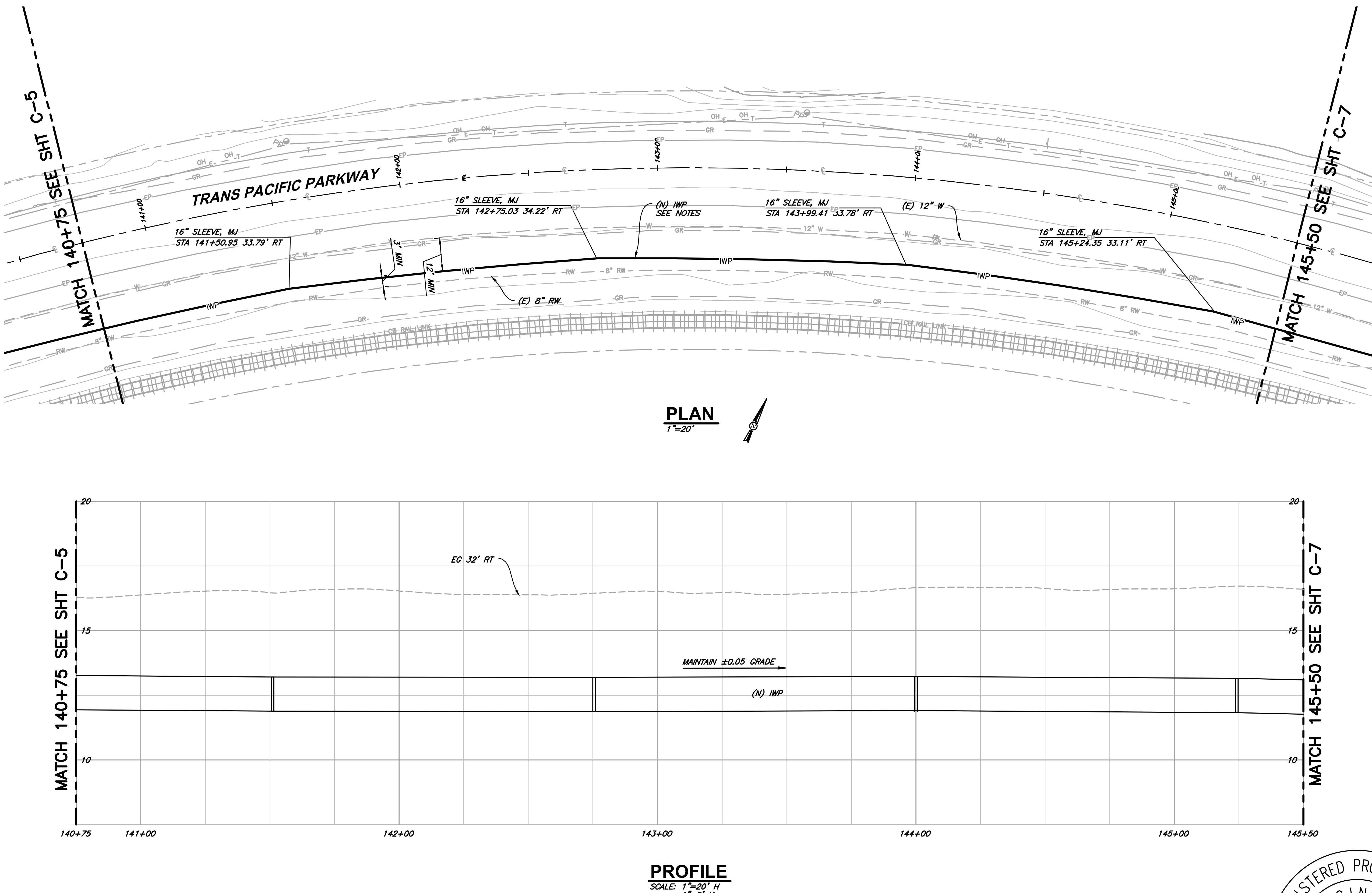
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-5
SEQ 9
DATE 03/2015
PROJ. NO. 614029.500



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RENEWS: 6/30/17

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WWW.SHN-ENGR.COM 541-266-9890

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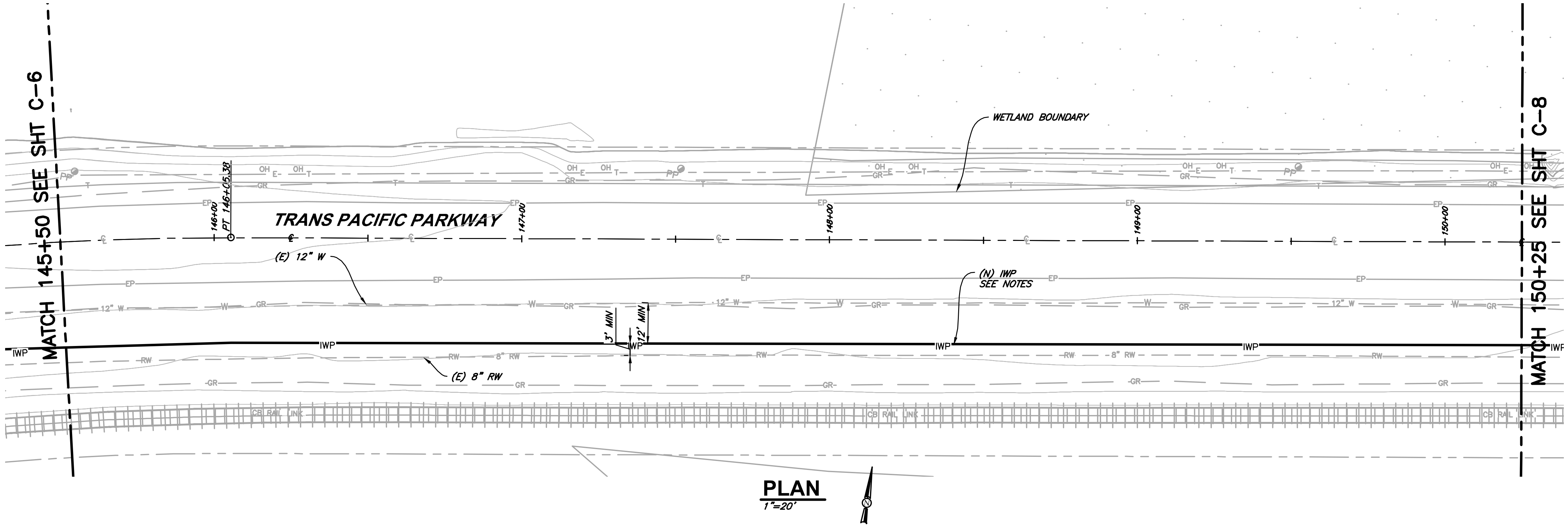
DSGN DPG | CHK SKD
DR NN/NR | APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
IWP PHASE 2
PLAN & PROFILE

SHEET C-6
SEQ 10
DATE 03/2015
PROJ. NO. 614029.500



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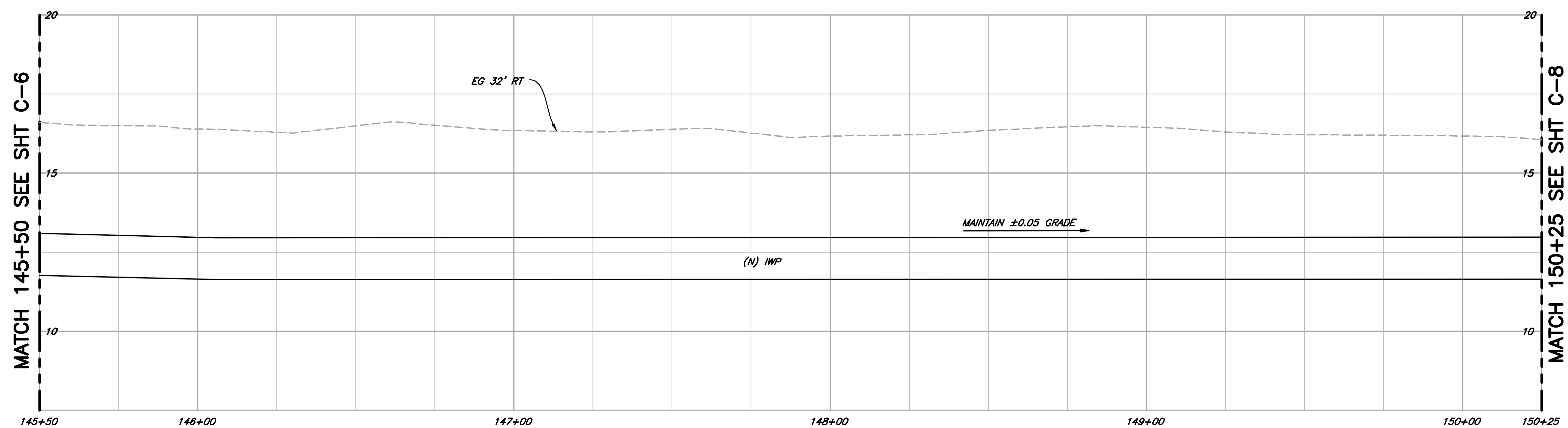

PROFILE
SCALE: 1"=20' H
1"=2' V

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\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg

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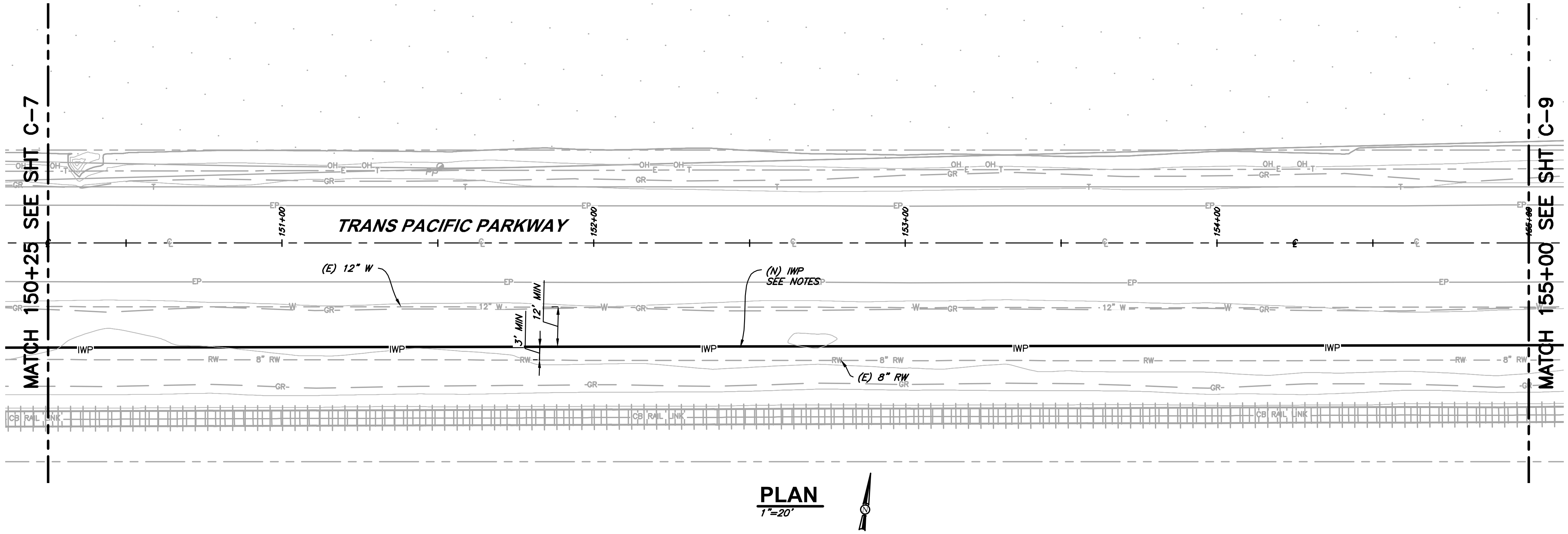
Doc No:	
REV:	REV Date:
DSGN DPG	CHK SKD
DR NN/NR	APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-7
SEQ 11
DATE 03/2015
PROJ. NO. 614029.500



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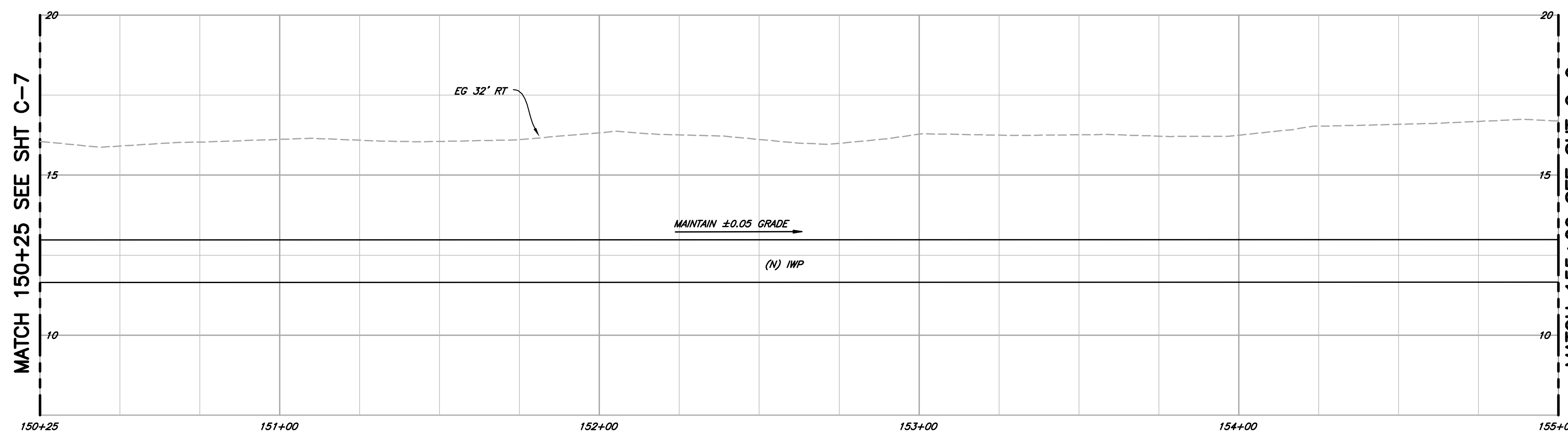

PROFILE
SCALE: 1"=20' H
1"=2' V

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5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

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\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg

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DSGN	DPG	CHK	SKD
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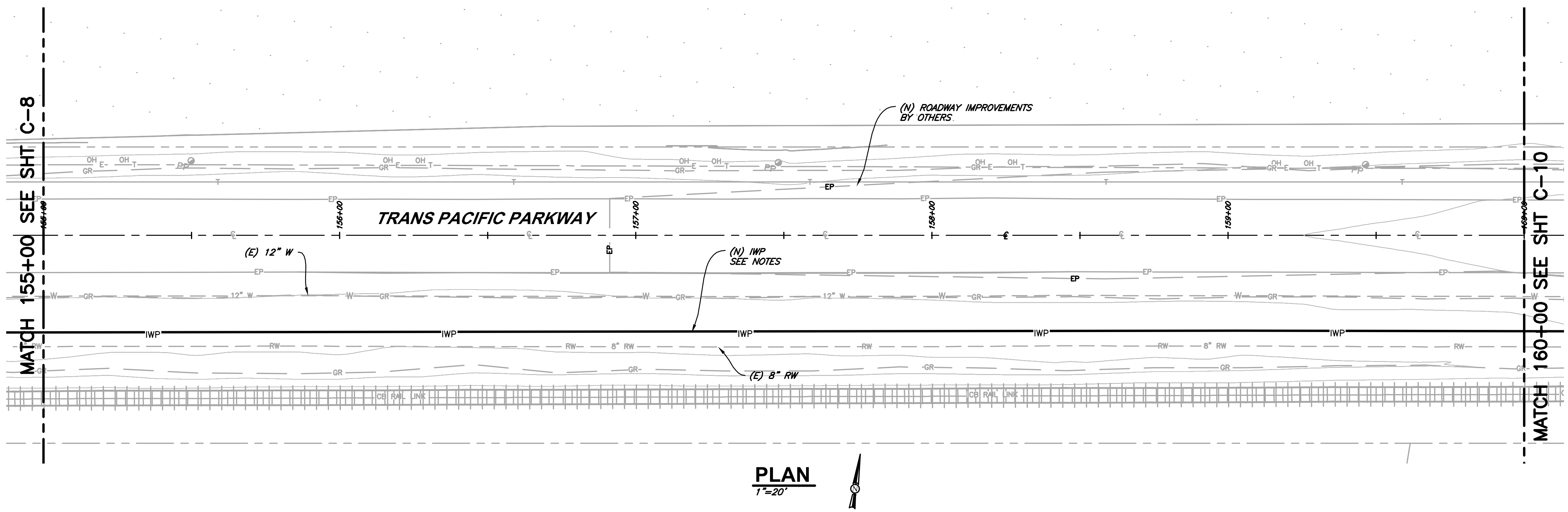
Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
IWP PHASE 2
PLAN & PROFILE

SHEET C-8
SEQ 12
DATE 03/2015
PROJ. NO. 614029.500



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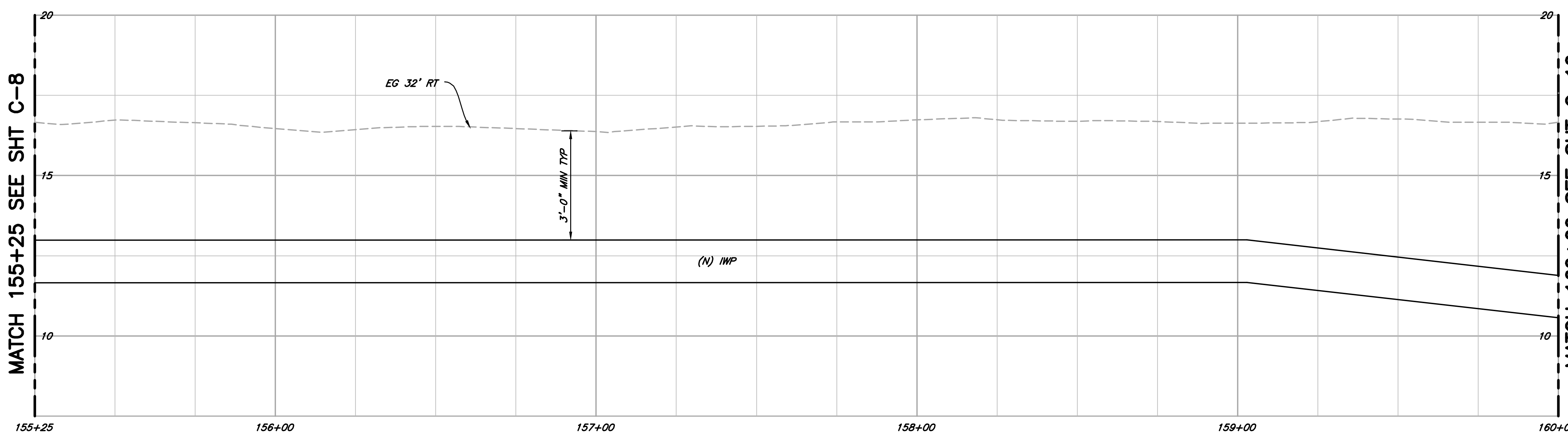

PROFILE
SCALE: 1"=20' H
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DSGN DPG	CHK SKD
DR NN/NR	APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2 PLAN & PROFILE

SHEET C-9
SEQ 13
DATE 03/2015
PROJ. NO. 614029.500

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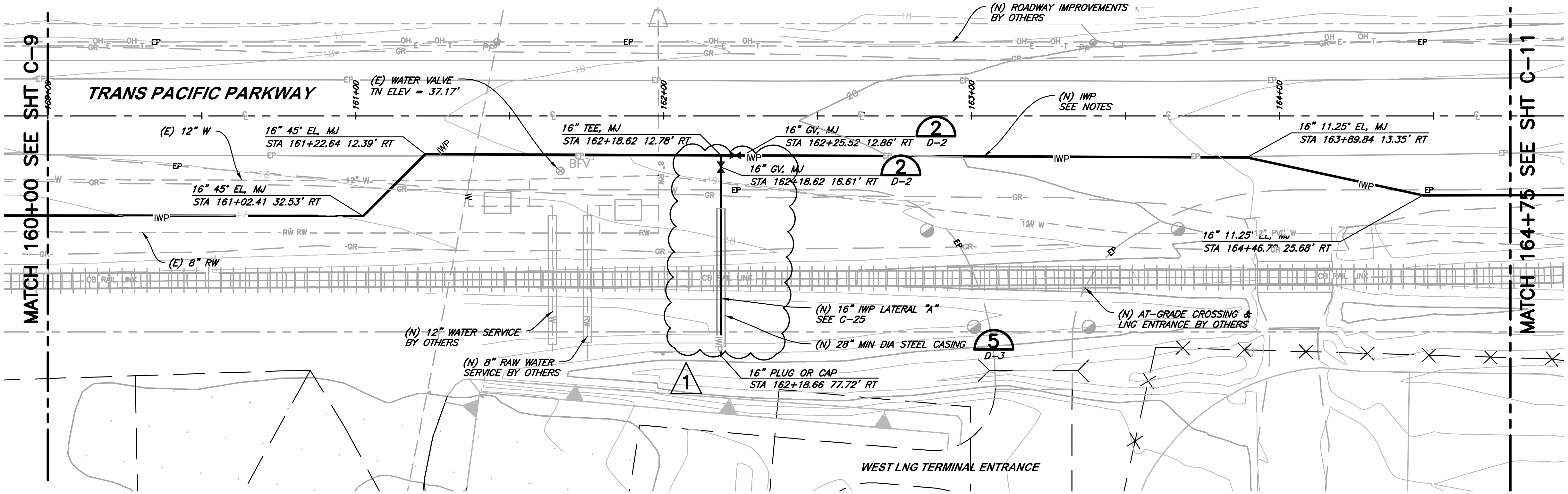

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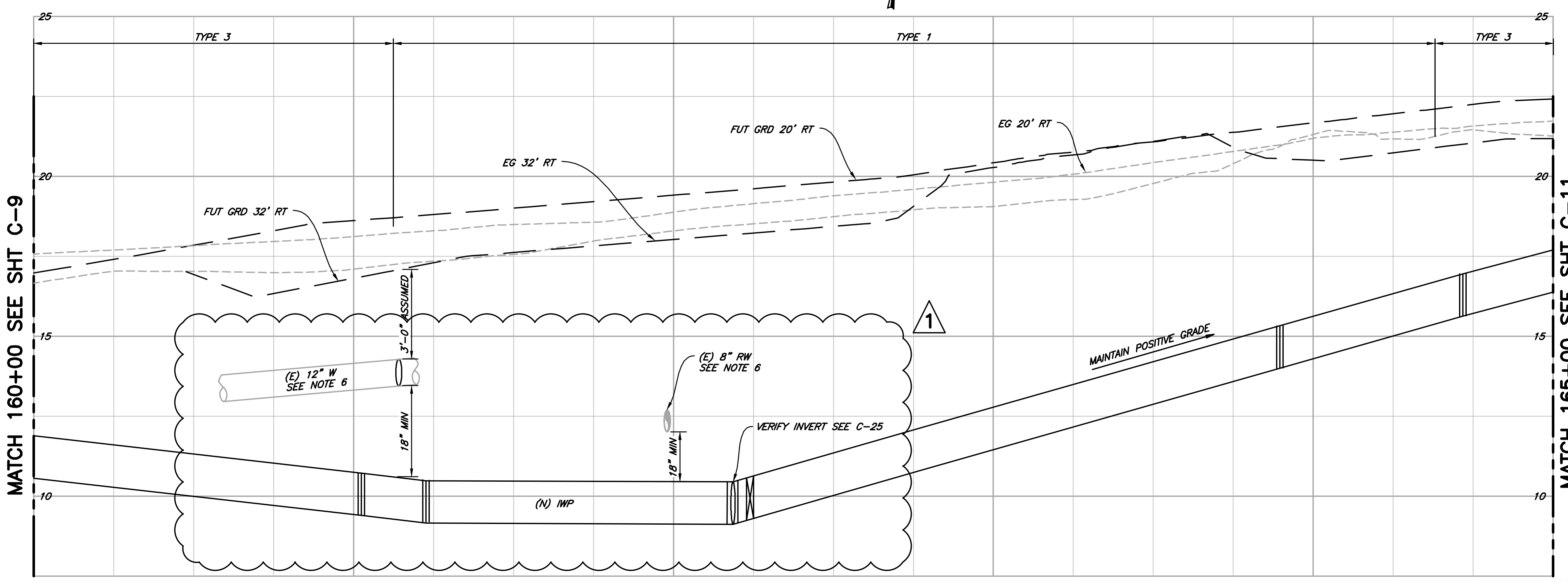

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5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.
6. IF LESS THAN 18" SEPARATION BETWEEN EXISTING WATER OR RAW WATER THEN CENTER 20'-0" STICK OF PIPE UNDER WATER CROSSING.

SAVED: 3/28/2016 2:27 PM DREED, PLOTTED: 3/28/2016 3:15 PM DAWN REED
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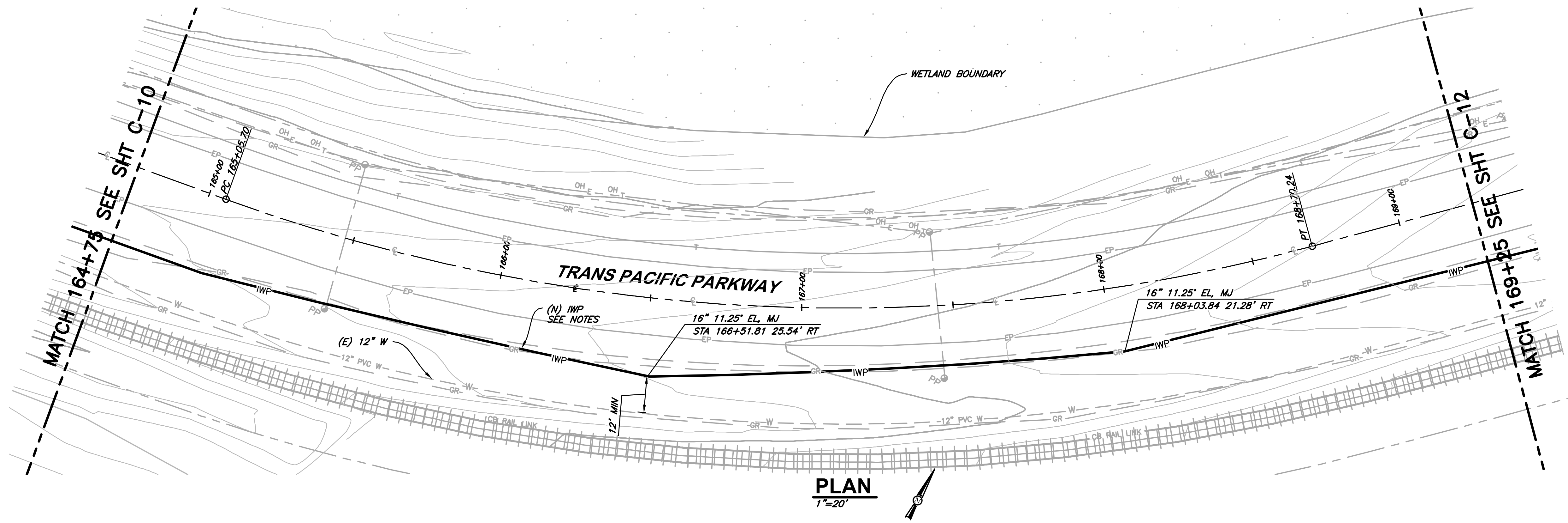
REV Description: REVISION
Doc No:
REV: 1 REV Date: 03/17/2016
DSGN DPG CHK SKD
DR NN/NR APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
IWP PHASE 2
PLAN & PROFILE

SHEET C-10
SEQ 14
DATE 03/2015
PROJ. NO. 614029.500



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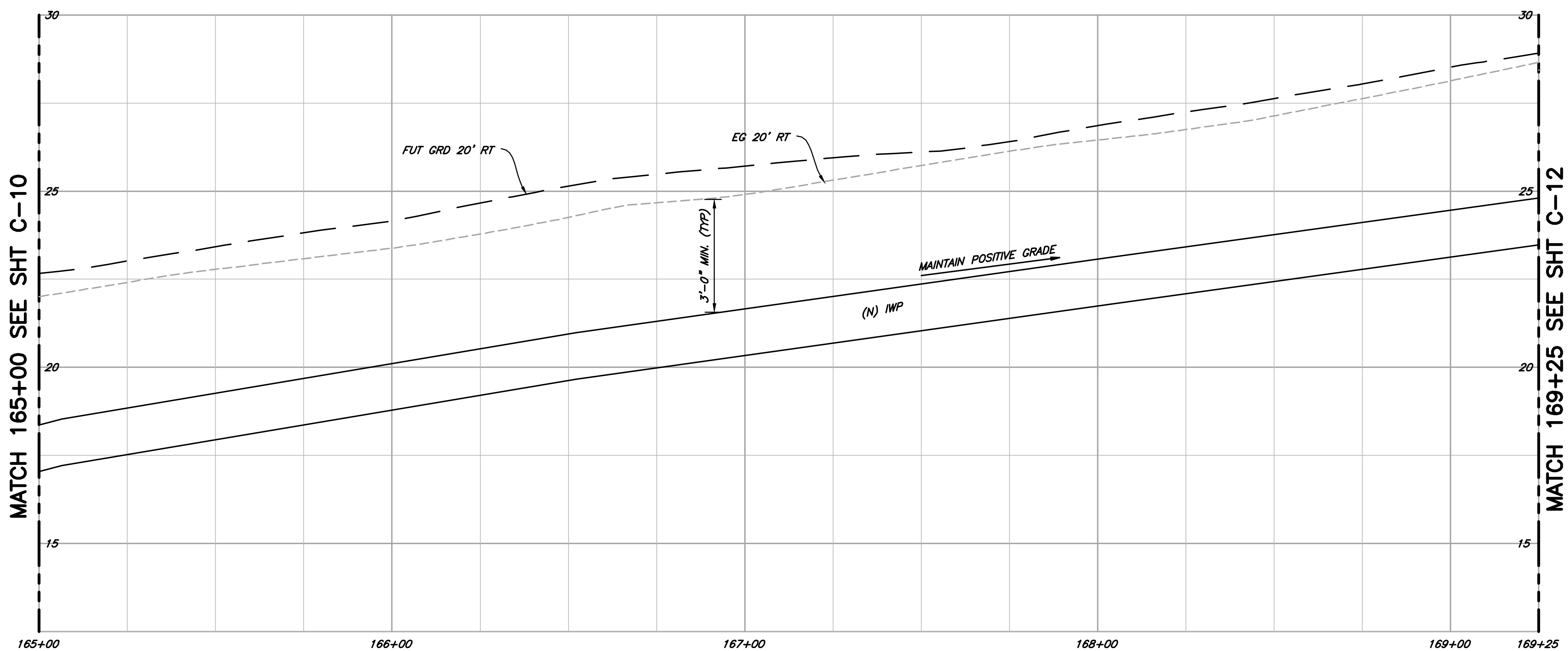

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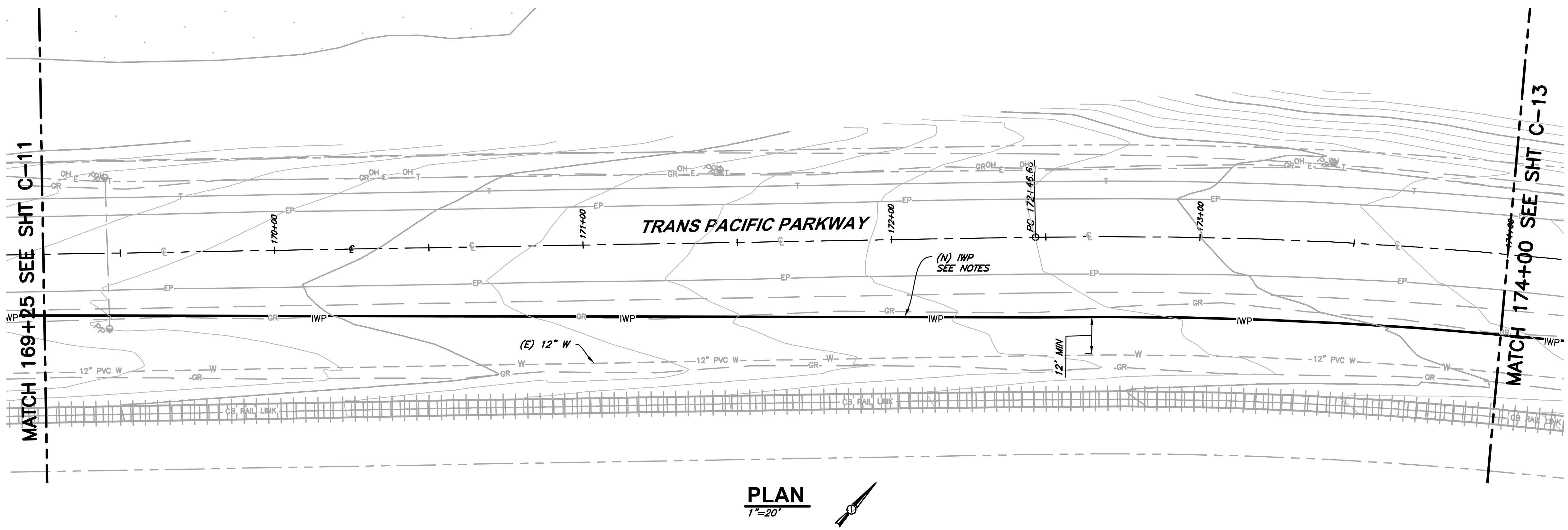
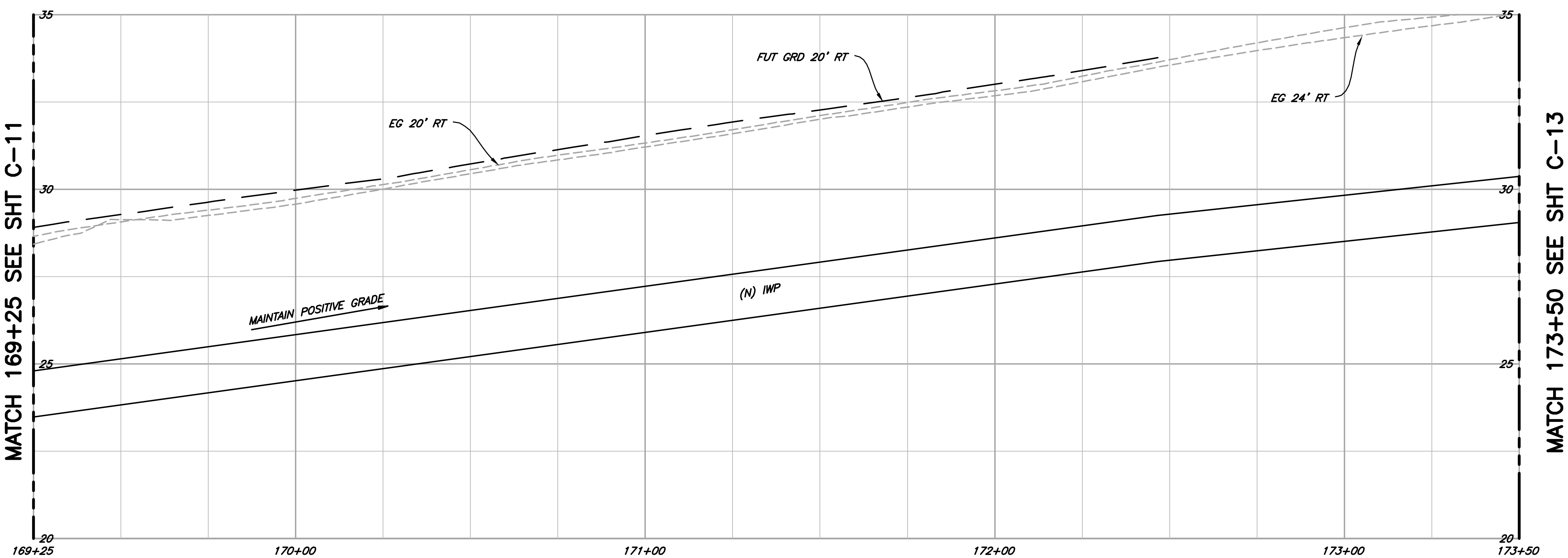
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-11
SEQ 15
DATE 03/2015
PROJ. NO. 614029.500



PLAN
1"=20'



PROFILE
SCALE: 1"=20' H
1"=2' V

NOTES:

1. MAINTAIN 12' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL WATER PIPE. IF LESS THAN 10' OUTSIDE TO OUTSIDE OF PIPES IWP MUST BE BELOW PARALLEL WATER PIPE.
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3. POTHOLE & VERIFY WATER PIPE LOCATION & DEPTH EVERY 1000' ON TANGENTS AND 500' ON CURVES OR AS DIRECTED.
4. MAXIMUM 3° DEFLECTION PER 20' PIPE SECTION.
5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

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\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg

REGISTERED PROFESSIONAL ENGINEER 15,479 OREGON JULY 25, 1991 DANIEL P. GRABER
RENEWS: 6/30/17

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

SHN CONSULTING ENGINEERS & GEOLOGISTS, INC.
275 MARKET AVENUE, COOS BAY, OR. 97420
WWW.SHN-ENGR.COM 541-266-9890

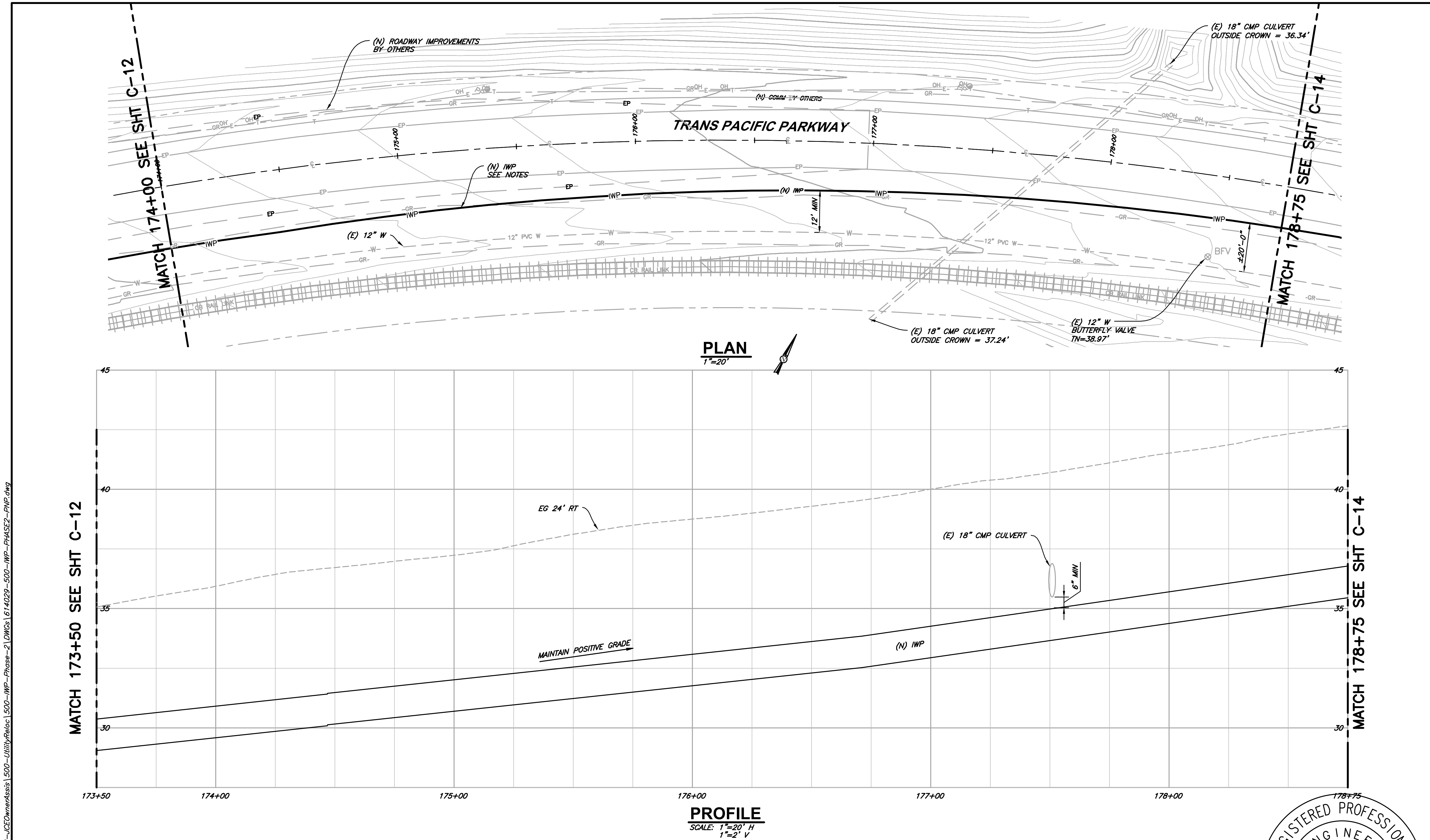
REV	Description:	Doc. No:	REV Date:
DSGN	DPG	CHK	SKD
DR	NN/NR	APVD	

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2 PLAN & PROFILE

SHEET C-12
SEQ 16
DATE 03/2015
PROJ. NO. 614029.500



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REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

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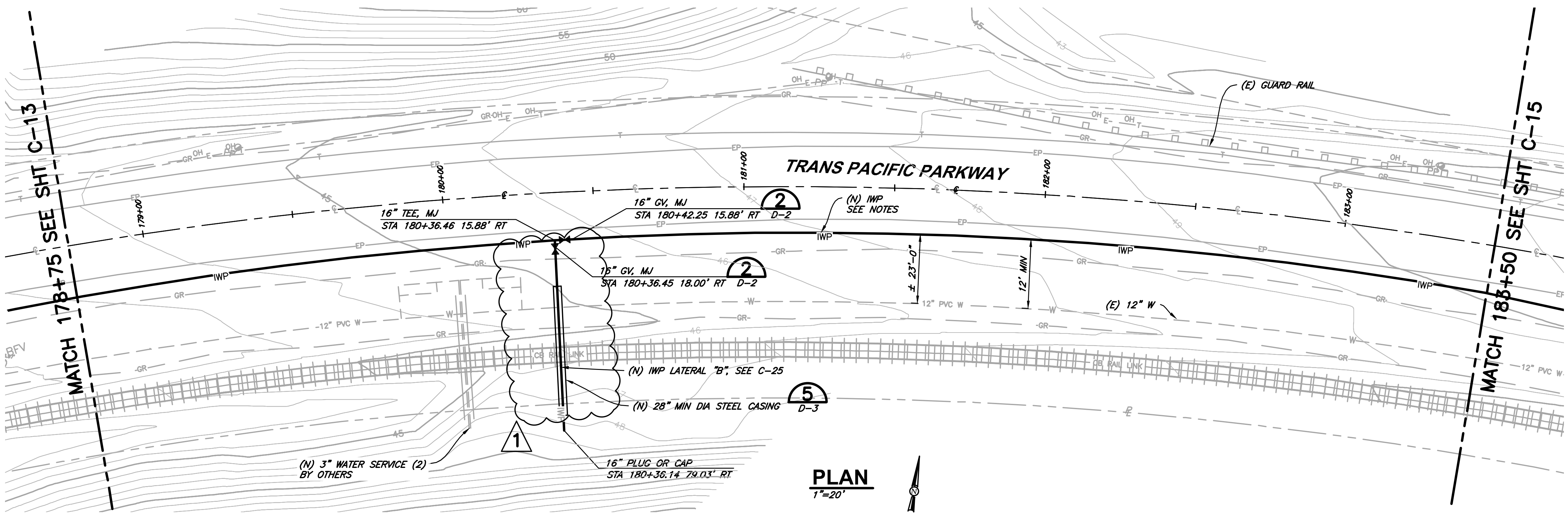
REV Description:
Doc No:
REV: | REV Date:
DSGN DPG | CHK SKD
DR NN/NR | APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2 PLAN & PROFILE

SHEET C-13
SEQ 17
DATE 03/2015
PROJ. NO. 614029.500



PLAN
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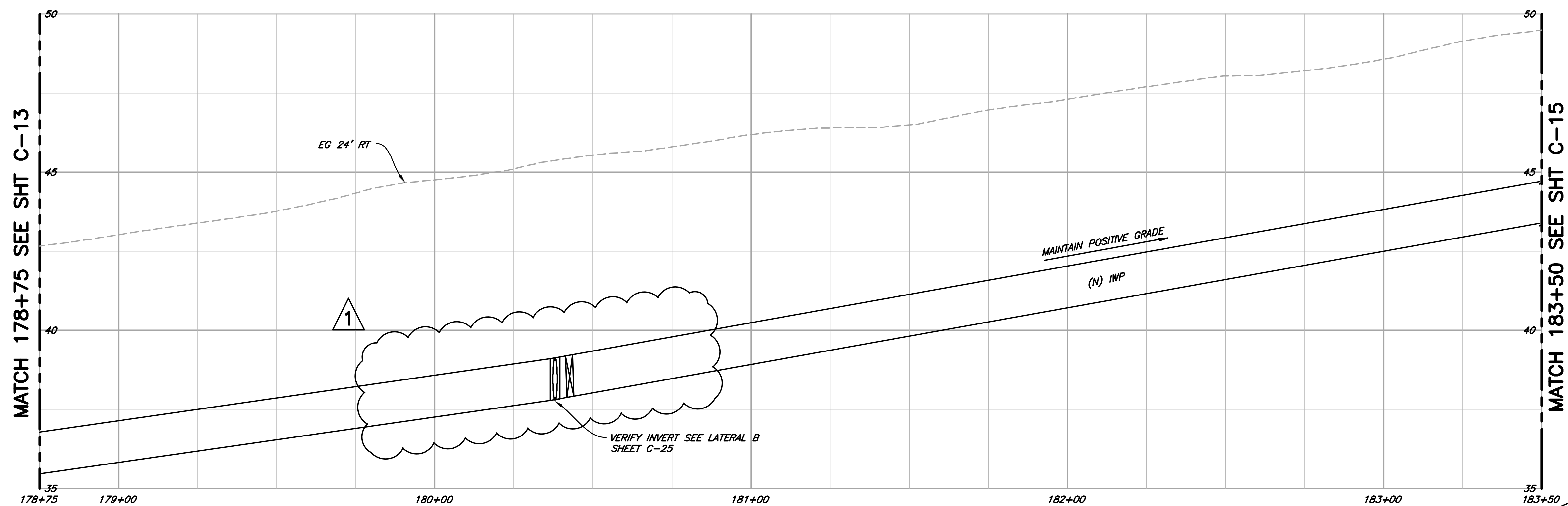

PROFILE
SCALE: 1"=20' H
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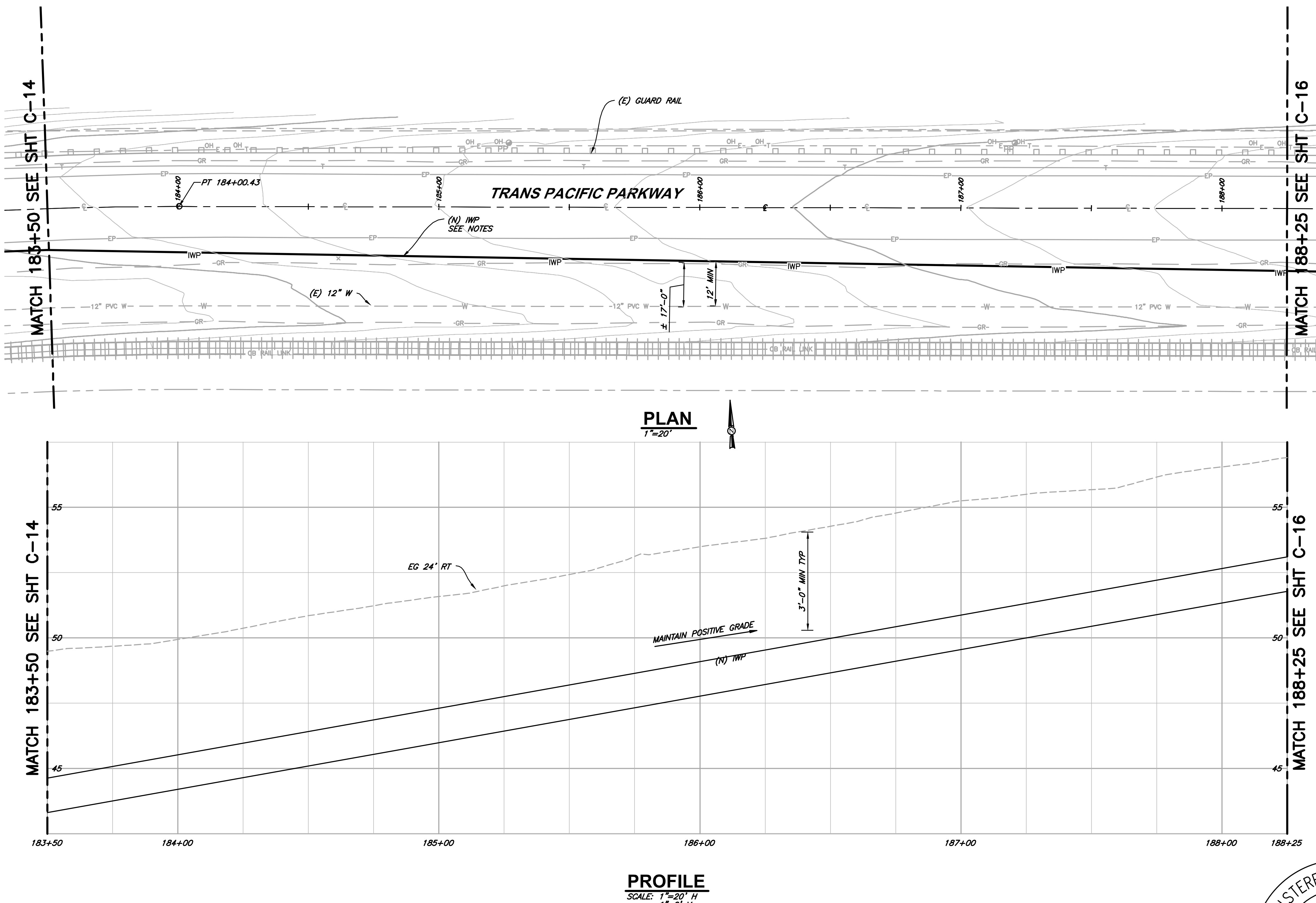
Doc. No:
REV: 1 REV Date: 03/17/2016
DSGN DPG | CHK SKD
DR NN/NR | APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
IWP PHASE 2
PLAN & PROFILE

SHEET C-14
SEQ 18
DATE 03/2015
PROJ. NO. 614029.500



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JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-15
SEQ 19
DATE 03/2015
PROJ. NO. 614029.500

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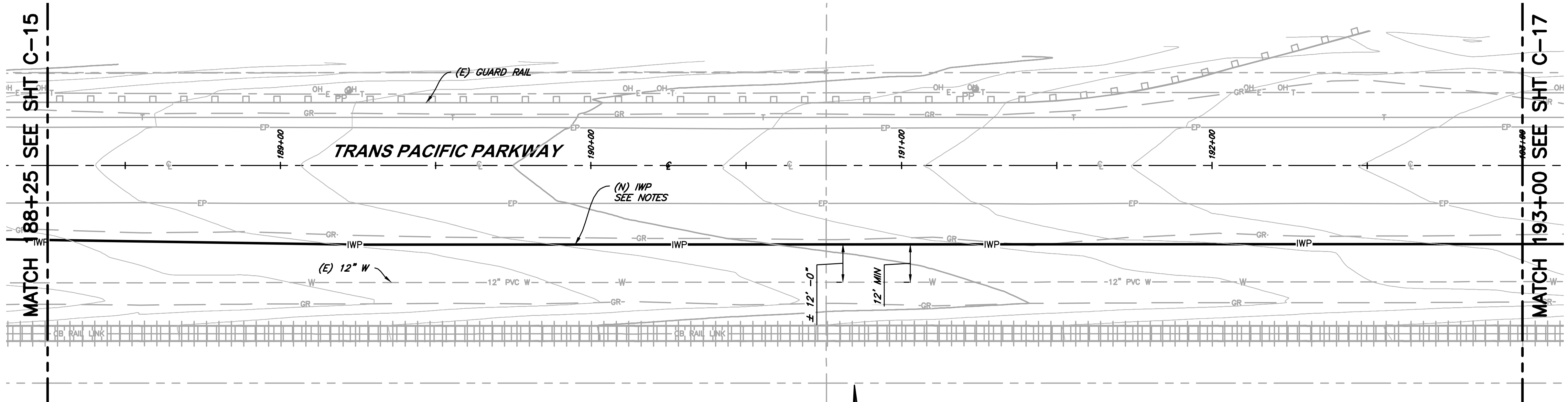

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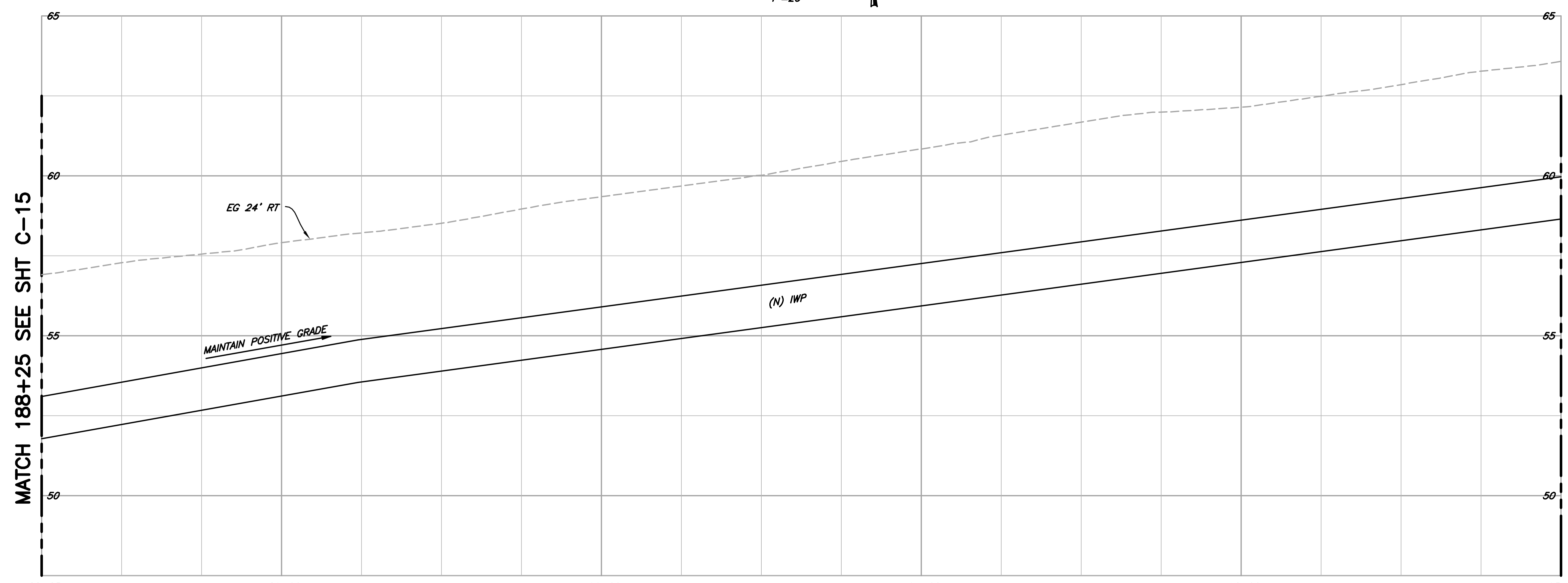

PROFILE
SCALE: 1"=20' H
1"=2' V

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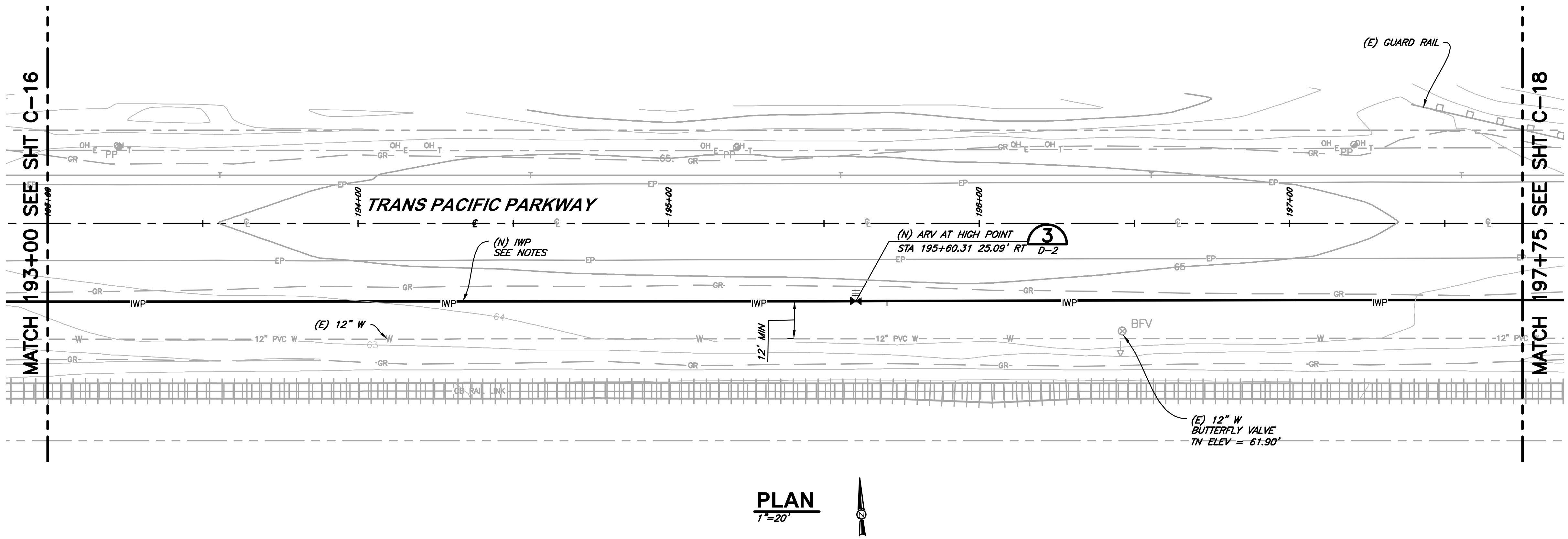
WWW.SHN-ENGR.COM
541-266-9890

REV Description:
Doc. No:
REV: | REV Date:
DSGN DPG | CHK SKD
DR NN/NR | APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
IWP PHASE 2
PLAN & PROFILE

SHEET C-16
SEQ 20
DATE 03/2015
PROJ. NO. 614029.500



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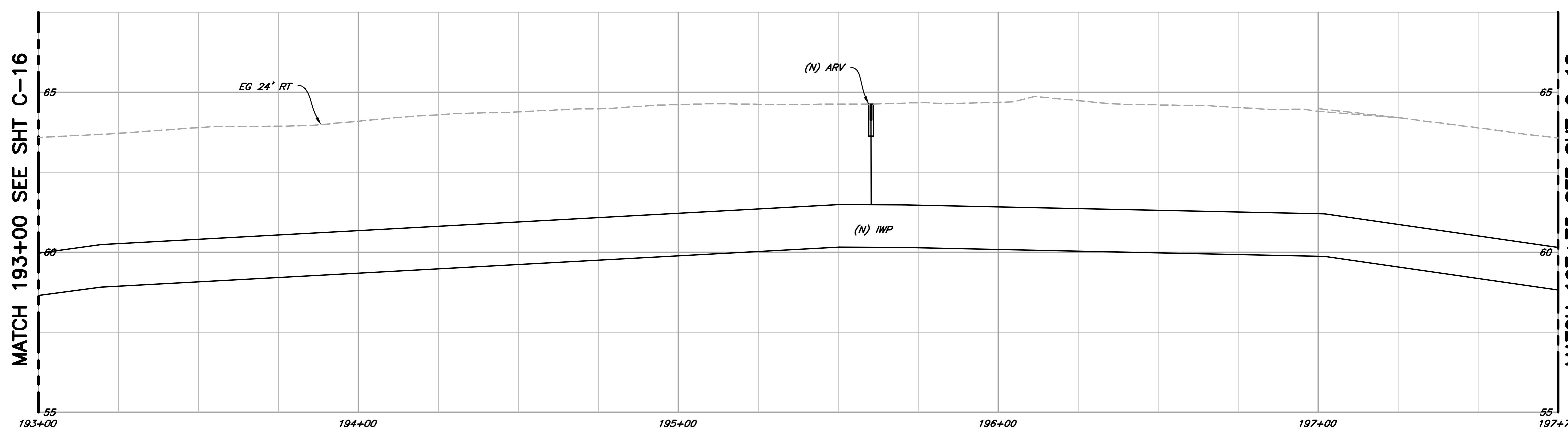

PROFILE
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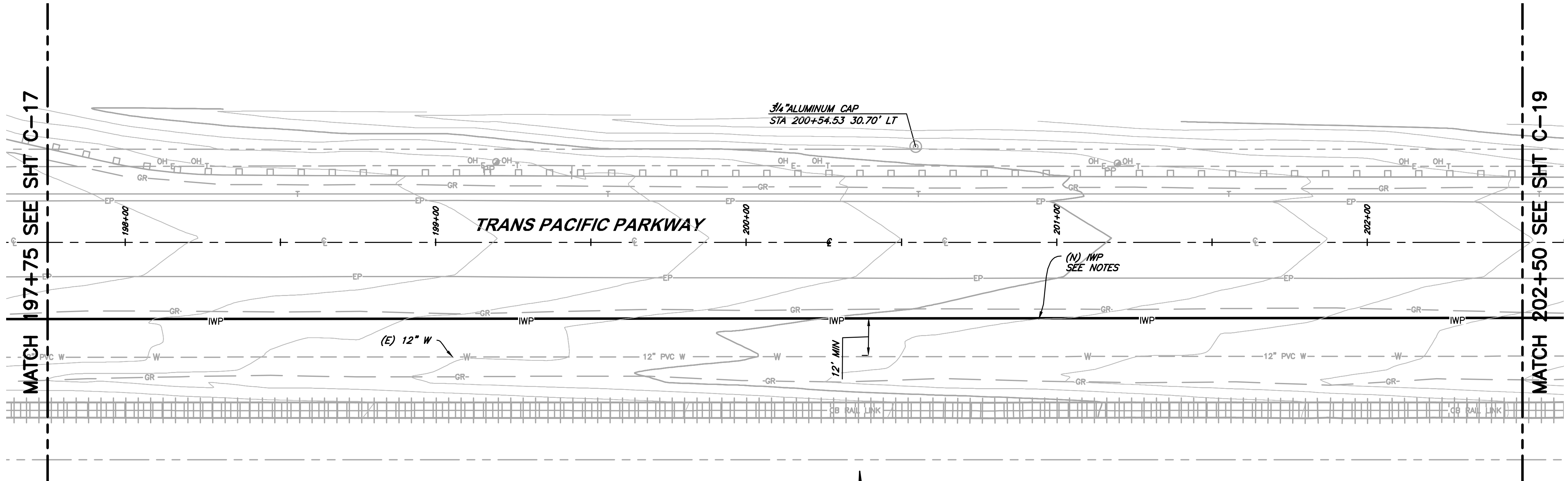
JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-17
SEQ 21
DATE 03/2015
PROJ. NO. 614029.500



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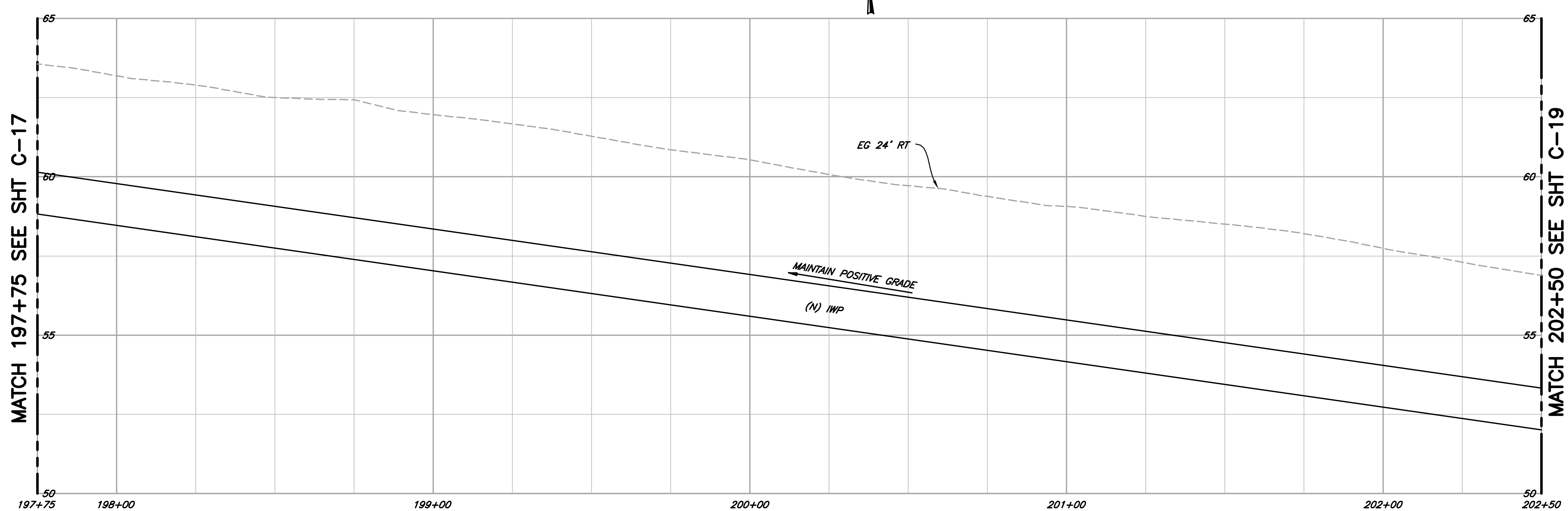

PROFILE
SCALE: 1"=20' H
1"=2' V

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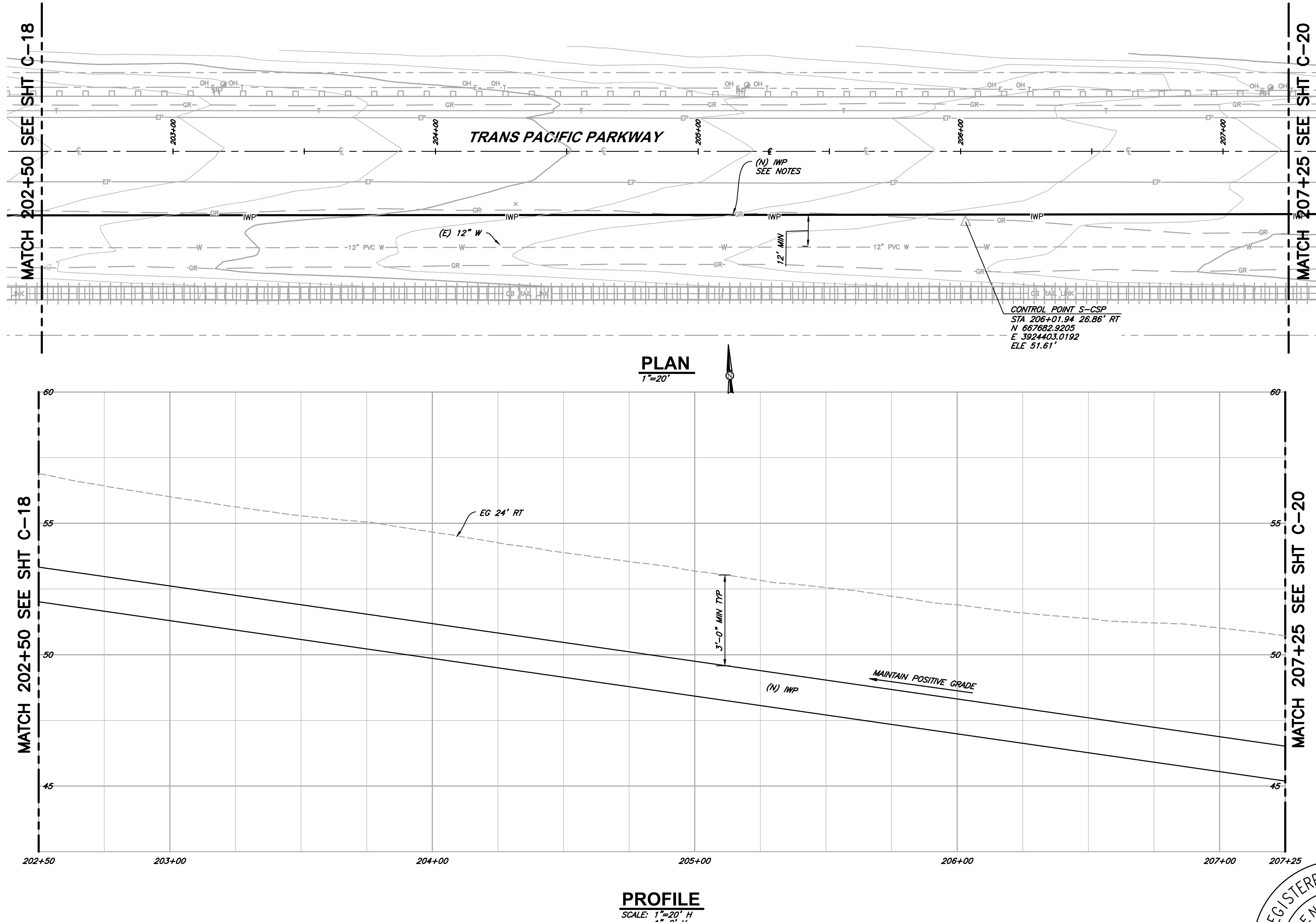
Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-18
SEQ 22
DATE 03/2015
PROJ. NO. 614029.500



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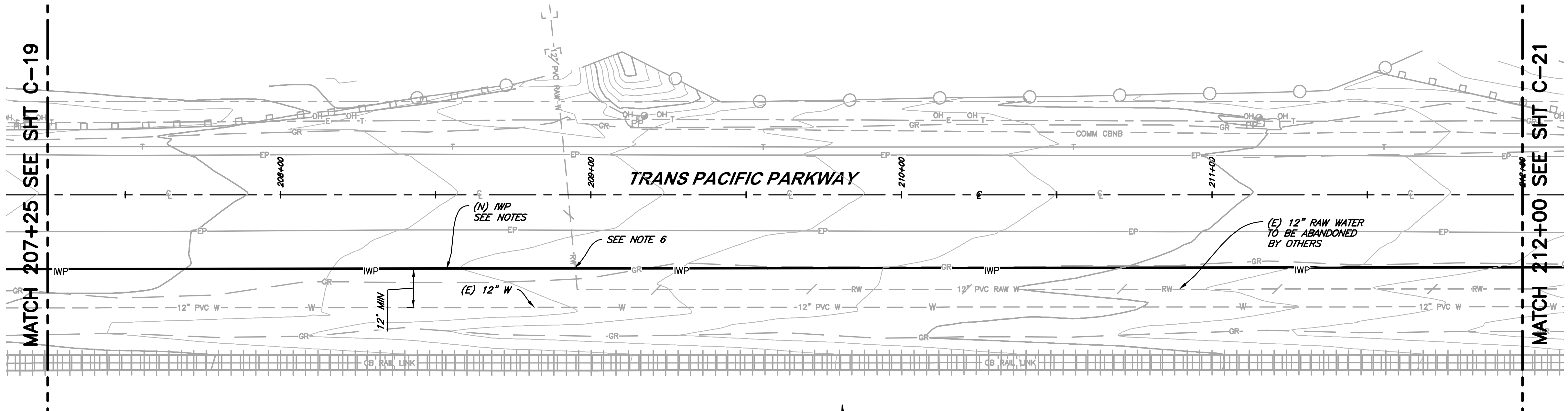
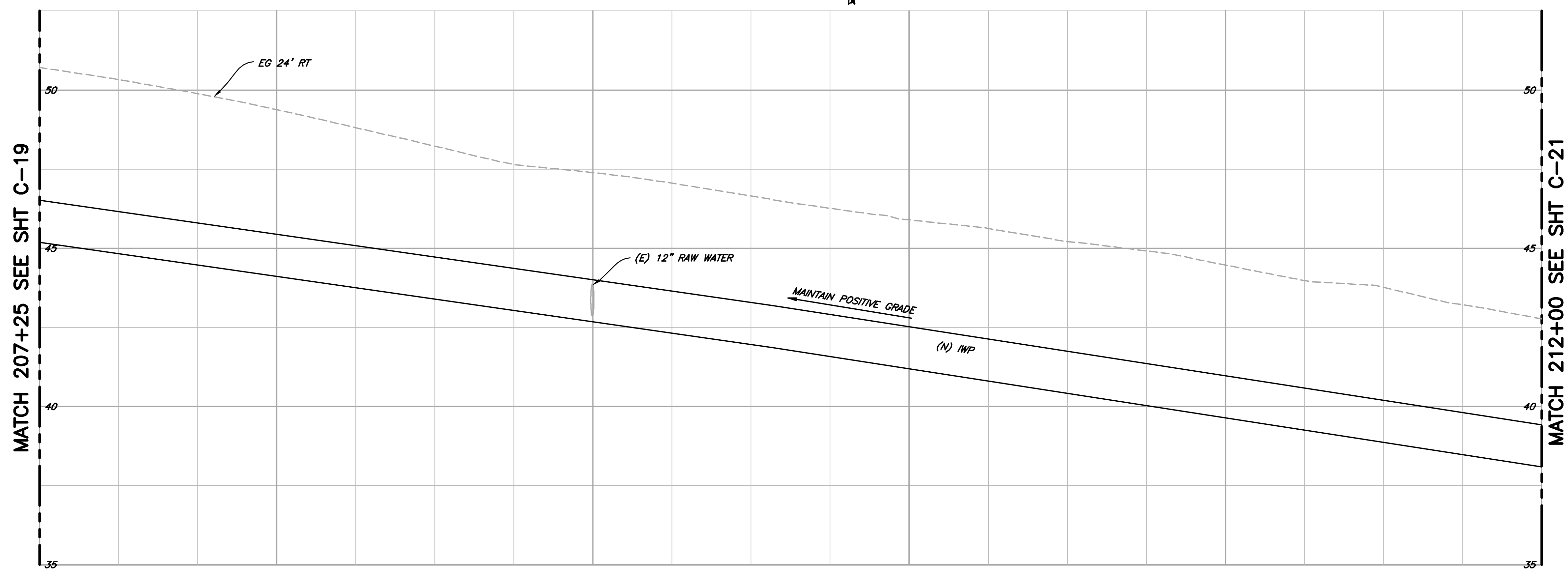
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
IWP PHASE 2
PLAN & PROFILE

SHEET C-19
SEQ 23
DATE 03/2015
PROJ. NO. 614029.500



PLAN
1"=20'



PROFILE
SCALE: 1"=20' H
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6. IF EXISTING PIPE IS IN CONFLICT CUT EXISTING PIPE MIN 5' EACH SIDE OF IWP. CAP OR PLUG PORTALS.

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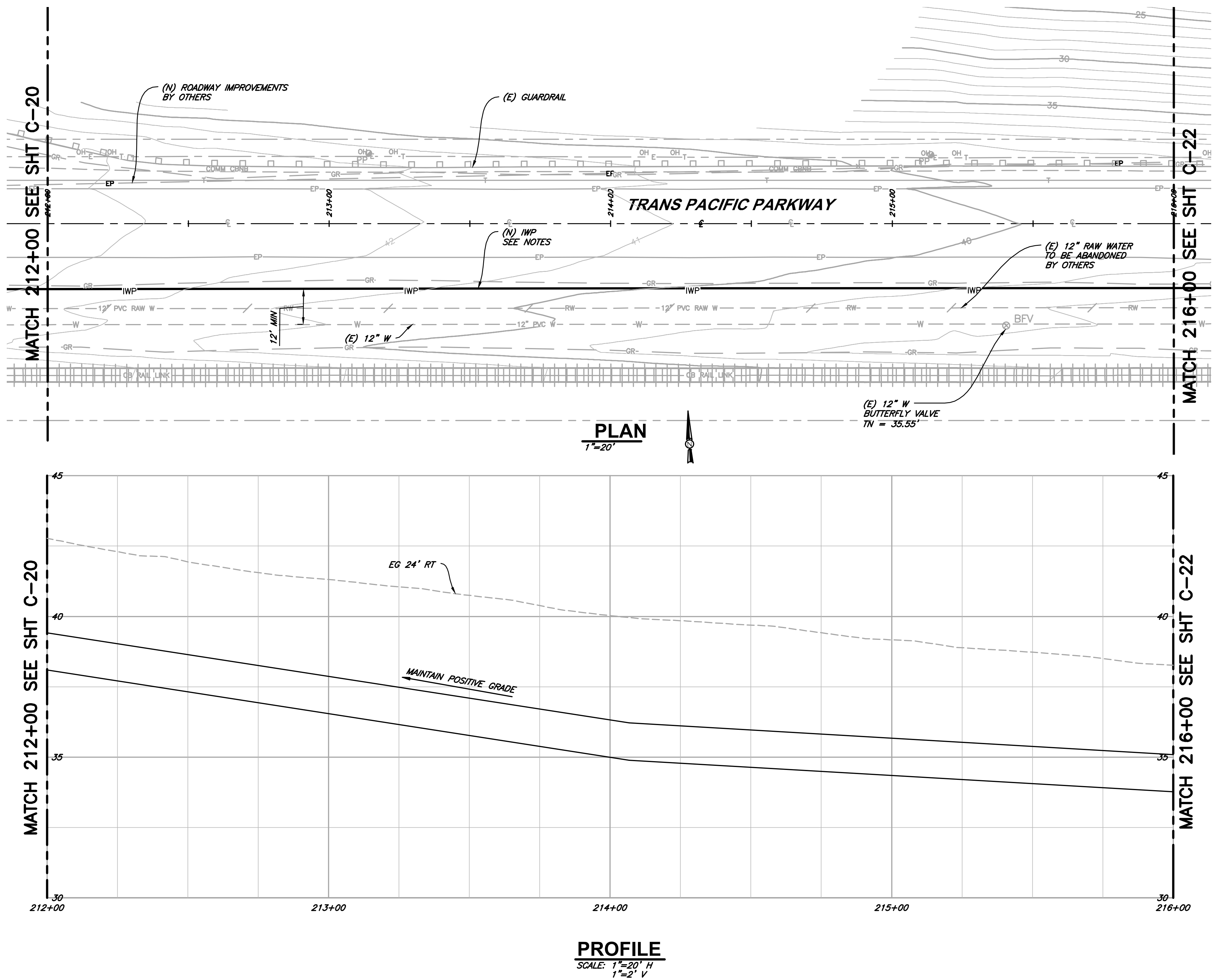
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-20
SEQ 24
DATE 03/2015
PROJ. NO. 614029.500



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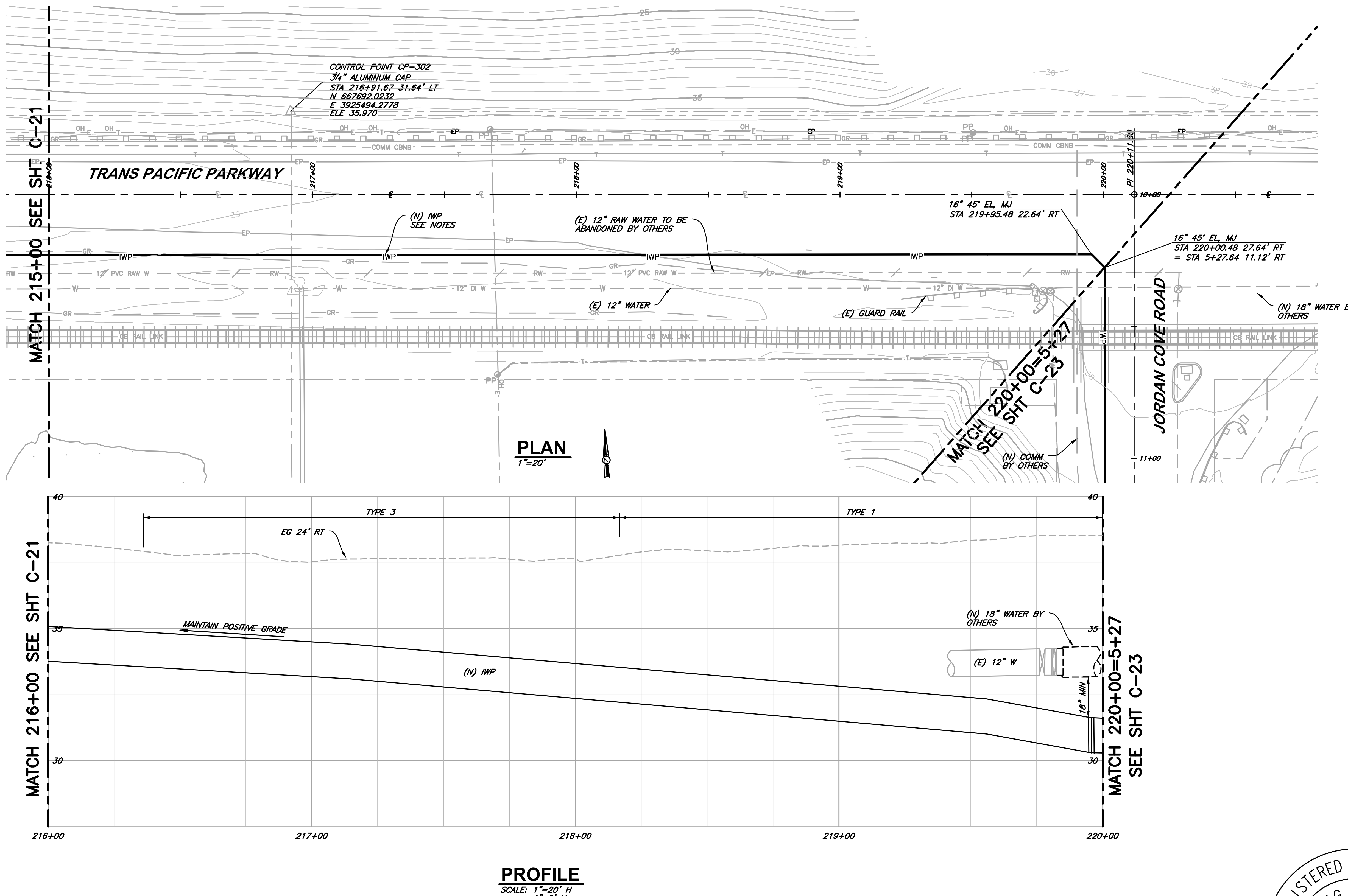
Doc. No:
REV: REV Date:
DSGN DPG CHK SKD
DR NN/NR APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2 PLAN & PROFILE

SHEET C-21
SEQ 25
DATE 03/2015
PROJ. NO. 614029.500



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BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
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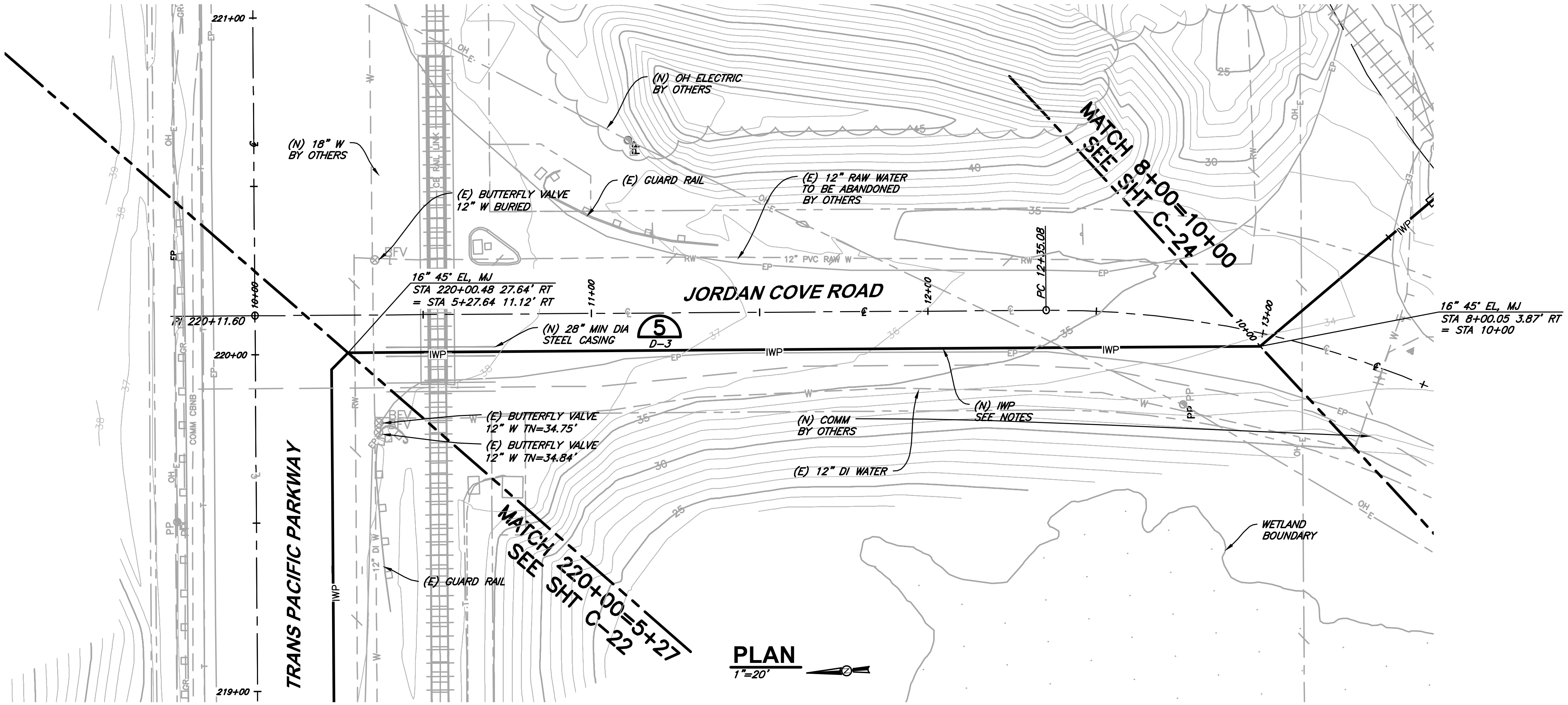
541-266-9890

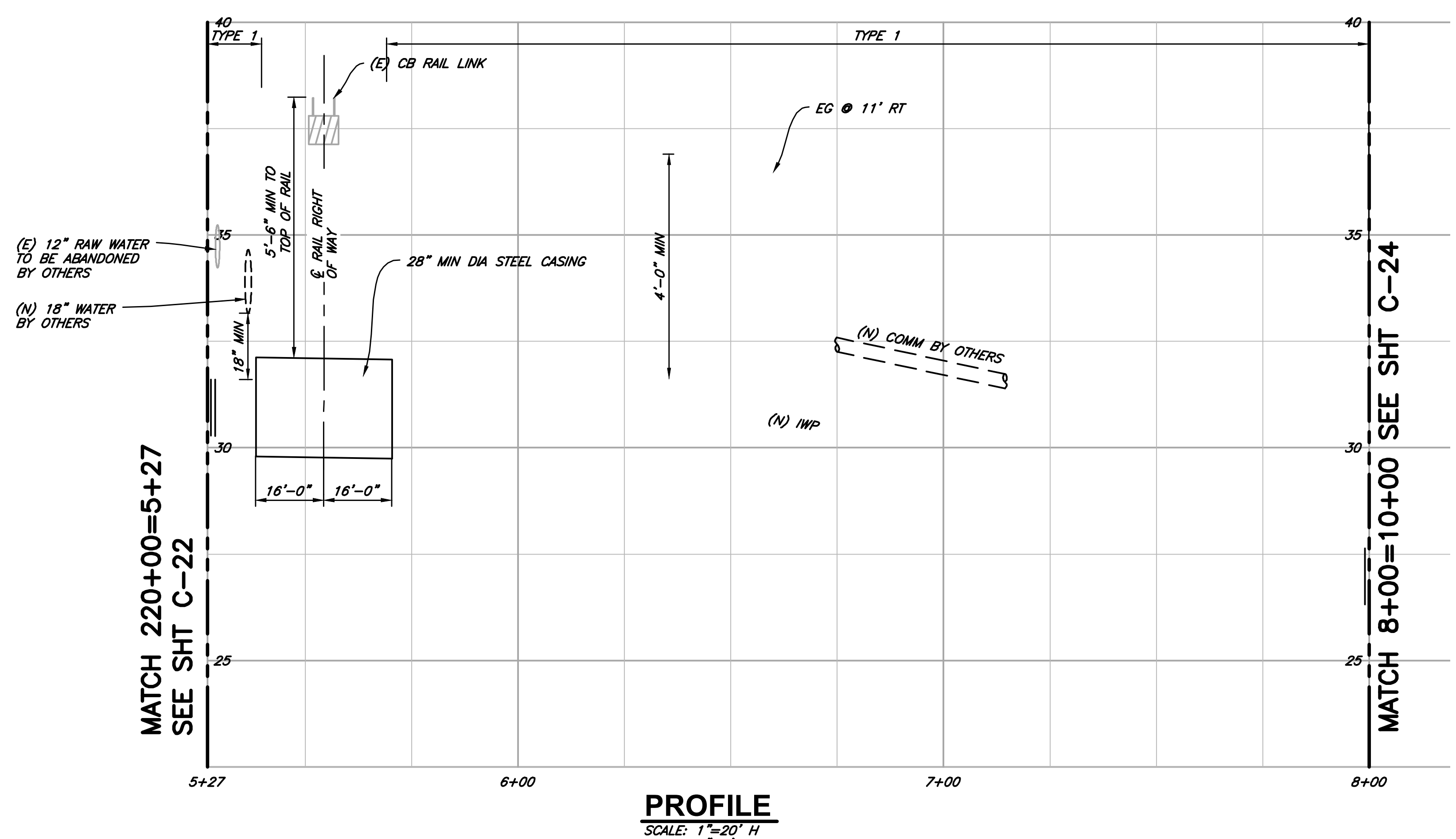
REV	Description:		
Doc No:			
REV:	REV Date:		
DSGN	DPG	CHK	SKD
DR	NN/NR	APVD	

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR
IWP PHASE 2
PLAN & PROFILE

SHEET C-22
SEQ 26
DATE 03/2015
PROJ. NO. 614029.500





NOTES:

1. MAINTAIN 12' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL WATER PIPE. IF LESS THAN 10' OUTSIDE TO OUTSIDE OF PIPES IWP MUST BE BELOW PARALLEL WATER PIPE.
2. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL RAW WATER PIPE.
3. POTHOLE & VERIFY WATER PIPE LOCATION & DEPTH EVERY 1000' ON TANGENTS AND 500' ON CURVES OR AS DIRECTED.
4. MAXIMUM 3° DEFLECTION PER 20' PIPE SECTION.
5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

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WWW.SHN-ENGR.COM 541-266-9890

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DSGN	DPG	CHK	SKD
DR	NN/NR	APVD	

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-23
SEQ 27
DATE 03/2015
PROJ. NO. 614029.500

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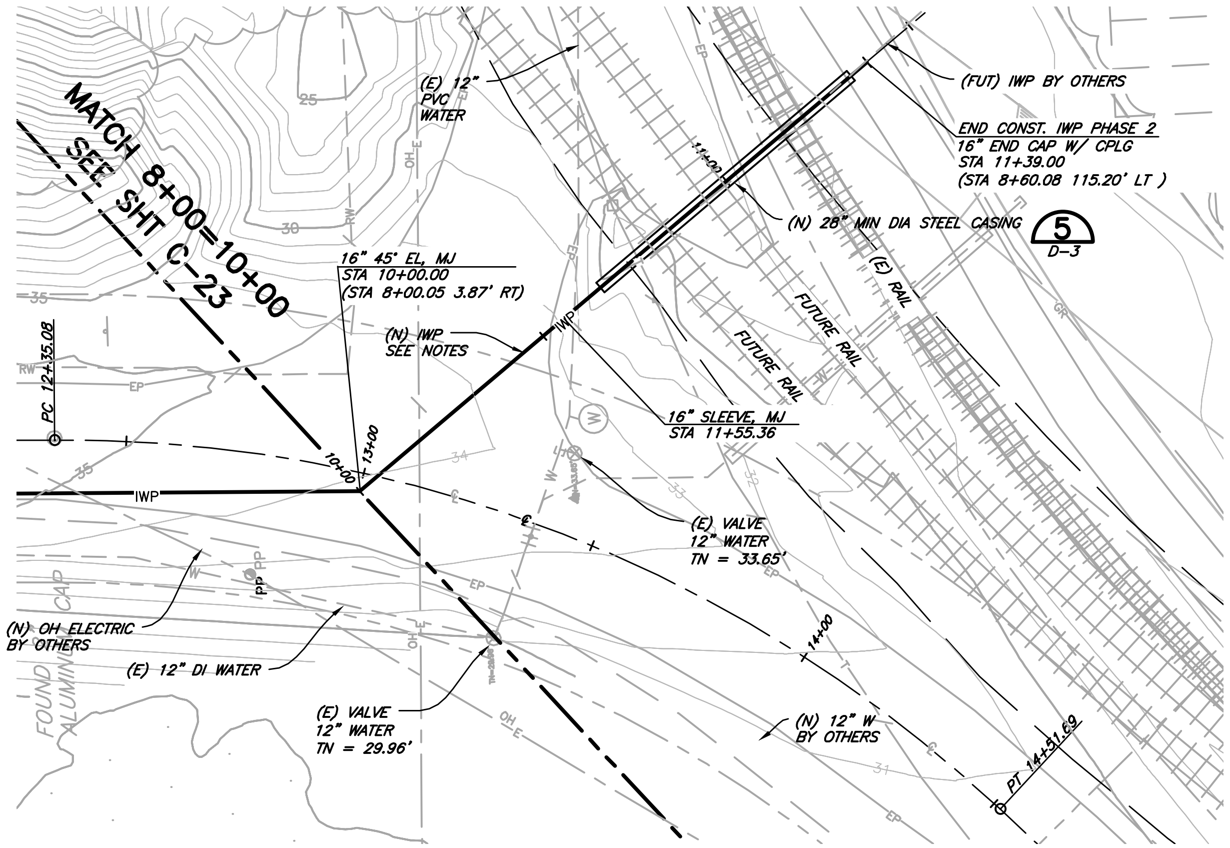
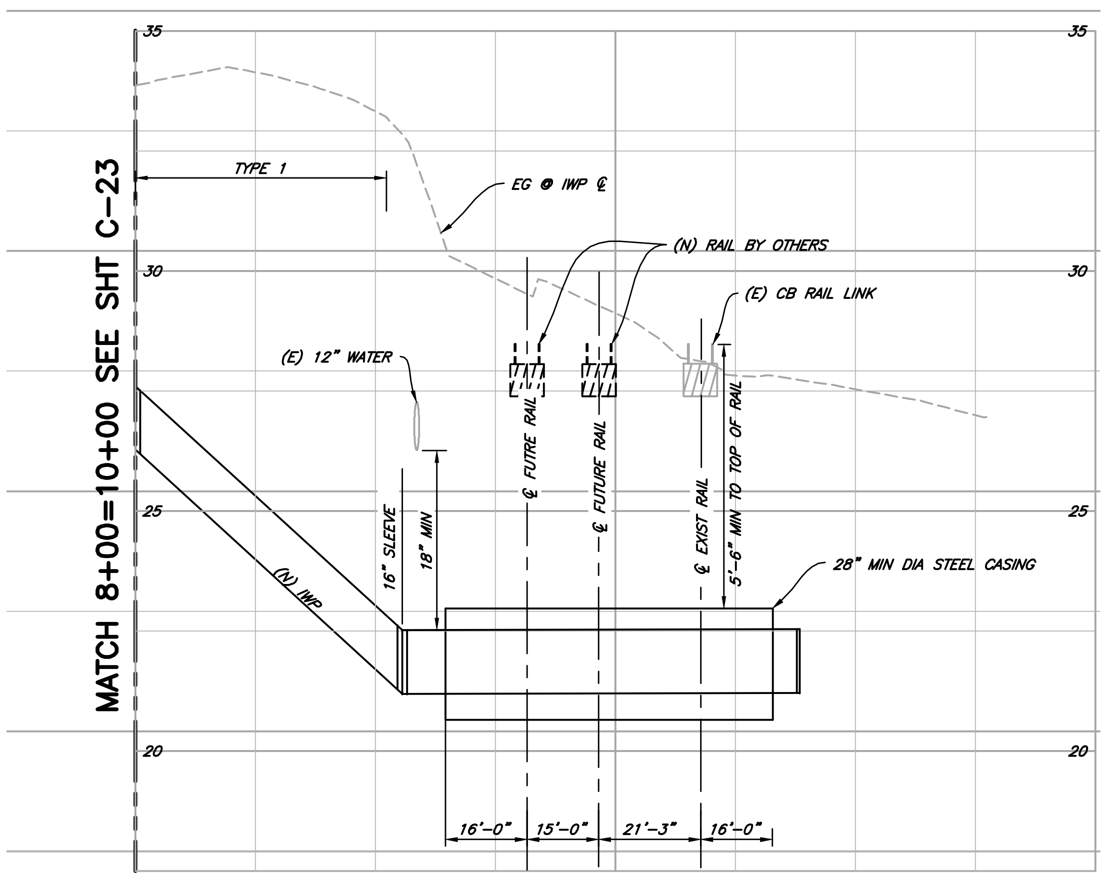


PLAN
1"=20'



PROFILE
SCALE: 1"=20' H
1"=2' V

NOTES:

1. MAINTAIN 12' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL WATER PIPE. IF LESS THAN 10' OUTSIDE TO OUTSIDE OF PIPES IWP MUST BE BELOW PARALLEL WATER PIPE.
2. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL RAW WATER PIPE.
3. POTHOLE & VERIFY WATER PIPE LOCATION & DEPTH EVERY 1000' ON TANGENTS AND 500' ON CURVES OR AS DIRECTED.
4. MAXIMUM 3° DEFLECTION PER 20' PIPE SECTION.
5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

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REV Description:			
Doc. No:			
REV:	REV Date:		
DSGN	DPG	CHK	SKD
DR	NN/NR	APVD	

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

IWP PHASE 2
PLAN & PROFILE

SHEET C-24
SEQ 28
DATE 03/2015
PROJ. NO. 614029.500

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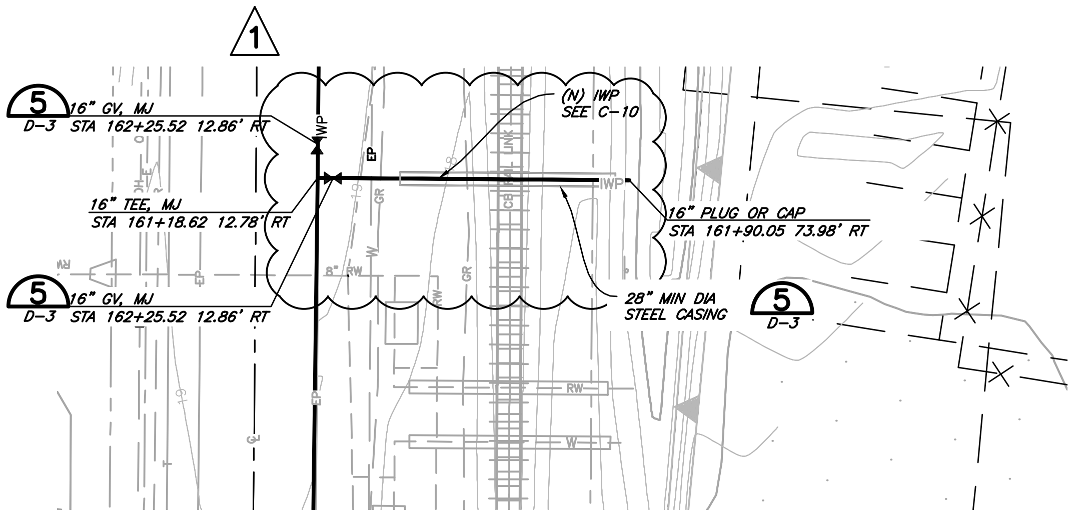
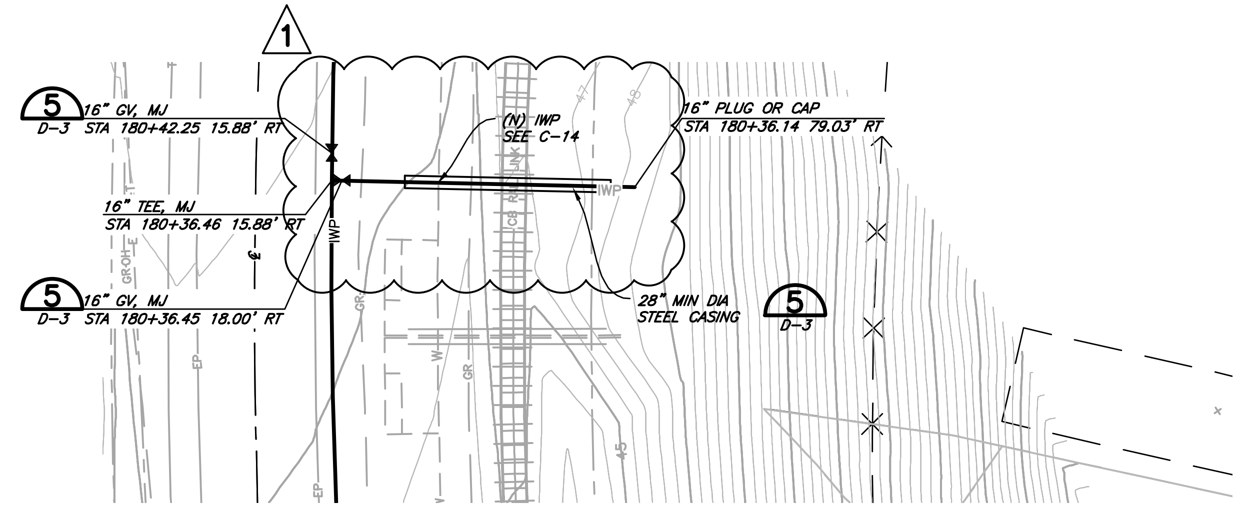
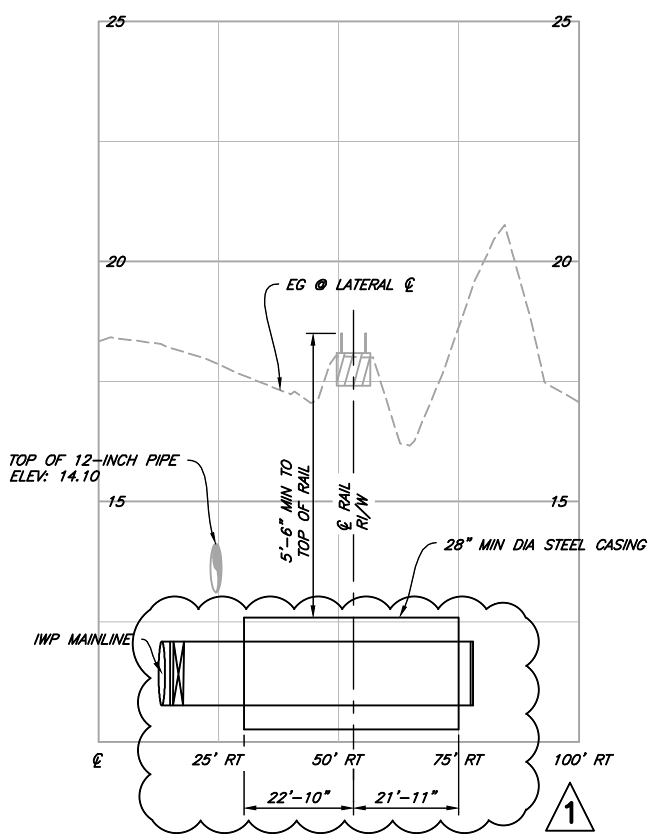


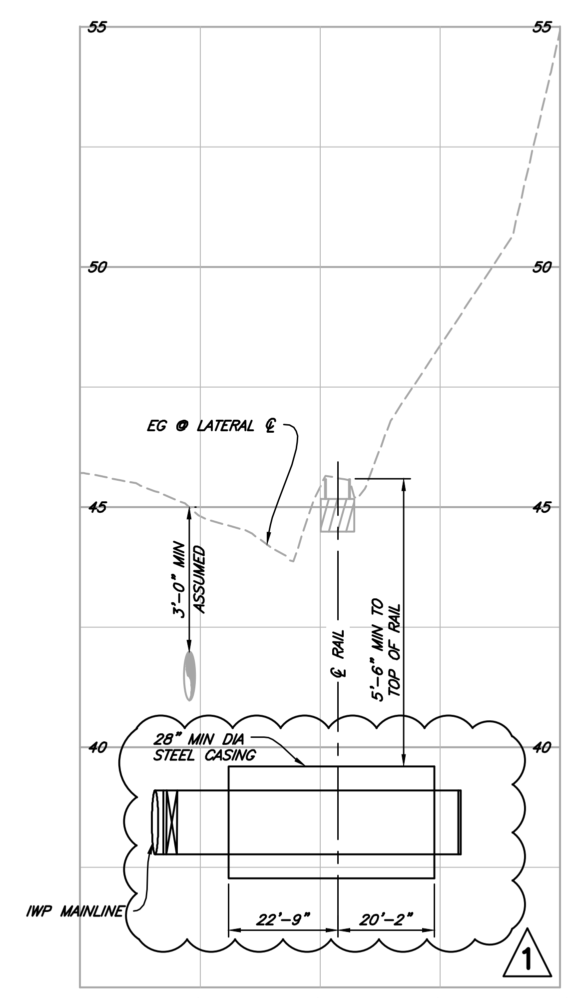
LATERAL "A" PLAN
1"=20'



LATERAL "B" PLAN
1"=20'



LATERAL "A" PROFILE
SCALE: 1"=20' H
1"=2' V



LATERAL "B" PROFILE
SCALE: 1"=20' H
1"=2' V

NOTES:
1. MAINTAIN 12' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL WATER PIPE. IF LESS THAN 10' OUTSIDE TO OUTSIDE OF PIPES IWP MUST BE BELOW PARALLEL WATER PIPE.
2. MAINTAIN 3' MINIMUM HORIZONTAL CLEARANCE FROM CENTER OF IWP TO CENTER OF PARALLEL RAW WATER PIPE.
3. POTHOLE & VERIFY WATER PIPE LOCATION & DEPTH EVERY 1000' ON TANGENTS AND 500' ON CURVES OR AS DIRECTED.
4. MAXIMUM 3" DEFLECTION PER 20' PIPE SECTION.
5. TYPE 4 TRENCH UNLESS OTHERWISE SPECIFIED.

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

SAVED: 3/28/2016 2:27 PM DREED, PLOTTED: 3/28/2016 3:21 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-PNP.dwg

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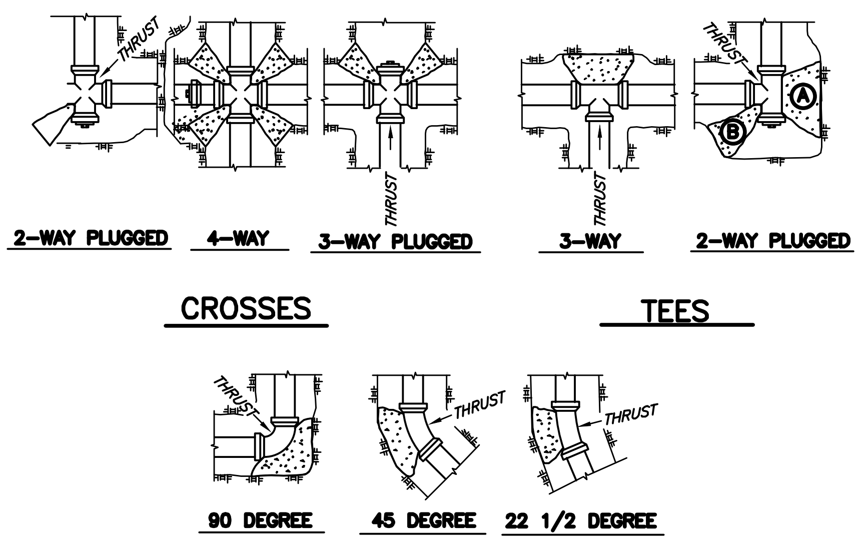
REV Description:	REVISION
Doc. No:	
REV: 1	REV Date: 03/17/2016
DSGN DPG	CHK SKD
DR NN/NR	APVD

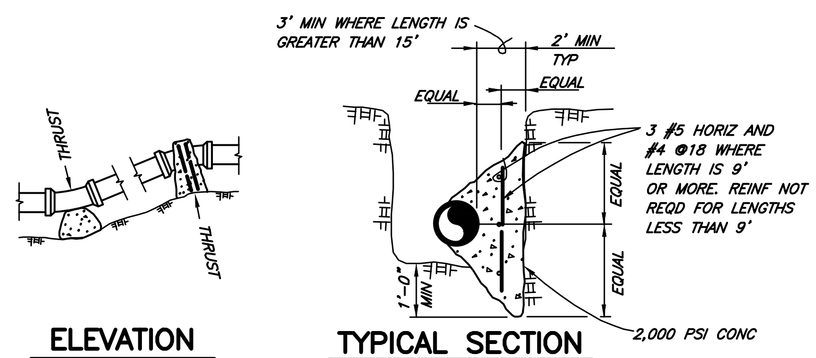
Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

LATERALS PLAN & PROFILE

SHEET C-25
SEQ 29
DATE 03/2015
PROJ. NO. 614029.500





SQ FT OF THRUST BLOCK BEARING AREA

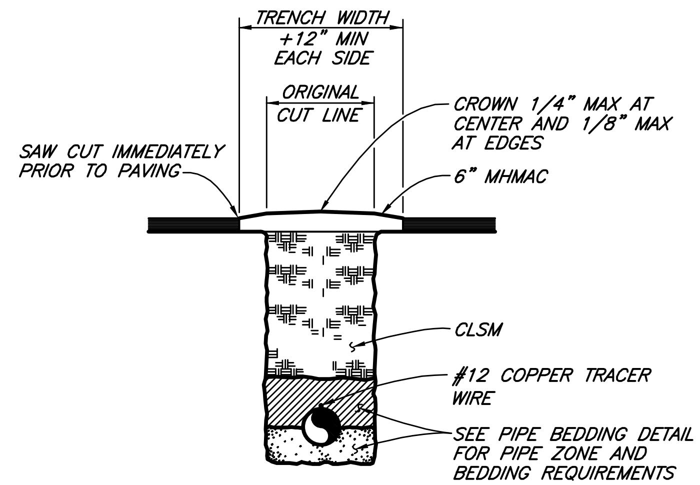
PIPE SIZE	TEE, WYE, PLUG OR CAP	90 DEGREE BEND, PLUGGED CROSS	TEE, PLUGGED (A)	TEE, PLUGGED (B)	45° BEND	22 1/2° BEND	11 1/4° BEND
4" OR LESS	2	3	2	3	2	1	1
6"	5	6	5	6	4	2	1
8"	8	11	8	11	6	3	2
12"	17	24	17	24	13	7	4
16"	36	50	36	50	27	14	7

NOTES:

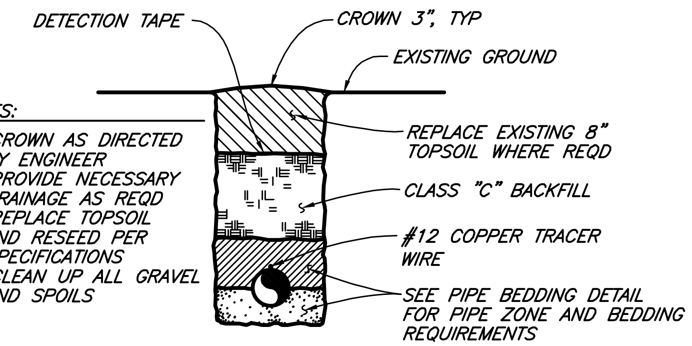
1. CONCRETE THRUST BLOCKS SHALL BE POURED AGAINST FIRM, UNDISTURBED EARTH OR STRUCTURAL BACKFILL.
2. CONCRETE SHALL BE KEPT CLEAR OF ALL JOINTS AND ACCESSORIES.
3. VOLUMES AND SPECIAL BLOCKING DETAILS SHOWN ON THE PLANS TAKE PRECEDENCE OVER VOLUMES AND BLOCKING DETAILS SHOWN ON THIS STANDARD DETAIL.
4. ALL BURIED PIPE EXCEPT FLANGED, SCREWED, SOLVENT-WELDED PVC, FUSION-BONDED PEP OR WELDED STEEL PIPE SPECIFIED TO BE PRESSURE TESTED SHALL BE PROVIDED WITH CONCRETE THRUST BLOCKS AT ALL DIRECTIONAL CHANGES UNLESS OTHERWISE NOTED.
5. THRUST BLOCKS SHALL NOT BE LOCATED OR SIZED TO ENCASE ADJACENT PIPES OR FITTINGS.
6. THE SIZE AND WEIGHT OF ALL UPLIFT THRUST BLOCKS SHALL BE DETERMINED BY THE ENGINEER.
7. THE BEARING AREAS ARE BASED ON TEST PRESSURE OF 150 PSI AND ALLOWABLE SOIL BEARING STRESS OF 1000 POUNDS PER SQUARE FOOT. TO COMPUTE BEARING AREAS FOR DIFFERENT TEST PRESSURES AND SOIL BEARING STRESSES USE THE FOLLOWING EQUATION:

BEARING AREA= (TEST PRESSURE/150) X (1000/ALLOWABLE SOIL BEARING STRESS) X (TABLE VALUE).

THRUST BLOCKING (131)
NTS

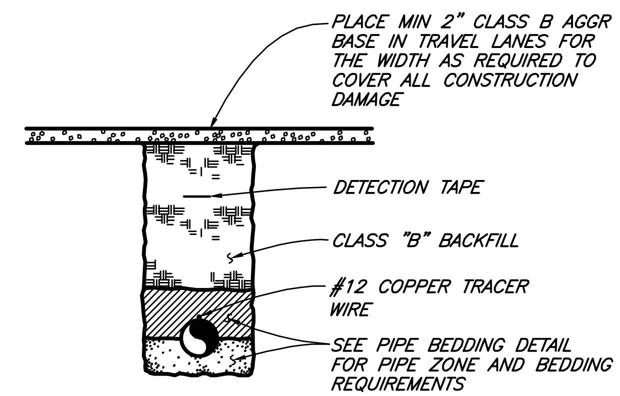


TYPE 1
ASPHALT CONCRETE STREETS (U.O.S.)

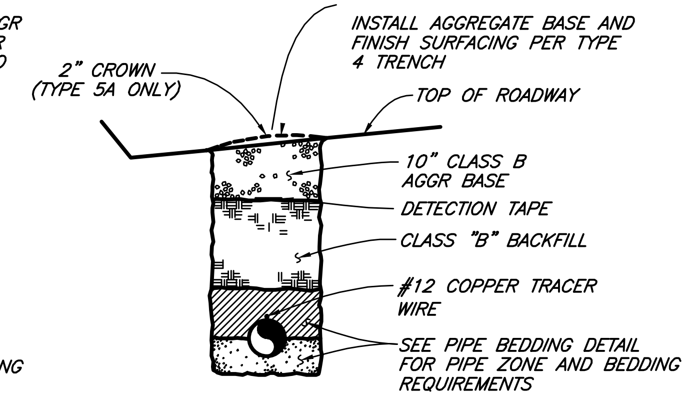


NOTES:
1. CROWN AS DIRECTED BY ENGINEER
2. PROVIDE NECESSARY DRAINAGE AS REQD
3. REPLACE TOPSOIL AND RESEED PER SPECIFICATIONS
4. CLEAN UP ALL GRAVEL AND SPOILS

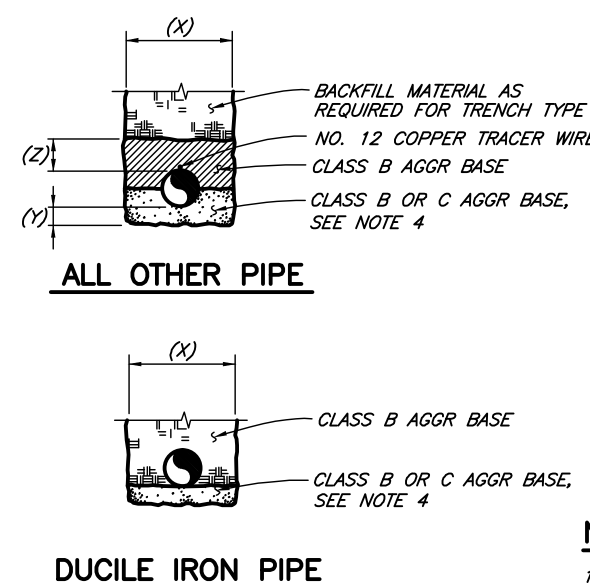
TYPE 4



TYPE 2
GRAVELED STREETS AND ROADS



TYPE 3
SHOULDER AREAS



TYPICAL PIPE BEDDING DETAIL

TRENCH DIMENSION CHART

PIPE SIZE	(X) TRENCH WIDTH (MIN)	(X) TRENCH WIDTH (MAX)	(Y) BEDDING (MIN)	(Z) COVER (MIN)
4"	24"	30"	4"	6"
6"	24"	30"	6"	8"
12"	32"	44	8"	12"
16"	36"	48"	8"	12"
16" + 6"	36"	48"	8"	12"

NOTES:

1. WIDER TRENCHES MAY REQUIRE STRENGTH PIPE AND/OR SPECIAL BEDDING.
2. DIFFERING TRENCH WIDTHS REQUIRE PRIOR APPROVAL OF THE ENGINEER.
3. EXISTING SURFACING MATERIALS AND THICKNESS VARY.
4. BEDDING & PIPE ZONE MATL TO BE CLASS B THROUGH RESTRAINED JOINT PIPE LENGTH PER RESTRAINED JOINT TABLE SHEET G-3.

STANDARD TRENCH DETAILS

REGISTERED PROFESSIONAL ENGINEER 15,479 Daniel P. Graber OREGON JULY 25, 1991 DANIEL P. GRABER
RENEWS: 6/30/17

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REV Description:
Doc. No:
REV: | REV Date:
DSGN DPG | CHK SKD
DR NN/NR | APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

TRENCH & THRUST BLOCKING DETAILS

SHEET D-1
SEQ 30
DATE 03/2015
PROJ. NO. 614029.500

SAVED: 3/23/2016 4:58 PM DREED, PLOTTED: 3/28/2016 3:22 PM DAWN REED
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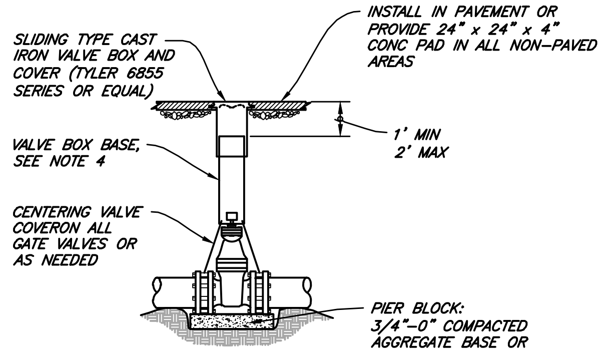
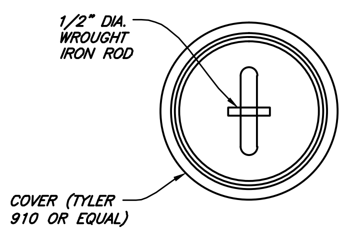
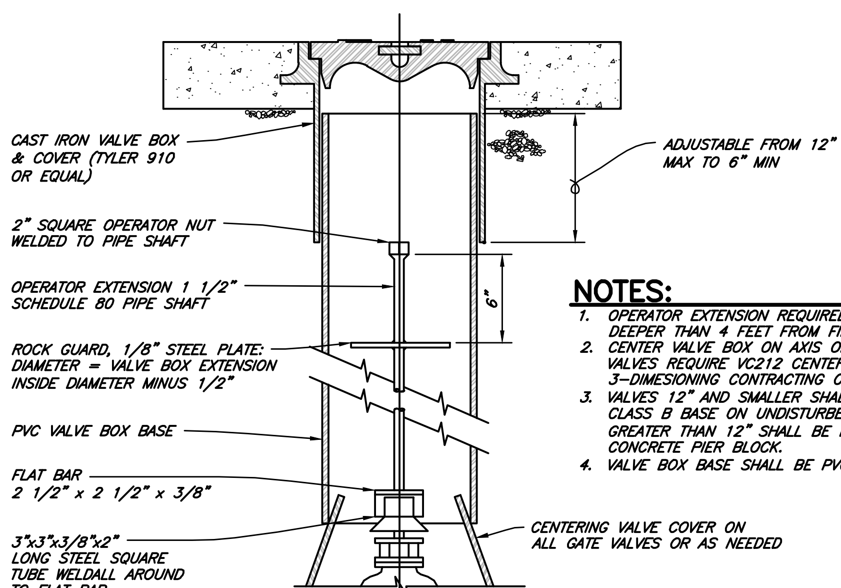


VALVE BOX ASSEMBLY DETAIL



PLAN

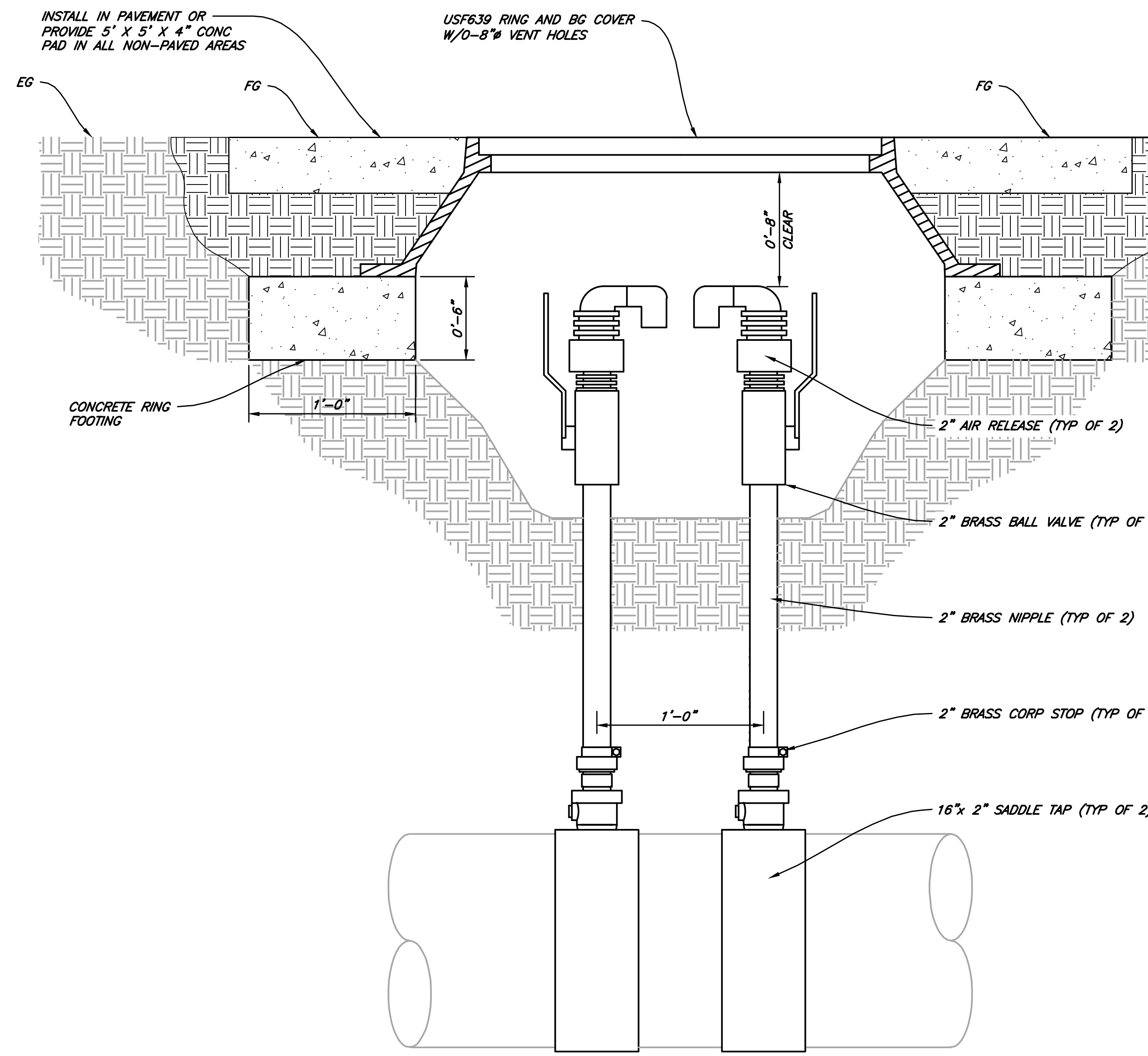


SECTION

NOTES:

1. OPERATOR EXTENSION REQUIRED WHEN VALVE NUT IS DEEPER THAN 4 FEET FROM FINISH GRADE.
2. CENTER VALVE BOX ON AXIS OF OPERATOR NUT. GATE VALVES REQUIRE VC212 CENTERING VALVE COVER BY 3-DIMESIONING CONTRACTING OR EQUAL.
3. VALVES 12" AND SMALLER SHALL BE PROVIDE WITH CLASS B BASE ON UNDISTURBED GROUND. VALVES GREATER THAN 12" SHALL BE INSTALLED ON PRECAST CONCRETE PIER BLOCK.
4. VALVE BOX BASE SHALL BE PVC (ASTM D3034, SDR 35).

VALVE BOX AND OPERATOR EXTENSION ASSEMBLY (2)
NTS



2" ARV ASSEMBLY (3)
NTS C-17

REGISTERED PROFESSIONAL ENGINEER 15,479 Daniel P. Graber OREGON JULY 25, 1991 DANIEL P. GRABER
RENEWS: 6/30/17

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Doc. No:
REV: REV Date:
DSGN DPG CHK SKD
DR NN/NR APVD

Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

GENERAL DETAILS

SHEET	D-2
SEQ	31
DATE	03/2015
PROJ. NO.	614029.500

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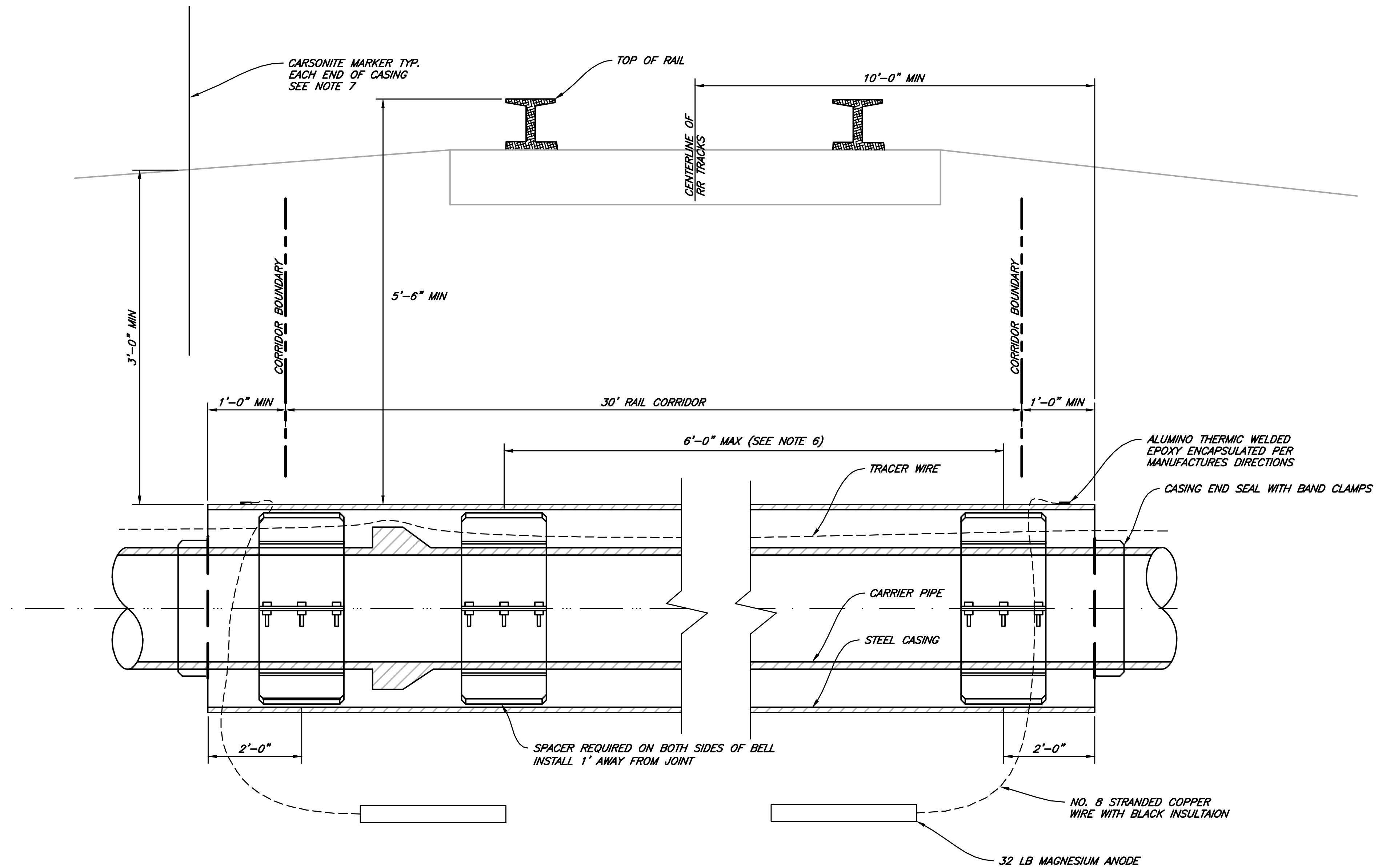
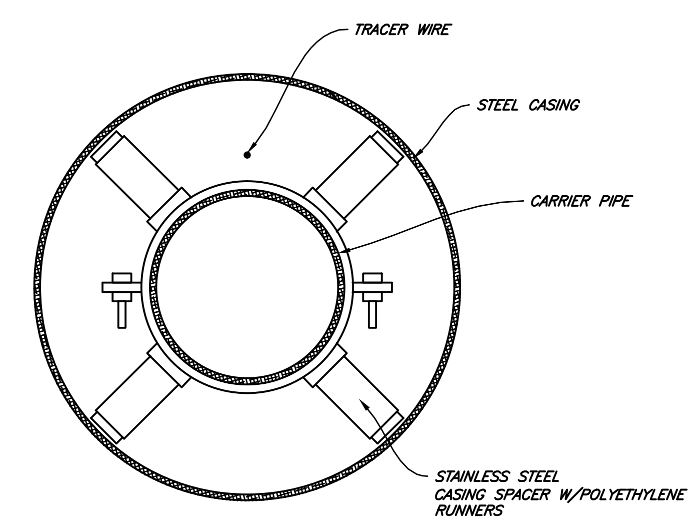


PLAN



SECTION

STEEL CASING SCHEDULE				
PVC SIZE	RESTRAINT O.D.	MIN. CASING SIZE I.D.	MIN. WALL THICKNESS CATHODICALLY PROTECTED	MIN. WALL THICKNESS NOT CATHODICALLY PROTECTED
6"	11.2"	16"	0.250	0.281
8"	14.7"	18"	0.250	0.312
12"	19.33"	24"	0.312	0.375
16"	25.51"	28"	0.375	0.438
18"	27.76"	30"	0.406	0.469

NOTES:

1. CASING SHALL BE INSTALLED BY THE BORE OR JACK METHOD.
2. SIZE AND THICKNESS OF CASING SHALL BE AS SHOWN IN STEEL CASING SCHEDULE.
3. ALL STEEL CASING PIPE FIELD JOINTS SHALL BE WELDED FULL-CIRCUMFERENCE.
4. CARRIER PIPE SHALL BE PRESSURE TESTED PRIOR TO SEALING ENDS OF CASING.
5. EACH END OF CASING SHALL BE SEALED WITH APPROVED CASING END SEALS.
6. NUMBER AND PLACEMENT OF SPACERS SHALL BE PER MANUFACTURES SPECIFICATIONS OR THE MINIMUM SHOWN.
7. INSTALL MARKER "CAUTION SEWER PIPELINE"

STEEL CASING (5)
NTS C-14, C-22, C-23

REGISTERED PROFESSIONAL ENGINEER
15,479
Daniel P. Graber
OREGON
JULY 25, 1991
DANIEL P. GRABER
RENEWS: 6/30/17

SAVED: 3/23/2016 4:58 PM DREED, PLOTTED: 3/28/2016 3:22 PM DAWN REED
\\CoosBaysvr1\Projects\2014\614029-JCEOwnerAssis\500-UtilityReloc\500-IWP-Phase-2\DWGs\614029-500-IWP-PHASE2-DETAIL1.dwg

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REV: REV Date:
DSGN DPG CHK SKD
DR NN/NR APVD

DPG
NER
SKD
Jordan Cove LNG

JORDAN COVE ENERGY PROJECT
INDUSTRIAL WASTEWATER PIPELINE
COOS COUNTY, OR

RAIL CROSSING DETAILS

SHEET D-3
SEQ 32
DATE 03/2015
PROJ. NO. 614029.500

JCEP ATTACHMENT 2

UTILITY EASEMENTS			
UTILITY	LENGTH	AREA(SQFT)	ACRES
IWP	2,616.3'	26,163.3	0.6

\\COOSBAYSVRNEW\Projects\2015\615058-Wtr-CommLines-SO1047\Etransmit\614029-500_Exhibits\BLM

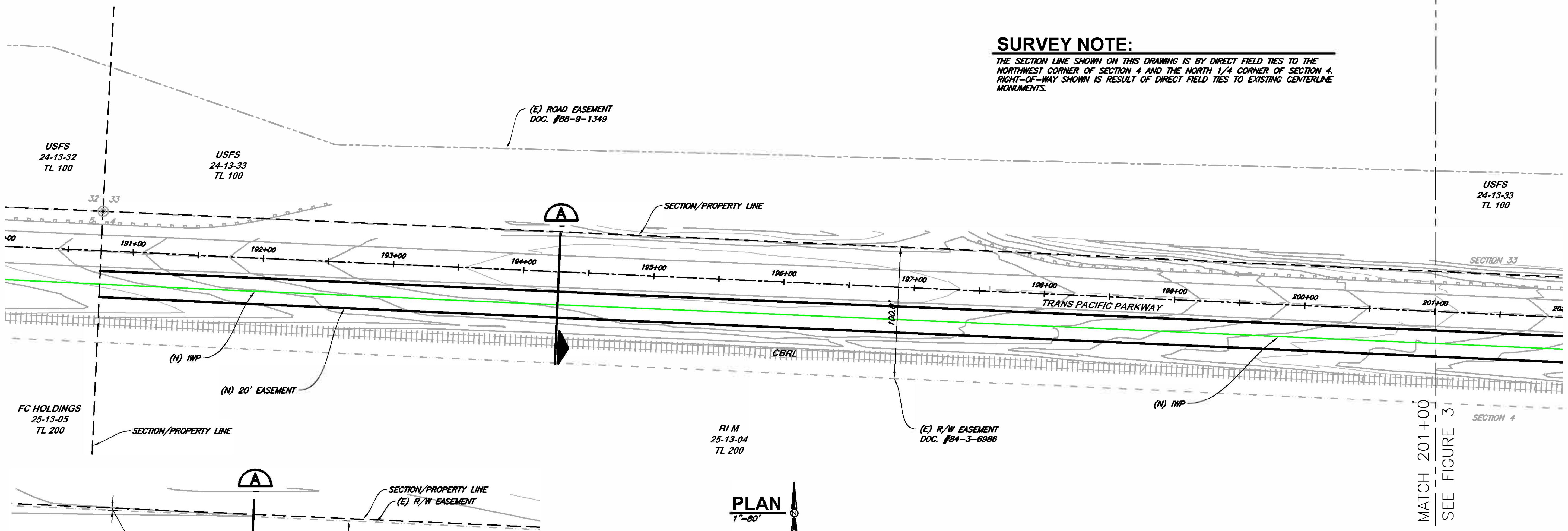
SHN

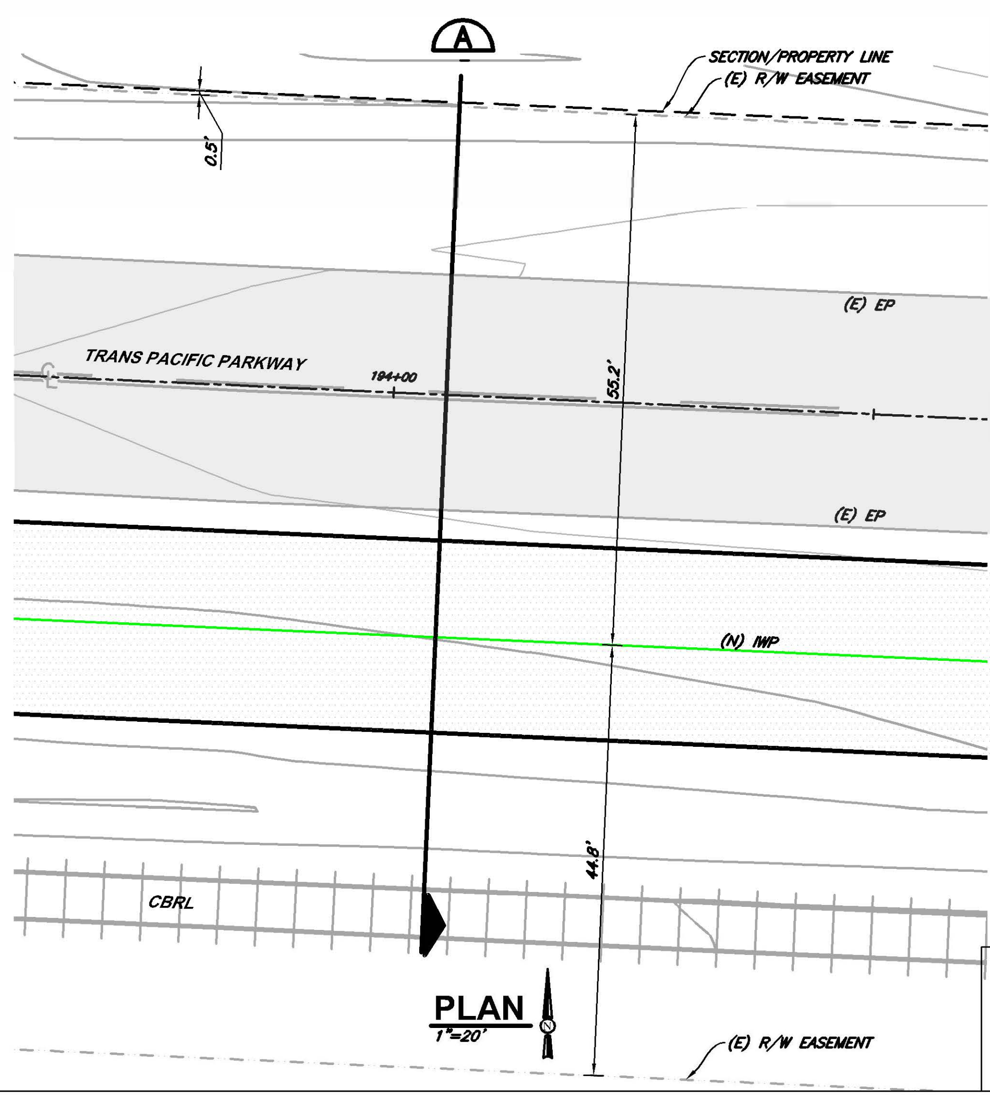
Transpacific Parkway Utility Corridor
Utility Permitting
Industrial Wastewater Pipeline "IWP"

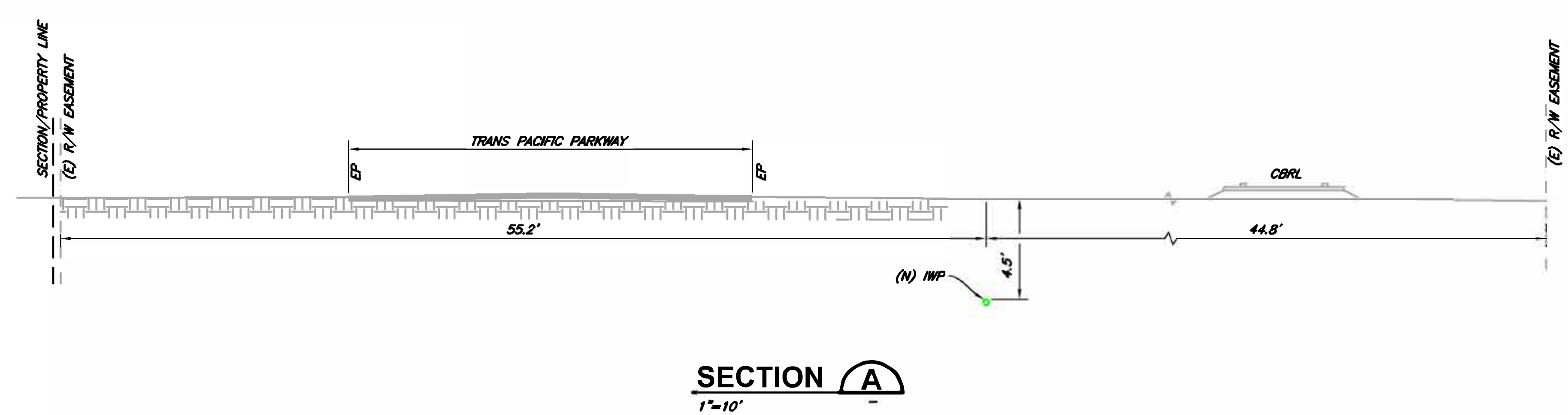
SHN 614029-500	614029-500-BLM-PERMIT-EXHIBITS-IWP

Jordan Cove LNG

REV Description: FOR REVIEW
Doc No: J1-000-CIV-DTL-SHN-00016-01
REV: A REV Date: 09/16/2019
Figure 1





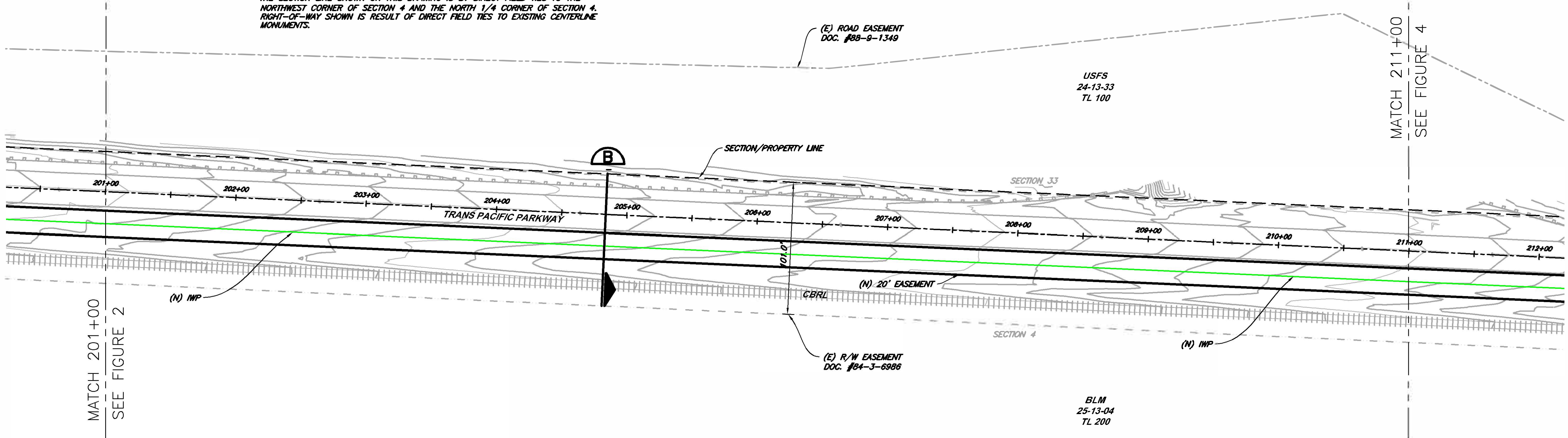


Transpacific Parkway Utility Corridor Utility Permitting Industrial Wastewater Pipeline "IWP"	Jordan Cove LNG	REV Description: FOR REVIEW
SHN 614029-500 | 614029-500-BLM-PERMIT-EXHIBITS-IWP		Doc No: J1-000-CIV-DTL-SHN-00016-02
		REV: A | REV Date: 09/16/2019
		Figure 2

\\COOSBAYSVRNEW\Projects\2015\615058-Wtr-CommLines-SO1047\Etransmit\614029-500_Exhibits\BLM

SURVEY NOTE:

THE SECTION LINE SHOWN ON THIS DRAWING IS BY DIRECT FIELD TIES TO THE NORTHWEST CORNER OF SECTION 4 AND THE NORTH 1/4 CORNER OF SECTION 4. RIGHT-OF-WAY SHOWN IS RESULT OF DIRECT FIELD TIES TO EXISTING CENTERLINE MONUMENTS.



PLAN
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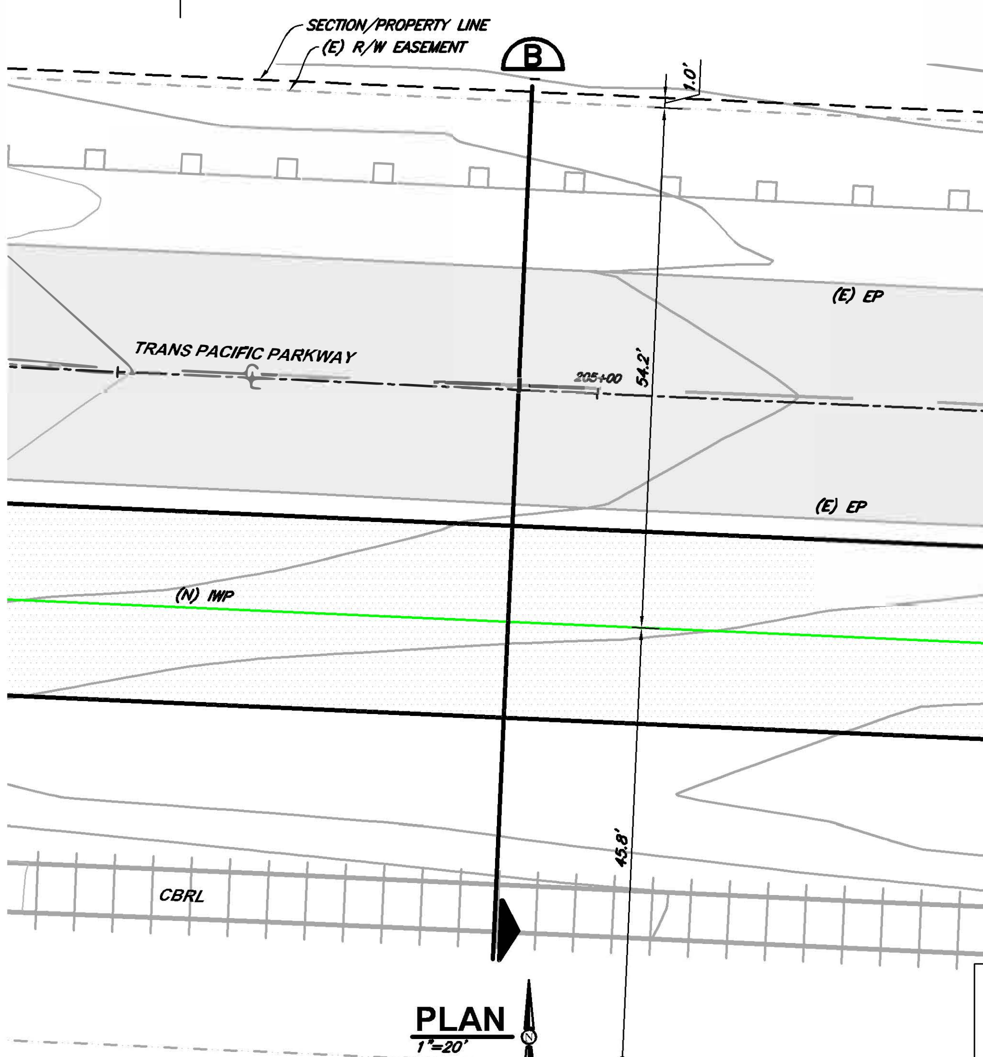
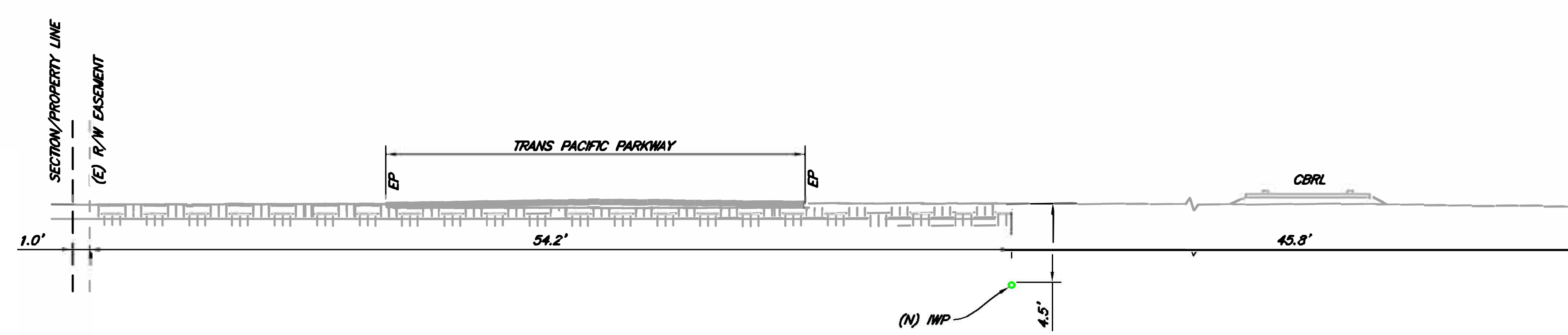


PLAN
1"=20'



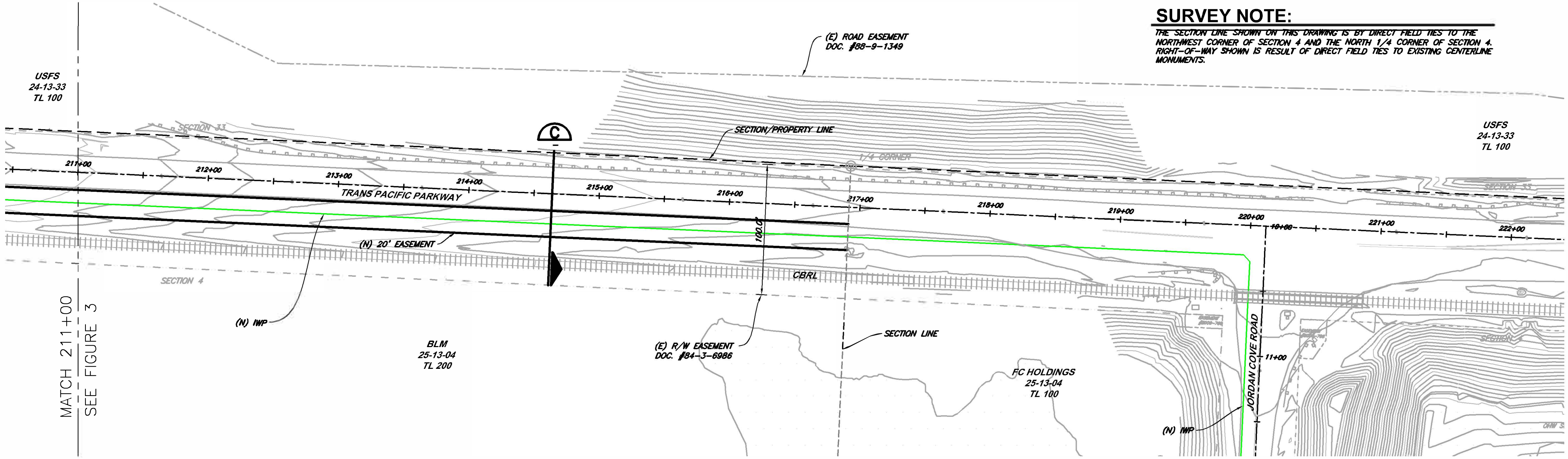
SECTION B
1"=10'

Transpacific Parkway Utility Corridor Utility Permitting Industrial Wastewater Pipeline "IWP"	Jordan Cove LNG	REV Description: FOR REVIEW
SHN 614029-500 / 614029-500-BLM-PERMIT-EXHIBITS-IWP		Doc No: J1-000-CIV-DTL-SHN-00016-03
		REV: A REV Date: 09/16/2019
		Figure 3

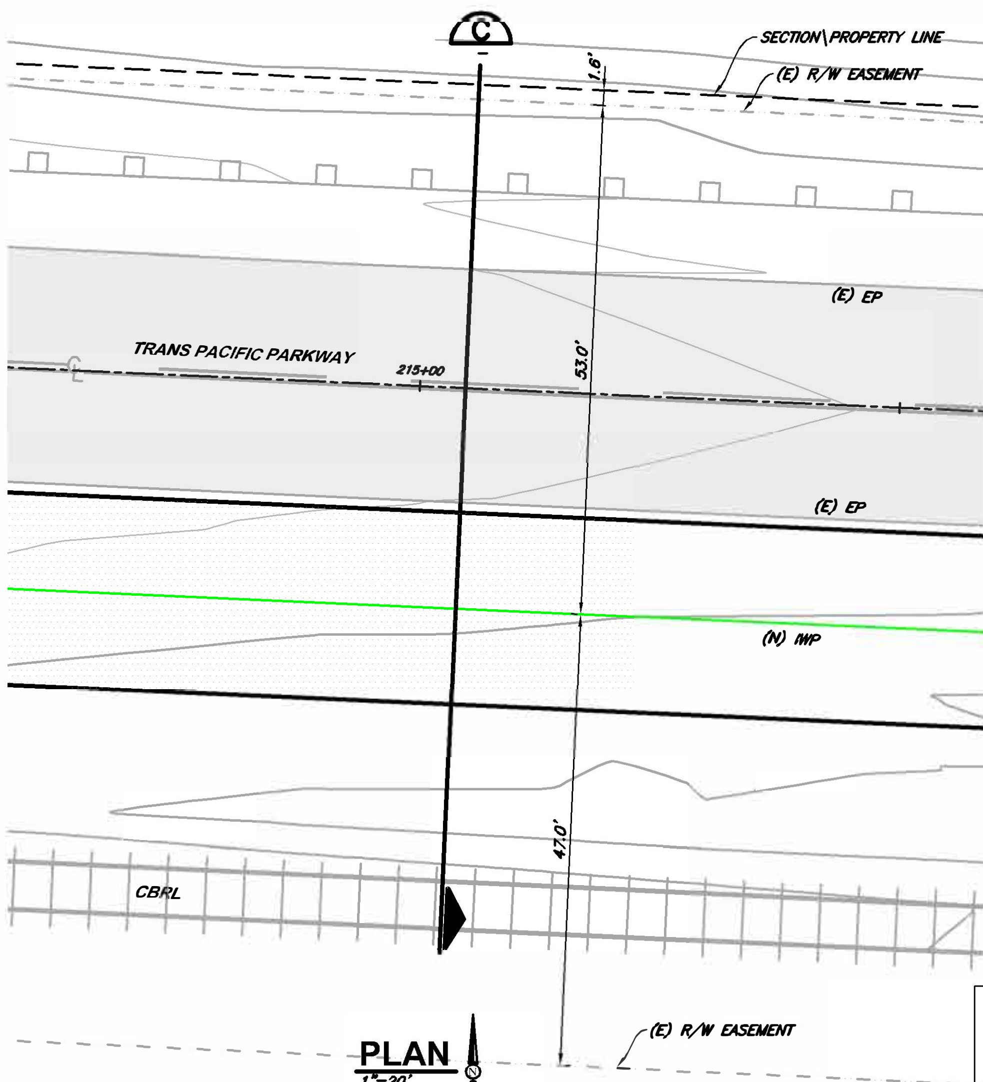
\\COOSBAYSVRNEW\Projects\2015\615058-Wtr-CommLines-SO1047\Etransmit\614029-500_Exhibits\BLM

SURVEY NOTE:

THE SECTION LINE SHOWN ON THIS DRAWING IS BY DIRECT FIELD TIES TO THE NORTHWEST CORNER OF SECTION 4 AND THE NORTH 1/4 CORNER OF SECTION 4. RIGHT-OF-WAY SHOWN IS RESULT OF DIRECT FIELD TIES TO EXISTING CENTERLINE MONUMENTS.



PLAN
1"=80'



PLAN
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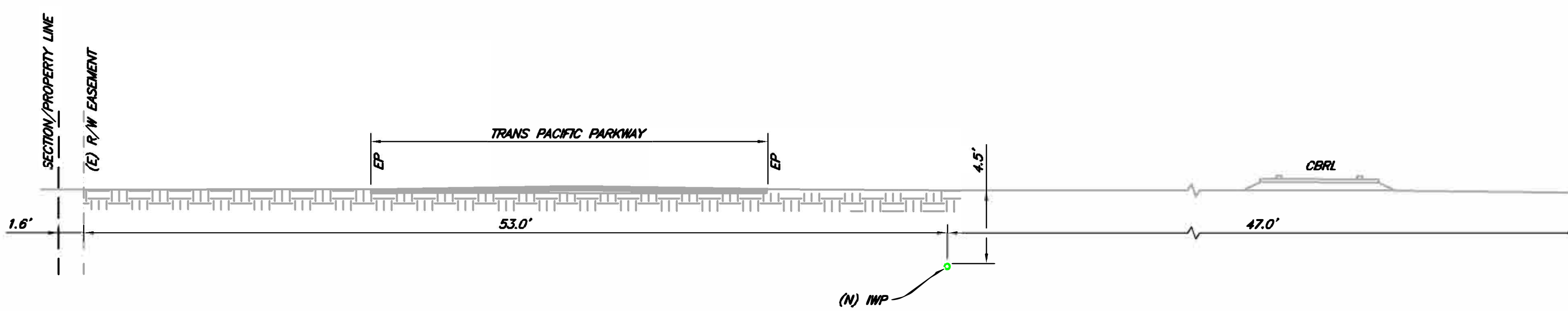

SECTION C
1"=10'

Transpacific Parkway Utility Corridor Utility Permitting Industrial Wastewater Pipeline "IWP"	Jordan Cove LNG	REV Description: FOR REVIEW
		Doc No: J1-000-CIV-DTL-SHN-00016-04
		REV: A REV Date: 09/16/2019
SHN 614029-500 | 614029-500-BLM-PERMIT-EXHIBITS-IWP		Figure 4

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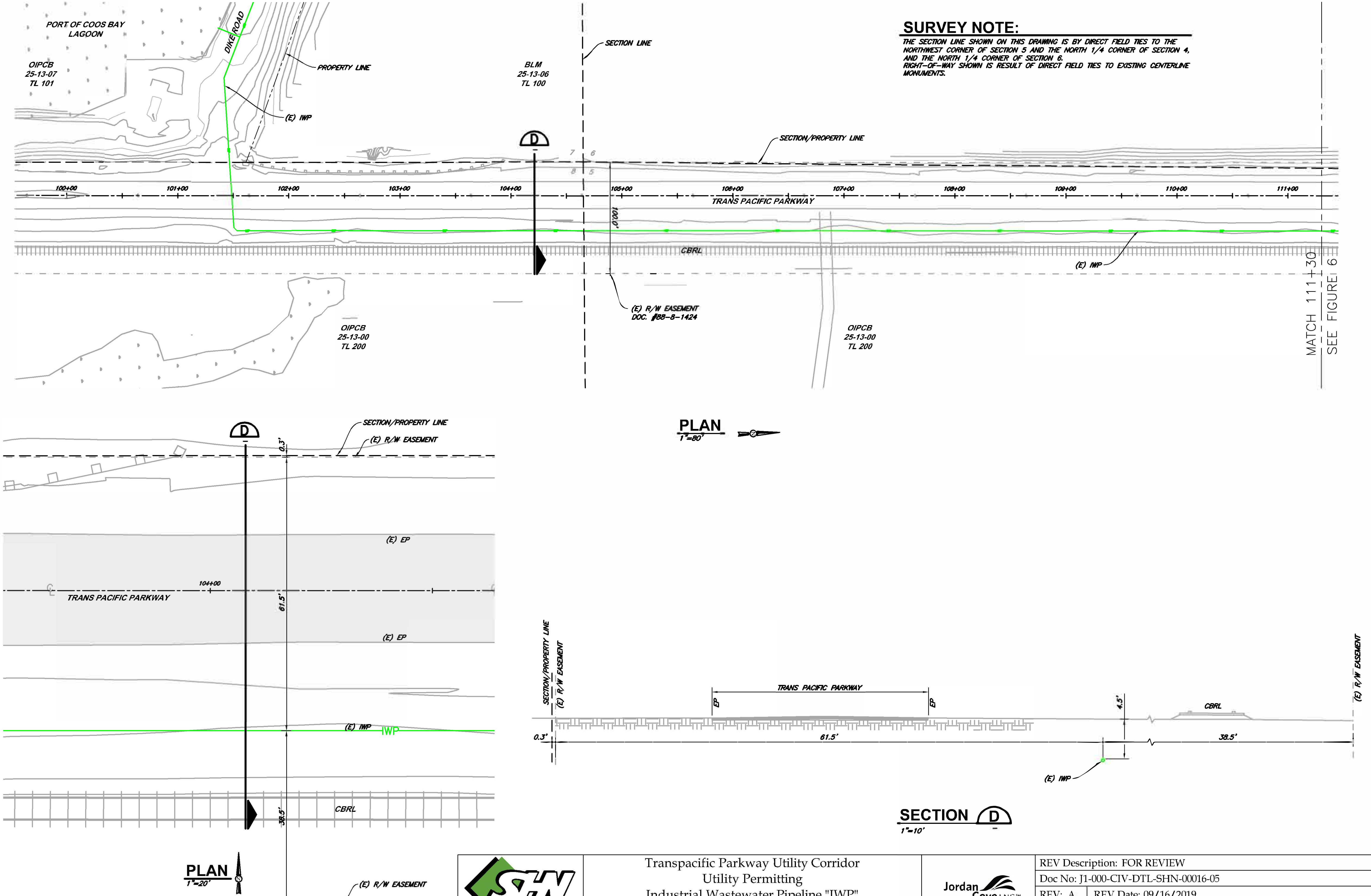


SURVEY NOTE:
THE SECTION LINE SHOWN ON THIS DRAWING IS BY DIRECT FIELD TIES TO THE NORTHWEST CORNER OF SECTION 5 AND THE NORTH 1/4 CORNER OF SECTION 4, AND THE NORTH 1/4 CORNER OF SECTION 6. RIGHT-OF-WAY SHOWN IS RESULT OF DIRECT FIELD TIES TO EXISTING CENTERLINE MONUMENTS.

Transpacific Parkway Utility Corridor
Utility Permitting
Industrial Wastewater Pipeline "IWP"

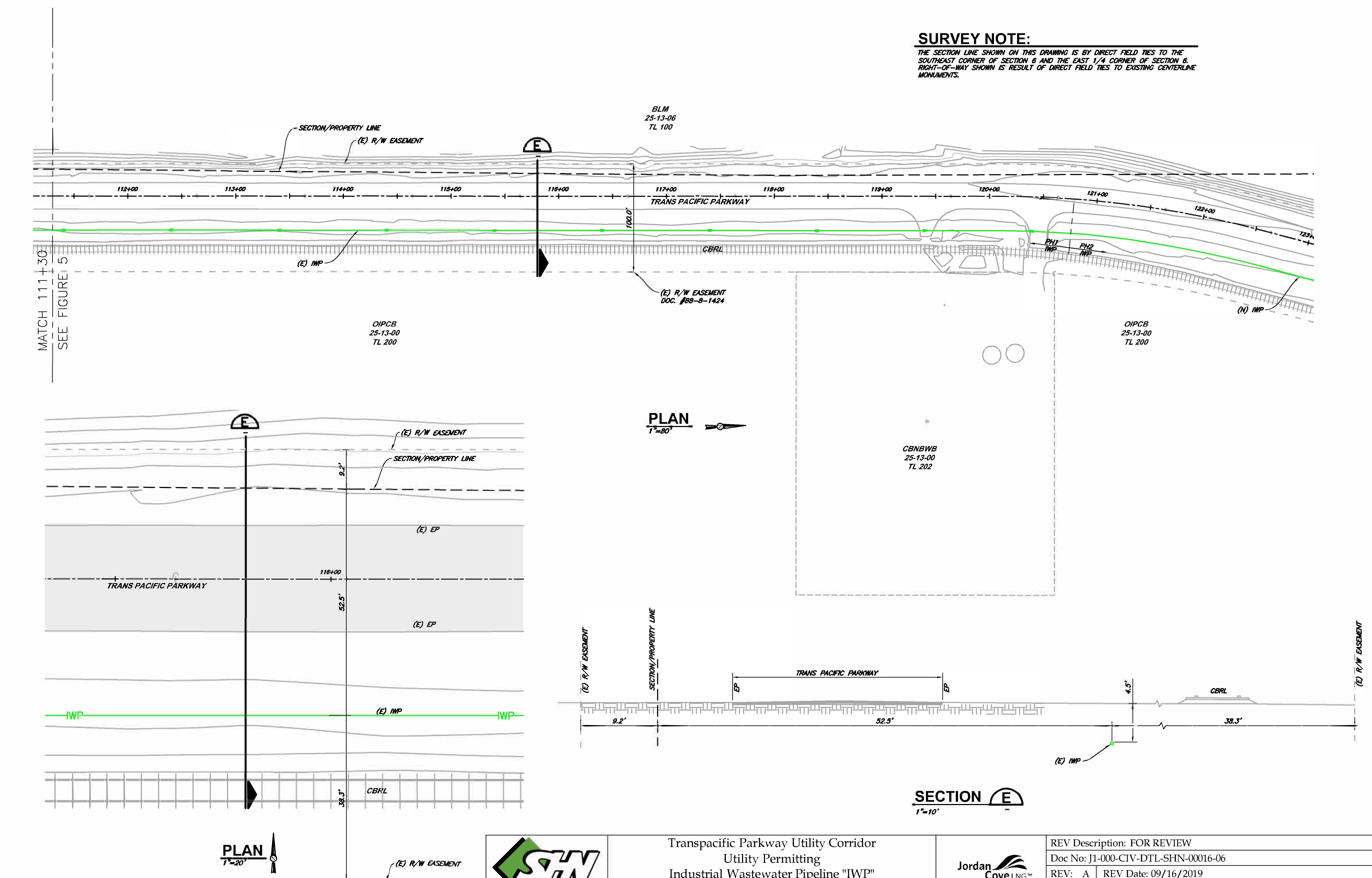
SHN 614029-500 | 614029-500-BLM-PERMIT-EXHIBITS-IWP

Jordan Cove LNG

REV Description: FOR REVIEW
Doc No: J1-000-CIV-DTL-SHN-00016-05
REV: A REV Date: 09/16/2019
Figure 5

\\COOSBAYSVRNEW\Projects\2015\615058-Wtr-CommLines-SO1047\Etransmit\614029-500_Exhibits\BLM

Exhibit 30



Transpacific Parkway Utility Corridor Utility Permitting Industrial Wastewater Pipeline "IWP"	REV Description: FOR REVIEW
SHN 614029-500 / 614029-500-BLM-PERMIT-EXHIBITS-IWP	Doc No: J1-000-CIV-DTL-SHN-00016-06
Jordan Cove LNG	REV: A REV Date: 09/16/2019
	Figure 6

\\COOSBAYSVRNEW\Projects\2015\615058-Wtr-CommLines-SO1047\Etransmit\614029-500_Exhibits\BLM

Document Content(s)

Jordan Cove Energy Project L.P.

Resource Report No. 1

General Project Description

Jordan Cove Energy Project

September 2017

contracts roll off on GTN and Ruby, there is ample supply from those two systems when gas is needed.

Pipeline transmission system subscription (volume reserved within the pipeline total capacity) and available capacity are provided in Table 1.2-1. This table depicts the shortage of available gas subscription capacity of the Williams Northwest Pipeline ("NWP") system and how it is not sufficient for the Project demand. While NWP can supply gas from Sumas for delivery at Stanfield, the amount of available capacity for Stanfield Delivery (227,846 Dth/d) is substantially less (approximately 80% less) than the required feedstock for the terminal (1,200,000 Dth/d). NWP can also deliver gas from the U.S. Rockies, however, this supply is highly seasonal. During summer, there is approximately 536,040 Dth/d available; during the peak winter months, this capacity is almost fully utilized (as an example, on Feb 1, 2017, only 70,000 Dth/d were available).

A connection from a point near the intersections of the Ruby Pipeline and the GTN Pipeline would provide more than sufficient capacity to access the aforementioned gas markets utilizing existing infrastructure and avoiding impacts to domestic use of the gas resources.

Table 1.2-1

Pipeline Capacity Available for New Long-Term Contracts

		Operating Capacity	**Subscribed Capacity**	**Available Capacity**
		Dth/d	**Dth/d**	**Dth/d**
Ruby Pipeline				
	Opal Receipt	1,500,000	819,534	680,466
Williams Northwest (NWP)				
	Sumas Receipt	1,314,750	1,113,815	200,935
	Opal- Stanfield (summer)	655,000	118,960	536,040
	Opal- Stanfield (winter)	655,000	584,993	70,007
	Stanfield Delivery	244,560	16,714	227,846
GTN				
	Kingsgate Receipt	2,812,440	2,047,243	765,197

Data extracted from EBB's of GTN, NWP and Ruby effective 08/21/2017 and Opal – Stanfield (winter) extracted from NWP's EBB effective 02/01/2017.

1.2.3 Current LNG Terminal Proposal

The design of the proposed LNG Terminal reflects several enhancements from the prior proposal in Docket No. CP13-483-000. These changes will result in an enhanced system design and a reduction in overall environmental impacts. Hydrocarbon processing and combustion, including pre-treatment, will be located on Ingram Yard in an effort to create a more efficient footprint and operating aspects of the facility. The LNG Terminal will now utilize a direct drive configuration by relocating the gas turbines adjacent to the refrigerant compressors, thereby eliminating the need for the South Dunes Power Plant and associated transmission line, making the facility simpler, more efficient, and easier to operate. The workforce housing facility has been consolidated onto the South Dunes Site reducing land and traffic impacts in the area of the previously proposed location at the North Point Site in North Bend adjacent to the suburb of Simpson Heights. The Southwest Oregon Regional Safety Center ("SORSC") building has been relocated to the northeast portion of the South Dunes Site and the Fire Department has been relocated to the Access and Utility Corridor, both relocations further reducing land and wetland impacts while improving emergency response time.

The Project under Docket No. CP13-483-000 included the 420-megawatt ("MW") South Dunes Power Plant. Within the current proposal, the Project proposes to use direct combustion-turbine liquefaction-drive instead of motor liquefaction-drive driven by electric power provided by the South Dunes Power Plant. A direct drive configuration is simpler, more efficient and easier to operate; and results in a number of reductions in environmental impact, including:

- Eliminates hydrocarbon processing combustion equipment from the South Dunes Site, which results in a single compact and consolidated facility process area on Ingram Yard;
- Eliminates the need for a railroad spur road overpass, reducing wetland impacts;
- Reduces combustion-turbine count from six to five, and maintains, and in some cases reduces, point source air emissions from the existing conditions permitted by the Oregon Department of Environmental Quality ("ODEQ");
- Reduces water consumption by 1 million gallons per day by eliminating the need for gas turbine water injection;
- Increases the distance from the nearest noise-sensitive receptors;
- Eliminates impacts on estuarine wetlands on the South Dunes Site;
- Allows for relocation of the workforce housing facility to the South Dunes Site addressing community concerns and significantly reducing workforce traffic movements on U.S. Highway 101 ("US 101") during the working week; and
- Allows for the relocation of the SORSC building to the northeast corner of the South Dunes Site and the elimination of 1 acre of wetland impacts.

In addition to the above enhancements, the following changes have been made to the design and construction of the LNG Terminal:

- Fire and other emergency incident response time has been improved by splitting the Fire Department building from the SORSC building and relocating the fire department to the Access and Utility Corridor from the South Dunes Site.
- The design now incorporates black-start capability reducing impacts from the Project on local utilities by eliminating the need to draw and export electricity from the local grid for operations, except the SORSC building. Limited temporary construction power within the capacity of the existing grid system will be utilized.
- The expansion of the Kentuck Mitigation Site from 33 acres to a more comprehensive Kentuck Project encompassing over 100 acres of wide-ranging habitat of mudflats, salt marsh, willowed scrub/shrubs and fish structures addressing a number of the key limiting factors Coho salmon face in this region, which will assist in the species' removal from the endangered species list
- The excavation of four submerged areas lying adjacent to the federally-authorized Coos Bay Navigation Channel ("Channel"). These minor enhancements (approximately 700,000 cubic yards) will allow for transit of LNG vessels of similar overall dimensions to

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April 12, 2019

Mr. Todd Cornett
Division Administrator--Energy Facility Siting
Oregon Department of Energy
550 Capital St NE
Salem, OR 97301

Re: Jordan Cove -- Withdrawal of Application for Exemption

Dear Mr. Cornett:

By letter dated June 14, 2018, Jordan Cove Energy Project L.P. ("JCEP") submitted to the Oregon Department of Energy ("ODOE") an Application for Exemption from a Site Certificate for a high-efficiency cogeneration energy facility to be constructed at its proposed Liquefied Natural Gas Terminal in Coos Bay, OR (the "LNG Terminal"). This letter is to inform you that JCEP is withdrawing that Application for Exemption.

JCEP has made a minor modification to the LNG Terminal such that the nominal electric generating capacity is less than 25 megawatts. Consequently, the LNG Terminal does not meet the definition of an "energy facility" in ORS 469.300(11)(a) and is below the Energy Facility Siting Council's jurisdictional threshold applied to state jurisdictional energy facilities. Therefore, there is no basis (or need) for JCEP to request, or the Siting Council to issue, an exemption. As a result, please consider our Application for Exemption from a Site Certificate withdrawn.

Thank you for your assistance and that of your staff.

Sincerely,

Mike Koski
VP, External Affairs

cc: Ms. Janine Benner, Director

BLACK & VEATCH
Building a world of difference.

BLACK & VEATCH COMPANY NAME
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+1 913-458-6235 | himesea@bv.com

January 11, 2016

Steve L. Pfeiffer
Perkins Coie LLP
1120 NW Couch Street, 10th Floor
Portland, OR 97209

Re: Industrial Emissions Evidentiary Letter

Dear Mr. Pfeiffer:

Please accept this letter into the record on behalf of the Jordan Cove Energy Project L.P. (Jordan Cove or JCEP) in support of the application for land use approvals for Jordan Cove's proposed liquefied natural gas (LNG) export terminal, hereinafter referred to as "the Project." The Project includes all supporting and integrated components as described in the application.

The purpose of this letter is to explain the source and types of potential industrial emissions at the Project and how they will be mitigated for. The Coos County Zoning and Land Development Ordinance (CCZLDO) Section 4.11.445(4) requires industrial uses as a part of regular operations not cause emissions of smoke, dust or steam that could obscure visibility within airport approach surfaces, unless mitigation measures will reduce the safety risk or incompatibility with airport operations to an insignificant level.

I am a Technical Project Lead in the Energy Division at Black and Veatch Corporation. Black and Veatch has extensive experience designing and constructing Import and Export LNG facilities. As the Technical Project Lead I am responsible for directing the overall design of the Jordan Cove facility. Formerly I was an Instrument & Controls Project Lead with Black and Veatch. I hold a Bachelor's of Science degree in Industrial Engineering from Penn State University. I have 46 years of experience in the Oil and Gas sector. I am a registered Professional Engineer (Texas, Louisiana). For the past 10 years I have worked on designing LNG Import and Export facilities in the United States. With this education and experience I believe I am qualified to explain the source of industrial emissions and types of mitigation for industrial emissions from the Project.

The likely sources of industrial emissions are: (1) dust during construction due to mobile equipment use, construction equipment and vehicle travel, (2) minimal thermal plumes from the off Thermal Oxidizers in the gas processing facility during operation. There are no visible or steam plumes from the facility. The Project will not generate any smoke. Each of these are assessed separately below.

As explained in Resource Reports 2 and 9, submitted to FERC in May 2013, the Project will mitigate dust during construction by using best management practices. These typically include watering areas of sand or dust at regular intervals. Also note that the water table in this area is very high which results in a high moisture content of the material being handled. This also reduces dust emissions.

As explained in Resource Report 2, Water Use and Quality, Section 2.1.5 Water Use:

> The CBNBWB also has two raw water lines, one for each of the well fields on the North Spit. One raw water line runs from the well field located to the north of the former linerboard mill site and was the source of water to the mill. A second raw water line connects a well field located to the west of the Project site and to the north of the Trans-Pacific Parkway to a water treatment plant. Prior to the construction of the potable water line, this plant provided the potable water on the North Spit. JCEP is planning on extending the raw line (before it gets to the treatment plant) to the Project site and use that water for the concrete batch plant, compaction during site grading (if required), dust suppression during construction, and to supplement the potable water available for hydrostatic testing (described further in Section 2.3.4) and any other construction activity requiring water.

Construction related dust and suppression is explained in Resource Report 9, Air and Noise Quality, Section 9.3.1.1:

> Air quality impacts associated with construction projects generally can be classified as: impacts associated with fugitive dust generation; and impacts associated with the operation of equipment during construction activities that may result in a minor, temporary increase in emissions.
>
> Fugitive dust generation may result from construction activities such as land clearing, grading, excavation, and concrete placement, along with vehicular traffic on paved and unpaved roads. The magnitude of fugitive dust generation will be primarily a function of the area of construction, silt and moisture contents of the soil, wind speed, frequency of precipitation, amount of vehicle traffic, vehicle types and paved roadway characteristics. Fugitive dust may be produced during all phases of construction. Emissions will be greater during the drier summer months and in areas of fine-textured soils. During these periods, dust suppression techniques, such as watering, will be used in these areas to minimize the impacts of fugitive dust on sensitive areas. Fugitive emissions during the construction activities alone will not require a permit.
>
> Air quality impacts are also associated with the operation of gasoline or diesel fueled engines in land clearing/grading equipment, cranes, bulldozers, and various types of trucks and cars. The engines will emit relatively small amounts of air emissions. Construction of the LNG Terminal is expected to last about 42 months. Other construction-related emissions include compactors, pavers, welding, brazing, soldering, solvent cleaning, grinding, cutting, etc.

TRC Environmental Corporation explains the source and volume of plumes in the Thermal Plume Study (Applicant's Exhibit 27, 1-4):

> The total combined volumetric flow rate from the two thermal oxidizers is 4% of the total flow from the five combustion turbines. Thus, it is expected that the plume vertical velocity generated from the thermal oxidizers will be substantially lower in magnitude than the plume vertical velocity from the combustion turbine stacks.

It is important to note, that the thermal oxidizers only contribute 4% of the total flow or plume. The remainder of the plume is generated by sources that are not part of this land use application.

Each of the two thermal oxidizers will have a thermal plume exiting the 3.5 feet diameter stack at 63.6 feet/second velocity. The stack outlet is 75 feet above grade or at an elevation 121 feet NAVD 88. The following is a table of the expected Exhaust Characteristics for the thermal oxidizers.

Exhaust Parameter	
Exhaust Height (ft above grade)	75
Exhaust Height (m above grade)	22.86
Exhaust Temperature (deg F)	980
Exhaust Flow (acfm)	36,744
Exhaust Velocity (ft/sec)	63.6
Exhaust Velocity (m/sec)	19.40
Inner Diameter (ft)	3.50
Inner Diameter (m)	1.07
Stack Base Elevation (ft)	48
Stack Locations (UTM NAD83)	399,180.6 m East 4,809,908.2 m North 399,253.7 m East 4,809,910.4 m North

The thermal plume from the thermal oxidizers will not cause a significant safety risk or be incompatible with airport operations. I reach this conclusion for three reasons. First, the thermal oxidizers are not directly under the flight path. See Applicant's Figure 15. Second, as explained in the Thermal Plume Study, "[u]nder these more typical meteorological conditions the CASA threshold would not be expected to be exceeded other than in the area directly above the South Dunes Power Plant exhausts." Exhibit 27, 1-10. As explained above, the thermal oxidizers are not under the flight path and only contribute 4% of the plume. Therefore, since the entire plume (including 96% from other sources) is expected to meet CASA standards in the flight path, the emissions from the thermal oxidizers would as well. Third, even when the CASA threshold is exceeded in the general direct airspace above the power plant, it quickly dissipates at less than 1.0m/s in the direct flight path to the airport. Exhibit 27, 1-9.

It is my professional opinion that the Jordan Cove Project, if constructed and operated consistent with the mitigation measures detailed in this letter, will not adversely affect airport approach surfaces.

Should you have any further questions please do not hesitate to contact me at 913-458-6235.

Sincerely,

Carl A. Himes Jr.

Earl Himes, Jr.
Energy Division Black & Veatch Corporation

Perkins Coie LLP

59892-0020/129116828.1

Jordan Cove Energy Project L.P.

Resource Report No. 9

Air and Noise Quality

Jordan Cove Energy Project

September 2017

Responses to Agency Comments

Agency	Agency Comment #	Agency Comment	Response Summary
FERC	1	Include any cultural sites and recreational areas that could be impacted by Project-related noise as NSAs in the analysis.	REC 1 included in discussion and tables.
FERC	2	The modeled concentrations presented in Table 9.2-10 (Cumulative Modeled Impacts) appear to differ from the modeled concentrations presented in Table 9.2-9 for the same pollutant and averaging period. In addition, the total impact presented in Table 9.2-10 appears to differ from the sum of modeled concentrations plus background in several cases. Include an updated version of Table 9.2-10 (and/or Table 9.2-9) to correct any errors, or include an explanation of the apparent discrepancies	Updated values were provided. In addition clarification that the values presented in Table 9.2-9 are the highest concentrations whereas the values in Table 9.2-10 are the form of the standards.
FERC	3	Include citations for the emission factors used in Appendix F.9 for emissions from LNG vessels and tugboats.	Citations for the emission factors were added for vessels and tugs.
FERC	4	Include the times of day when Jordan Cove would perform construction activities for the LNG terminal. In addition, indicate if construction would take place on weekends and federal holidays.	See section 9.4.1.2
FERC	5	Include a table that identifies the equipment needed for construction of the LNG Terminal. The table should include the type of equipment, number of equipment/vehicles, and associated sound power level or sound pressure level at a reference distance (e.g., 50 feet).	See Table 9.4-1
FERC	6	Include the noise levels from blowdown facilities, venting, or flaring at the terminal site. Describe the expected types, estimate the average number of yearly events by type, and estimate the duration. Indicate whether noise mitigation would be installed, and estimate the noise impact at the nearest NSAs.	See Section 9.4.2.2
FERC	7	Include an evaluation and quantification of noise impacts from pile driving and dredging operations at the nearest NSAs in L_{dn}. Indicate if these operations would be 24 hours and identify the length of time dredging would occur. Provide supporting documents, calculations, and a list of all assumptions used to estimate the noise impacts.	See Sections 9.4.1.2 and 9.4.1.3
FERC	8	Include an evaluation and quantification of noise impacts from sound pressure waves generated within the water due to pile driving and dredging operations, as well as noise due to the operation of the tugs and LNG vessels. Quantify sound pressure levels in the aquatic environment (in dB re: 1μPa) to a distance of 1	See Sections 9.4.1.2 and 9.4.1.3

Agency	Agency Comment #	Agency Comment	Response Summary
		mile and discuss impacts to all threatened and endangered aquatic species, marine mammals, and commercial and recreational fish species.	
FERC	9	Include Appendix G.9, including a table of sound sources associated with LNG Terminal operation presented in terms of both octave band and broadband sound levels. Appendix G.9 should also include a table of all proposed noise mitigation measures, providing their associated octave band insertion loss or transmission loss values.	A table of proposed mitigation measures with their associated insertion losses was not provided in Appendix G9 because no additional mitigation measures were required to meet the noise limit. Noise impacts were prevented through selection of a site distant from sensitive receivers. Noise reductions are inherent to the design through equipment selection meeting acoustical limits. Vapor barrier walls and topography also attenuate sound levels produced by the facility but are not specifically noise mitigation measures with insertion losses of a certain magnitude or any goal requirement for reduction.
FERC	10	Include a table listing the construction equipment needed to widen and/or modify the Coos Bay Channel as part of the Pilots Project. The table should include the type of equipment, number of equipment/vehicles, and their associated sound power level or sound pressure level at a reference distance (e.g., 50 feet).	See Section 9.4.1.3. A table was not included since only two types of dredges are being used and they are described in the text.
FERC	11a	Estimate potential in-air and underwater noise impacts associated with the construction activities and equipment needed to widen and/or modify the Coos Bay Channel as part of the proposed Pilots Project	See Section 9.4.1.3
FERC	11b	Estimate potential in-air and underwater noise impacts associated with the construction activities and equipment needed to widen and/or modify the Coos Bay Channel as part of the proposed Pilots Project	See Section 9.4.1.3
FERC	12	Provide concurrence from the State of Oregon that its noise regulations (OAR 340-035-0035) are not directly applicable to the construction and operational noise levels generated by the Project.	JCLNG is coordinating with DEQ.
EPA	13	The EPA recommends the EIS provide a detailed discussion of ambient air conditions (baseline or existing conditions), National Ambient Air Quality Standards, criteria pollutant nonattainment areas, and potential air quality impacts of the proposed project (including cumulative and indirect	The existing conditions and potential air quality impacts of the proposed project have been evaluated in the ACDP Application and the RR9. The ACDP application is included as Appendix A.9.

Agency	Agency Comment #	Agency Comment	Response Summary
		impacts). Such an evaluation is necessary to assure compliance With State and Federal air quality regulations, and to disclose the potential impacts from temporary or cumulative degradation of air quality.	
EPA	14	The EPA recommends the EIS describe and estimate air emissions from potential construction, operation, and maintenance activities, including emissions associated with LNG carriers at berth. The analysis should also include assumptions used regarding the types of fuel burned and/or the ability for carriers to utilize dockside power (i.e. cold ironing). Emissions at berth are of particular relevance because the deep draft LNG carriers would be required to remain docked between high tides. We also recommend proposing mitigation measures in the EIS to address identified emissions impacts.	Air emissions from construction, operation, and LNG carrier emissions have been quantified and addressed in the ACDP Application and the RR9. The carriers burn two types of fuel and will not use dockside power. Carrier emissions and operations are described in Appendix F.9.

JCEP LNG TERMINAL PROJECT

Resource Report 9 – Air and Noise Quality

Minimum FERC Filing Requirement:	Resource Report Section:
1. Describe the existing air quality, including background levels of nitrogen dioxide and other criteria pollutants that may be emitted above EPA-identified significance levels. (§ 380.12(k)(1)).	Section 9.1
2. Quantitatively describe existing noise levels at noise-sensitive areas such as schools, hospitals, or residences and include any areas covered by relevant state or local noise ordinances: • Report existing noise levels as the L_{eq} (day), L_{eq} (night), and L_{dn} and include the basis for the data or estimates. • For existing compressor stations, include the results of a sound level survey at the site property line and nearby noise-sensitive areas while the compressors are operated at full load. • For proposed new compressor station sites, measure or estimate the existing ambient sound environment based on current land uses and activities. • Include a plot plan that identifies the locations and duration of noise measurements, the time of day, weather conditions, wind speed and direction, engine load, and other noise sources present during each measurement. (§ 380.12(k)(2)).	Section 9.3 Figure 9.3-1 Tables 9.3-1, 9.3-2, and 9.3-3
3. Estimate the impact of the project on air quality, including how existing regulatory standards would be met. • Provide the emission rate of nitrogen oxides from existing and proposed facilities, expressed in pounds per hour and tons per year for maximum operating conditions, include supporting calculations, emission factors, fuel consumption rates, and annual hours of operation. • For major sources of air emissions (as defined by the Environmental Protection Agency), provide copies of applications for permits to construct (and operate, if applicable) or for applicability determinations under regulations for the prevention of significant air quality deterioration and subsequent determinations. (§ 380.12(k)(3)).	Section 9.2 Tables 9.2-1, 9.2-2, 9.2-3, 9.2-4, 9.2-5, 9.2-6, 9.2-7, and 9.2-8
4. Provide a quantitative estimate of the impact of the project on noise levels at noise-sensitive areas, such as schools, hospitals, or residences. • Include step-by-step supporting calculations or identify the computer program used to model the noise levels, the input and raw output data and all assumptions made when running the model, far-field sound level data for maximum facility operation, and the source of the data. • Include sound pressure levels for unmuffled engine inlets and exhausts, engine casings, and cooling equipment; dynamic insertion loss for all mufflers; sound transmission loss for all compressor building components, including walls, roof, doors, windows and ventilation openings; sound attenuation from the station to nearby noise-sensitive areas; the manufacturer's name, the model number, the performance rating; and a description of each noise source and noise control component to be employed at the proposed compressor station. For proposed compressors the initial filing must include at least the proposed horsepower, type of compression, and energy source for the compressor. • Far-field sound level data measured from similar units in service elsewhere, when available, may be substituted for manufacturer's far-field sound level data. • If specific noise control equipment has not been chosen, include a schedule for submitting the data prior to certification. • The estimate must demonstrate that the project will comply with applicable noise regulations. (§ 380.12(k)(4)).	Section 9.4

Resource Report 9 – Air and Noise Quality	
Minimum FERC Filing Requirement:	**Resource Report Section:**
5. Describe measures and manufacturer's specifications for equipment proposed to mitigate impact to air and noise quality, including emission control systems, installation of filters, mufflers, or insulation of piping and buildings, and orientation of equipment away from noise-sensitive areas. (§ 380.12(k)(5)).	Section 9.2 Section 9.4

INFORMATION RECOMMENDED OR OFTEN MISSING	See the Following Resource Report Section:
1. Include climate information as part of the air quality information provided for the project area.	Section 9.1
2. Identify potentially applicable federal and state air quality regulations.	Section 9.1
3. Provide construction emissions (criteria pollutants, hazardous air pollutants, greenhouse gases) for proposed pipelines and aboveground facilities.	Section 9.2 Tables 9.2-1, 9.2-2, 9.2-3, 9.2-4, 9.2-5, and 9.2-6
4. Provide copies of state and federal applications for air permits.	Appendix A.9
5. Provide operation and fugitive emissions (criteria pollutants, hazardous air pollutants, greenhouse gases) for pipelines and aboveground facilities.	Section 9.2 Table 9.2-7 and 9.2-8
6. Identify temporary and permanent emissions sources that may have cumulative air quality effects in addition to those resulting from the project.	Section 9.2
7. Describe the existing noise environment and ambient noise surveys for compressor stations, liquefied natural gas facilities, meter and regulation facilities, and drilling locations.	Section 9.3
8. Identify any state or local noise regulations applicable to construction and operation of the project.	Section 9.3
9. Indicate whether construction activities would occur over 24-hour periods.	Section 9.4
10. Discuss construction noise impacts and quantify construction noise impacts from drilling, pile driving, dredging, etc.	Section 9.4
11. Quantify operation noise from aboveground facilities, including blowdowns.	Section 9.4
12. Describe the potential for the operation of the proposed facilities to result in an increase in perceptible vibration and how this would be prevented.	Section 9.4
13. Identify temporary and permanent noise sources that may have cumulative noise effects in addition to those resulting from the project.	Section 9.4

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TABLES

FIGURES

APPENDICES

ACRONYMS

AQRV	Air Quality Related Values
ACDP	Air Contaminant Discharge Permit
ASL	Above Sea Level
BOG	Boil Off Gas
Bscf/d	Billion Standard Cubic Feet Per Day
CaDOT	California Department of Transportation
CAA	Clean Air Act
CFR	Code of Federal Regulations
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_{2e}	Carbon Dioxide Equivalent
dB	Decibels
dBA	Decibels of the A-weight Scale
DFDE	Dual-Fuel Diesel Electric
DOT	U.S. Department of Transportation
Dth/d	Dekatherms Per Day
°F	Degrees Fahrenheit
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FLM	Federal Land Managers
GHG	Greenhouse Gases
HAPs	Hazardous Air Pollutants
HDD	Horizontal Directional Drilling
HP	Horsepower
JCEP	Jordan Cove Energy Project L.P.
km	Kilometers
KW	Kilowatt
L_{dn}	Average Day/Night Noise Level
L_{eq}	A-Weighted Equivalent Continuous Noise Level
LNG	Liquefied Natural Gas
LNG Terminal	LNG Export Facility
m^3	Cubic Meter
m^3/hr	Cubic Meter Per Hour
MERP	Modeled Emission Rates for Precursors
MTPA	Million Tonnes per Annum
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NANSR	Non-Attainment New Source Review
NCDC	National Climatic Data Center
NCEI	National Centers for Environmental Information
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGA	Natural Gas Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic Atmospheric Administration
NO_x	Nitrogen Oxides

NO_2	Nitrogen Dioxide
N_2O	Nitrous Oxide
NSA	Noise Sensitive Area
NSPS	New Source Performance Standards
NSR	New Source Review
O_3	Ozone
OAR	Oregon Administrative Rules
ODEQ	Oregon Department of Environmental Quality
Pb	Lead
PCGP	Pacific Connector Gas Pipeline, LP
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter Less Than 2.5 Microns
PM_{10}	Particulate Matter Less Than 10 Microns
ppb	Parts Per Billion
ppm	Parts Per Million
PSD	Prevention of Significant Deterioration
PSEL	Plant Site Emission Limit
RMP	Risk Management Plan
SER	Significant Emission Rate
SIL	Significant Impact Level
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
Title V	Title V of the Clean Air Act
tpy	Tons Per Year
$\mu g/m^3$	Micrograms per cubic meter
U.S.	United States
USC	U.S. Code
VOC	Volatile Organic Compound

9. INTRODUCTION

Jordan Cove Energy Project L.P. ("JCEP") is seeking authorization from the Federal Energy Regulatory Commission ("FERC" or "Commission") under Section 3 of the Natural Gas Act ("NGA") to site, construct, and operate a natural gas liquefaction and liquefied natural gas ("LNG") export facility ("LNG Terminal"), located on the bay side of the North Spit of Coos Bay, Oregon. JCEP will design the LNG Terminal to receive a maximum of 1,200,000 dekatherms per day ("Dth/d") of natural gas and produce a maximum of 7.8 metric tonnes per annum ("mtpa") of LNG for export. The LNG Terminal will turn natural gas into its liquid form via cooling to about -260ºF, and in doing so it will reduce in volume to approximately 1/600th of its original volume, making it easier and more efficient to transport.

In order to supply the LNG Terminal with natural gas, Pacific Connector Gas Pipeline, LP ("PCGP") is proposing to contemporaneously construct and operate a new, approximately 229-mile-long, 36-inch-diameter natural gas transmission pipeline from a point of origin near the intersection of the Ruby Pipeline LLC ("Ruby") and Gas Transmission Northwest LLC ("GTN") systems to the LNG Terminal ("Pipeline," and collectively with the LNG Terminal, the "Project"). PCGP will submit a contemporaneous application to FERC that will include its own set of resource reports with references to certain materials in the LNG Terminal resource reports.

This Resource Report 9 contains a discussion of, and an evaluation of, the potential impacts to air and noise within the JCEP Project Area.

9.1 AIR QUALITY

9.1.1 Regional Climatology

The State of Oregon is divided into nine (9) climate zones as established by the National Centers for Environmental Information ("NCEI"). The JCEP Project Area lies in the southern part of Zone 1 – The Oregon Coast. The coastal zone is characterized by wet winters, relatively dry summers, and mild temperatures year round. Terrain features include the coastal plain, which extends from less than a mile to a few tens of miles in width, numerous coastal valleys, and the Coast Range, whose peaks range from 2,000 to 5,500 feet above sea level ("ASL").

The Zone's heaviest precipitation occurs mainly during the winter months when moist air masses move off the Pacific Ocean onto land. Normal annual precipitation at the Southwest Oregon Regional Airport, formerly the North Bend Municipal Airport, which is located just across Coos Bay from the JCEP Project Area, is approximately 65 inches. Normal annual snowfall is approximately one inch. The highest monthly precipitation values occur during the months of November, December, and January.

The mean maximum temperature is approximately 60°F, the mean minimum temperature is approximately 46°F, and the mean temperature is approximately 53°F. Temperatures of 90°F or higher occur less than once per year, on average, and freezing temperatures are infrequent, with killing frosts being even less frequent. There is a 60% chance of the frost free period extending to 251 days.

Strong winds occur occasionally, usually in advance of winter storms, and can exceed hurricane force. Strong winds have been known to cause significant damage to structures and vegetation. Such events, however, are typically short-lived, and last less than one day. Partly cloudy skies are prevalent during the summer. Winter skies are typically cloudy. As a result of the persistent cloudiness, total solar radiation is lower in Zone 1 than it is in any other climatic zones of Oregon.

9.1.2 Regulatory Requirements for Air Quality

The Clean Air Act (CAA) of 1970, 42 United States Code ("USC") § 7401 *et seq.,* amended in 1977 and 1990, is the basic federal statute governing air quality. The provisions of the CAA that are potentially relevant to construction and operational emission sources include the following:

- National Ambient Air Quality Standards ("NAAQS");
- New Source Review ("NSR");
- New Source Performance Standards ("NSPS");
- National Emission Standards for Hazardous Air Pollutants ("NESHAP");
- CAA Title V Operating Permits;
- Chemical Accident Prevention;
- Mandatory Greenhouse Gas Reporting Rule; and
- General Conformity.

9.1.2.1 National Ambient Air Quality Standards

The CAA defines National Ambient Air Quality Standards ("NAAQS") for six criteria pollutants. The six criteria pollutants include nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), ozone (O_3), and lead (Pb). The NAAQS were developed to protect human health (primary standards) and human welfare (secondary standards). Oregon has adopted the NAAQS. The NAAQS for the six criteria pollutants are provided in **Table 9.1-1** and **Table 9.1-2**.

Table 9.1-1 National and Oregon Ambient Air Quality Standards

Pollutant	Value	Description of Standard
PM_{10}	150 µg/m³	24-hour concentration (not to be exceeded more than once per year on average over 3 years)
$PM_{2.5}$	35 µg/m³	24-hour concentration (98th percentile averaged over 3 years)
	12 µg/m³	Annual mean concentration (averaged over 3 years)
SO_2	75 ppb	1-hour concentration (99th percentile of 1-hour daily maximum concentrations, averaged over 3 years)
	500 ppb	3-hour concentration (not to be exceeded more than once per year)
	100 ppb	24-hour concentration (not to be exceeded more than once per year)(1)
	20 ppb	Annual concentration(1)
CO	35 ppm	1-hour concentration (not to be exceeded more than once per year)
	9 ppm	8-hour concentration (not to be exceeded more than once per year)
O_3	0.070 ppm	8-hour concentration (annual fourth-highest daily maximum, averaged over 3 years)
NO_2	100 ppb	1-hour concentration (98th percentile of 1-hour daily maximum concentrations, averaged over 3 years)
	53 ppb	Annual mean concentration
Pb	0.15 µg/m³	Rolling 3 month average (not to be exceeded)

Key:
µg/m³ = Micrograms per cubic meter.
PM_{10} = particulate matter less than 10 micrometers aerodynamic diameter.
$PM_{2.5}$ = particulate matter less than 2.5 micrometers aerodynamic diameter.

(1) EPA revoked 24-hour and annual SO_2 standards in 2010, however Oregon regulations include the 24-hour and annual SO_2 standards.

Table 9.1-2 National Secondary Ambient Air Quality Standards

Pollutant	Value	Description of Standard
PM_{10}	150 µg/m³	24-hour concentration (not to be exceeded more than once per year on average over 3 years)
$PM_{2.5}$	35 µg/m³	24-hour concentration (98th percentile averaged over 3 years)
	15 µg/m³	Annual mean concentration (averaged over 3 years)
SO_2	0.5 ppm	3-hour concentration (not to be exceeded more than once per year)
O_3	0.070 ppm	8-hour concentration (annual fourth-highest daily maximum, averaged over 3 years)
NO_2	53 ppb	Annual mean concentration
Pb	0.15 µg/m³	Rolling 3 month average (not to be exceeded)

9.1.2.2 Attainment Status

Areas in which the NAAQS are violated are designated as “non-attainment” areas for the relevant air pollutants. Areas that are in compliance with the NAAQS are designated as “attainment” areas for the relevant air pollutants. Areas with insufficient data available are designated as “attainment/unclassified” areas. The air quality in the JCEP Project Area does not violate any NAAQS and is, therefore, designated as an attainment/unclassified area.

9.1.2.3 New Source Review ("NSR")/Prevention of Significant Deterioration Permits ("PSD")

The EPA has established separate air quality programs for pre-construction review of certain large projects. Federal pre-construction review for affected sources located in non-attainment areas is commonly referred to as Non-Attainment New Source Review ("NANSR"). Federal pre-construction review for affected sources located in attainment/unclassifiable areas is known as Prevention of Significant Deterioration (PSD). The pre-construction review process is intended to prevent a new source from causing existing air quality to deteriorate below acceptable levels. Because the proposed JCEP Project Area location is currently designated as attainment/unclassifiable for each NAAQS, the determination must be made if the LNG Terminal is a PSD major source and is thus subject to the PSD pre-construction review program.

ODEQ's NSR program was approved by the EPA in the early 1980's. The program regulates construction and modification of larger or major sources in Oregon. The program is a unique State Implementation Plan ("SIP")-approved program that utilizes Plant Site Emission Limits ("PSEL") and Baseline Emission Rates for regulating source emissions, as well as determining when new and modified sources are subject to New Source Review ("NSR"). The Oregon Administrative Rules ("OAR") (OAR 340-200-0020) define a federal major source as any source with a potential to emit listed pollutants in amounts equal to or greater than 250 tons per year ("tpy") or 100 tpy for 28 specific source categories identified in OAR 340-200-0020(66)(c). Sources which do not meet the definition of federal major source but which have emissions greater than significant emission rates ("SER") must meet State NSR requirements. The PSD and State NSR requirements are contained in OAR Chapter 340, Division 224.

JCEP submitted an air quality permit application to the Oregon Department of Environmental Quality ("ODEQ") on March 29, 2013. The air quality permit application demonstrated that the LNG Terminal would be in compliance with all applicable air quality regulations and ambient air quality standards. As such, ODEQ issued PSD Air Contaminant Discharge Permit (ACDP) 06-0118-ST-01 to the JCEP on June 16, 2015. ACDP 06-0118-ST-01 covers the LNG Terminal and the previously proposed South Dune Power Plant facility. Because the design of the facility has changed (i.e., the South Dunes Power Plant facility is no longer included), the LNG terminal no longer meets the criteria for and definition of a federal major source (i.e., JCEP is no longer classifiable as one of the 28 listed sources and the facility's annual potential to emit is less than the 250 tpy limit for unlisted sources). The facility is, therefore, no longer subject to the PSD pre-construction permitting program. JCEP is submitting a Type B State NSR application to ODEQ to obtain a Standard ACDP for approval to construct and operate the terminal. A copy of the air permit application is provided as **Appendix A.9**.

9.1.2.4 New Source Performance Standards ("NSPS")

The New Source Performance Standards ("NSPS"), found in 40 CFR 60, establish requirements for new, modified, or reconstructed emission units in specific source categories. The LNG Terminal includes certain emission units, storage tanks, and process equipment that would be applicable to specific NSPS as summarized in **Table 9.1-3**.

Table 9.1-3 NSPS Affected Sources

Source Type	Number of Sources	Rated Capacity		Fuel Type	Annual Hours Of Operation	Applicable NSPS
Combustion Turbine	5	524.1	MMBtu/hr	Natural Gas	8,760	Subpart KKKK
Thermal Oxidizer	1	110	MMBtu/hr	Natural Gas	8,760	N/A
Auxiliary Boiler	1	296.2	MMBtu/hr	Natural Gas	876	Subpart Db
Black Start Engine	2	4,376	hp	Diesel	200	Subpart IIII
Backup Engine	2	1,073	hp	Diesel	200	Subpart IIII
Enclosed Marine Flare	1	0.74	MMBtu/hr	Natural Gas	8,760	N/A
Multipoint Ground Flare	1	2.13	MMBtu/hr	Natural Gas	8,760	N/A
Firewater Pump Engine	3	700	hp	Diesel	200	Subpart IIII

40 CFR 60 Subpart Db

The Standards of Performance for Industrial, Commercial, and Institutional Steam Generating Units apply to the Auxiliary Boiler. The requirements of 40 CFR 60 Subpart Db include emission limits, performance testing, monitoring, recordkeeping, and reporting.

40 CFR 60 Subpart IIII

The Standards of Performance for Stationary Compression Ignition Internal Combustion Engines constructed after July 15, 2005, apply to the diesel-fired generator engines, back up engines, and firewater pump engines. The requirements of 40 CFR 60 Subpart IIII include emission standards, fuel sulfur content, monitoring, and recordkeeping.

40 CFR 60 Subpart KKKK

The Standards of Performance for Stationary Combustion Turbines constructed after February 18, 2005, apply to the combustion turbines. The requirements of 40 CFR 60 Subpart KKKK include emission limits, performance testing, monitoring, recordkeeping, and reporting.

40 CFR 60 Subpart OOOOa

The Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution for which construction, modification, or reconstruction commenced after September 18, 2015, will not apply to any process equipment at the LNG Terminal. The requirements of 40 CFR 60 Subpart OOOOa do not apply to the LNG storage tanks, because the LNG storage tanks will not contain the products covered by Subpart OOOOa, and the tanks will not have the potential to emit six tpy of Volatile Organic Compound (“VOC”) emissions. In addition, the facility operations do not meet the definition of ‘natural gas processing plant’ so pneumatic controllers and components in VOC and wet gas service would be not be subject to Subpart OOOOa. Proposed compressors for the BOG fuel gas system will be centrifugal compressors with dry seals, which are not an affected source type under Subpart OOOOa.

9.1.2.5 National Emission Standards for Hazardous Air Pollutants ("NESHAPs")/Maximum Achievable Control Technology ("MACT")

NESHAPs, codified in 40 CFR Part 61 and Part 63, regulate the emission of hazardous air pollutants ("HAPs") from existing and new sources. Part 61 was promulgated prior to the 1990 CAA Amendments and regulates only eight types of hazardous substances, which include: asbestos, benzene, beryllium, coke oven emissions, inorganic arsenic, mercury, radionuclides, and vinyl chloride. The LNG Terminal would not operate any processes that are regulated by Part 61. As a result, the requirements of Part 61 are not applicable.

The 1990 CAA Amendments established a list of 189 additional HAPs, which necessitated the need for issuing standards under Part 63. Known as the MACT standards, Part 63 regulates HAP emissions from major sources of HAPs and specific source categories that emit HAPs, as well as certain minor or "area" sources of HAPs. Part 63 defines a stationary source with the potential to emit 10 tpy of any single HAP and/or 25 tpy of HAPs in aggregate as a major source of HAPs. Potential HAP emissions from operations are included in the potential to emit analysis.

Based on potential HAP emissions, the LNG Terminal will be a HAPs area source. HAP emissions are provided in **Table 9.1-4**. Supporting calculations are provided in **Appendix B.9 Stationary Source Emission Unit Inventory and Emission Calculations**.

Table 9.1-4 Potential HAP Emissions – Operations

Air Pollutant	Potential Emissions
Total HAPs	8.1 tons/year
Single Highest HAP (n-hexane)	3.3 tons/year

40 CFR 63 Subpart ZZZZ

The National Emission Standard for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines applies to the diesel-fired generator engines, back-up engines, and firewater pump engines. According to Subpart ZZZZ, new stationary reciprocating internal combustion engines located at a HAPs area source must meet the requirements of Subpart ZZZZ by meeting the requirements of 40 CFR 60 Subpart IIII. No further requirements apply for such engines under Subpart ZZZZ. The diesel-fired generator engines, back-up engines, and firewater pump engines would meet the requirements of 40 CFR 60 Subpart IIII and thus meet the requirements of 40 CFR 63 Subpart ZZZZ.

9.1.2.6 Title V Operating Permit

Title V of the CAA requires sources that have the potential to emit more than 100 tpy of any criteria pollutant, are a major source of HAPs, or are subject to certain NSPS or NESHAP subparts to obtain a Title V Operating Permit. The authority to issue Title V Operating Permits has been delegated to ODEQ by the EPA.

9.1.2.7 Chemical Accident Prevention

Section 112r of the 1990 CAA Amendments requires the EPA to publish regulations and guidance for chemical accident prevention at facilities for substances with the greatest risk of harm from accidental release. The chemical accident prevention provisions, referred to as the Risk Management Plan (RMP) Rule are codified in 40 CFR Part 68. A RMP must be prepared if a facility stores a regulated substance in a quantity greater than certain thresholds. The RMP regulated flammable substances list includes methane, ethane, ethylene, propane and pentane, each with a threshold quantity of 10,000 pounds. The LNG Terminal will process and/or store these substances in quantities greater than 10,000 pounds each. Applicability would be determined based on the final facility design. Flammable substances used as fuel or held for sale as fuel at a retail facility are not covered under the Risk Management Program. It is likely an RMP will be required for the flammable substances used as refrigerants because all natural gas handled at the facility will be combusted on site as fuel or sold for export. If an RMP is required, JCEP will prepare and submit an RMP plan to the EPA prior to introduction of hydrocarbons.

The RMP applies only to stationary sources and does not apply to transportation, including storage incident to transportation. Transportation includes, but is not limited to, transportation subject to oversight or regulation under 49 CFR Parts 192 (federal safety standards for transportation of natural and other gas by pipeline), 193 (federal safety standards for liquefied natural gas facilities), or 195 (federal safety standards for transportation of hazardous liquids by pipeline), or a state natural gas or hazardous liquid program for which the state has in effect a certification to the U.S. Department of Transportation ("DOT") under 49 USC § 60105. Because the LNG storage tanks are regulated under 49 CFR Part 193, the LNG storage tanks are not subject to RMP requirements under 40 CFR Part 68.

9.1.2.8 Mandatory Greenhouse Gas ("GHG") Reporting

The EPA established mandatory GHG reporting under 40 CFR 98. These regulations prescribe the sources for which GHG emissions must be reported and the manner in which GHG emissions are to be monitored, calculated, and quality assured for different source categories. Facilities with GHG emissions above the reporting threshold of 25,000 tonnes of carbon dioxide equivalent (CO_2e) per calendar year are required to report GHG emissions under 40 CFR 98. Additionally, a GHG Monitoring Plan which includes data collection requirements, GHG calculation methodology, and data quality assurance procedures would be required. Jordan Cove will have GHG emissions in excess of the reporting threshold for the mandatory GHG reporting rule.

9.1.2.9 Applicable State Regulations

The following ODEQ regulations (OAR) were evaluated for applicability:

- Division 200 General Air Pollution Procedures and Definitions;
- Division 202 Ambient Air Quality Standards and PSD Increments;
- Division 204 Designation of Air Quality Areas
- Division 208 Visible Emissions and Nuisance Requirements;
- Division 210 Stationary Source Notification Requirements;

- Division 212 Stationary Source Testing and Monitoring;
- Division 214 Stationary Source Reporting Requirements;
- Division 216 Air Contaminant Discharge Permits;
- Division 218 Oregon Title V Operating Permits;
- Division 220 Oregon Title V Operating Permit Fees;
- Division 222 Stationary Source Plant Site Emission Limits;
- Division 224 New Source Review;
- Division 225 Air Quality Analysis Requirements;
- Division 226 General Emission Standards;
- Division 228 Requirements For Fuel Burning Equipment and Fuel Sulfur Content; and
- Division 246 Oregon State Air Toxics Program.

The Project has applied for a Type B State NSR Standard Air Contaminant Discharge Permit because emissions of PM, PM_{10}, $PM_{2.5}$, NO_X, CO, SO_2, VOC, and H_2SO_4 will each exceed significant emission rates, but will be less than the PSD threshold.

9.1.3 Ambient Air Quality

The existing ambient air quality must be characterized to understand the potential impact of the LNG Terminal. The only monitors for CO, NO_2, and SO_2 in the state are in Portland, which is approximately 260 kilometers (km) northeast of the LNG Terminal site. The monitor selected for PM-10 is outside of Eugene in Lane County, which is approximately 120 km northeast of the LNG Terminal site. The monitor selected for PM-2.5 and ozone is located in Cottage Grove in Lane County, which is 110 km northeast of the LNG Terminal site. All monitoring sites show compliance with the ambient air quality standards as shown in **Table 9.1-5**.

Table 9.1-5 Existing Ambient Air Quality Data

Pollutant	Averaging Period	Ambient Air Quality	National Ambient Air Standard	State Ambient Air Standard	Monitoring Period	Site
SO_2	1-hour	4 ppb	75 ppb	75 ppb	2013-2015	41-051-0080
	3-hour	8 ppb	500 ppb	500 ppb	2015	
	24-hour(1)	2 ppb	N/A	100 ppb	2015	
	Annual(1)	0 ppb	N/A	20 ppb	2015	
NO_2	1-hour	29 ppb	100 ppb	100 ppb	2013-2015	41-051-0080
	Annual	9 ppb	53 ppb	53 ppb	2015	41-051-0080
CO	1-hour	2.4 ppm	9 ppm	9 ppm	2015	41-051-0080
	8-hour	1.9 ppm	35 ppm	35 ppm	2015	41-051-0080
PM-10	24-hour	53 µg/m^3	150 µg/m^3	150 µg/m^3	2015	41-039-0059
PM-2.5	24-hour	22 µg/m^3	35 µg/m^3	35 µg/m^3	2013-2015	41-039-9004
PM-2.5	Annual	8.2	12 µg/m^3	12 µg/m^3	2015	41-039-9004

Pollutant	Averaging Period	Ambient Air Quality	National Ambient Air Standard	State Ambient Air Standard	Monitoring Period	Site
Ozone	8-hour	0.061	0.070 ppm	0.070 ppm	2013-2015	41-039-9004

(1) EPA revoked 24-hour and annual SO_2 standards in 2010, however Oregon regulations include the 24-hour and annual SO_2 standards.

The above monitors are located within or nearby the two largest cities in Oregon (*i.e.*, Portland and Eugene). These areas have a substantially larger population than the Coos Bay area and therefore have a significantly higher density of industrial facilities and mobile source air emissions compared to the LNG Terminal. Thus, these monitors would be considered to conservatively represent the ambient air quality within the LNG Terminal. This is confirmed when the monitored data are compared to the NW AIRQUEST model output for the LNG Terminal location as provided in **Table 9.1-6**. The NW AIRQUEST modeling is the result of regional photochemical grid modeling combined with observational air quality data for the period of 2009-2011. The result is a hybrid dataset that allows for an estimate of air quality anywhere within the modeled domain, including Coos Bay (*i.e.*, data extracted for 43.42981, -124.2542).

Table 9.1-6 Existing Ambient Air Quality Data Comparison

Pollutant	Averaging Period	Monitored Ambient Air Quality	NW AIRQUEST Database	National Ambient Air Standard	State Ambient Air Standard
SO_2	1-hour	4 ppb	1.2 ppb	75 ppb	75 ppb
	3-hour	8 ppb	1.1 ppb	500 ppb	500 ppb
	24-hour(1)	2 ppb	1.1 ppb	N/A	100 ppb
	Annual(1)	0 ppb	0.4 ppb	N/A	20 ppb
NO_2	1-hour	29 ppb	8.4 ppb	100 ppb	100 ppb
	Annual	9 ppb	1.0 ppb	53 ppb	53 ppb
CO	1-hour	2.4 ppm	0.659 ppm	9 ppm	9 ppm
	8-hour	1.9 ppm	0.516 ppm	35 ppm	35 ppm
PM-10	24-hour	53 µg/m^3	35 µg/m^3	150 µg/m^3	150 µg/m^3
PM-2.5	24-hour	22 µg/m^3	9.9 µg/m^3	35 µg/m^3	35 µg/m^3
PM-2.5	Annual	8.2 µg/m^3	6.7 µg/m^3	12 µg/m^3	12 µg/m^3
Ozone	8-hour	0.061 ppm	0.046 ppm	0.070 ppm	0.070 ppm

(1) EPA revoked 24-hour and annual SO_2 standards in 2010, however Oregon regulations include the 24-hour and annual SO_2 standards.

Pre-construction monitoring is not required for Type B State NSR projects.

9.1.4 Ambient Area Air Quality Analysis

An ACDP application for the LNG Terminal requires a demonstration that compliance is achieved with all applicable air quality standards. An ambient air quality impact analysis (dispersion modeling) was performed consistent with the requirements and procedures described in the Guideline on Air Quality Models (EPA 2017), Oregon Administrative Rules, and the Federal Land Managers' Air Quality Related Values work group ("FLAG") (NPS 2010).

Other guidance was used, as appropriate, such as the Guidance on the Development of Modeled Emission Rates for Precursors ("MERPs") (EPA 2016) and the New Source Review Workshop Manual (EPA 1990).

An Air Quality Modeling Protocol was approved by ODEQ in July 2017 and was based on a modeling discussion held with ODEQ on March 13, 2017. Using the approved modeling protocol, an ambient air quality impact analysis was conducted to demonstrate compliance with the NAAQS.

The ambient air quality analysis used the following approach:

- The results from the ambient air quality analysis are compared to the Class II modeling significant impact levels ("SILs") on a pollutant and averaging period basis.
- If the LNG Terminal's impacts are less than the SILs and there is sufficient "headroom" between the existing background air quality levels and the ambient air quality standard, then the NAAQS are considered to be protected.
- If the LNG Terminal's impacts are greater than the SILs, then the LNG Terminal's emission rates must be further analyzed to demonstrate compliance with all applicable PSD increments and NAAQS. Compliance with the applicable PSD increments must be demonstrated as part of the ACDP permit application.

The results of this analysis are provided in Section 9.2.2.1.

9.1.4.1 Model Selection and Methodology

The most recent version of the AERMOD modeling system (version 16216r) available was used to generate impacts for the ambient air quality impact analysis. AERMOD is the EPA preferred model for near-field (*i.e.*, <50 km) analyses.

The inputs and methodology used for the ambient air quality analysis are based on standard modeling practice and applicable guidance, which are summarized herein:

- The surface data used in the analysis is the five most-recent complete years of data collected at the Southwest Oregon Regional Airport (call sign KOTH), located at 43.419°N, 124.243°W, which is approximately 2 km southeast of the LNG Terminal site. Upper air data from McNary Field in Salem, OR (44.92°N, 123.02°W) will also be used, which is approximately 197 km northeast of the LNG Terminal site. The period of meteorological data that was used is January 1, 2012 to December 31, 2016.
- Ground-level concentrations will be calculated within a nested, Cartesian receptor grid. The nested grids will cover an area extending up to 50 km from the proposed facility, but truncated over the Pacific Ocean. The proposed grids will be defined as follows:
    - receptors spaced every 25 m along the facility fence line;
    - receptors spaced every 25 m that extend 100 m from the facility fence line;
    - receptors spaced every 100 m that extend from 100 m to 3 km;
    - receptors spaced every 250 m that extend from 3 km to 5 km;
    - receptors spaced every 500 m that extend from 5 km to 20 km; and
    - receptors spaced every 1,000 m that extend from 20 km to 50 km.
- Treatment of downwash with BPIPPRM (version 04274).

- Evaluation of LNG Terminal operations for both normal operation and startup and shutdown (SU/SD).
- Evaluation of offsite stationary and mobile source emissions (*i.e.*, other permitted sources, LNG carriers, and support vessels) during carrier transiting, hotelling and loading combined.
- Assessment of LNG Terminal impacts compared to the applicable PSD SILs and, if above, compared to the applicable NAAQS.

9.1.4.2 Class I Areas

FERC guidance recommends an analysis of project impacts on Class I areas if there are PSD Class I areas within 100 km, the project is subject to PSD review, or comments are anticipated. There are no federal PSD Class I areas located within 100 km of the LNG Terminal site, but there are five within 200 km of the LNG Terminal site. The closest Class I area is the Kalmiopsis Wilderness Area, which is located approximately 110 km south of the LNG Terminal site.

Compliance with the Class I PSD Increments is assessed in the state NSR permit application. The state NSR permit application does not require an analysis of air quality related values ("AQRVs") for State NSR sources, but a screening level analysis was performed for completeness. The FLAG guidance for air AQRV analyses recommends the use of the Q/D screening approach to determine if visibility impacts are likely to result from a project. This screening analysis is based on the distance from the source to the Class I area and the annualized, maximum daily emissions of AQRV-impacting pollutants. If the Q/D analysis results are less than or equal to the screening factor of 10, then FLM agencies do not require any further Class I AQRV impact analyses.

Using the calculations summarized in **Appendix C.9 Q/D Emission Calculations** for the visibility-impairing pollutants of NOx, SO_2, PM, and H_2SO_4 the calculated Q value is 849 tons per year. Using the shortest distance of 110 km, the Q/D value is calculated to be 7.7, which is below the threshold value of 10. FLM concurrence with these calculations and that additional Class I modeling is not required is also provided in **Appendix C.9**.

9.1.4.3 Source Parameters and Emissions

The main criteria air pollutant emission sources from the LNG Terminal would consist of five compressor-direct drive combustion turbines, a thermal oxidizer for the gas conditioning system, an auxiliary boiler, two diesel black-start generator engines, two diesel back-up engines, three firewater pump engines, one marine flare, and a combined (warm and cold) multipoint ground flare. The modeled emission rates and stack parameters for normal operations are presented in **Table 9.1-7**.

Table 9.1-7 LNG Terminal Emission Rates and Stack Parameters

Emission Units	Stack Parameters				Potential Emission Rates Per Unit			
	Temperature (°F)	Velocity (ft./sec)	Stack Diameter (ft.)	Stack Height (ft.)	NO_X (lb./hr.)	$PM_{10}/PM_{2.5}$ (lb./hr.)	SO_2 (lb./hr.)	CO (lb./hr.)
Combustion Turbine with Duct Firing	243	71	10	119	3.8	5.4	1.64	4.6
Auxiliary Boiler	330	49	6	100	2.18	2.20	0.83	2.66
Thermal Oxidizer	1,600	42	9.5	131	14.44	0.88	4.53	8.79
Marine Flare	1,832	30	45	100	0.05	0.023	0.0023	0.23
Ground Flare (warm and cold)	Ambient	Negligible	259' x 227'	85	0.14	0.065	0.0067	0.66
Fire Water Pump (1)	948.3	193	0.67	18	5.31	0.30	0.0071	2.68
Backup Generator (1)	952.5	287	0.67	13	16.63	0.19	0.012	1.42
Black Start Generator (1)	873.6	177	1.67	18	7.43	0.23	0.044	1.04

(1) The emission sources are intermittent and will operate less than 200 hours per year. The modeled emission rates are based on annualized emissions.

The LNG Terminal will also have associated marine vessels (*i.e.,* LNG carriers and tugboats) that will be moored at the berth during loading of the LNG from the LNG storage tanks. Emissions and exhaust parameters from the LNG carriers are included in the cumulative modeling analysis starting from the process of transit, berthing, to hotelling and LNG loading and finally to connecting the towlines and de-berthing.

9.1.5 Along the Waterway

Approximately 110 to 120 LNG carriers per year would transit to the LNG Terminal. Tugs would be provided by JCEP to be used in the transit and berthing (and de-berthing) of the LNG carriers. The tugs would be berthed adjacent to the LNG ship berth to be ready when called upon. Emissions and exhaust parameters from the LNG carriers are included in the preliminary ambient air quality analysis as an emission source for cumulative impact demonstration modeling starting from the transit to the process of berthing, to hoteling and LNG loading and finally to connecting the towlines and de-berthing.

9.2 ENVIRONMENTAL CONSEQUENCES – AIR QUALITY

9.2.1 Construction Related Emissions

Air quality impacts associated with the construction of the LNG Terminal can be classified as impacts associated with fugitive dust emissions (PM emissions suspended in air) during site preparation and impacts associated with operating fossil fuel burning equipment. The construction of the LNG terminal would result in a temporary increase in emissions.

Emissions of criteria pollutants, including nitrogen oxides (NO_X), CO, PM, VOCs, and SO_2, along with GHGs (*i.e.*, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)) would result from the combustion of fossil fuels. These emissions would be released in the exhaust of the equipment used in land clearing/grading equipment, cranes, bulldozers, and various types of trucks and cars. Other construction-related emissions include compactors, pavers, welding, brazing, soldering, solvent cleaning, grinding, cutting, etc.

Fugitive dust emissions would result from construction activities such as land clearing, grading, excavation, and concrete placement, along with vehicular traffic on paved and unpaved roads. The magnitude of fugitive dust emissions would primarily be a function of the area of construction, silt and moisture contents of the soil, wind speed, frequency of precipitation, amount of vehicle traffic, vehicle types, and paved roadway characteristics. Fugitive dust emissions would be produced during all phases of construction. Emissions would be greater during the drier summer months and in areas of fine-textured soils. During these periods, dust suppression techniques, such as watering, would be used in these areas to minimize the impacts of fugitive dust on sensitive areas. The potential emissions from construction are provided in **Table 9.2-1, Table 9.2-2, Table 9.2-3, Table 9.2-4, and Table 9.2-5**. Supporting calculations are provided in **Appendix E.9 Construction Emission Inventory and Emission Calculations**.

Table 9.2-1 Pollutant Emissions Summary – Construction Year 1

Construction Activity Source	Year 1 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
On-road Construction Equipment	3.50	0.01	2.76	0.21	0.19	0.51	1,048.87	0.09
Non-road Construction Equipment	119.80	0.21	52.88	6.10	5.92	15.25	39,786.69	6.85
Boats/Tugs	223.02	0.11	51.11	3.73	3.62	5.96	10,642.63	0.16
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	257.32	29.38	0	0.00	0
Material Delivery and Worker Commuting	4.61	0.01	13.11	0.20	0.18	1.06	1,918.59	0.27

Table 9.2-2 Pollutant Emissions Summary – Construction Year 2

Construction Activity Source	Year 2 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
On-road Construction Equipment	4.03	0.01	3.03	0.24	0.22	0.58	1,209.10	0.10
Non-road Construction Equipment	176.16	0.27	95.89	9.75	9.46	22.90	50,673.63	10.09
Boats/Tugs	212.40	0.11	48.68	3.55	3.44	5.68	10,135.84	0.15
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	296.10	86.56	0	0.00	0
Material Delivery and Worker Commuting	11.14	0.03	36.05	0.43	0.39	2.70	4,689.67	0.69

Table 9.2-3 Pollutant Emissions Summary – Construction Year 3

Construction Activity Source	Year 3 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
On-road Construction Equipment	3.77	0.01	2.89	0.22	0.20	0.55	1,132.05	0.10
Non-road Construction Equipment	153.94	0.22	121.07	10.19	9.88	23.58	40,644.24	10.11
Boats/Tugs	95.58	0.05	21.90	1.60	1.55	2.55	4,561.13	0.07
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	179.26	75.21	0	0.00	0
Material Delivery and Worker Commuting	15.68	0.05	53.05	0.54	0.49	3.82	6,430.47	0.99

Table 9.2-4 Pollutant Emissions Summary – Construction Year 4

Construction Activity Source	Year 4 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
On-road Construction Equipment	1.21	0.00	0.79	0.07	0.06	0.17	362.97	0.03
Non-road Construction Equipment	33.42	0.05	48.49	2.81	2.72	7.53	9,618.98	3.05
Boats/Tugs	0	0	0	0	0	0	0.00	0
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	14.35	14.35	0	0.00	0
Material Delivery and Worker Commuting	8.51	0.03	31.70	0.28	0.26	2.21	3,632.68	0.58

Table 9.2-5 Pollutant Emissions Summary – Construction Year 5

Construction Activity Source	Year 5 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
On-road Construction Equipment	0.07	0.00	0.03	0.00	0.00	0.01	20.86	0.00
Non-road Construction Equipment	6.49	0.01	4.20	0.40	0.39	0.92	2,483.25	0.41
Boats/Tugs	0	0	0	0	0	0	0.00	0
Stationary Emission Units	64.74	20.93	75.90	52.46	52.46	69.30	922,824.41	3.61
Fugitive Sources	0	0	0	156.09	15.61	0	0.00	0
Material Delivery and Worker Commuting	1.16	0.00	4.53	0.04	0.04	0.32	527.88	0.08

Construction activities would take place over multiple years. **Table 9.2-6** provides a summary of the total emissions of criteria pollutants and GHGs for construction by year. The construction emission totals during year five include operation of the LNG Terminal equipment for commissioning. Supporting calculations are provided in **Appendix E.9 Construction Emission Inventory and Emission Calculations**.

Table 9.2-6 Total Construction Emissions by Year

Construction Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	351	0.35	120	268	39	23	53,397	7.4
Year 2	404	0.43	184	310	100	32	66,708	11.0
Year 3	269	0.33	199	192	87	31	52,768	11.3
Year 4	43	0.08	81	18	17	10	13,615	3.7
Year 5	72	20.94	85	209	68	71	925,856	4.1

9.2.2 Operational Emissions

The operation of the LNG Terminal would include operating the compressor-direct drive combustion turbines, a thermal oxidizer for the gas conditioning system, an auxiliary boiler, diesel generator engines, diesel backup engines, flares, and firewater pump engines. The LNG Terminal equipment would combust fossil fuels and would release combustion emissions that include NO_X, CO, PM, VOCs, SO_2, and GHGs. Enclosed ground flares would be used to burn gas released from the process during emergencies or while purging equipment in preparation for maintenance, and LNG tanker conditioning activities. Fugitive VOC and GHG emissions, emissions that could not reasonably pass through an exhaust stack, would also result from evaporative losses from valves, connectors, open ended lines, pressure relief valves, and storage vessels. The potential annual emissions from operations are provided in **Table 9.2-7** and fugitive emissions are provided in **Table 9.2-8**. Supporting calculations are provided in **Appendix B.9 Stationary Source Emission Unit Inventory and Emission Calculations**.

Table 9.2-7 Pollutant Emissions Summary – Operations

Source	Emissions (tons/year)							
	NO_X	CO	$PM_{2.5}$	PM_{10}	VOC	SO_2	HAP	GHG (as CO_2e)
Combustion Turbines	81.99	97.82	112.26	112.26	32.72	35.19	5.06	1,292,706
Combustion Turbines Startup/Shutdown	0.23	0.73	0.11	0.11	0.10	4.4E-03	6.2E-04	188
Thermal Oxidizer	63.25	38.50	3.85	3.85	1.08	19.84	0.96	622,154
Auxiliary Boiler	0.96	1.16	1.3	1.3	0.67	0.36	0.24	15,193
Firewater Pump Engines	1.59	0.80	9.0E-02	9.0E-02	4.5E-02	2.1E-03	3.6E-03	241
Backup Generator Engines	3.33	0.28	0.04	0.04	0.04	2.5E-03	4.1E-03	278
Black Start Generator Engines	1.49	0.21	0.05	0.05	0.09	8.8E-03	1.5E-02	1,002
Flares	0.86	3.90	0.38	0.38	8.31	3.9E-02	4.3E-02	2,177
Gas-Up	2.09	9.5	1.12	1.12	17.53	0.16	3.8E-02	4,351

Table 9.2-8 Fugitive Emissions

Pollutants	Annual Emissions (tons/year)		
	LNG Tanks	Equipment Leaks	Total
VOC	0.11	7.87	7.98
CO_2	0.00	1.64	1.64
CH_4	23.06	501.52	524.58
N-Hexane	0.03	1.75	1.77

9.2.2.1 PSD Class II Impacts

The results from the ambient air quality analysis are compared to the Oregon Class II modeling significant impact levels (SILs) on a pollutant and averaging period basis in **Table 9.2-9**. These results are the maximum of either the normal operating scenario or the startup/shutdown scenario. For those pollutants and averaging periods with impacts greater than the SILs, additional modeling was conducted that included an offsite stationary and mobile source emission inventory (*i.e.*, other permitted sources, LNG carriers, and support vessels during carrier transiting, hoteling and loading). The results of this cumulative ambient air quality analysis are added to representative background values and compared to the NAAQS in **Table 9.2-10**.

The results of the preliminary air quality modeling indicate that all CO and 3-hr, 24-hr, and annual SO_2 impacts are less than the Class II SILs and, therefore, no further modeling is required. The remaining pollutants and averaging times were further modeled with the above-mentioned offsite stationary and mobile source inventory. The results of the cumulative modeling analysis indicate compliance with all NAAQS.

A demonstration of compliance with both the NAAQS and PSD Increments is required for the ACDP application. Compliance with the PSD Increments is addressed in the permit application included as **Appendix A.9**.

Table 9.2-9 LNG Terminal-Only Maximum Modeled Impacts

Pollutant	Averaging Period	Maximum Modeled Concentration(1) (μg/m^3)	Oregon Class II SIL (μg/m^3)
CO	1-hour	108.0	2000.0
	8-hour	16.2	500.0
NO_2(2)	1-hour	**50.5**	8.0
	Annual	**3.4**	1.0
PM_{10}	24-hour	**8.1**	1.0
	Annual	**1.1**	0.2
$PM_{2.5}$(3)	24-hour	**8.1**	1.2
	Annual	**1.1**	0.3
SO_2	1-hour	**11.5**	8.0
	3-hour	5.7	25.0

Pollutant	Averaging Period	Maximum Modeled Concentration(1) (μg/m³)	Oregon Class II SIL (μg/m³)
	24-hour	2.5	5.0
	Annual	0.3	1.0

(1) Modeled concentrations are the overall maximum values at any receptor. Modeled concentrations shown in **bold** type exceed the Class II SILs and additional analysis of impacts is required. See Table 9.2-10 for these pollutants.
(2) The reported NO_2 modeled concentration assumes 100% conversion of NOx to NO_2.
(3) Direct $PM_{2.5}$ only.

Table 9.2-10 Cumulative Modeled Impacts (in the Form of the Standard(1))

Pollutant	Averaging Period	Modeled Concentration(1) (μg/m³)	Background (μg/m³)	Total Impact (μg/m³)	NAAQS (μg/m³)
NO_2(2)	1-hour	132.3	16.0	148.3	188.0
	Annual	4.1	1.9	6.0	100.0
PM_{10}(3)	24-hour	9.3	35.0	44.3	150.0
	Annual	1.4	n/a	1.4	n/a
$PM_{2.5}$(4)	24-hour	6.9	9.9	17.2	35.0
	Annual	1.3	6.7	8.4	12.0
SO_2	1-hour	30.1	3.1	33.2	196.0

(1) Modeled concentrations are in the form of the NAAQS:
  a. The modeled 1-hour NO_2 concentration is the 98th percentile of 1-hour daily maximum concentrations, averaged over three years
  b. The modeled annual NO_2 is the maximum concentration at any receptor
  c. The modeled 24-hour PM10 concentration is not to be exceeded more than once per year on average over three years
  d. The modeled 24-hour $PM_{2.5}$ concentration is the 98th percentile averaged over three years
  e. The modeled annual $PM_{2.5}$ concentration is the maximum concentration at any receptor
  f. The modeled 1-hour SO_2 concentration is the 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
(2) The reported NO_2 modeled concentration is based on the ARM2 method in AERMOD.
(3) PM_{10} has a Class II SIL defined in OAR 340, but no associated NAAQS.
(4) Includes an estimated secondary component of 0.39 μg/m³ as described in the ACDP application.

9.2.2.2 PSD Class I Impacts

The air quality related values (AQRVs) that are applicable at PSD Class I areas, such as regional haze and acid deposition, were screened using the FLAG 2010 Q/D approach. Q/D is the sum of certain pollutant emissions (tpy) divided by distance (km) from the Class I area. A Q/D ≤ 10 indicates no further analysis of AQRVs is required.

Section 9.1.4.2 provides the Q/D calculation, which results in a value well under the threshold value of 10. This approach and calculation has been confirmed with the appropriate FLMs. Compliance with the Class I PSD increments is demonstrated as part of the ACDP permit application.

9.2.2.3 Secondary Formation

Ozone is formed through a series of complex reactions between precursor pollutants (*e.g.*, NOx and VOC) that take place in the atmosphere in the presence of sunlight. Generally, ozone is considered a regional pollutant due to substantial international and regional transport of both ozone and precursor emissions. Secondary formation from NOx and SO_2 to particulate $PM_{2.5}$ is also formed through complex reactions in the atmosphere that depend on factors such as temperature, humidity, ammonia, etc. The LNG Terminal area is in attainment of the EPA standards for ozone and $PM_{2.5}$.

The final ambient air quality impact analysis includes an evaluation of potential secondary formation for ozone and $PM_{2.5}$ from the LNG Terminal emissions using the EPA document Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) (EPA, 2016). The ACDP permit application report contains a discussion of the final approach. Based on this final approach and the LNG Terminal emissions, the LNG Terminal will have secondary formation of ozone and $PM_{2.5}$ that is considered insignificant.

9.2.2.4 Along the Waterway

Different types of LNG carriers would transit to the LNG Terminal site; steam turbine vessels firing fuel oil, steam turbine vessels firing natural gas, dual-fuel diesel electric ("DFDE") vessels, totally approximately 110 to 120 LNG carriers per year. The worst case potential emissions, assuming 120 calls per year for each type of LNG carrier, were calculated and are provided in **Table 9.2-11**. Supporting calculations are provided in **Appendix F.9 Marine Vessel Emission Inventory and Emission Calculations.**

Table 9.2-11 Worst Case Potential Emissions Summary – Marine Vessels

Source	Emissions (tons/year)						
	NO_X	CO	$PM_{2.5}$	PM_{10}	VOC	SO_2	GHG (as CO_2e)
Steam Turbine Vessels – Fuel Oil	28.10	2.98	3.31	3.31	0.17	9.5	14,653.02
Steam Turbine Vessels – Natural Gas	14.90	6.69	0.60	0.60	0.44	0.11	10,394.41
DFDE Vessels	48.68	36.68	2.06	2.06	9.47	3.57	8,756.88
Tugboats	9.51	17.68	0.317	0.317	1.00	2.6	3736.15

In the unlikely event of an LNG spill on the ground or another warm surface, the LNG would boil quickly and vaporize. The vapor would be primarily methane, which is not a criteria pollutant. Without an ignition source and specific flammability limit conditions, the methane would disperse in the air, which in turn would cause a temporary degradation of ambient air quality. Natural gas burns with a visible flame and has narrow flammability limits, combusting only in air-to-fuel proportions of 5-15%. Below 5% the mix is too lean to burn and above 15% the mix is too rich to burn. Pools of liquefied natural gas do not ignite as readily as pools of gasoline or diesel fuel. The auto-ignition temperature of methane is 1004° F, significantly higher than gasoline (495° F) or diesel (600° F). So while open flames and sparks can ignite natural gas, many hot surfaces such as a car muffler will not. Methane vapors in open air exhibit a very slow flame speed of about 4 mph. Methane is also considered a greenhouse gas and the release of an amount of methane may contribute to global warming. Methane vapor release effects would likely be confined to along the LNG ship transit route and would not affect any sensitive receptors outside of that zone. Consequently, an LNG spill without ignition of the vapor is not anticipated to have a long-term adverse effect on air quality.

If the vapor from an LNG spill were to come in contact with an ignition source and meet the specific flammability limit conditions, it is likely that products of combustion would degrade the local air quality particularly downwind of the LNG spill. The incomplete products of the combustion of methane include criteria pollutants, ozone precursors, and carbon particulates. While the types and amounts of air contaminants from burning vapor due to an LNG spill would depend on a number of factors, the emissions would be limited to a localized area and would be temporary, and would not result in significant effects on air quality.

9.2.3 Mitigation

During construction, ambient air quality will be affected by emissions and fugitive dust generated by construction equipment. Fugitive dust and emissions from construction activities generally do not result in a significant increase in regional pollutant levels, although local pollutant levels could intermittently increase during the construction phase of this project. Fortunately the LNG Terminal would be located in an area zoned for industrial use and is void of permanent residents. Sensitive receptors, such as children, elderly, and infirm are not expected to be near the project area where localized construction emissions will occur.

Regardless, the LNG Terminal would utilize techniques to minimize the air quality impacts during construction and operation of the LNG Terminal. Construction activities must comply with the Oregon DEQ Regulations for dust control in OAR 340-208-0210 and JCEP will operate according to the Erosion and Sediment Control Plan. During construction of the LNG Terminal dust control mitigation measures would include one or more of the following:

- Dust suppression techniques, such as watering, which would reduce fugitive PM emissions from construction activities such as material storage, land clearing, grading, excavation, and concrete batching;
- Wheel washing stations, as necessary, to prevent tracking of materials onto public roads;
- Street sweepers, as needed, to clean any inadvertent materials tracked onto public roads near the project site;
- Material hauling operations will endeavor to prevent spillage. Methods can include covering loads, limiting fill height in trucks, and proper training of operators;
- Excavated materials being hauled off-site on public roads will be covered; and
- Enclosing cement storage silos at the Batch Plant.

Speed will be limited to 15 mph for non-earthmoving equipment on the site in active construction areas to ensure personnel safety and reduce emissions. However, speed will only be limited by the safe travel speed of the haul road and equipment for earthmoving operations. Unnecessarily constraining haul speeds would lengthen the project and cause additional fugitive emissions from extended support operations and supervision. Wind fencing is not an appropriate dust mitigation measure for the Terminal Site design and construction process and would cause unnecessary burdens for the project.

The LNG Terminal would minimize vehicular and crankcase emissions from gasoline and diesel engines by complying with applicable EPA mobile and stationary source emissions performance standards and by using engines manufactured to meet these standards. Additionally, the LNG Terminal will minimize emissions using the following techniques:

- KBJ (EPC Contractor) will self-perform the majority of the construction activities for the LNG terminal and will utilize their company-owned fleet. The average age of the fleet is 6 years old. MOVES emission factors used to create the emissions estimates for the construction of the LNG Terminal used national average emission rates from similar equipment. The equipment in the KBJ fleet are newer than the national average and therefore are likely more efficient and the emissions calculated in Table 9.2-6 provide a conservative estimate of project-related emissions.
- Local subcontractors and outside rental equipment owners will comply with federal, state, and local laws;
- Performing regular maintenance of the emission units, which maintains efficient combustion. Efficient combustion reduces the fuel required to operate the emission units and thus reduces combustion emissions. The maintenance program for the KBJ equipment includes daily inspections, 500 operation hour preventative maintenance, engine oil analysis, and equipment specific activities;
- Operating equipment only within the manufacturer's guidelines;
- Equipment will not be modified or retrofitted without manufacturer involvement to ensure warranty and liability criteria are met;
- Combustion of ultralow sulfur diesel (ULSD) in heavy construction, diesel-burning equipment;
- Use of industry recognized standard emissions controls on stationary construction equipment;
- Following the KBJ Idling Policy, which includes requirements such as not allowing construction vehicles and equipment to idle for more than a set amount of time if the vehicle or equipment is not in motion to reduce fuel consumption, which reduces NO_X, CO, PM, VOCs, SO_2, and GHGs emissions; and
- Reducing roadway traffic congestion and minimizing vehicle trips through implementation of the Traffic Impact Study included in the Resource Report 8. Some traffic congestion and emissions reduction techniques include utilizing on-site and off-site parking and locating the Batch Plant and laydown areas in the North Spit to avoid excessive traffic through the project area.

When construction is commenced the decision to use alternative fuels to reduce emissions would be based on technical, operational, commercial, and resource availability considerations. KBJ does not own alternative fuel equipment, however, KBJ's newer fleet and rigorous equipment maintenance program and policies will help ensure maximum fuel efficiency and minimize emissions. Also, alternative fuel infrastructure is not widely available in the area to support a project of this magnitude.

During operations of the LNG Terminal air pollution mitigation measures will include:

- The combustion turbines will be equipped with post-combustion emission controls (catalytic oxidizers and selective catalytic reduction), which reduces NO_X, CO, and VOC emissions;
- The auxiliary boiler will be equipped with post-combustion emission controls (catalytic oxidizers and selective catalytic reduction), which reduces NO_X, CO, and VOC emissions;

- The combustion turbines will fire natural gas for facility startup and boil-off gas during normal operations, which reduces the consumption of diesel fuel;
- The HRSG steam will be used to drive a steam generator, providing ancillary power to the facility which reduces the need for additional power to be produced or purchased for the LNG Terminal;
- Tier 2 and Tier 3 stationary engines are specified which comply with emission limits for PM, NO_X and NMHC;
- Performing regular maintenance of the emission units, which maintains efficient combustion. Efficient combustion reduces the fuel required to operate the emission units and thus reduce the amount of combustion emissions emitted; and
- A halon-free, fire-suppression system. This system would remove the possibility of a release of ozone-depleting substances.

9.3 NOISE QUALITY

At any location, both the amplitude and frequency of environmental noise may vary considerably over the course of the day and throughout the week. This variation is caused in part by changing weather conditions and the effects of seasonal vegetative cover, in addition to human activities. There are two measures used by federal agencies to relate the time-varying quality of environmental noise. The A-weighted equivalent continuous noise level (L_{eq}) for 24 hours ($L_{eq(24)}$) is the level of steady sound with the same total energy as the time-varying sound of interest averaged over a 24-hour period. The day-night average noise level (L_{dn}) is the $L_{eq(24)}$ with 10 dBA added to the nighttime sound levels between the hours of 10 p.m. and 7 a.m. to account for people's greater sensitivity to sound during nighttime hours.

Another way of judging potential noise impact is the amount of increase over existing levels of noise at receptors around a site. In general, an increase of 3 decibels (dB) is barely detectable by the human ear and an increase of 5 dB is considered slightly significant. Increases of greater than 10 dB are generally considered significant, being perceived as an apparent doubling of loudness.

9.3.1 Ambient Noise Levels

The LNG Terminal is located in an area along the northern shore of Coos Bay, approximately one mile north of the Cities of North Bend and Coos Bay. The surrounding area consists of sand dunes interspersed with lower flat marsh areas, water bodies, and grassy fields. The sand dunes are covered with dense stands of vegetation, except where it has been affected by human activities.

There are no NSAs within one mile of the LNG Terminal site. This is a significant buffer that should greatly reduce the potential for any noise impacts. Two noise surveys previously have been conducted in the area: one in 2005, and the other in 2013, both of which identified two NSAs. A new sound level survey was performed in May 2017. There are a few campgrounds within 1.3 miles of the LNG Terminal site, which were also considered as part of the noise survey and identified as an additional NSA. The previously identified NSAs have been retained and an additional NSA, NSA 3, has been added to address the campground facilities to the north of the LNG Terminal. The noise survey results are summarized below.

All NSAs and distances to the LNG Terminal are shown on **Figure 9.3-1**. In order to evaluate the impact of the Project on the nearby recreation area, an additional noise receptor point has been included in the evaluation. As this location is not necessarily an NSA, it has been designated REC 1. **Table 9.3-1** shows the receptors, directions to the receptors, and approximate distance from the center of the liquefaction area. The following are the noise receptor locations included in the noise impact evaluation for the project:

- NSA 1 consists of single-family residences in a subdivision about 1.3 miles south of the LNG Terminal in the City of North Bend along the south side of the bay adjacent to the airport. The subdivision is bordered on the north by Colorado Avenue and on the west by Arthur Street.
- NSA 2 is a group of single-family residences, located approximately 2.2 miles east on Russell Point.
- NSA 3 is the Horsfall campground, the closest campground to the LNG Terminal site, located approximately 1.2 miles northeast of the LNG Terminal site.
- REC 1 is the recreation area located to the west and northwest of the LNG Terminal site.

Table 9.3-1 Receptor Distances and Directions from the LNG Terminal Equipment

Receptor	Description	Direction to Receptor	Distance, miles
NSA 1	Residential	South	1.3
NSA 2	Residential	East	2.2
NSA 3	Campground	Northeast	1.2
REC 1	Recreation Area	West	0.7

9.3.1.1 Summary of Previous Noise Surveys

The sound level measurement locations near the two previously identified NSAs were as follows:

- NSA 1: at the corner of Colorado Avenue and Arthur Street adjacent to a subdivision on the south side of the bay; and
- NSA 2: off East Bay Street about 90 feet east of US 101.

Previous noise surveys were conducted in 2005 and 2013:

- Between 1700 hours on August 31, 2005, and 1700 hours on September 1, 2005; and
- Between 1000 hours on April 11, 2013, and 0900 hours on April 18, 2013.

Table 9.3-2 summarizes the previously-measured results and shows the results of the 2017 sound level survey, which included NSA 3 and REC 1. The data are fairly consistent among the surveys.

Table 9.3-2 Summary of Existing Noise Levels at NSAs

Receptor	2005 $L_{eq(1\text{-}hr)}$	2005 L_{dn}	2013 $L_{eq(1\text{-}hr)}$	2013 L_{dn}	2017 $L_{eq(1\text{-}hr)}$	2017 L_{dn}
NSA 1	35.1 – 53.8	53.7	31.9 – 57.6	47.4 – 51.6	33.2 – 58.9	52.7
NSA 2	48.7 – 66.4	65.7	42.6 – 63.7	59.8 – 62.2	52.8 – 67.7	65.2
NSA 3	--	--	--	--	34.8 – 67.6	56.3
REC 1	--	--	--	--	42.4 – 61.2	55.2

The primary sources of man-made noise in the area included vehicle traffic on the Trans-Pacific Parkway and US Highway 101, recreational vehicle use in the Oregon Dunes National Recreation Area, and boat traffic in Coos Bay. Natural sounds included birds, insects and wind. At REC 1, ocean surf sounds are a significant and continuous source of ambient sounds. Occasional aircraft could be heard at the Southwest Oregon Regional Airport just across the bay from the site. A generator was operating at the wastewater treatment plant near NSA 1 during the first day of the 2017 monitoring. Noise levels at existing NSAs nearest the LNG Terminal site are controlled primarily by vehicular traffic. Noise levels experienced at the NSAs are similar in level to those in suburban areas where traffic is the primary source of noise.

9.3.1.2 2017 Noise Survey

The results of the updated noise survey are shown in **Table 9.3-3**. The Baseline Environmental Noise Survey Report in **Appendix D.9** provides the details of the baseline ambient noise survey, including weather conditions, site observations, survey methodology and results. The data shown in **Table 9.3-3** have been processed to remove periods of high wind, as discussed in **Appendix D.9**.

Table 9.3-3 Baseline Sound Level Measurement Results at NSAs

Receptor	Distance to Receptor, miles	Direction	Duration HH:MM	Daytime L_{eq}, dBA	Nighttime L_{eq}, dBA	Ambient L_{dn}, dBA
NSA 1	1.3	South	29:48	51.7	43.9	**52.7**
NSA 2	2.2	East	32:39	62.7	57.5	**65.2**
NSA 3	1.3	Northeast	32:03	57.9	40.3	**56.3**
REC 1	0.7	West	31:50	51.1	48.3	**55.2**

9.3.1.3 Ambient Underwater Noise Levels

Ambient underwater noise levels range from about 74 dB to 100 dB re 1 µPa in the open ocean with no ship traffic nearby, to about 115 dB to 135 dB re 1 µPa in large marine inlets with some recreational boat traffic (CaDOT 2009). Existing shipping traffic in the Coos Bay area means that ambient underwater noise levels are expected to correspond to this latter range in the presence of shipping, but may be lower at times corresponding to reduced boat traffic activity.

9.3.2 Applicable Standards and Ordinances

9.3.2.1 Federal Guidelines

The only federal noise guidelines applicable to the LNG Terminal are those of the FERC. The FERC guidelines (18 CFR § 380.12) limit generated sound to an L_{dn} level no greater than 55 dBA at the nearest NSA, such as a residence, school, campground, or hospital, during facility operations. If it is projected that the sound criteria could be exceeded at any nearby NSA, it will be necessary to develop noise mitigation measures which would be implemented to reduce the noise impacts of the operations and achieve the sound criteria.

Due to the 10 dBA nighttime penalty added when calculating the L_{dn}, the actual constant noise level required to produce an L_{dn} of 55 dBA is approximately 48.6 dBA. Therefore, compliance with the FERC guideline of an L_{dn} of 55 dBA at the nearest pre-existing NSA requires that the LNG facility be designed such that the actual continuous operational noise levels do not exceed 48.6 dBA at any NSA. For noise sources which are not continuous, such as flaring, the L_{dn} calculation will depend on the specific hours of operation of each noise source.

The National Marine Fisheries Service (NMFS) provides interim guidance on underwater noise thresholds for behavioral disturbance for marine mammals (NMFS 2012), and guidance on thresholds for the onset of permanent threshold shift (PTS), which represents non-recoverable hearing damage (NMFS 2016). For the LNG Terminal, the proposed in-water activities are not considered to present any realistic potential for PTS to marine mammals. Recommended sound exposure guidelines for fish and sea turtles are provided in Popper, et al. (2014).

The NMFS interim underwater thresholds for marine mammal behavioral effects are 160 dB (rms) referenced to 1 micro Pascal (re 1 µPa), for impulsive noise sources such as impact pile driving. For continuous in-water noise sources such as the noise from vibratory pile driving or dredging, the interim threshold for behavioral effects is 120 dB (rms) re 1 µPa.

9.3.2.2 State Guidelines

The ODEQ noise standards are contained in OAR, Chapter 340, Division 35 – Noise Control Regulations. The OAR noise regulations are not directly applicable to the operational noise from the LNG Terminal site.

9.3.2.3 Local Guidelines

The City of North Bend has a noise ordinance that prohibits the “making of unnecessary noise” but the ordinance has no specific numerical limits (North Bend City Code, Section 9.04.030). Daytime construction noise between the hours of 7 a.m. to 6 p.m. is exempt. Coos County does not have a noise ordinance. The project is located in Coos County.

9.4 ENVIRONMENTAL CONSEQUENCES - NOISE

9.4.1 Facility Construction Noise and Mitigation

9.4.1.1 General Construction

Noise could affect the local environment during construction and operation of the LNG Terminal. Noise associated with construction activities will be intermittent, as equipment is operated on an as-needed basis. During the site grading and filling operations, the equipment may be operated on a schedule of two 10-hour shifts, per day, with two daytime hours and two nighttime hours used as the shift change break. Construction will not result in generation of or exposure of persons to excessive noise or vibration levels. Site investigations and soil characterization has not identified the need for blasting as the entire the LNG Terminal area is predominantly sand.

Construction noise was estimated based on equipment needed to construct a project of this magnitude. The sound level due to each piece of equipment was estimated using the Federal Highway Administration's Roadway Construction Noise Model (RCNM). **Table 9.4-1** shows a schedule of the equipment expected to potentially be in simultaneous operation, along with the maximum sound level, L_{max}, at 50 feet, the usage percentage, and the expected L_{eq} at 50 feet considering the usage percentage.

The Lmax is the maximum sound level during a given period using either the slow or fast time constant. The Lmax is a very different metric than the Leq that is used to characterize steady state sound levels and direct comparison is usually inappropriate. High Lmax sound levels can be experienced even in otherwise quiet locations due to short-term events such as wind gusts.

Table 9.4-1 Proposed General Construction Equipment

Equipment Type	Make/ Model	RCNM Category	Usage (%)	L_{max} at 50 ft, dBA	L_{eq} at 50 ft, dBA	# of Units Operating Simultaneously	Operating Shift
Pickup Trucks	Ford F-150	Pickup Truck	40%	75.0	71.0	35	Day
Large Trucks	Ford F-350	Pickup Truck	40%	75.0	71.0	61	Day
Offroad Trucks	Caterpillar 740	Dump Truck	40%	76.5	72.5	3	Day/Night
RT Cranes	Grove RT770E	Crane (mobile or stationary)	16%	80.6	72.6	42	Day
Dozers	Caterpillar D6	Dozer	40%	81.7	77.7	7	Day/Night
Forklifts	Xtreme XR3034	Front End Loader	40%	79.1	75.1	43	Day
Loaders	Caterpillar 966F	Front End Loader	40%	79.1	75.1	3	Day/Night
Tractors	Caterpillar Challenger 65	Tractor	40%	84	80.0	3	Day/Night
Lifts / Hoists	80' Manlift	Man Lift	20%	74.7	67.7	63	Day

Equipment Type	Make/ Model	RCNM Category	Usage (%)	L_{max} at 50 ft, dBA	L_{eq} at 50 ft, dBA	# of Units Operating Simultaneously	Operating Shift
Rollers	Caterpillar 563 - 84"	Roller	20%	80.0	73.0	2	Day/Night
Scrapers	Caterpillar 657	Scraper	40%	83.6	79.6	1	Day/Night
Motor Graders	Caterpillar 14H	Grader	40%	85	81.0	1	Day/Night
Backhoes	Caterpillar 330, John Deere 330	Backhoe	40%	77.6	73.6	3	Day/Night
Compressors	Air Compressor (185 CFM)	Compressor (air)	40%	77.7	73.7	18	Day
Generators / Light Plants	Portable Light Plant	Generator	50%	80.6	77.6	11	Night
Welders	Welder (400-450 Amp)	Welder/ Torch	40%	74.0	70.0	30	Day
Crawler Cranes	Manitowoc 999	Crane	16%	80.6	72.6	13	Day
Augers/Soil Mix Equipment	Soilmec SR 90 Rotary Drill	Soil Mix Drill Rig	50%	80	77.0	17	Day
Pumps	Centrifugal Pump (10")	Pumps	50%	80.9	77.9	1	Day/Night
Excavator	Caterpillar 390F L	Excavator	40%	80.7	76.7	0	Day/Night
Concrete Pumps	BSA 14000 Series	Concrete Pump Truck	20%	81.4	74.4	3	Day

Both daytime and nighttime construction levels were calculated based on planned equipment usage for the currently planned equipment allocation for each of the five years of construction. The highest levels were calculated for year three. These are the levels that were used to model construction noise. This equipment schedule was used to develop overall construction sound power levels for peak construction activities of 129 dBA during the day and 125 dBA at night. The frequency spectrum used was based on measurements of an active construction site, and is representative of a combination of various types of diesel-engine powered equipment.

A construction noise model was developed using CadnaA version 2017, a commercial noise modeling package developed by DataKustik GmbH. The derived total day and night construction sound power spectra were included in the noise model as area sources, uniformly distributed throughout the general construction work area at an average height above grade of 10 feet. The noise model was then used to predict the construction sound level contributions at the closest NSAs.

The predicted sound levels at the nearest NSAs during general construction activities are summarized in **Table 9.4-2** and **Figure 9.4-1**. There are two daytime and two nighttime hours during which there are no planned construction activities to allow the crew to change shifts. Construction activities and equipment are different during the daytime and nighttime periods. Table 9.4-2 shows both the A-weighted construction sound level contribution predicted for activities occurring during the day and separately for those occurring at night. The daytime period average uses the construction contribution (from daytime activities) averaged over 13 of 15 daytime hours, and the nighttime period average is the nighttime activity contribution averaged over 7 of 9 nighttime hours. Thus the daytime and nighttime average levels are 0.6 and 1.1 dBA lower than the respective construction contributions would be for full 15 hour and 9 hour periods, because there is no construction contribution during the shift-change hours.

Table 9.4-2 Predicted General Construction Sound Levels at Receptors
All levels shown are A-weighted Decibels, re: 20 μPa

Receptor	Predicted A-Weighted Construction Contribution During Activities, dBA		Predicted Period Average Sound Level, dBA (Includes adjustments for idle shift-change hours)			Existing Ambient Level, dBA	Future Combined Level, dBA	Increase Over Existing Ambient, dB
	Day	Night	Day, L_d	Night, L_n	L_{dn}	L_{dn}	L_{dn}	
NSA 1	49.1	45.1	48.5	44.0	51.5	52.7	55.2	2.5
NSA 2	39.1	35.1	38.5	34.0	41.4	65.2	65.2	0.0
NSA 3	42.5	38.5	41.9	37.4	44.8	56.3	56.6	0.3
REC 1	49.5	45.5	48.9	44.4	51.8	55.2	56.8	1.6

As shown in Table 9.4-2, the sound levels due to general construction noise are less than 52 dBA L_{dn} at all NSAs and the predicted increase over ambient conditions is between 0 and 3 dB. Noise impacts due to general construction equipment are not expected to be significant at any of the receptor locations, including the NSAs and REC 1, the recreational area receptor.

9.4.1.2 Pile Driving

Pile driving is expected to take place between July 2019 and July 2021 over two 10-hour shifts per day, six days per week (i.e. not on Sundays or major holidays). Up to 14 concurrent diesel impact pile hammers will be used during construction of the facility to drive approximately 3,600 pipe piles in the plant facility area. Up to six vibratory hammers will be in use to install roughly 11,800 sheet piles.

The pipe piles range from 24 inches to 72 inches in diameter. Maximum sound pressure level data from a pile driving equipment manufacturer for each size pile was used for the analysis. Vibratory pile drivers were modeled using an L_{max} level of 101 dBA at a distance of 50 feet with a usage factor of 20 percent based on RCNM data. These data are shown in Table 9.4-3, below.

Table 9.4-3 Pipe Pile Driving Equipment Sound Levels and Operating Parameters

Pile Diameter (Inches)	Sound pressure level at 23 feet, dBA L_{max}	Est. Total Piles	Est. Piling Hammer Blows Required	Rig Scheduled Deployed Time, Days	Est. Pile Driving Usage Factor
18 – 24	106	1468	255,476	717	0.12%
30 – 36	110	1581	569,847	717	0.26%
48	114	261	147,987	350	0.14%
60 – 72	116	284	179,093	350	0.17%

As pile driving is an impact noise source with a large variation between the maximum and long-term average sound levels, the sound level contribution at the NSAs has been calculated using both the L_{eq} / L_{dn}, as well as the L_{max}. As the pile driving events are not synchronized, the L_{max} presented is the highest single L_{max} level for any single pile driver. The overall L_{eq} shows the cumulative long term average sound level due to pile driving activities for 14 impact pile driving rigs and 6 vibratory pile driving rigs in operation, simultaneously.

The pile rigs were distributed in the model based on the pile driving schedule such that areas that will require larger numbers of piles were assigned more pile driving sources. The impact pile sources were modeled at an elevation equal to half of the average pile length for each hammer diameter and location.

For each impact pile hammer size, a usage factor was developed based on an average pile driving time for each pile size. A total pile impact sound level period of 200 milliseconds per blow was assumed. Each of these is an estimate as the pile driving rate depends on the specific soil composition and conditions at each pile driving location. The usage factor for each rig type was used to calculate the long-term L_{eq} sound levels from the manufacturer L_{max} levels.

There will be two daytime and nighttime hours during which there are no planned pile driving activities due to the crew shift change. Table 9.4-3 shows both the A-weighted pile driving sound level contribution predicted for pile driving activities along with the daytime and nighttime period averages. The pile driving noise is expected to be the same during daytime and nighttime, so there is a single level for the pile driving noise contribution during activities. The daytime and nighttime average levels are 0.6 and 1.1 dBA lower, than the pile driving contribution during activity due to these shift-change hours.

Table 9.4-4 shows that the predicted L_{max} sound levels for pile driving at the receptors will range from 55 to 69 dBA. While most regulatory agencies use L_{dn} as the favored metric to assess noise annoyance and compliance, both the World Health Organization (WHO) and the American Public Transit Association (APTA) have also issued noise goals in terms of L_{max}.

WHO's criterion is a nighttime level designed to be protective of people sleeping with windows open, and is set as a nighttime L_{max} of 60 dBA (WHO 1999). APTA's criteria are to protect from annoyance due to airborne noise from train operations. The L_{max} criteria are 70 dBA for single family homes in low density areas, 65 dBA for "quiet" outdoor recreational areas, and 60 dBA for amphitheaters (APTA 1981). The predicted L_{max} levels at the NSAs are all below 65 dBA, as shown in Table 9.4-4.

Table 9.4-4 Predicted Pile Driving Noise Levels at Receptors

Receptor	Predicted A-Weighted Pile Driving Contribution During Activities, dBA	Predicted Period Average Sound Levels, dBA (Includes adjustments for idle shift-change hours)			Existing Ambient Level, dBA L_{dn}	Future Combined Level, dBA L_{dn}	Increase Over Existing Ambient, dB	Predicted Maximum Level, dBA L_{max}
	Day/Night	Day, L_d	Night, L_n	L_{dn}				
NSA 1	54.1	53.5	53.0	59.5	52.7	60.3	7.6	64.7
NSA 2	39.5	38.9	38.4	44.9	65.2	65.2	0.0	54.9
NSA 3	43.0	42.4	41.9	48.4	56.3	57.0	0.7	59.5
REC 1	51.7	51.1	50.6	57.1	55.2	59.3	4.1	69.3

The potential extents of underwater noise above the marine mammal interim behavioral disturbance thresholds during vibratory piling (Deveau and MacGillivray 2017) and during impact piling (O'Neill and MacGillivray 2017) have been identified in two studies. Sheet piles are expected to be installed "in the dry," behind a soil berm to be installed between the water and the sheet pile location. The modeling in the studies indicates that the highest underwater noise levels from piling would be found where the sound is able to propagate away from the source in deeper water for the furthest distance, before being attenuated by bottom loss in shallower water. The maximum modeled distance to the interim marine mammal behavioral disturbance threshold is less than 2 km from the noise source.

On the basis of the noise levels predicted during the studies (Deveau and MacGillivray 2017; O'Neill and MacGillivray 2017), and with reference to Popper, et al. (2014), there is a high likelihood of behavioral responses for fish in the vicinity of vibratory piling. More severe impacts (mortality or injury) to fish due to underwater noise from vibratory piling behind the soil berm are not expected. When piling in water using an impact hammer, there is potential for fish mortality or injury if fish are present within about 100 feet of the largest marine pipe piles (36 inch diameter) during pile driving. The areas with potential piling noise physical impacts to fish would be within the excavated and dredged area required to construct the marine facility.

Additional evaluation and quantification of noise impacts from sound pressure waves generated within the water due to pile driving are provided in the Underwater Noise Impact Assessment, included as **Appendix I.9**, to this RR9 report.

9.4.1.3 Open Water Dredging Operations

Dredging is scheduled to take place during the first three years of the project. Two different dredge types are anticipated to be used during construction and operate on a 24-hour basis. A portion of the initial dredging will be undertaken using a clamshell dredge. Other portions will utilize a hydraulic cutter-head suction dredge. Clamshell dredging operations are performed with a standard mechanical crane and are expected to blend into the general construction sound levels discussed earlier in this Resource Report.

A noise model was developed to predict the sound levels due to the hydraulic open water dredging operations. Dredging sound power levels were based on sound level measurements of a typical diesel driven dredge during channel maintenance activities at a Corps of Engineers channel. This dredge produced sound levels of 59 dBA at 500 feet during standard dredging operations.

Open water dredging activities will occur in five separate work areas, with four work areas along the Federal Navigation Channel and one in the slip area of the Project. Once it commences, dredging will take place 24 hours per day, 7 days per week until it is complete or the work window closes. Generally, due to the large distances between the dredging activities and the nearest NSAs, airborne sound level contributions at the NSAs from dredging will be minimal. To simplify the noise model calculation and data presentation, the noise model includes a dredging noise source at each of the five separate work areas, all operating simultaneously. This is an extremely conservative approach as it will overestimate the levels at the NSAs.

The modeled sound pressure levels at the NSAs are shown in **Table 9.4-5**. Because the Federal Navigation Channel extends south through a large distance of Coos Bay, NSA 1 is not the closest residential receptor to the dredging operations. An additional NSA, labeled NSA D1, has been included in the dredging evaluation, located at the closest residential area to the Federal Navigation Channel dredging area. This NSA location is shown along with the predicted sound level contours in **Figure 9.4-3**. As shown in **Table 9.4-5**, dredging noise levels will be quite low at the NSAs and are not expected to result in a substantial increase in sound level over the ambient levels.

Dredging will take place over 24-hours; therefore the dredging contribution during activity is equivalent to the daytime average and the nighttime average.

Table 9.4-5 Predicted Dredging Noise Levels at Receptors

Receptor	Predicted Sound Level, dBA L_{eq} (1)	Predicted Sound Level, dBA L_{dn}(1)	Existing Ambient Level, dBA L_{dn}	Future Combined Level, dBA L_{dn}	Increase Over Existing Ambient, dB
NSA 1	35.8	42.2	52.7	53.1	0.4
NSA 2	24.6	31.0	65.2	65.2	0.0
NSA 3	22.0	28.4	56.3	56.3	0.0
REC 1	28.0	34.4	55.2	55.2	0.0
NSA D1	44.7	51.1	52.7	55.0	2.3

(1) For simplicity, the sound levels shown include sound level contributions from simultaneous dredging activities at five areas, even though only one dredge will be used.

(2) Ambient sound levels at NSA D1 are assumed to be the same as at NSA 1, a residence in the same neighborhood, and the same distance from the bay and ocean as NSA D1.

As for underwater noise impacts, most of the dredging will be conducted in isolation from Coos Bay. Only the dredging of the access channel and the berm (which isolates the slip construction area from Coos Bay) will be dredged with a connection to Coos Bay. The noise associated with dredging is largely related to ship traffic. It is not anticipated that dredging noise would have any potential to cause more severe effects to marine mammals or fish than behavioral disturbance. This is discussed in more detail in the Marine Mammal Noise Impact Assessment included in **Appendix H.9**

Major dredging operations can generate underwater sound levels of up to 185 dB re 1 μPa at one meter (CEDA 2011) if using a large trailing suction hopper dredger to excavate rock. For the LNG Terminal, the material to be removed is expected to be soil or relatively soft sediment. Underwater noise emissions are expected to be greater from the hydraulic dredge than from the clamshell dredge, since this type of equipment adds sounds generated by the rotating cutterhead, slurry intake, suction pumps and sediment moving through pipes to the ship and machinery sounds generated by a clamshell dredge. Reine and Dickerson (2014) measured noise from a hydraulic dredge during maintenance dredging in a deepwater shipping channel in California. They identified rms source noise levels of up to 157 dB re 1μPa at one meter from the source for a dredge with overall length approximately 100 ft., a total power of 1000 hp operating the main pumps, and with dredged material moving through a 16-in. pipeline. Use of a similar dredge is anticipated for JCEP dredging.

Underwater noise levels attenuate with distance. The NMFS (2012) suggests that underwater noise transmission loss with distance can be estimated using a practical spreading loss model. The algorithm utilized is provided below:

$$R1 = 10^{(TL/15)} * R2$$

Where:

R1 = distance (meters) to the required sound level;

R2 = reference distance (meters) from the source of the sound; and

TL = required reduction in sound level (dB).

The NMFS interim underwater threshold for marine mammal behavioral effects for continuous noise sources such as dredging is 120 dB (rms) re 1 μPa. Utilizing the above algorithm, hydraulic dredging noise would be reduced to below the 120 dB marine mammal behavioral disturbance threshold level at a distance of approximately 300 meters or 1,000 feet from the dredging.

Similarly for fish, behavioral reactions such as avoidance behavior are possible but there is a low probability of more severe effects due to underwater dredging noise (Popper et al., 2014).

Additional evaluation and quantification of noise impacts from sound pressure waves generated within the water due to dredging both in the berth pocket and along the Coos Bay navigation channel are provided in the attached Underwater Noise Impact Assessment in **Appendix I.9**.

9.4.1.4 Cumulative Construction Noise Impacts

Sound levels from general construction, dredging, and pile driving have been evaluated in separate sections of this Resource Report. With the current construction schedule, these activities will overlap, and there will be cumulative noise impacts due to the combined construction sound levels. However, the cumulative noise impact will not be the direct summation of the individual contributions, as the period of maximum general construction sound levels are unlikely to overlap with the periods of maximum pile driving sound levels. Jordan Cove construction personnel have estimated the worst-case combination of pile driving and construction activities. With the equipment operating during this combined case, the construction, pile driving, and dredging noise models have been used to calculate the expected cumulative sound levels at the closest NSAs.

As shown in **Table 9.4-6**, cumulative construction noise levels are just slightly higher than the pile driving noise levels alone, indicating that pile driving noise is the dominant noise source.

Table 9.4-6 Predicted Cumulative Construction Noise Levels at Receptors

Receptor	Predicted Sound Level, dBA (Weighted to account for duration of each activity)			Existing Ambient Level, dBA	Future Combined Level, dBA	Increase Over Existing Ambient, dB
	Day, L_d	Night, L_n	L_{dn}	L_{dn}	L_{dn}	
NSA 1	54.8	53.6	60.2	52.7	60.9	8.2
NSA 2	41.8	39.9	46.6	65.2	65.3	0.1
NSA 3	45.2	43.3	50.0	56.3	57.2	0.9
REC 1	53.2	51.6	58.3	55.2	60.0	4.8
NSA D1	44.7	44.7	51.1	52.7(1)	55.0	2.3

(1) Ambient sound levels at NSA D1 are assumed to the same as at NSA 1, a residence in the same neighborhood, and the same distance from the bay and ocean as NSA D1.

9.4.2 Facility Operation Noise and Mitigation

9.4.2.1 General Operation

The following major noise-producing equipment will normally be in operation at the LNG Terminal:

- Five refrigerant compressors, combustion turbines, heat recovery steam generators (HRSGs), and associated piping;
- Refrigerant compressor interstage and discharge aerial coolers;
- Three steam turbines and their associated air-cooled condensers;
- Two BOG compressors with interstage and discharge aerial coolers; and
- Various other smaller condensers, coolers, pumps and valves.

The above equipment packages will be specified to meet sound level requirements appropriate to support an overall far-field sound level that does not exceed the applicable FERC regulatory limits.

Facility operational noise levels have been evaluated using a CadnaA noise model. Noise associated with an idling tanker and ground flares were also included in the model. The results of the analysis are presented in **Table 9.4-7**. The calculated LNG Terminal L_{dn} levels, the existing ambient L_{dn} levels, and the projected increases in future noise at each NSA are also shown. The predicted L_{dn} levels at all NSAs are below the FERC criterion of 55 dBA and the predicted increase over ambient is well below 10 dB at all NSAs.

The predicted sound level due to operations at REC 1, the receptor representative of the closest areas of the nearby Oregon Dunes Recreational Area, is 54 dBA L_{dn}, or just below the FERC criteria for NSAs.

Table 9.4-7 Predicted Operational Noise Levels at Receptors

Receptor	Predicted Sound Level, dBA L_{eq}	Predicted Sound Level, dBA L_{dn}	Existing Ambient Level, dBA L_{dn} (1)	Future Combined Level, dBA L_{dn}	Increase Over Existing Ambient, dB
NSA 1	45	51	52.7	54.9	2.2
NSA 2	37	43	65.2	65.2	0.0
NSA 3	43	49	56.3	57.0	0.7
REC 1(1)	49	55	55.2	58.1	2.9

(1) Predicted levels at REC 1 were estimated based on Figure 7-1 in the Acoustical Modeling Report in Appendix G.9.

The complete Computer Noise Modeling and Mitigation Report is attached as **Appendix G.9**. The report provides details of the noise modeling methodology, inputs, and results, including the octave band sound power levels of noise sources and the data sources.

Mitigation

Mitigation is discussed in **Appendix G.9**. No supplemental mitigation measures such as acoustical enclosures, acoustical barriers, or custom silencers were included in the LNG Terminal design. Rather, the LNG Terminal equipment will be specified to meet the sound power level specifications noted in Appendix G.9, and will be inherently quiet enough to produce the sound levels shown in Table 9.4-7.

Vibration

Ground borne vibrations are typically not significant outside of the facility boundary. Facility equipment is designed and balanced in order to minimize extraneous vibration as a means to preserve and extend the service life of the equipment. Ground borne vibration resulting from the LNG Terminal equipment is not expected at the NSAs.

Low frequency airborne sound has the potential to induce rattling of residential building structures. ANSI S12.2-2008 publishes criteria for sound pressure levels that should not be exceeded in order to avoid moderately perceptible vibration and rattle inside a room. These criteria are 65 dB and 70 dB in the 31.5 Hz and 63 Hz octave bands, respectively. The predicted LNG Terminal (only) sound levels in the 31.5 and 63 Hz bands at the NSA receptors are expected to all be below 65 dB, thus satisfying these criteria. The LNG Terminal site is not expected to cause a perceptible increase in vibration at any noise-sensitive area.

9.4.2.2 Flaring

Flaring is not expected to occur as part of normal operations. Flaring noise levels were therefore evaluated separately from general facility operations. Cold process flaring is expected to occur five times a year and last for approximately 30 minutes and warm process flaring is expected to take place once every three years and last for approximately two hours. The marine flare is expected to be used four times a year and could last approximately 14 hours per event.

The process flare is a multi-point ground flare with 324 burners surrounded by a 60 to 85 foot radiation wall. The marine flare is a totally enclosed ground flare with 55 burners in a 120 foot enclosure.

Modeled process flare noise levels were based on vendor estimated noise levels and the flare noise spectrum was based on measurements taken of another flare system. There is no expected noise level difference between hot and cold process flaring. The process flare was modeled as a 259 foot by 227 foot area source with a height of 12 feet. The sound power spectrum was adjusted to produce a total sound pressure level of 100 dBA at 3 feet outside of the radiation wall at a height of 5 feet. The radiation wall was assumed to have the transmission loss of a standard metal louver.

The marine flare was modeled as a 45 foot diameter source at a height of 120 feet, with an additional source around the perimeter at a height of approximately 15 feet to simulate the burner noise. The marine flare was modeled as producing a sound pressure level of 85 dBA at three feet.

The results of process and marine flaring are shown in **Table 9.4-8**. Because flaring lasts for fewer than 24-hours, nighttime flaring was conservatively assumed to take place before daytime flaring in the L_{dn} calculations. For example, the marine flare is expected to last for 14 hours. These hours were allocated to the 9 nighttime hours between 10:00 pm and 7:00 am first, and the remaining 5 hours were allocated to daytime use. Process flaring was assumed to consist of the warm flare operating for 2 hours during the night and not at all during the day and the cold flare operating for 30 minutes during the night and not at all during the day.

Though process and marine flaring are not expected to take place simultaneously, they were also modeled together to be conservative. Process flaring is significantly louder than marine flaring and therefore dominates the combined case. Noise contours for simultaneous process and marine flaring are shown in **Figure 9.4-4**.

Table 9.4-8 Predicted Process and Marine Flare Noise Levels at NSAs

Receptor	Predicted Sound Level Contribution During Activity dBA L_{eq}	Predicted Sound Level dBA L_{dn} (Adjusted for event duration)	Existing Ambient Level, dBA L_{dn}	Future Combined Level, dBA L_{dn}	Increase Over Existing Ambient, dB
Process Flare					
NSA 1	47.0	44.1	52.7	53.3	0.6
NSA 2	39.7	36.8	65.2	65.2	0.0
NSA 3	45.9	43.1	56.3	56.5	0.2
REC 1	60.0	57.1	55.2	59.3	4.1
Marine Flare					
NSA 1	25.2	31.2	52.7	52.7	0.0
NSA 2	15.5	21.5	65.2	65.2	0.0
NSA 3	11.6	17.6	56.3	56.3	0.0
REC 1	28.2	34.2	55.2	55.2	0.0
Combined Process and Marine Flares					
NSA 1	47.0	44.3	52.7	53.3	0.6
NSA 2	39.7	36.9	65.2	65.2	0.0
NSA 3	45.9	43.1	56.3	56.5	0.2
REC 1	59.9	57.1	55.2	59.3	4.1

9.4.2.3 Ship Traffic

Underwater noise levels from large commercial ships are fairly consistent, ranging from about 177 dB to 188 dB re 1µPa at one meter (McKenna 2011). The Coos Bay area has therefore historically, and currently, experienced elevated underwater noise levels due to shipping. LNG carriers travelling at half speed generate underwater noise levels of about 175 dB re 1µPa at one meter. Considering both peak noise levels and cumulative sound exposure, vessel noise is not expected to exceed the NMFS guideline thresholds for the onset of PTS for cetaceans and pinnipeds.

Marine animals in close proximity to the transiting carriers would be exposed to elevated noise levels for approximately 20 to 25 minutes (LGL 2005). Marine life in the bay has historically, and currently, experienced similar sound level from transiting commercials ships.

The addition of approximately 110-120 additional LNG carriers on an annual basis will add some noise to the existing environment specifically within the 0.3 mile zone. The addition of approximately 110-120 LNG carriers to the existing average deep-draft traffic (50 ships per year) and existing commercial and recreational vessel traffic will increase the average ambient in-water sound level (Coos Bay Pilots' Association 2017). An estimate of the increase is derived based on the assumption that noise levels from all large ships that traverse the waterway generate essentially the same underwater sound levels, which is supported by research conducted by McKenna (2011). The increase in the average annual noise level due to shipping is subsequently conservatively based on the increase in large ship traffic. A doubling of ship traffic would result in a 3 dB increase in noise. The increase in average sound levels is based on the following formula:

$$Increase\ dB = 10*\log_{10}(total\ ship\ traffic/existing\ ship\ traffic)$$

Accordingly then, the projected addition of up to 120 LNG carriers annually to the existing volume of 50 deep draft ships results in a 5.3 dB increase in the annual average underwater noise level due to shipping. Since the additional LNG carrier traffic, when combined with the existing ship traffic, will still be less than the number of ships that once called on the Port, the effect of the slight increase in noise is predicted to be insignificant.

Additional evaluation and quantification of noise impacts from sound pressure waves generated within the water due to tugs and LNG vessels are provided in the Underwater Noise Impact Assessment in **Appendix I.9**.

9.4.2.4 Cumulative Noise Impacts

Resource Report 1, Attachment A.1 lists "Recent, Current, or Proposed Actions that may Cumulatively Affect Resources." Of the many Proposed Actions in the list, the vast majority are not likely to cause any significant cumulative noise impact with the Project. Proposed Actions that have been eliminated from potential cumulative noise impacts include those that meet any of the following criteria:

- All timber-related Actions – timber tracks are too far away from the NSAs to be significant cumulative noise contributors
- Actions in other counties – due to distance
- Residential developments – no significant operational noise contribution
- Hotel / casino developments – remote from the NSAs

There are three Proposed Actions that are not eliminated from consideration using the above criteria. Two of these Actions are dredging and channel maintenance associated with Coos Bay: Port – Maintenance Dredging and USACE Coos Bay Navigation Channel Maintenance Dredging. As discussed in **Section 9.4.1.3** of this Resource Report, the distances between the Federal Navigation Channel and the closest NSAs are large enough that noise due to dredging in the channel is not a significant impact at the closest residences. It is likely that any channel dredging will be performed using similar equipment to that proposed for the Project with similar sound level impacts.

The third Proposed Action that might have some cumulative impact is the Coos County Airport District's plan to expand the Southwest Oregon Regional Airport. The plan is to extend Runway 4-22 by an additional 400 feet. A review of the Coos County Airport District master plan for the Southwest Oregon Regional Airport indicates that there has been a significant decrease in passenger traffic from the airport due to the departure of Horizon Air in October of 2008 (Reynolds et al., 2013). Air traffic at the airport, even with the expansion of the runway, is not expected to approach 2008 levels until 2030. As such, the runway extension project is not expected to have a cumulative impact for noise as there will not be a commensurate dramatic increase in air traffic at the airport.

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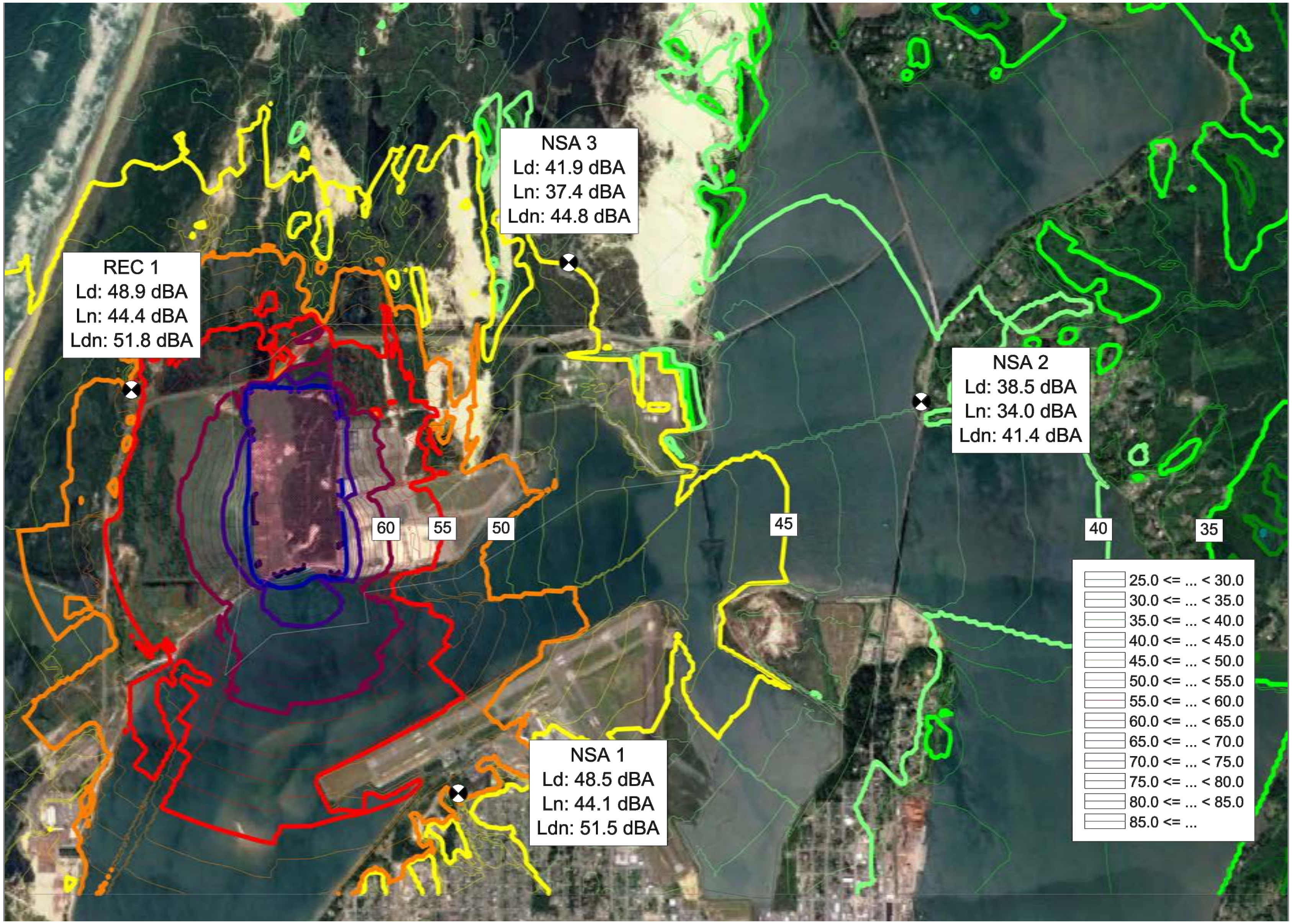
Jordan Cove Energy Project, L.P.

Jordan Cove Energy Project

Figure 9.3-1

Noise Survey Monitoring Locations



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N

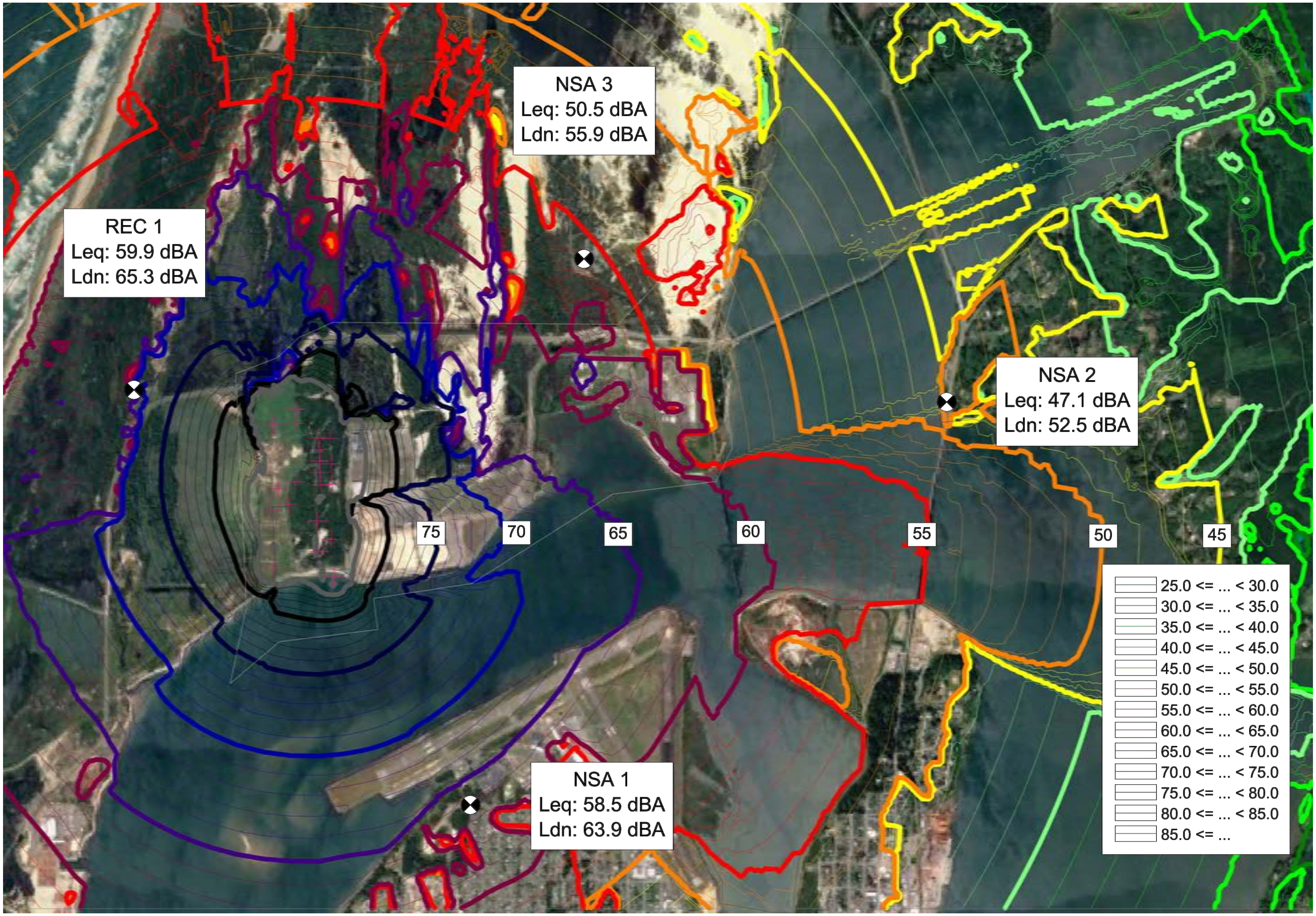
Scale, feet

0 1000 2000 4000

Jordan Cove Energy Project

Figure 9.4-1

Predicted General Construction L_{dn} Levels (dBA)

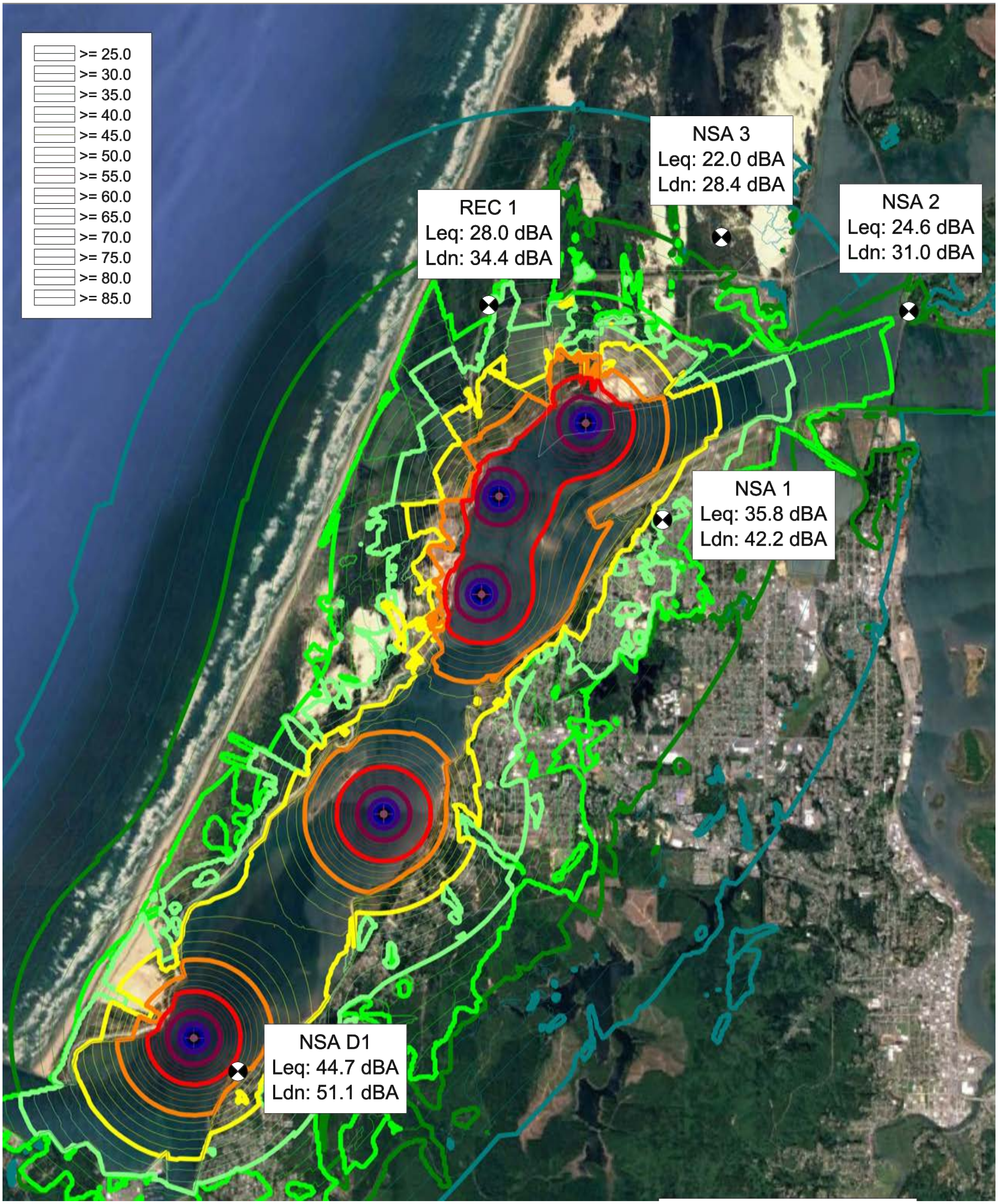


Jordan Cove Energy Project, L.P.

Jordan Cove Energy Project

Figure 9.4-2

Predicted Pile Driving L_{dn} Levels (dBA)



Jordan Cove Energy Project, L.P.

N

Scale, feet

0 2000 4000 8000

Jordan Cove Energy Project

Figure 9.4-3

Predicted Dredging L_{dn} Levels (dBA)

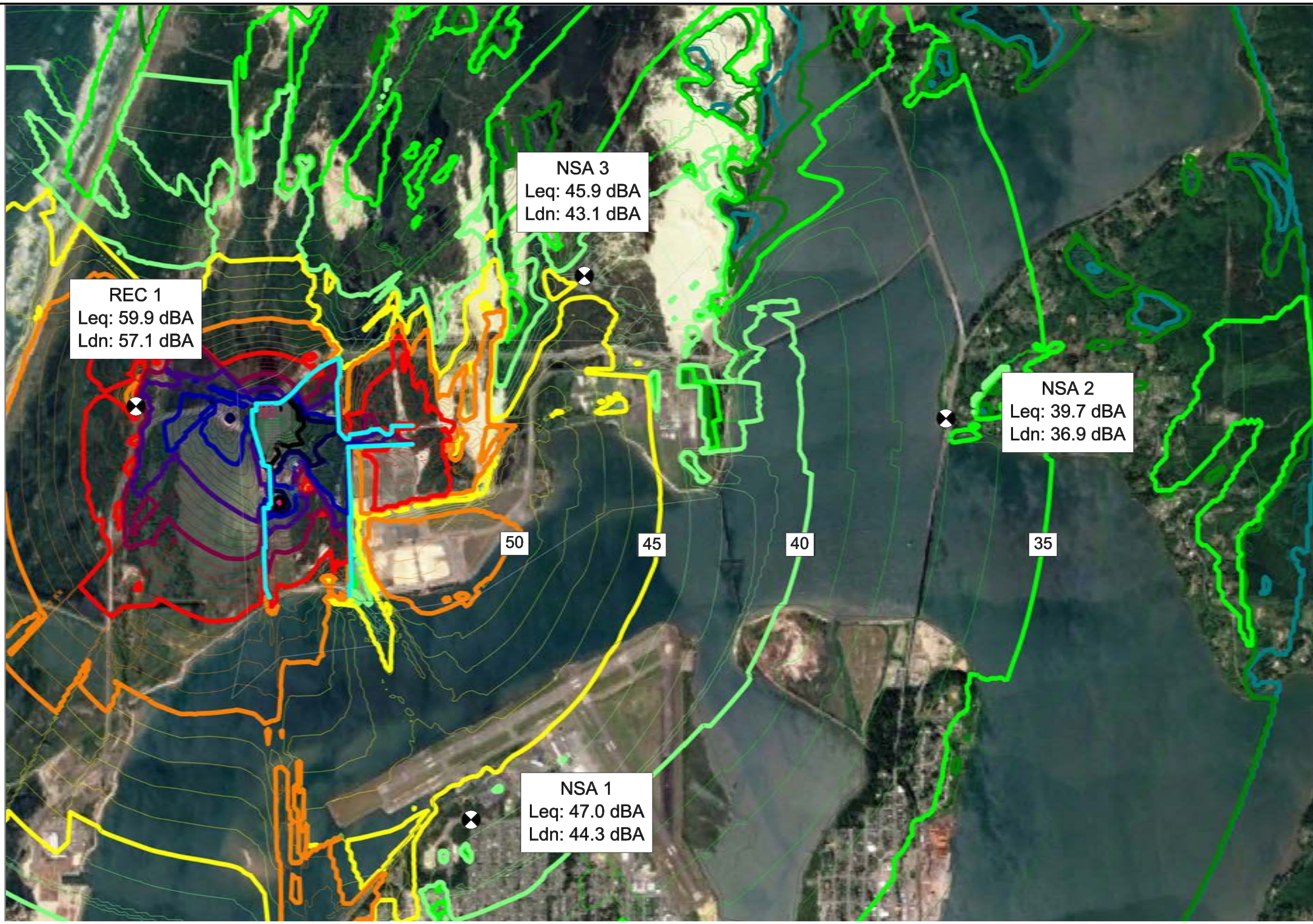


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Figure 9.4-4

Predicted Flaring L_{dn} Levels (dBA)

APPENDIX A.9

ACDP Application

JORDAN COVE ENERGY PROJECT, L.P.
LNG Terminal

Type B State New Source Review Application

Prepared for: Jordan Cove Energy, LLC
5615 Kirby, Suite 500
Houston, TX 77005

Client Ref: 108.01593.00001

September 2017

SLR

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ACRONYMS

ACDP	Air Contaminant Discharge Permit
ARM	Ambient Ratio Method
AQRV	Air Quality Related Value
BOG	Boil-Off Gas
BPIPPRM	Building Profile Input Program
Btu/scf	British Thermal Unit per Standard Cubic Feet
°C	Degrees Celsius
CEMS	Continuous Emission Monitoring System
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CT	Combustion Turbine
DFDE	Duel-Fuel Diesel-Electric
Dth/d	Dekatherm Per Day
EPA	Environmental Protection Agency
°F	Degrees Fahrenheit
ft	Feet
FLM	Federal Land Managers
g/hp-hr	Grams per Horsepower-Hour
g/kW-hr	Grams per Kilowatt-Hour
GEP	Good Engineering Practice
GHG	Greenhouse Gas
gr/100 scf	Grain per 100 Standard Cubic Feet
H_2O	Water
H_2S	Hydrogen Sulfide
H_2SO_4	Sulfuric Acid
HAPs	Hazardous Air Pollutants
HHV	Higher Heating Value
hp	Horsepower
hr	Hour
HRSG	Heat Recovery Steam Generator

ACRONYMS (CONTINUED)

JCEP	Jordan Cove Energy Project, L.P.
JCLNG	Jordan Cove LNG Terminal
K	Kelvin
KBJ	Kiewit, Black & Veatch, and JGC
kg	Kilogram
km	Kilometer
kPa	Kilopascals
Lb	Pound
lb/MWh	Pound per Megawatt-hour
LHV	Lower Heating Value
LNB	Low NO_X Burners
LNG	Liquefied Natural Gas
LNGC	LNG Carrier
m	Meter
m^3	Cubic meter
µg	Microgram
$µg/m^3$	Micrograms per cubic meter
MERPs	Modeled Emission Rates for Precursors
MMBtu	Million British Thermal Units
MMCF	Million Cubic Feet
MMscf/d	Million Standard Cubic Feet per Day
MOF	Material Offloading Facility
MPGF	Multi-Point Ground Flare
mtpa	Million Tonnes Per Annum
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
NESHAP	National Emission Standards for Hazardous Air Pollutants
NMHC	Non-Methane Hydrocarbon
NO	Nitric Oxide
NO_2	Nitrogen Dioxide

ACRONYMS (CONTINUED)

NO_X	Nitrogen Oxides
NSPS	New Source Performance Standards
NSR	New Source Review
O_2	Oxygen
OAR	Oregon Administrative Rules
OCIMF	Oil Companies International Marine Forum
ODEQ	Oregon Department of Environmental Quality
OLM	Ozone Limiting Method
PCGP	Pacific Connector Gas Pipeline
PM	Particulate Matter
PM_{10}	Particulate Matter less than 10-microns in diameter
$PM_{2.5}$	Particulate Matter less than 2.5-microns in diameter
ppm	Parts Per Million
ppmv	Parts Per Million By Volume
ppmvd	Parts Per Million By Volume, Dry
PSD	Prevention of Significant Deterioration
PSEL	Plant Site Emission Limit
PVMRM	Plume Volume Molar Ratio Method
RICE	Reciprocating Internal Combustion Engine
SCF	Standard Cubic Feet
SCR	Selective Catalytic Reduction
sec	Seconds
SER	Significant Emission Rate
SILs	Significant Impact Levels
SMR	Single Mixed Refrigerant
SO_2	Sulfur Dioxide
SORSC	Southwest Oregon Regional Security Center
ST	Steam Turbine
STG	Steam Turbine Generator
SU/SD	Startup and Shutdown
TEGF	Totally Enclosed Ground Flare

ACRONYMS (CONTINUED)

TO	Thermal Oxidizer
tpy	Tons Per Year
USCG	United States Coast Guard
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
VOL	Volatile Organic Liquids
yr	Year

1. INTRODUCTION

Jordan Cove Energy Project, L.P. (JCEP) is submitting a Type B State New Source Review (NSR) application for approval to construct and operate the Jordan Cove liquefied natural gas (LNG) Terminal (JCLNG) near Coos Bay, Oregon. JCEP obtained approval for construction and operation of the terminal under Standard Air Contaminant Discharge Permit (ACDP) No. 06-0118-ST-01 on June 16, 2015. Since that approval, several changes were made to the facility design to optimize energy use and lower the environmental impacts. This permit application is being submitted to obtain a Standard ACDP to reflect the final facility equipment and emissions.

JCLNG will be a LNG export terminal and will consist of facilities to receive, liquefy, store, and load the refrigerated fuel onto LNG carriers (LNGC). JCEP has designed the LNG Terminal to receive a maximum of 1,200,000 dekatherms per day (dth/d) of natural gas and produce a maximum of 7.8 million tonnes per annum (mtpa) of LNG for export.

The project site is 199 acres located on the bay side of the North Spit of Coos Bay, between Coos Bay Navigation Channel Miles 7.0 and 8.0. The site consists of two areas located on either side of Roseburg Forest Products and connected by a utility corridor. The liquefaction facility, LNG storage tanks, and berth will be located at Ingram Yard to the west of Roseburg Forest Products. The South Dunes part of the site will contain administrative buildings and temporary workforce housing. JCLNG will include five turbine-driven refrigeration compressors, gas conditioning equipment, a thermal oxidizer, an auxiliary boiler, emergency fire water pumps, black start engine generators, backup engine generators, a marine flare, a warm flare, and a cold flare.

The LNG Terminal site is located in Coos County, Oregon, which is in attainment or unclassified for all pollutants. The proposed Jordan Cove LNG Project has the potential to emit nitrogen oxides (NO_X), volatile organic compounds (VOC), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), particulate matter less than 10 micrometers (PM_{10}), particulate matter less than 2.5 micrometers ($PM_{2.5}$), and sulfuric acid mist (H_2SO_4) above Oregon Significant Emission Rates (SERs) but below the Prevention of Significant Deterioration (PSD) threshold of 250 tons per year (tpy).[1] JCEP is submitting an application for approval in accordance with Oregon Administrative Rule (OAR) 340-224-0270 for these pollutants, which includes a Type B State NSR air quality impact analysis for CO, SO_2, PM_{10}, $PM_{2.5}$, and NO_X. This report provides a description of the proposed facility, emission calculations, regulatory applicability, and the air quality impact analysis.

[1] 340-224-0010(2)(b)(A)

2. PROJECT DESCRIPTION

Jordan Cove Energy Project, L.P. is proposing to construct and operate an LNG export terminal in Coos Bay, Oregon. The LNG Terminal will turn natural gas into its liquid form via refrigeration to approximately -260 degrees Fahrenheit (°F). The Jordan Cove terminal includes an access channel from the Coos Bay navigation channel, a marine slip with one LNG carrier berth, an emergency lay berth, four tug boat berths, a loading platform and transfer piping, two LNG storage tanks, five liquefaction trains, one gas conditioning train, several support buildings, and the Southwest Oregon Regional Security Center (SORSC).

In coordination with federal and state agencies and in consultation with the public, plans for both the terminal and natural gas pipeline route have been optimized to avoid or minimize potential impacts and increase efficiency.

The project will include the following emitting equipment:

- Five aero-derivative gas turbines (with waste heat recovery);
- Thermal oxidizer;
- Auxiliary boiler;
- Fire-water pumps;
- Black start generators;
- Backup generators;
- A multi-point ground flare (warm and cold flares); and
- A totally enclosed ground flare (marine flare).

The general location of the proposed LNG Terminal is shown on Figure 1. Also, Figure 1 includes a general layout of the surrounding area and identifies the names of various geographic areas related to the project.

The LNG Terminal will receive natural gas from the Pacific Connector Gas Pipeline (PCGP), process the gas, liquefy the gas into LNG, store the LNG, and load the LNG onto ocean-going LNG carriers at its marine berth. The main operational components of the LNG Terminal are shown on Figure 2 (Plot Plan of the LNG Terminal) and include a connection to the Pipeline metering station, gas inlet facilities, a gas conditioning plant, an access and utility corridor, liquefaction facilities (including five liquefaction trains), two full-containment LNG storage tanks, an LNG loading line, LNG loading facilities, a marine slip, and an access channel for LNG carriers.

JCEP currently anticipates that construction for the Project would begin in the first half of 2019, with a target in-service date in the first half of 2024. Planned construction milestones are:

- Q1 2019 - Q4 2019 – Purchasing combustion equipment
- Q3 2019 - Q4 2019 – Release combustion equipment for manufacturing
- Q3 2019 – Mobilize to site and break ground
- Q3 2021 - Q2 2023 – Pre-Commissioning
- Q4 2022 – Introduce natural gas to site

- Q3 2022 - Q4 2023 – Commissioning
- Q2 2023 – LNG Tank Cooldown
- Q4 2023 – Plant Completion/Operations Begin

2.1 PROPOSED PROJECT

2.1.1 PROCESS DESCRIPTION

2.1.1.1 Gas Inlet and Conditioning

Pipeline quality feed gas will be supplied to the LNG Terminal via the 36-inch-diameter PCGP natural gas transmission pipeline routed from Malin, Oregon to a metering skid located on the South Dunes Site. Inlet pipeline metering facilities consist of a pipeline pig receiver, inlet filter/separator, and a flow meter. Additionally, a feed inlet heater will provide heating of the high pressure feed gas on cold days to prevent formation of natural gas hydrates resulting from Joule-Thomson cooling when gas pressure is let down by the pressure reduction unit. The feed inlet heater uses low pressure steam to warm the gas.

The feed gas from the pipeline will be treated before the gas enters the liquefaction trains. A Gas Conditioning train, in a 1 x 100 percent configuration, will include a system for mercury removal via sulfur impregnated activated carbon, carbon dioxide (CO_2) and acid gas removal via an amine system, and dehydration via a molecular sieve adsorbent system.

Mercury is removed via adsorption onto sulfur-impregnated activated carbon beds, in a 3 x 33 percent configuration, in order to prevent cold box corrosion during gas liquefaction and to minimize the exposure of other equipment and vent streams to mercury contamination. The mercury removal beds will reduce the amount of mercury in the treated pipeline gas down to less than 0.01 micrograms per Normal cubic meter ($\mu g/Nm^3$). Spent catalyst from the mercury removal vessels will be removed periodically and sent off-site for disposal at a licensed hazardous waste management contractor.

Acid gas removal involves a closed-loop system that circulates a promoted methyldiethanolamine solution to absorb CO_2 and sulfur species from the feed gas. The process reduces the feed gas CO_2 concentration from a maximum of 2 percent on a molar basis to less than 50 parts per million on a volumetric basis (ppmv). The CO_2 removed from the feed gas is to be vented to the atmosphere, but the vent stream must first be treated for co-absorbed contaminants. To limit emissions, absorbed hydrogen sulfide (H_2S) and other sulfur species in the vent stream will be thermally oxidized after passing through the sulfur scavenger unit. Co-absorbed hydrocarbons, including benzene, toluene, ethylbenzene, and xylenes, will also be combusted and destroyed in the thermal oxidizer at greater than 99.9 percent destruction efficiency.

The dehydration system is located immediately downstream of the acid gas removal system and employs four molecular sieve adsorption beds. The water removal system will reduce water in the treated feed gas to less than 0.1 ppmv. At any time, two beds will be in adsorption mode, one bed will be in regeneration/cooling mode, and the remaining bed will be on stand-by. Regeneration of a bed involves passing dehydrated heated feed gas through it, in an up-flow direction, which drives the adsorbed water out of the bed. This water-saturated regeneration gas is then cooled to condense and remove the water, which is collected and recycled back into the acid gas removal system. This regeneration gas is then compressed and recycled upstream of the dehydration units. The regenerated bed will then be cooled by non-heated dehydrated feed gas until a low enough temperature is achieved to place it back into adsorption service.

2.1.1.2 Natural Gas Liquefaction

Liquefaction Trains

The LNG Terminal includes five liquefaction trains utilizing the Black & Veatch proprietary PRICO® LNG technology to produce a maximum of 7.8 mtpa (1,077 MMscf/d [million standard cubic feet per day]) of LNG production net, after deduction for Boil-Off Gas (BOG) generation. Each liquefaction train will have an anticipated maximum annual capacity of 1.56 mtpa (215.5 MMscf/d). The nominal annual capacity may be less than this value due to annual ambient temperature variation, planned non-major facility maintenance outages, unplanned facility outages, and the expected degradation of the combustion gas turbines. The PRICO® LNG technology utilizes a single mixed refrigerant (SMR) circuit with a two-stage compressor and a brazed aluminum refrigerant exchanger.

The dry treated gas from the gas conditioning train is divided equally among the five liquefaction trains. In each liquefaction train, the dry treated gas stream flows into a refrigerant exchanger where it is pre-cooled and condensed into liquid by cooling it to approximately -260 °F via heat transfer with the mixed refrigerant. The refrigeration cycle is a closed-loop process that utilizes a single-body, two-stage refrigerant compressor. For each liquefaction train, an aero-derivative combustion turbine directly provides the power to drive the refrigerant compressor. Turbine exhaust-gas waste heat recovery steam generators (HRSGs) maximize the overall thermal efficiency of the LNG Terminal.

Heavies Removal

Heavy hydrocarbons, or “heavies” (generally referred to as C5+ components), will be removed from the feed gas before the final liquefaction step in order to meet the LNG specification and prevent possible freezing in the brazed aluminum refrigerant exchanger at subcooled temperatures. The system will be designed to remove the most likely-to-freeze components—benzene and octane—to less than 1 ppmv while recovering as much of the C4 and lighter molecules as economically as possible into the gas going to the final liquefaction step. The total volume of heavies removed across the range of feed compositions is not enough to produce economically viable natural gas liquids product for sale or export; however, it will be blended into the fuel gas stream, so no tankage or disposal logistics need to be considered.

Refrigerant Makeup

For many technologies, refrigerant losses occur from the closed-loop refrigeration loops primarily due to normal compressor seal leakage. However, the Black & Veatch patented seal gas recovery system will be utilized to minimize the refrigerant losses to flare by returning the normal leakage to the refrigerant compressor suction. Even with seal gas recovery, the refrigeration loop components must be replenished periodically to normal operation inventory levels. The hydrocarbons that provide make-up to the SMR circuit used in the liquefaction trains cannot be generated on-site (with the exception of methane, which comes from the treated feed gas) and will be delivered to the LNG Terminal and stored in pressurized vessels for intermittent makeup to the SMR circuit.

LNG Storage and Containment

The LNG will be stored in two full-containment insulated LNG storage tanks, each of which is designed for a working capacity of 160,000 cubic meters (m^3) (42,232,000 gallons) of LNG. Each tank will have a primary 9 percent nickel inner tank and a secondary concrete outer containment wall with a steel vapor barrier. The LNG storage tanks will have top connections only with piping that will permit top and bottom loading. Top loading operation will be done via a spray device/splash plate in order to obtain flashing and mixing of the LNG as it combines with LNG inventory. The bottom loading operation will be achieved via a standpipe to ensure effective mixing. The separated flash vapor combines with vapors from tank displacement and heat leak and flows to the boil-off gas compressors for use as fuel.

LNG is pumped to the marine berth and into an LNG carrier at a normal loading rate of 12,000 m^3/hr. An LNG transfer line will connect the shore-based storage system with the LNG loading system. A smaller recirculation, “keep cool” line is provided from the LNG storage tank area to the marine berth in order to maintain the LNG transfer piping at cryogenic temperatures to avoid excessive boil-off losses and potential damage from thermal cycling between carrier arrivals.

Marine Facilities

The LNG Terminal will include a single-use marine slip dedicated to supporting LNG exports. The east side of the slip will be utilized for the LNG carrier loading berth and LNG loading facilities. Berths for tugboats and security vessels will be located on the north side of the slip. An emergency lay berth will be provided on the west side of the slip to allow for berthing a temporarily disabled LNG carrier in an emergency. This berth will have no product loading facility, but it will comply with and be designed to meet all of the safety and security standards of the Oil Companies International Marine Forum (OCIMF) and the United States Coast Guard (USCG).

The LNG carrier loading berth will be capable of accommodating LNG carriers with a cargo capacity range of 89,000 m^3 to 217,000 m^3.

Vessel Transit

LNG carriers would access the LNG Terminal through a waterway for LNG marine traffic, which is defined by the USCG for the Project as extending from the outer limits of the U.S. territorial waters 12 nautical miles off the coast of Oregon, and up the existing Federal Navigation Channel about 7.5 miles to the LNG Terminal.

The total average LNG carrier port time is estimated to be approximately 36 hours, assuming there are no delays caused by natural environmental conditions. This estimate includes the transit time from the Pilot boarding to arrival at the LNG loading berth to the Pilot drop-off at departure, time of mooring, unmooring and cast off, the bulk LNG loading time of approximately 15 hours (using the 12,000 m^3/hr loading rate), and the 8 hours of time waiting for the next available high tide cycle needed for safe departure transit of the Federal Navigation Channel.

Vapor Handling System

BOG is primarily generated from the LNG storage and loading system and consists of flash gas from the LNG product stream entering the LNG flash drum, vapors from the heat leak into the LNG storage tanks, piping and pump systems, vapor displaced as the LNG storage tanks are filled, and vapor return from the LNG carrier during LNG loading. The BOG will be consumed as fuel. Two BOG compressor trains are included to compress the vapor from LNG storage tank pressure to fuel gas pressure. The centrifugal compressors have electric motors and dry gas seals.

The mode of operation of the liquefaction plant when not loading an LNG carrier is known as "holding mode." The mode of operation during LNG carrier loading is known as "loading mode." One BOG compression train will be operating continuously to handle holding mode BOG volumes; the second will be needed only during loading mode or during an off-design condition that results in increased BOG generation.

During normal operation, fuel gas will be supplied from BOG and vaporized heavy hydrocarbon streams and supplemented with gas from the inlet pipeline upstream of the gas conditioning train. After mixture in the high-pressure fuel gas mixing drum, this high-pressure fuel gas stream primarily feeds the combustion gas turbines to drive the refrigerant compressors. Some high-pressure fuel gas is let down from the high-pressure fuel gas header to the low-pressure fuel gas knockout drum before going to other smaller consumers, such as the thermal oxidizer, duct burners, and flare pilots. Normally, a small amount of makeup to the high-pressure fuel from the pipeline feed gas is required to meet demands; if the BOG/heavies mixture results in excess fuel for the demand, it can be recycled upstream of the amine unit and re-liquefied.

Instrument Air

Instrument air will be provided through compression and drying packages. Air will be compressed in 1 x 100 percent centrifugal compressors. There will be one additional compressor with the ability to provide essential instrument air duty. Air will be dried in 2 x 100 percent air dryer packages, with each package containing four air dryers designed for full, continuous operation. During operations, one dryer will be in adsorption mode while the other dryer regenerates. Instrument air will be used for pneumatic control of automated instrumentation, utility air, and supply for nitrogen generation.

Flare, Relief, and Blowdown System

Flare systems are a necessary safety feature of all LNG export facilities. The LNG Terminal will have three separate flare systems for pressure relief plant-protection conditions: one for warm (wet) reliefs; one for cold, cryogenic (dry) reliefs; and one for low-pressure cryogenic reliefs from the LNG storage tanks and marine loading system. The “warm” relief loads are separated to ensure that wet fluids cannot freeze in the header if there was a cryogenic relieving event. The “cold” and “marine” relief loads are separated to ensure that the relief of near-atmospheric pressure vapors is not affected by back-pressure in the header if an unrelated release were to occur. The warm and cold flares will both be within a multi-point ground flare field surrounded by radiation fencing, while the marine flare will be a cylindrical totally enclosed ground flare. Small pilots with electronic ignition are provided on each flare.

The flare system will be used only during plant-protection situations, maintenance activities, cases of purging and gassing-up an LNG carrier, and initial commissioning/start-up.

Electrical Systems

JCEP plans to obtain limited power from the regional electric grid for the SORSC and temporary construction activities. With the exception of the SORSC, the LNG Terminal facilities will be islanded (with black-start capability) and will not have the means, infrastructure, or need to import or export power during operations. The total power requirements for the LNG Terminal are 39.2 MW (holding mode) and 49.5 MW (loading mode).

Electrical power will be via two 30 MW steam turbine generators (STGs) and one spare 30 MW STG. The steam is efficiently generated by HRSGs using exhaust from the refrigerant compressor combustion turbine drivers. A black-start auxiliary boiler will be used to generate steam for power when gas turbines are not in operation. In addition, there are 2 x 100 percent standby diesel generators for the LNG facility and one for the SORSC. The facility will not be connected to the local grid and will not import or export power.

2.1.2 PROPOSED EQUIPMENT

Final vendors have not been selected for the LNG Terminal equipment. Equipment parameters and specifications presented in this application are based on design needs of the project and preliminary quotes obtained from vendors, where available.

The proposed project will include five combustion turbine-driven refrigeration compressors with duct burners operating in combined-cycle mode with a HRSG. Steam will be used to generate power for the facility in STGs. All power produced by the STGs will be used on site. Steam from the HRSGs will be used as a heat transfer fluid for process heating.

The project will also involve installation of combustion and post-combustion emission controls. The aero-derivative turbines will use dry low NO_X burners (LNBs) and selective catalytic reduction (SCR) systems with aqueous ammonia injection to control NO_X emissions and oxidation catalysts to control emissions of CO and VOC.

The operating parameters for the turbines and duct burners are presented in Table 2-1. During startup of the facility, the turbines will be fueled by pipeline natural gas. During routine facility operations the turbines will be fueled by BOG from the LNG vapor system, supplemented by pipeline natural gas. Fuel specifications for pipeline gas and BOG differ slightly but do not affect emissions substantially.

The turbines are expected to operate full time with the exception of maintenance downtime. One startup and shutdown per month per turbine is expected. Duct burner firing is dependent on the power needs of the facility given the ambient temperature. Per year, 4,000 hours of duct burner firing per turbine is anticipated. The turbines have inlet air preheating to 42 °F during cold weather. A chiller provides inlet air cooling for the turbines during warmer weather.

Table 2-1. Combined Cycle Turbine Model Parameters for JCEP

Parameter(1)	Aero-derivative Turbine
Mechanical Power Output (MW)	55.6
Maximum CT Heat Input – HHV (MMBtu/hr)	504.4
Maximum Duct Burner Heat Input – HHV (MMBtu/hr)	19.7
Maximum Total Heat Input – HHV (MMBtu/hr)	524.1

(1) 100 percent load at 42 degrees Fahrenheit ambient dry bulb temperature

In addition, the JCLNG will include a 296.2 MMBtu/hr natural gas-fired auxiliary boiler for startup of the liquefaction trains. The boiler may also be used to provide supplemental steam if more than two liquefaction turbines are offline. The auxiliary boiler will be equipped with SCR for NO_X control and an oxidation catalyst for CO and VOC control. The boiler will be used extensively during facility commissioning but is expected to operate only 10 percent of the year after facility startup. The operating parameters for the auxiliary boiler are presented in Table 2-2.

Table 2-2. Description of Auxiliary Boiler

Parameter	Auxiliary Boiler
Manufacturer/Model	TBD
Fuel	Natural Gas
Sulfur Content	1 gr/100 scf
Maximum Fuel Consumption	296.2 MMBtu/hr HHV
Operating Hours	876 hrs/yr

A thermal oxidizer will combust the gases exhausted from the acid gas removal system to destroy reduced sulfurs and co-absorbed hydrocarbons. The oxidizer will also combust flash gases and supplemental fuel gas. The single oxidizer will operate full time. Acid gas removal exhaust will be vented during any maintenance downtime. The operating parameters for the thermal oxidizer are presented in Table 2-3.

Table 2-3. Description of Thermal Oxidizer

Parameter	Thermal Oxidizer
Manufacturer/Model	TBD
Process Feeds	Acid Gas, Flash Gas, Natural Gas assist
Maximum Process Mass Input	238,142 lb/hr
Maximum Process Heat Input	110 MMBtu/hr

JCLNG will include three 700 hp diesel-fired fire water pump engines and two 1,073 hp diesel-fired backup generators to provide emergency back-up power for the SORSC and two 4,376 hp diesel-fired black-start generators for the LNG Terminal. Operation of the fire water pumps and backup generators, other than for emergency purposes, will be limited to reliability testing and maintenance. The two diesel-fired black-start generators will be used to power the auxiliary boiler; the backup air compressor; control building essential loads; miscellaneous electrical loads for enclosures and buildings; and miscellaneous process loads during initial startup of the facility and in the event of a facility-wide power outage. A summary of the operating parameters for the diesel-fired engines is provided in Table 2-4 below.

Table 2-4. Description of Diesel-Fired Engines

Parameter	Fire Water Booster Pumps	Backup Generators	Black-Start Generators
Manufacturer/Model	Caterpillar/C18	Caterpillar/C27	Caterpillar/C175
Number of Units	3	2	2
Engine Tier	Tier 3	Tier 2	Tier 2
Fuel	Diesel	Diesel	Diesel
Fuel Sulfur Content	15 ppm	15 ppm	15 ppm
Maximum Fuel Consumption	35.9 gal/hr	57.3 gal/hr	219 gal/hr

There will be three separate flare systems: one for warm (wet) reliefs; one for cold, cryogenic (dry) reliefs; and one marine flare for low-pressure cryogenic relief. The low-pressure cryogenic relief totally enclosed ground flare (TEGF) will be located at the southwest side of the LNG tank area. The warm and cold flare systems have been combined into one multi-point ground flare which will be located in the northwest corner of the facility. A summary of the operating parameters for the flares is provided in Table 2-5 below.

Table 2-5. Description of Flares

Parameter	MPGF	TEGF
Manufacturer/Model	TBD	TBD
Description	Warm and cold flares	Marine flare
Fuel Sulfur Content	1 grain/100 scf	1 grain/100 scf
Number of Pilots	28 pilots	6 pilots
Pilot Fuel Consumption – LHV	1.82 MMBtu/hr	0.39 MMBtu/hr
Purge Gas Fuel Consumption – LHV	0.31 MMBtu/hr	0.35 MMBtu/hr

2.1.3 APPLICATION FORMS

The ODEQ application forms for the project and equipment described above are included in Appendix A. Specification sheets (or pertinent portions of vendor quotes) and equipment performance data have been included as attachments to each form where available.

2.2 SITE LOCATION

The proposed site of the LNG Terminal is located in the coastal, western region of the State (Section 5, Township (T.) 25 South (S.), Range (R.) 13 West (W.), shown on Coos County Assessor's map as tax lots 100/200/300) on the bay side of the North Spit, about 7.5 miles up the existing Federal Navigation Channel, approximately 1,000 feet north of the city limit of North Bend, in Coos County, Oregon. An area map indicating the location of the proposed terminal is shown in Figure 3. The area map shows the site property relative to predominant geographical features such as the bay, roads, and surrounding dunes. Typically, and due to the functional requirements of the facility, the facility will be at or above 46 feet above sea level. Exceptions include the LNG tanks and water-dependent facilities such as the marine terminal and Material Offloading Facility (MOF).

2.3 EMISSIONS

Emissions attributable to the LNG Terminal are generated from natural gas combustion in the combustion turbines (CTs), natural gas combustion in the HRSG duct burners, natural gas combustion in the auxiliary boiler, combustion of the gas conditioning train acid gas stream in the thermal oxidizer, and diesel combustion in the fire water pumps, backup generator, and black start generators. Routine pilot and purge gas combustion will result in emissions from the MPGF and the TEGF; both of those units will also have emissions during upset or other condition flaring events. Fugitive emissions of natural gas (or BOG) and refrigerants will result from components and fittings throughout the LNG Terminal.

Emissions from the five CTs are exhausted via the HRSG stacks. The heating value of the turbine fuel gas is assumed to be 952 Btu/scf (standard cubic feet) HHV, based on a fuel specification provided by the terminal design engineering firm (a Kiewit, Black & Veatch, and JGC joint venture, "KBJ"), incorporating a mix of pipeline natural gas with BOG.

Emission factors for the CTs were provided by KBJ for several operation loads and ambient temperatures. Annual potential emissions for each CT are estimated from maximum hourly emissions at 100% load with 4,000 hours per year of duct burner firing and an ambient temperature of 42 °F. The turbines will have inlet air pre-heating to a minimum of 42 °F, and the highest emissions occur at the lowest inlet temperature.

Emissions are based on the proposed emission limits with control using SCR for NO_X, oxidation catalysts for CO and VOC, and good combustion practices for particulate matter species. A maximum fuel sulfur content of 1 grain per 100 standard cubic feet (gr/100 scf) of natural gas is used to estimate emissions of SO_2 and oxidation rates. H_2SO_4 emissions are based on oxidation rates provided by KBJ (SO_2 to SO_3 based on the turbine type, post-combustion configuration and control, and 100% conversion of SO_3 to H_2SO_4). SO_2 emission rates do not take oxidation into account and are conservative. A two percent by volume oxidation rate of SO_2 in the CT is assumed, with zero oxidation in the duct burner. A 20 percent oxidation rate is expected to occur in the CO catalyst and a three percent oxidation rate is expected for the SCR. Ammonia slip is calculated at 5 ppmvd for a maximum emission rate of 3.47 lb/hr at 42 °F.

Turbine startup and shutdown emissions are calculated for 12 startups and 12 shutdowns for each turbine per year. The liquefaction trains will operate continuously with the exception of maintenance downtime. Low load turbine operations are not expected except during short startup and shutdown periods.

Emission estimates for PM_{10} and $PM_{2.5}$ include the ammonium sulfates created downstream of the SCR (again assuming all SO_3 is converted to H_2SO_4). Hazardous air pollutant (HAP) emissions are based on AP-42 Section 1.4 (September 1999) for duct burner and Section 3.1 (April 2000) for combustion turbine emission factors.

Criteria pollutant emissions from the auxiliary boiler are calculated using manufacturer's emission factors and information from KBJ. SO_2 emissions are based on natural gas sulfur content of 1 gr/100 scf. 44 percent by volume conversion of SO_3 to H_2SO_4 is assumed. PM and HAP emissions are calculated using factors from AP-42 Section 1.4, July 1998. The boiler will have SCR and an oxidation catalyst to control NO_X and CO/VOC, respectively.

The gas conditioning unit produces an acid gas process stream which is routed to the thermal oxidizer for destruction. Emissions are calculated using manufacturer's emission rate information. The VOC and greenhouse gas (GHG) emission estimates also include 350 hours per year of venting to account for maintenance downtime. HAP emissions are calculated using factors from AP-42 Section 1.4, July 1998.

For the fire water pump engines, the backup generators, and the black start generators, PM/PM_{10}/$PM_{2.5}$, CO, NO_X, and VOC emission factors are based on the emission rates provided by the manufacturer. Mass balance with a diesel fuel sulfur content of 0.0015 percent by weight (15 ppm) is used to estimate SO_2 emissions for all diesel engines. AP-42 Section 3.1 and Section 3.4, October 1996, emission factors are used to estimate HAP emissions for all diesel engines.

For the MPGF and the TEGF, emissions are calculated for full time firing of pilot gas and purge gas.

The flare events which will occur are unplanned and have unknown gas volumes, with one exception. When an LNGC arrives following a dry dock overhaul period, the hull will be too warm to load LNG, and the carrier must be 'conditioned' prior to loading. The conditioning process is typically called "Gas-up" and "Cool Down." During "Gas Up," the ship vapor within the hull is replaced by vaporized LNG (methane), and the inert gases are displaced. At this stage the tanks are full of methane at ambient temperature. During "Cool Down" LNG is sprayed into the tanks by spray heads which vaporizes and cools the tank. When tank temperatures reach -220 °F, the tanks are ready for bulk loading.

At the LNG Terminal, the "Gas Up" displaced hull vapors will be routed to the TEGF for combustion. When the gas contains less than 50 ppmv CO_2 it will be routed to the fuel gas system. The emission calculations include up to 3 ships a year requiring "Gas Up." During the "Cool Down" procedure, all vapors will be sent to the fuel gas system.

Fugitive emissions of natural gas, BOG, and refrigerants will result from the components and fittings throughout the facility. Fugitive emission estimates of VOC, GHGs, and HAPs have been estimated for equipment leaks using component counts and emission factors from the EPA Protocol for Equipment Leak Emission Estimates, November 1995. LNG Tank fugitive emissions were provided in the May 2013 PSD Air Permit Application for the JCEP; those emission estimates have been included.

One ton per year of aggregate insignificant emissions is included for each criteria pollutant, and 0.7 tons per year of aggregate insignificant emissions of H_2SO_4 is included.

The potential emissions are summarized in Table 2-6 below. Detailed emission rate calculations are provided in Appendix B.

Table 2-6. JCLNG Potential Emission Rates (tons/yr)

Unit	NO_X	CO	SO_2	VOC	$PM/PM_{10}/PM_{2.5}$	H_2SO_4	NH_3	Lead	CO_2(e)	HAPs(1)
Turbines	81.99	97.82	35.19	32.72	112.26	23.61	75.4	--	1,292,706	5.06
Turbine Startup/ Shutdown	0.23	0.73	4.4E-03	0.10	0.11	--	--	--	188	6.2E-04
Gas Conditioning (TO)	63.25	38.5	19.84	1.08	3.85	--	--	2.5E-04	622,154	0.96
Auxiliary Boiler	0.96	1.16	0.36	0.67	1.30	2.4E-01	0.87	6.3E-05	15,193	0.24
Fire Water Pumps	1.59	0.8	2.1E-03	4.5E-02	9.0E-02	1.6E-04	--	2.1E-05	241	3.6E-03
Emergency Generators	3.33	0.28	2.5E-03	0.04	0.04	1.9E-04	--	2.4E-05	278	4.1E-03
Black Start Generators	1.49	0.21	8.8E-03	0.09	0.05	6.8E-04	--	8.6E-05	1,002	1.5E-02
Flares (MPGF and TEGF)	0.86	3.9	3.9E-02	8.31	0.38	3.0E-03	--	7.6E-06	2,177	4.3E-02

Unit	NO_X	CO	SO_2	VOC	PM/PM_{10}/ $PM_{2.5}$	H_2SO_4	NH_3	Lead	CO_2(e)	HAPs[(1)]
Gas Up (TEGF)	2.09	9.5	0.16	17.53	1.12	1.3E-02	--	2.1E-05	4,351	3.8E-02
Fugitives	--	--	--	7.98	--	--	--	--	13,116	1.77
Aggregate Insignificant	1.0	1.0	1.0	1.0	1.0	0.7	--	--	--	--
Total Emissions	**156.8**	**153.9**	**56.6**	**69.5**	**120.2**	**24.6**	**76.3**	**4.8E-04**	**1,951,406**	**8.1**

Note: '--' = not applicable.
(1) Maximum single HAP is n-hexane at 3.29 tpy.

2.4 PROPOSED PLANT SITE EMISSION LIMITS

Based on the proposed installation of the equipment described in this application, the Plant Site Emission Limits (PSELs) presented in Table 2-7 are requested.

Table 2-7. Proposed PSELs for JCLNG (tons/yr)

Pollutant	Proposed PSELs
PM	121
PM_{10}	121
$PM_{2.5}$	121
SO_2	57
NO_X	157
CO	154
VOC	70
H_2SO_4	25
GHG	1,951,410

3. REGULATORY APPLICABILITY

This section describes the applicable regulations triggered by the proposed project. The applicability determination conducted in this analysis is pursuant to the Oregon NSR regulations, National Emissions Standards for Hazardous Air Pollutants (NESHAP), and New Source Performance Standards (NSPS).

3.1 NEW SOURCE REVIEW APPLICABILITY

The JCLNG must be evaluated in relation to Oregon's NSR program. The Coos Bay area is designated as "attainment" or is unclassified for all criteria pollutants. JCLNG was permitted as a Prevention of Significant Deterioration (PSD) source under ACDP No. 06-0118-ST-01 in 2015. The facility has not yet been constructed and the design has changed. The planned facility and equipment must then be re-evaluated under the NSR and PSD requirements of OAR 340, Division 224 to determine whether it will be a federal major source in order to determine whether Oregon's PSD program has been triggered and, if so, for what pollutants.[2]

A "federal major source" is a source with the potential to emit 100 tons per year or more of any individual regulated pollutant (excluding greenhouse gases and hazardous air pollutants) if that source is in one of the designated source categories or 250 tons per year or more if it is not.[3] The JCLNG (i.e., the source) is no longer within one of the designated source categories which have a PSD threshold of 100 tons per year. The design no longer includes a power plant. The fossil fuel fired auxiliary boiler does have a capacity in excess of 250 MMBtu/hr heat input. The auxiliary boiler potential to emit will not, however, exceed 100 tons per year, meaning the boiler is not a federal major source.[4]

Because LNG terminals are not within any of the 28 listed source categories in OAR 340-200-0020(66), the JCLNG emissions must be compared to the 250-tpy threshold to determine whether the project constitutes a federal major source. The potential to emit is compared to the PSD threshold for each regulated pollutant except GHG and HAPs in Table 3-1.

Table 3-1. Oregon PSD Applicability (tons/yr)

Pollutant	Potential to Emit	PSD Federal Major Source Threshold	PSEL Requested in Excess of PSD Threshold?
PM	120	250	No
PM_{10}	120	250	No
$PM_{2.5}$	120	250	No
SO_2	57	250	No
NO_X	157	250	No
CO	154	250	No
VOC	70	250	No

[2] OAR 340-224-0070. It is important to note that the term "federal major source" should not be taken to imply that the federal PSD rules apply to the JCEP. Rather "federal major source" is a defined term of art under the Oregon New Source Review program.
[3] OAR 340-200-0020(66)
[4] Refer to the Dispersion Modeling Protocol included in Appendix D for additional analysis of the boiler applicability.

As shown in Table 3-1, the potential to emit of the plant as a whole will be less than 250 tpy for each for each regulated pollutant. As neither the facility as a whole nor the fossil fuel fired boiler qualifies as a federal major source, the JCLNG is not subject to Major NSR/PSD program requirements.

The project must then be assessed for applicability under State NSR requirements per OAR 340-224-0010(2)(b)(A). The requested PSELs are compared to the significant emission rates for each regulated pollutant in Table 3-2.

Table 3-2. Oregon State NSR Applicability (tons/yr)

Pollutant	Requested PSEL	Significant Emission Rate	PSEL Requested in Excess of SER?
PM	120	25	**Yes**
PM_{10}	120	15	**Yes**
$PM_{2.5}$	120	10	**Yes**
SO_2	57	40	**Yes**
NO_X	157	40	**Yes**
CO	154	100	**Yes**
VOC	70	40	**Yes**
H_2SO_4	25	7	**Yes**
Lead	0	0.6	No
GHG	1,951,406	75,000	NA

The project is subject to State NSR requirements because emissions of PM, PM_{10}, $PM_{2.5}$, NO_X, CO, SO_2, VOC, and H_2SO_4 will each exceed the significant emission rates, as identified in Table 3-2. GHG emissions will exceed the SER, but GHGs are not subject to State NSR.

State NSR projects are categorized as Type A or Type B actions. Construction of projects located in attainment areas are categorized as Type B State NSR actions. JCLNG will be located in an attainment area and construction of the LNG Terminal will be a Type B State NSR action.

As a result, this application is prepared in accordance with OAR 340-224-0270, "State New Source Review Requirements for Sources in Attainment or Unclassified Areas" for the proposed emissions of PM, PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, VOC, and H_2SO_4.

3.2 AMBIENT AIR QUALITY ANALYSIS

JCEP must provide an air quality impacts analysis for the proposed project in accordance with OAR 340-225-0050(1) and (2) and 340-225-0060 for each pollutant other than GHGs for which emissions will exceed the SER.[5] The JCLNG potential emissions of CO, SO_2, VOC, PM_{10}, $PM_{2.5}$, PM, NO_X, and H_2SO_4 exceed the netting basis of zero by more than the SERs; therefore, an air quality impact analysis is required for CO, SO_2, PM_{10}, $PM_{2.5}$, and NO_X. No air quality impact analysis is required for H_2SO_4 as no

[5] OAR 340-224-0270(1)(a)

National Ambient Air Quality Standard (NAAQS) or PSD Increment has been established in relation to this pollutant.

A dispersion modeling analysis is conducted to demonstrate that impacts from PM_{10}, $PM_{2.5}$, NO_X, SO_2, and CO emissions from the JCLNG comply with the NAAQS and PSD Increments as they apply to Class I and Class II areas. The analyses are provided in Section 4 and Section 5 of this report.

In addition, for increases of direct $PM_{2.5}$ or $PM_{2.5}$ precursors greater than the SER, an analysis of $PM_{2.5}$ air quality impacts based on the emission increases must be performed.[6]

Draft EPA guidance on addressing secondary formation of ozone was used to develop a project-specific evaluation of the potential impacts from project VOC and NO_X emissions. Following this guidance, it was determined that significant ozone concentrations will not be generated from the project. Further discussion of the ozone precursor analysis may be found in Section 4.7.3.

3.2.1 AIR QUALITY MAINTENANCE AREAS

The owner or operator of any source subject to OAR 340-224-0270 that significantly affects air quality in a designated nonattainment or maintenance area must meet the requirements of net air quality benefit in OAR 340-224-510 and 340-224-0520 for ozone areas and OAR 340-224-510 and 340-224-0540 for other designated areas.[7] The JCLNG is located greater than 100 km from all designated nonattainment and maintenance areas, including the Grants Pass particulate and CO maintenance area, the Eugene-Springfield CO area, and the Salem ozone and CO maintenance area.

3.3 NEW SOURCE PERFORMANCE STANDARDS

NSPS are established under 40 CFR Part 60 and adopted by reference in OAR 340-238-0060. The following NSPS are applicable to the proposed project.

3.3.1 NSPS SUBPART KKKK

The combustion turbines are subject to 40 CFR 60 Subpart KKKK, *Standards of Performance for Stationary Combustion Turbines*, because they are stationary combustion turbines with a heat input capacity greater than 10 MMBtu/hr and will commence construction after February 18, 2005. Pursuant to 40 CFR 60.4305, the turbines, HRSGs, and duct burners are exempt from the requirements of Subparts GG, Da, Db, and Dc.

Subpart KKKK regulates emissions of SO_2 and NO_X. Based on the source type and heat input, the NO_X emission limit for the JCEP turbines is 25 ppm at 15% O_2 or 1.2 lb/MW-hr of useful output. The heat content of the natural gas/BOG mixture meets the definition of 'natural gas' in Subpart KKKK. JCLNG will use a continuous emission monitoring system (CEMS) in accordance with §60.4335(b) and 60.4345 to demonstrate continuous compliance with the NO_X emissions limit for each unit.

[6] OAR 340-224-0270(1)(b)
[7] OAR 340-224-0070(4)

The SO_2 emission limit of 0.90 pounds per megawatt-hour (lb/MWh) gross output is based on an emission factor of 0.06 lb/MMBtu-heat input (or 20 gr/100 scf). JCLNG will maintain a natural gas tariff sheet to demonstrate that the fuel burned by each affected facility contains a total sulfur content of 20 gr/100 scf, or less, in accordance with §60.4365(a). The fuel gas fired in the turbines will often have a lower sulfur content than the incoming pipeline natural gas because the BOG has had sulfur compounds removed.

3.3.2 NSPS SUBPART Db

The proposed 296 MMBtu/hr auxiliary boiler is subject to 40 CFR 60 Subpart Db, *Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units*, because it is a steam generating unit with a design capacity greater than 100 MMBtu/hr heat input that will commence construction after June 19, 1984. Units firing only gaseous fuel with a potential SO_2 emission rate of 140 ng/J (0.32 lb/MMBtu) heat input or less are exempt from the SO_2 emissions limit in §60.42b(k)(1). In addition, PM standards do not apply to units combusting only natural gas. Per §60.44b(l)(1), the auxiliary boiler will be subject to the emission standard of 0.20 lb/MMBtu heat input determined on a 30-day rolling average basis.

The projected boiler operating hours result in a 10 percent annual capacity factor estimate. The annual capacity factor is calculated on annual actual operating hours. Because there may be years when auxiliary boiler operations exceed 876 hours per year, JCEP does not want to take a federally enforceable limit on the annual capacity factor. A NO_X CEMS will be required to monitor NO_X emissions.

Refer to Table 3-3 for a summary of NSPS Subpart Db emission limits applicable to the auxiliary boiler. Refer to Appendix C for a more detailed compliance summary and the supporting calculations.

Table 3-3. Emission Standards for Auxiliary Boilers

Boiler Category	Annual Capacity Factor	NO_X lb/MMBtu	PM lb/MMBtu	SO_2 lb/MMBtu
Natural gas-fired, > 250 MMBtu/hr	10%	0.20	Exempt	Exempt

3.3.3 NSPS SUBPART IIII

NSPS Subpart IIII, *Standards of Performance for Stationary Compression Ignition Internal Combustion Engines*, applies to all of the proposed diesel-fired engines. The 700 hp fire pump engines are subject to the emission limits of Table 4 in Subpart IIII, and JCLNG must comply with the emission standards shown in Table 3-4. The proposed engines are rated to meet Tier 3 standards.

Table 3-4. Emission Standards for Stationary Fire Pump Diesel Engines

Maximum Engine Power	Model Year	NMHC + NO_X g/kW-hr (g/hp-hr)	PM g/kW-hr (g/hp-hr)
450≤KW≤560 (600≤HP≤750)	2009 +	4.0 (3.0)	0.20 (0.15)

The 1,214 hp emergency backup generator engines have a displacement of 2.25 liters per cylinder and must comply with the certification emission standards for new non-road compression ignition engines for the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants because the engines will be newer than the 2007 model year. The engines must be certified for Tier 2 standards and operation will be limited according to 40 CFR 60.4211(f). The engines must comply with the emission standards shown in Table 3-5.

Table 3-5. Emission Standards for Stationary Emergency Diesel Engines

Maximum Engine Power	Model Year	NMHC + NO_X g/kW-hr (g/hp-hr)	CO g/kW-hr (g/hp-hr)	PM g/kW-hr (g/hp-hr)
kW ≥ 560 (hp ≥ 750)	2007 +	6.4 (4.8))	3.5 (2.6)	0.2 (0.15)

The 4,376 hp black start engines will serve the dual function of providing power for turbine startup and providing power to supply the plant's critical essential services during loss of on-site generation, resulting from turbine trips offline. The facility, including instrument air and safety mechanisms, is islanded from the power grid and the black start generators serve an emergency response function. The engines have a displacement of 5.29 liters per cylinder and must comply with the certification emission standards for new non-road compression ignition engines for the same model year and maximum engine power in 40 CFR 89.112 and 40 CFR 89.113 for all pollutants because the engines will be newer than the 2007 model year. The engines must be certified for Tier 2 standards and operation will be limited according to 40 CFR 60.4211(f). The applicable emission standards are shown in Table 3-6.

Table 3-6. Emission Standards for Stationary Emergency Diesel Engines

Maximum Engine Power	Model Year	NMHC + NO_X g/kW-hr (g/hp-hr)	CO g/kW-hr (g/hp-hr)	PM g/kW-hr (g/hp-hr)
kW ≥ 560 (hp ≥ 750)	2007 +	6.4 (4.8))	3.5 (2.6)	0.2 (0.15)

In order to demonstrate compliance with the NSPS, JCEP will purchase engines certified by the manufacturer and operate and maintain all diesel engines according to the manufacturer's instructions. Pursuant to §60.4207, JCEP will only burn ultra-low-sulfur fuel (15 ppm sulfur) in the diesel-fired engines. A non-resettable hour meter will also be installed for the fire pump engines, emergency backup generator units, and black start units. Initial notification is not required by this subpart.

3.3.4 NSPS SUBPART Kb

40 CFR 60, Subpart Kb, *Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for which Construction, Reconstruction, or Modification Commenced after July 23, 1984*, applies to storage vessels greater than 75 cubic meters that are used to store volatile organic liquids (VOL), which is an organic liquid that can emit VOC into the atmosphere. Methane is not considered a VOC due to its limited photochemical reactivity. LNG typically includes more than just methane, specifically propane and butane, which are considered VOCs. However, Subpart Kb does not apply to storage vessels with a capacity greater than or equal to 151 cubic meters, storing a liquid with a maximum true vapor pressure less than 3.5 kilopascals (kPa). The maximum true vapor pressure is the

equilibrium partial pressure exerted by the VOCs in the stored VOL. The vapor pressure of propane (and butane) is below 3.5 kPa at the storage temperature. As such, 40 CFR 60 Subpart Kb is not applicable to the LNG storage tanks at JCLNG.

3.3.5 NSPS SUBPART OOOOa

40 CFR 60, Subpart OOOOa, *Standards of Performance for Crude Oil and Natural Gas Production Facilities for which Construction, Modification or Reconstruction Commenced After September 18, 2015*, applies to certain equipment within the crude oil and natural gas source category that are constructed, modified, or reconstructed after September 18, 2015. Subpart OOOOa has superceded, in date, the NSPS, Subpart OOOO, which was found to be applicable to certain operations at JCLNG in ACDP 06-0118.

Subpart OOOOa must be examined for applicability. Each affected facility equipment type must be considered. The applicability findings are as follows.

- JCLNG will not include any well affected facilities.
- JCLNG will not include any centrifugal or reciprocating compressor affected facilities. Centrifugal compressors will be used to move BOG through the fuel gas system, but the compressors will have dry seals.
- JCLNG does not meet the definition of natural gas processing plant (gas plant) in Subpart OOOOa. Consequently, pneumatic controllers will not be affected sources. In addition, the process unit equipment associated with the liquefied natural gas unit is exempt from the provisions of §§60.5400a, 60.5401a, 60.5402a, 60.5421a, and 60.5422a because it is not located at an onshore natural gas processing plant site.
- JCLNG will not operate a sweetening unit because the pipeline natural gas being treated in the gas conditioning unit is not sour gas.
- JCLNG will not include any affected source VOC storage tanks. The LNG storage tanks will not contain an accumulation of crude oil, condensate, intermediate hydrocarbon liquids, or produced water, and fugitive VOC emissions will be less than 6 tons per year.
- JCLNG will not include any pneumatic pumps.
- JCLNG does meet the definition of compressor station in Subpart OOOOa. Consequently, JCLNG will not have a fugitive component affected source.

JCLNG will not be subject to any NSPS Subpart OOOOa requirements.

3.4 NATIONAL EMISSIONS STANDARDS FOR HAZARDOUS AIR POLLUTANTS

NESHAPs have been established in 40 CFR Parts 61 and 63 to control the emissions of HAPs. NESHAP regulations establish emission standards or work practices for specific types of equipment located at a HAP major source. A HAP major source is a facility with a potential to emit 10 tpy or more of a single HAP or 25 tpy or more of a combination of HAPs. The JCLNG will not be a Major Source of HAPs. Potential emissions are below the 10 tpy single HAP and 25 tpy total HAPs thresholds. Thus, JCLNG qualifies as an “area source” under the following NESHAP rules.

The following NESHAPs were reviewed for applicability to the proposed project.

3.4.1 40 CFR 63, SUBPART JJJJJJ

The proposed 296.2 MMBtu/hr auxiliary boiler is exempt from 40 CFR 63 Subpart JJJJJJ, *National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers Area Sources,* because it is a gas-fired boiler.

3.4.2 40 CFR 63, SUBPART ZZZZ

Subpart ZZZZ, *National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines* (RICE), applies to all of the proposed diesel-fired engines. However, a new diesel engine meeting the criteria in paragraphs 40 CFR 63.6590 (c)(1) through (7) of Subpart ZZZZ meets the requirements of the subpart by meeting the requirements of 40 CFR 60 Subpart IIII for compression ignition engines. Each of the proposed diesel engines will meet the criteria of 40 CFR 63.6590(c)(1), so no further requirements apply for any of the engines under the NESHAP.

3.5 TITLE V

JCLNG will be a major source of air pollutants because the facility will have the potential to emit over 100 tpy or more of NO_X, CO, and $PM/PM_{10}/PM_{2.5}$. JCEP will be required by OAR 340, Division 218 to obtain a Title V Operating Permit from ODEQ. The complete application to obtain the Oregon Title V Operating Permit must be submitted within 12 months after commencing operation (initial startup).[8]

3.6 CONTINUOUS EMISSIONS MONITORING

JCEP will install CEMS to record the exhaust concentration of NO_X and CO from all five combustion turbines. These CEMS will be used to demonstrate compliance with the NSPS standards and to provide accurate measurement of actual emissions from each turbine for PSEL compliance demonstration on a rolling 12-month basis. Because the turbines are subject to NSPS Subpart KKKK, the CEMS will comply with the performance evaluations for the monitoring systems detailed in 40 CFR 60. Although Subpart KKKK provides alternative provisions for use of Part 75 CEMS methods, JCEP is not subject to Acid Rain requirements and use of the Part 75 alternative methods is not proposed.

JCEP will also install a NO_X CEMS on the auxiliary boiler to meet the monitoring requirements of NSPS Subpart Db. The auxiliary boiler CEMS will also be installed and operated following Part 60 methods.

[8] 340-218-0040(1)(a)(B)

4. CLASS II AMBIENT AIR QUALITY ANALYSIS

This section summarizes the dispersion modeling used to demonstrate compliance with the applicable NAAQS and Class II PSD Increments. A dispersion modeling analysis was conducted to demonstrate compliance with the applicable air quality standards for all criteria pollutants subject to State NSR review. The results of the analysis, summarized below, indicate that the project will be in compliance with all applicable Class II air quality standards.

The modeling analysis summarized herein is based on the approved modeling protocol[9], except for the following clarifications or revisions:

- Clarification - the meteorological data were not processed with the adjust_u* option;
- Clarification - the moisture selection by month was based on data collected at the Southwest Oregon Regional Airport following EPA guidance; and
- Revision - the receptor grid was extended out to 50 km in the north, east, and south directions to capture all potential significant impacts (to the west lies the Pacific Ocean).

A full discussion of the modeling methodology, including model versions, meteorology, land use, receptor grid setup, and downwash analyses, is provided in the approved modeling protocol (the Protocol), attached as Appendix D. Summaries of model inputs are provided in Appendix E. All modeling files used in support of this analysis are provided in Appendix F.

4.1 EQUIPMENT LIST

JCLNG emission units include the following equipment:

- Five (5) combined-cycle natural gas turbines with duct burners;
- One (1) auxiliary boiler;
- Three (3) liquefaction area fire pumps;
- Four (4) emergency generators;
- One (1) thermal oxidizer;
- One (1) multipoint (warm and cold) ground flares; and
- One (1) totally enclosed (marine) ground flare.

LNG carrier emissions are not part of the stationary source, but LNGC emissions and downwash are included in the cumulative source analysis as competing sources.

4.2 SITE LAYOUT

The effect of plume downwash due to airflow around project-related buildings and structures was considered for all stationary point sources.[10] As shown in Figure 4, large buildings and structures near

[9] The modeling protocol was approved, with edits, by ODEQ on July 15, 2017. Email from Phil Allen (ODEQ) to Jason Reed (SLR).

[10] For the totally enclosed (marine) ground flare, downwash effects were considered from other surrounding structures, but not the flare enclosure itself.

the stationary sources were entered in to the current version of the EPA-approved Building Profile Input Program (BPIPPRM Version 04274). BPIPPRM produced direction-specific downwash parameters for direct input into AERMOD and also the Good Engineering Practice (GEP) stack height for each stack. All stacks are below their calculated GEP-stack height.

The facility design also includes the use of vapor dispersion walls along the fenceline of the LNG Terminal for safety purposes. The vapor dispersion walls will range from 20 feet to 80 feet above grade. Although BPIPRM was not designed or tested for a structure with these height-to-width ratios, a sensitivity analysis was conducted to quantify the potential impact of these features on air quality concentrations. Based on the site layout and the height of the vapor dispersion walls, only the fire-water pumps would be affected by the inclusion of the walls in the development of downwash coefficients using BPIPRM. When input into AERMOD, the design-value air quality concentrations for all averaging periods are virtually identical when the vapor dispersion walls are included.

4.3 SOURCE PARAMETERS

All emissions from the combined-cycle turbines, auxiliary boiler, fire pumps, emergency generators, and thermal oxidizer will be released from vertical, unobstructed stacks. One of the three flares, the total enclosed ground flare, is also treated as a vertical stack. The other two flares are warm and cold flare lines in a combined multi-point ground flare, which were modeled as an area source. The source locations and elevations are shown in Table 4-1.

Table 4-1. Source Locations

Source ID	Description	UTM-x (m)(1)	UTM-y (m)(1)	Stack Elevation (m)
Turb1(2), Turb1SU(3)	Combined Cycle Turbine	397644.9	4809333.4	14.0
Turb2(2), Turb2SU(3)	Combined Cycle Turbine	397643.0	4809401.2	14.0
Turb3(2), Turb3SU(3)	Combined Cycle Turbine	397641.2	4809469.0	14.0
Turb4(2), Turb4SU(3)	Combined Cycle Turbine	397639.3	4809536.8	14.0
Turb5(2), Turb5SU(3)	Combined Cycle Turbine	397637.5	4809604.6	14.0
ThermOx	Thermal Oxidizer	397465.0	4809694.7	14.0
AuxBoil	Auxiliary Boiler	397385.3	4809623.5	14.0
FP1	Fire Pump	397823.0	4809674.7	15.8
FP2	Fire Pump	397830.3	4809674.9	15.8
FP3	Fire Pump	397835.5	4809675.1	15.8
Gen1	Backup Generator	399631.0	4809864.4	19.8
Gen2	Backup Generator	399627.0	4809864.2	19.8
BSGen1	Black Start Generator	397297.1	4809620.9	14.0

Source ID	Description	UTM-x (m)[1]	UTM-y (m)[1]	Stack Elevation (m)
BSGen2	Black Start Generator	397289.4	4809620.7	14.0
MFlare	Marine Flare	397361.3	4809303.0	14.0
GFlare	Ground Flare	397253.6	4809794.1	14.0

(1) UTM zone 10, NAD 83 horizontal datum.
(2) These turbine sources are for normal operation (i.e., no startups or shutdowns) for the entire operating period.
(3) These turbine sources indicate a scenario where startup and shutdown emissions are included from the source. For the 1, 3, 8, and 24-hour averaging periods, either one startup or one shutdown is included in the period, depending on which of the events produced the worst emissions for each pollutant. For the annual averaging periods, these sources include 12 startups and 12 shutdowns per year.

The source release parameters are listed in Table 4-2 for the point sources and Table 4-3 for the multi-point ground flare.

Table 4-2. Stack Parameters for JCLNG Point Sources[1]

Source ID	Description	Release Height (ft)	Exit Temperature (°F)	Exit velocity (ft/s)	Stack Diameter (ft)
Turb1, Turb1SU	Combined Cycle Turbine	119.1	242.8	71.0	10.0
Turb2, Turb2SU	Combined Cycle Turbine	119.1	242.8	71.0	10.0
Turb3, Turb3SU	Combined Cycle Turbine	119.1	242.8	71.0	10.0
Turb4, Turb4SU	Combined Cycle Turbine	119.1	242.8	71.0	10.0
Turb5, Turb5SU	Combined Cycle Turbine	119.1	242.8	71.0	10.0
ThermOx	Thermal Oxidizer	131.2	1600.0	41.7	9.5
AuxBoil	Auxiliary Boiler	100.0	330.0	48.7	6.0
FP1	Fire Pump	18.0	948.3	193.0	0.7
FP2	Fire Pump	18.0	948.3	193.0	0.7
FP3	Fire Pump	18.0	948.3	193.0	0.7
Gen1	Backup Generator	13.1	952.5	287.0	0.7
Gen2	Backup Generator	13.1	952.5	287.0	0.7
BSGen1	Black Start Generator	18.0	873.6	177.0	1.7

Source ID	Description	Release Height (ft)	Exit Temperature (°F)	Exit velocity (ft/s)	Stack Diameter (ft)
BSGen2	Black Start Generator	18.0	873.6	177.0	1.7
MFlare	Marine Flare	100.1	1831.7	29.7	45.0

(1) The stack parameters were input into the model using the metric units. English units are shown here for ease of comparison with the supplied vendor data in Appendix A.

Table 4-3. Parameters for JCLNG Area Source(1)

Source ID	Description	Release Height (ft)	East-West Dimension (ft)	North-South Dimension (ft)	Initital Vertical Dimension of Plume(ft)
GFlare	MPGF	85.0	259	227	39.5

(1) The parameters were input into the model using the metric units. English units are shown here for ease of comparison with the supplied vendor data in Appendix A.

4.4 OPERATING SCENARIOS

The potential operating scenarios for the turbines include normal operation and startup and shutdown (SU/SD). The support equipment is held constant for both turbine scenarios. The scenarios will include the following:

- Normal operation – where the turbine operates in normal mode for the entire period (short-term).
- SU/SD mode – where the turbine undergoes a startup or shutdown for a portion of the period (i.e., 9-10 minutes) and operates in normal mode for the remainder of the period (short-term).

The annual emissions scenario includes the total emissions from the expected number of startups and shutdowns plus normal operation for the remainder of the year.

4.5 BACKGROUND CONCENTRATIONS

The use of ambient background concentrations is an important aspect to air quality analyses as they represent the effects from existing sources, which directly influences the attainment status with respect to ambient standards. For the NAAQS analysis, background concentrations represent non-modeled sources and are added to the modeled impacts of the proposed project and any nearby industrial sources to assess the potential cumulative impacts.

Ambient background concentrations for this project were obtained from the Northwest AIRQUEST database hosted by Washington State University. Northwest AIRQUEST maintains a database of criteria pollutant design values based on monitoring data and archived CMAQ modeling runs for the 2009-2011 period. The database of design values exists for 12 km by 12 km grid cells covering the states of Idaho, Oregon, and Washington. For the modeling demonstration, the values were obtained from the grid cell representative of the proposed facility location (latitude 43.434°, longitude -124.524°).

Background concentrations can also be used to assess the available headroom between existing conditions and the ambient standards in order to justify the use the SILs.[11] If that headroom is less than the SIL, then project contributions less than the SIL may not be sufficient to demonstrate that the standards will be protected. A list of background concentrations, NAAQS, the difference between the background and NAAQS (i.e. "headroom"), and SILs are shown in Table 4-4. In all cases, the difference between the NAAQS and background concentration is at least 10 times the level of the SIL. This table demonstrates that the difference between the background concentrations and NAAQS is adequate to demonstrate that use of the SIL will not threaten compliance with the NAAQS in the project area.

Table 4-4. Analysis of Headroom Between NAAQS and Background Air Quality (µg/m^3)

Pollutant/ Averaging Period	Background Concentration	NAAQS	Difference	SIL
NO_2 1-hr	16	188	172	8
NO_2 Annual	1.9	100	98.1	1
CO 1-hr	755	40,000	39,245	2,000
CO 8-hr	591	10,000	9,409	500
$PM_{2.5}$ 24-hr	9.9	35	25.1	1.2
$PM_{2.5}$ Annual	6.7	12	5.3	0.3
PM_{10} 24-hr	35.0	150	115.0	1.0
PM_{10} Annual	N/A(1)	N/A(1)	N/A(1)	0.2(1)
SO_2 1-hr	3.1	196	192.9	8
SO_2 3-hr	2.9	1,300	1,297.1	25
SO_2 24-hr	2.9	260	259.1	5
SO_2 Annual	1.1	52	50.9	1

(1) There is no current Oregon standard or NAAQS for PM_{10} at the annual averaging period; however, there is still a SIL per OAR 340-200-0010(163).

4.6 SIGNIFICANCE ANALYSIS

Using the source inputs summarized in previous sections and inputs and methodology described in the approved modeling protocol (Appendix D), the maximum project impacts from either operating scenario are shown in Table 4-5 and maximum concentration contour plots are provided in Figures 5 through 16. Table 4-5 also lists SILs and monitoring *de minimis* levels for comparison to the project modeled concentrations.

The maximum predicted 1-hr CO concentration and the maximum predicted 8-hr CO concentration both occur on the western facility fenceline. As shown in Figures 5 and 6 and Table 4-5 below, predicted concentrations of CO do not exceed the SIL for either the 1-hr averaging period or the 8-hr averaging period. Therefore, no further analysis is required of CO for either averaging period.

For the SIL analysis, the NO to NO_2 conversion ratio has been conservatively assumed to be 100 percent. The maximum predicted 1-hr NO_2 concentration is located on the western facility fenceline, while the

11 OAR 340-225-0050(1)(b)(A)

maximum predicted annual NO_2 concentration is located on the South Dunes fenceline. As shown in Figures 7 and 8 and Table 4-5 below, predicted concentrations of NO_2 exceed the SIL for the 1-hr averaging period and the annual averaging period. Therefore, full impact analysis for NO_2 is required for the 1-hr averaging period and annual averaging period.

The maximum predicted 1-hr SO_2 concentration is located in hilly terrain approximately 8 km south of the facility. The maximum predicted 3-hr SO_2 concentration is located on the southern facility fenceline. The maximum predicted 24-hr concentration is located about 1 km northwest of the facility. The maximum predicted annual concentration is located on the western facility fenceline. As shown in Figures 9 to 12 and Table 4-5 below, predicted concentrations of SO_2 exceed the SIL for the 1-hr averaging period but do not exceed the SIL for the 3-hr, 24-hr, and annual averaging periods. Therefore full impact analysis for SO_2 is required for the 1-hr averaging period, but no further analysis is required for the 3-hr, 24-hr, and annual averaging periods.

The maximum predicted concentrations for $PM_{2.5}$ and PM_{10} for the 24-hr averaging period occurs just west of the facility. The maximum predicted concentrations for $PM_{2.5}$ and PM_{10} for the annual averaging period occur on the western facility fenceline. As shown in Figures 13 to 16 and Table 4-5 below, for both species of particulate matter and both the 24-hr and annual averaging periods, the predicted concentrations of particulate matter exceed the SILs. Therefore, full impact analysis of both $PM_{2.5}$ and PM_{10} for the 24-hr and annual averaging periods will be required. [12]

Table 4-5. Significance Analysis Results

Pollutant	Averaging Period	Maximum Modeled Concentration (μg/m^3)	SIL (μg/m^3)
NO_2(1)	Annual	3.4	1
	1-hr	50.5	8
$PM_{2.5}$	Annual	1.1	0.3
	24-hr	8.1	1.2
PM_{10}	Annual	1.1	0.2
	24-hr	8.1	1
SO_2	Annual	0.3	1
	24-hr	2.5	5
	3-hr	5.7	25
	1-hr	11.5	8
CO	8-hr	16.2	500
	1-hr	108.0	2,000

(1) Assumes 100% NO_X to NO_2 conversion.

[12] It is noted that there are currently no state or federal ambient air quality standards for annual PM_{10}; however, an annual Class II increment is still present.

4.7 FULL IMPACT ANALYSIS

The proposed project emissions are shown to have maximum ambient concentrations that exceed the SILs for PM_{10} at the 24-hr and annual averaging periods, $PM_{2.5}$ at the 24-hr and annual averaging periods, SO_2 at the 1-hr averaging period, and NO_2 at the 1-hr and annual averaging periods. Therefore, a Full Impact Analysis is conducted for these seven combinations of pollutants and averaging periods. The same project emission and operating scenarios from the significance analysis are combined with LNG carrier emissions and nearby, competing sources that were provided by ODEQ. Only receptors where the predicted concentration, for each pollutant and averaging time, was greater than the SIL are considered in the Full Impact Analysis.[13]

4.7.1 COMPETING SOURCES

ODEQ provided a list of competing sources on August 5, 2017 for NO_2, $PM_{2.5}$, PM_{10}, and SO_2.[14] All provided sources are included in the full impact analysis as provided by ODEQ. A list of those sources and emission rates are included in Appendix E. The information provided by ODEQ includes the actual emissions for calendar year 2016, as well as the allowable, potential to emit for each source. The allowable, potential to emit values are used in the competing source analysis. Tons per year emission rates provided by ODEQ were converted to grams per second rates for input into AERMOD[15], and stack parameters provided in English units were converted to metric units before AERMOD input.

The fleet of LNG vessels expected to call at the JCEP terminal consists of both vessels that have boiler/steam turbine-driven (ST) propulsion systems, as well as vessels powered by duel-fuel diesel-electric (DFDE) propulsion. Further, each type of vessel may be operated on either natural gas or fuel oil. For the DFDE ships, however, operation on oil versus operation on natural gas was confined to different activities during the ship's call. Therefore, three vessel emissions scenarios were created in order to determine worst-case air emissions calculations and associated air quality impacts:

- ST carriers operating on oil;
- ST carriers operating on natural gas; and
- DFDE carriers.

JCEP expects up to 120 LNG vessel calls per year. For the purposes of the modeling, in each of the three scenarios, it is assumed that all of the 120 vessel calls will be of ships of the same propulsion and fuel type.

The LNG vessel call activities can be divided into several scenarios and operating periods per visit. These activity times are not dependent on the ship or fuel type. Emission rates for different activities during the carrier's call were developed from the emission factors shown in Appendix G and the amount of power expected to be consumed during that particular activity. As the emission factors are in a g/kW-hr basis, and the power will vary depending on activity, the emission rates (on a mass per unit time basis) will vary depending on the activity in which the ship is engaged.

[13] OAR 340-225-0050(1)(a) and (b).
[14] Further discussions between ODEQ and SLR on August 30, 2017 about larger significant impact areas confirmed no additional offsite sources needed to be included.
[15] Assuming 8,760 hours of operation.

If a ship is engaged in a particular activity for the full averaging period, than the full mass per unit time rate was used for modeling of that activity. If a ship is engaged for the activity for a portion of the averaging period, then the mass per unit time emission factor was weighted by the proportion of the activity time to the time of the averaging period. For example, for an activity that takes four hours, the full mass per unit time emission rate calculated was used for 1-hour averaging periods (as the activity time is longer than that averaging period), but one-sixth of the full mass per unit time emission rate was used for 24-hour averaging periods (as the four hours of activity time is one-sixth of the averaging period).

In addition to the activities at, and in, the immediate vicinity of the terminal, the emissions of the carrier's transit of the channel and near-shore open water were considered by setting up 68 surrogate sources[16] along the geographic track of arriving and departing ships. The transit emission rates were used for these surrogate sources, with the emissions divided equally over the 68 surrogate sources.

In addition to the 120 LNG vessels, three tugboats will also be deployed in operation at the JCEP LNG Terminal. The worst-case scenario resulting in the highest emissions involves use of one tugboat while the carrier is berthed. Because the tugboat will be maneuvering around the ship during the worst case scenario, the tugboat is represented as a series of four surrogate sources in the channel adjacent to the ship dock, with one-quarter of the total tugboat emissions assigned to each surrogate source. The tugboat emissions, location of surrogate sources, and stack parameters are shown in Appendix G. The effects of plume downwash were also considered for the marine carriers and support vessels in the multisource modeling.

4.7.2 NO_2 FORMATION

The modeling analysis used the first two tiers in the approach described in the latest EPA guidance:

1. The first Tier will assume a full, 100% conversion of NO_X to NO_2.
2. If needed, the second tier will utilize the ambient ratio method (ARM2) method implemented and documented per EPA guidance.
3. If needed, the third tier will utilize the Ozone Limiting Method (OLM) or Plume Volume Molar Ratio Method (PVMRM) implemented and documented per EPA guidance.

The significant impact analysis utilized the first tier and the NAAQS and increment analysis utilized the second tier, ARM2.

4.7.3 OZONE AND $PM_{2.5}$ SECONDARY FORMATION

The draft EPA guidance on addressing secondary formation of $PM_{2.5}$ and ozone was used to develop a project-specific evaluation of the potential impacts from project VOC, SO_2, and NO_X emissions.[17,18] The

[16] The surrogate sources are the discrete locations where the carrier emissions are modeled to represent the movement of the ship along the channel.

[17] Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program, December 2016.

project emissions were compared to the information provided in the EPA guidance for Modeled Emission Rates for Precursors (MERPs). This EPA guidance is based on a suite of photochemical modeling runs across the continental U.S. designed to assess secondary ozone and $PM_{2.5}$ formation from various, hypothetical sources. These runs were used to establish modeled responses to precursor emissions, which can be used to determine:

- Emission thresholds below which insignificant secondary formation is expected to occur
- Secondarily-formed downwind concentrations of ammonium sulfate, ammonium nitrate, or ozone from emitted precursors.

The first step of the guidance is to compare Project emissions to the emission thresholds. Since the Project emits more than one precursor pollutant, an additional calculation is needed to account for the combined effect of the precursors. This is accomplished by adding ratios (project emissions divided by an emission threshold) for each precursor together. If the combined ratios of the precursors are greater than one, then significant secondary formation is possible and needs to be quantified.

The second use of the guidance allows for quantification of the secondary formation. Because the EPA modeling was for a limited number of sources, several inputs were varied by EPA to obtain more robust model responses. The inputs that were varied include stack height and parameters, precursor emission levels, and inherently based on the source's location, regional emissions, and geophysical characteristics (i.e., climate, terrain, proximity to other large sources or cities). For the pollutants in which the quantification of secondary effects is required, Appendix A of the EPA guidance was reviewed to find a source-impact relationship that is representative of the Project. Representativeness was determined by stack parameters, emission levels, local/regional emissions, and geophysical environment.

Table 4-6 compares the lowest (most conservative) ozone emission threshold values for NO_X and VOCs in the Western U.S to Project emissions. Because both NO_X and VOC are emitted, the combined effect is accounted for, as shown in Table 4-6. Following the draft EPA guidance, since the sum of the combined ratios (project emissions/emission threshold value) for each precursor is less than a value of 1, significant ozone concentrations will not be generated from the Project.

Table 4-6. Summary of MERPs Analysis for Ozone

Precursor	Project Emissions (tpy)	8-hr O3 MERP (tpy)[(1)]	Ratio of Project Emissions to Daily Ozone MERP	Sum of Ratios
NO_X	155.0	184	0.84	0.91
VOC	72.5	1,049	0.07	

(1) These are the most conservative (lowest) MERP values for ozone in the Western U.S. as summarized in the February 23, 2017 memorandum.

[18]Distribution of the EPA's modeling data used to develop illustrative examples in the draft Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program, February, 2017.

A similar analysis for daily and annual $PM_{2.5}$ is shown in Tables 4-7 and 4-8, respectively. The approach for secondary $PM_{2.5}$ formation from NO_X and SO_2 emissions is the same as ozone, but $PM_{2.5}$ also needs to include direct $PM_{2.5}$ impacts as modeled in AERMOD.[19] As shown in Tables 4-7 and 4-8, insignificant secondary formation is expected to occur for both daily and annual $PM_{2.5}$. However, because Project direct $PM_{2.5}$ impacts (i.e., modeled in AERMOD) are above the significant impact level (see Table 4-5), then the reported $PM_{2.5}$ will include the expected secondary formation using representative modeled responses in Appendix A of the EPA guidance as discussed further below.

While the lowest (most conservative) emission thresholds are useful for screening project emissions, they are not necessarily representative of potential secondary formation due to project emissions. For instance, the sources with the lowest (most conservative) SO_2 and NO_X emission thresholds are in interior California, which is not representative of the climatology or source environment of the proposed project. Furthermore, both of these sources were modeled with 'low' source heights (release height of 1 m), which is not representative of Project sources.

The summarized modeling results for 24-hour average concentrations of secondary formation for precursor SO_2 and NO_X in Appendix A of the MERP guidance was further reviewed. The data were sorted to only include:

- Sources located in Oregon or Washington (considered to be more representative of climate at the Project site);
- Precursor emissions of 500 tpy (similar in magnitude to Project emissions, yet conservative); and
- And 'high' stack heights (similar to Project sources).

The results of this analysis are summarized in Table 4-9. Taking the two highest modeled responses, 0.15 $\mu g/m^3$ and 0.24 $\mu g/m^3$ for NO_X and SO_2, respectively, the combined potential secondary formation from Project emissions is 0.39 $\mu g/m^3$. This concentration is added to the modeled result for direct $PM_{2.5}$ on a 24-hour basis to represent the additional concentration from $PM_{2.5}$ formation. For conservatism, this 24-hour secondary formation will also be added to annual $PM_{2.5}$ impacts.

Table 4-7. Summary of MERPs Analysis for Daily $PM_{2.5}$

Precursor	Project Emissions (tpy)	Daily $PM_{2.5}$ MERP (tpy)(1)	Ratio of Project Emissions to Daily $PM_{2.5}$ MERP	Sum of Ratios
Direct $PM_{2.5}$	AERMOD results > SIL			0.34
NO_X	155.0	1,075	0.14	
SO_2	40.2	210	0.19	

(1) These are the most conservative (lowest) MERP values for ozone in the Western U.S. as summarized in the February 23, 2017 memorandum.

[19] Total $PM_{2.5}$ is the sum of direct $PM_{2.5}$ plus secondary $PM_{2.5}$. Direct $PM_{2.5}$ emissions and downwind impacts are modeled in AERMOD. The secondary formation of Project NO_X and SO_2 emissions into $PM_{2.5}$ is crux of the MERPs guidance.

Table 4-8. Summary of MERPs Analysis for Annual $PM_{2.5}$

Precursor	Project Emissions (tpy)	Annual $PM_{2.5}$ MERP (tpy)(1)	Ratio of Project Emissions to Annual $PM_{2.5}$ MERP	Sum of Ratios
Direct $PM_{2.5}$	AERMOD results > SIL			0.07
NO_X	155.0	2,289	0.05	
SO_2	40.2	3,184	0.02	

(1) These are the most conservative (lowest) MERP values for ozone in the Western U.S. as summarized in the February 23, 2017 memorandum.

Table 4-9. Summary of Modeled Responses for Representative Sources

Precursor	Area	Emissions (tpy)	Height	Source	FIPs	State	County	Modeled Response (μg/m^3)
NO_X	**WUS**	**500**	**H**	**18**	**41049**	**Oregon**	**Morrow**	**0.15**
NO_X	WUS	500	H	22	53057	Washington	Skagit	0.05
NO_X	WUS	500	H	23	53039	Washington	Klickitat	0.03
SO_2	**WUS**	**500**	**H**	**23**	**53039**	**Washington**	**Klickitat**	**0.24**
SO_2	WUS	500	H	18	41049	Oregon	Morrow	0.19
SO_2	WUS	500	H	22	53057	Washington	Skagit	0.08

4.7.4 NAAQS ANALYSIS

The NAAQS analysis takes into consideration a representative background concentration in addition to emissions from competing sources and the proposed project to determine compliance. Results of the NAAQS analysis for the seven pollutants and averaging periods that were above their respective SILs are shown in Figures 17 through 22 and Table 4-10 below. As shown, the total predicted concentration from the proposed and competing sources plus background concentration is below the NAAQS for all pollutants and averaging periods.

Table 4-10. NAAQS Analysis Results

Pollutant	Averaging Period	Modeled Concentration(1) (μg/m^3)	Secondary Formation (μg/m^3)	Background (μg/m^3)	Total Impact (μg/m^3)	NAAQS (μg/m^3)
NO_2(2)	1-hour	132.3	--	16.0	148.3	188.0
	Annual	4.1	--	1.9	6.0	100.0
PM_{10}(3)	24-hour	9.3	--	35.0	44.3	150.0
	Annual	1.4	--	n/a	1.4	n/a
$PM_{2.5}$(4)	24-hour	6.9	0.4	9.9	17.2	35.0
	Annual	1.3	0.4	6.7	8.4	12.0
SO_2	1-hour	30.1	--	3.1	33.2	196.0

(1) Modeled concentrations are as follows. These are in some cases conservative as compared to the NAAQS, as several NAAQS standards allow use of three-year average values, while the presented results are based on results from the single worst year.
   a. The modeled 1-hour NO_2 concentration is the highest result for the 98th percentile of 1-hour daily maximum concentrations for any of the five given years.
   b. The modeled annual NO_2 is the maximum concentration at any receptor.
   c. The modeled 24-hour PM_{10} concentration is the highest second high result for any of the five given years.
   d. The modeled 24-hour $PM_{2.5}$ concentration is the highest result for the 98th percentile of 1-hour daily maximum concentrations for any of the five given years.
   e. The modeled annual $PM_{2.5}$ concentration is the maximum concentration at any receptor.
   f. The modeled 1-hour SO_2 concentration is the the highest result for the 99th percentile of 1-hour daily maximum concentrations for any of the five given years.

(2) The reported NO_2 modeled concentration is based on the ARM2 method in AERMOD.
(3) PM_{10} has a Class II SIL defined in OAR 340, but no associated NAAQS.
(4) As described in Section 4.7.3.

4.7.5 CLASS II PSD INCREMENT ANALYSIS

Results of the Class II PSD Increment analysis for NO_2, PM_{10}, and $PM_{2.5}$ are provided in Figures 23 through 27 and Table 4-11 below. The 1-hr NO_2 and SO_2 pollutants/averaging periods do not have an applicable increment, so an increment analysis was not performed for those pollutants. As shown, the total predicted concentration is below the Class II PSD Increment standard for all pollutants and both averaging periods.

Table 4-11. Class II PSD Increment Results (µg/m^3)

Pollutant	Averaging Period	Modeled Concentration(1) (µg/m^3)	Secondary Formation (µg/m^3)	Total Impact (µg/m^3)	Class II Increment (µg/m^3)
NO_2	Annual	4.1	--	4.1	25.0
PM_{10}	24-hour	9.3	--	9.3	30.0
	Annual	1.4	--	1.4	17.0
$PM_{2.5}$(2)	24-hour	7.9	0.4	8.3	9.0
	Annual	1.3	0.4	1.7	4.0

(1) Maximum second highest 24-hour concentration in the modeled year. Maximum annual average concentration.
(2) As described in Section 4.7.3.

5. CLASS I AMBIENT AIR QUALITY ANALYSIS

In addition to the Class II air quality analysis discussed in Section 4 above, a Class I screening air quality and regional haze analysis was also performed for relevant areas within 200 km of the project site. There are five federal Class I areas within that radius, managed by either the National Park Service or the Forest Service. The modeling analysis summarized herein is based on the approved modeling protocol and the project inputs detailed in Section 4.

5.1 CLASS I PSD SIGNIFICANCE ANALYSIS

An assessment of project impacts in comparison to the Class I significant impact level for the Class I PSD increments was run using with the same model and inputs as described in Section 4. If results for all years at these 50 km receptors for a particular Class I area were below the SIL for a particular pollutant and averaging period, then it was presumed the concentrations would be below the SIL for that pollutant and averaging period at the more distant Class I area (110 km to 178 km) as well, and no further analysis was conducted in these cases.

Receptors were placed at a distance of 50 km from the project (the farthest distance for which AERMOD is approved) in arcs that were located to capture plume impacts in the direction of each Class I area. The elevations of the receptors were based on the actual elevation of each receptor location as determined by AERMAP and standard NED data. Receptors were also placed at the potential plume height to ensure the maximum potential impacts were captured. Results from the screening modeling are compared to the Class I SILs defined in the OAR, which are listed in Table 5-1, below. For Project impacts that are above the Class I SILs, a screening analysis was conducted to determine the impacts on the Class I areas within 200 km of the proposed facility.

Further analysis was conducted if results at 50 km associated with a particular pollutant, averaging period, and Class I area were above the SIL. In these cases, the concentrations from each year and receptor were averaged over the five years, and the receptor on the 50 km ring with the highest five-year average concentration was chosen. A receptor was then placed at the 1 km distance along the ray ranging from the center of the proposed facility to the 50 km receptor with the highest average concentration. AERMOD was run at this 1 km receptor for each of the five years, and the average of the five years was taken. As such, five-year averages at both 1 km and 50 km were obtained. Use of the five-year average at 50 km was chosen based on an assumption that steady-state, deterministic results at that distance are conservative, particularly for longer time periods. The use of the five-year average at 1 km, rather than the single highest value obtained from any year, was a conservative choice so as not to allow a particularly high value to create a sharp and rapid decay function and corresponding lower result at the farther Class 1 areas.

An exponential decay function was then calculated to fit the results at 1 km and 50 km. The exponential decay function was used as the concentrations will decrease faster than they would under a linear relationship as distance increases from the facility, and the concentrations cannot go below zero (a limit for development of a mathematical extrapolation of concentration versus distance). The faster-than-linear decrease occurs because rather than existing in one dimension, air may move in three different dimensions as distance increases from the facility. In addition, sinks such as deposition would reduce the ambient air concentrations of the pollutant as well. The rate of decay depends on the relative difference between the 1 and 50 km values; higher values at 1 km and lower values at 50 km produce a more rapid rate of decay. Hence the use of the average value rather than the highest value at 1 km is conservative because it lowers the rate of modeled decay, resulting in a higher pollutant concentration at the Class I area distances (110 to 178 km away).

Curve parameters were determined for each pollutant, averaging period, and Class I area for which there was a modeled result at 50 km measured above the SIL, and the parameters were used to determine a concentration at the distance to the boundary of the Class I areas. It is shown that for all cases, the concentrations obtained through the curve fitting and extrapolation analysis are below the Class I SILs at the distance to the Class I areas. Class I analysis results for each area are summarized in Appendix H. Table 5-1 shows the results of the highest concentrations from all Class I areas. The results demonstrate the LNG Terminal emissions will below the Class I SILs and the project is not expected to contribute to Increment or NAAQS impacts in those locations.

Table 5-1. Class I Results and Significant Impact Levels (μg/m^3)

Pollutant	Averaging Period	Maximum Concentration at 50 km	Maximum Concentration at Class I Area Boundary	Class I SILs[(1)]
SO_2	3-hr	1.33	0.24	1.0
	24-hr	0.35	0.023	0.2
	Annual	0.012	N/A	0.1
NO_2	Annual	0.032	N/A	0.1
PM_{10}	24-hr	0.854	0.061	0.3
	Annual	0.026	N/A	0.2
$PM_{2.5}$	24-hr	0.854	0.061	0.07
	Annual	0.026	N/A	0.06

(1) OAR 340-200-0020(163). All SILs are based on the first highest concentration at any one location.

5.2 CLASS I AQRV ANALYSIS

An air quality related values (AQRV) analysis is not required for a Type B State NSR project but is part of other regulatory requirements for the Project.[20] Therefore, for consistency and informational purposes, a Q/D calculation for regional haze and deposition was used to screen for AQRVs.[21] The screening analysis was based on distance from the source to the Class I area and the annualized daily emissions of AQRV-impacting pollutants. If the Q/D analysis results are less than or equal to the screening factor of 10, then FLM agencies do not require any further Class I AQRV impact analyses from those sources.

[20] The 2017 FERC guidance recommends Class I analyses for those projects within 100 km of a Class I area, subject to PSD permitting requirements, or for projects in which comments are expected.

[21] U.S. Forest Service – Air Quality Program, National Park Service – Air Resources Division, U.S. Fish and Wildlife Service – Air Quality Branch, *Phase I Report of the Federal Land Managers' Air Quality Related Values Workgroup (FLAG)- Revised*, Section 3.2. October 2010.

A detailed calculation of the Q value along with the resultant Q/D values (all less than 10) is provided in Appendix H. Also provided are concurrences from the National Park Service and US Forest Service that no additional AQRV analyses are warranted.

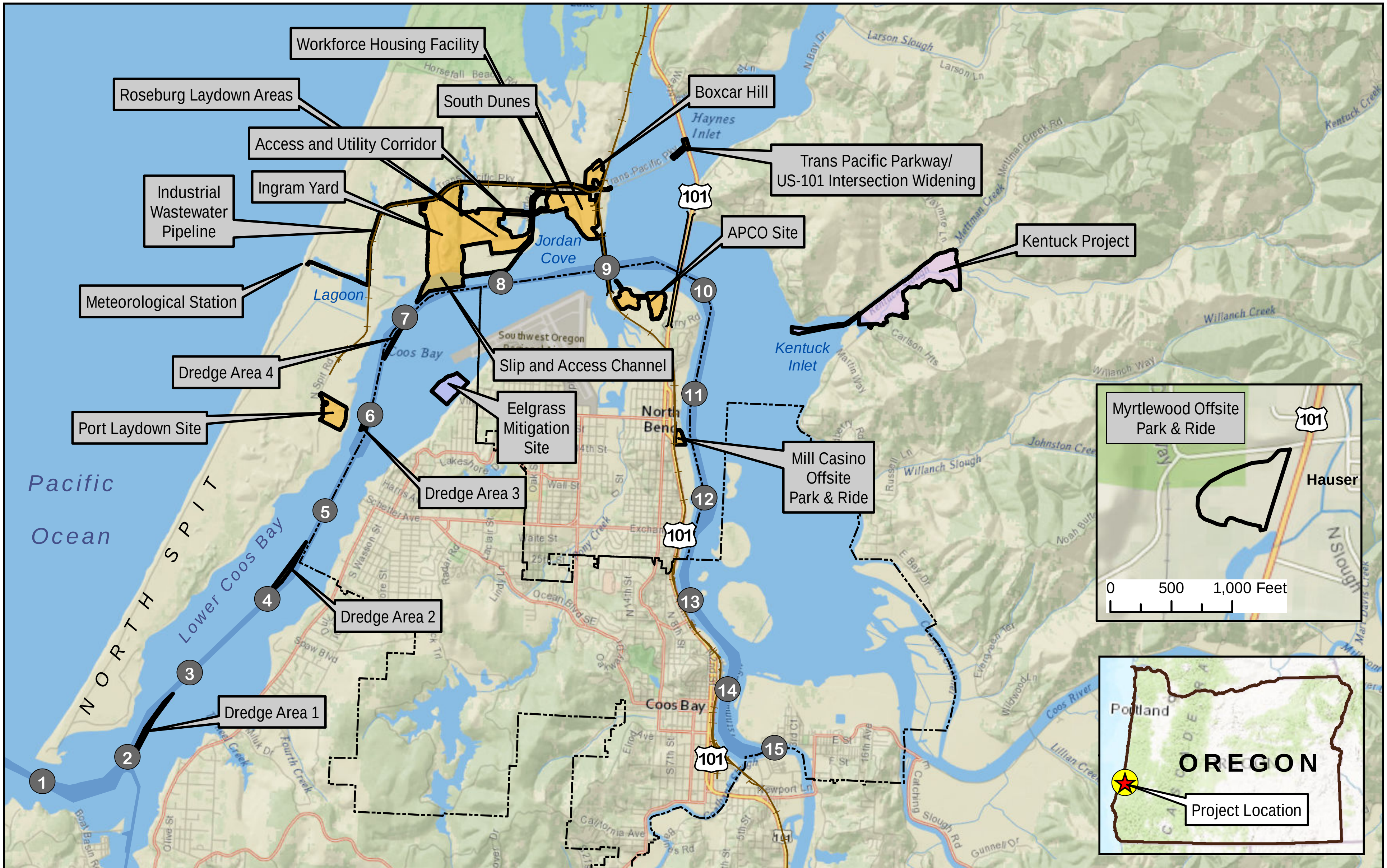
6. REFERENCES

Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and $PM_{2.5}$ under the PSD Permitting Program, December 2016.

US Environmental Protection Agency, AP-42, Fifth Edition *Compilation of Air Pollutant Emission Factors, Volume I, Stationary Point and Area Sources,* January 1995 (with updates to chapters).

U.S. Forest Service – Air Quality Program, National Park Service – Air Resources Division, U.S. Fish and Wildlife Service – Air Quality Branch*, Phase I Report of the Federal Land Managers' Air Quality Related Values Workgroup (FLAG)- Revised*, Section 3.2. October 2010.

FIGURES



Jordan Cove Energy Project, L.P.

N

0 1 Mile

JCEP Project Area

Mitigation Site

Federal Navigation Channel

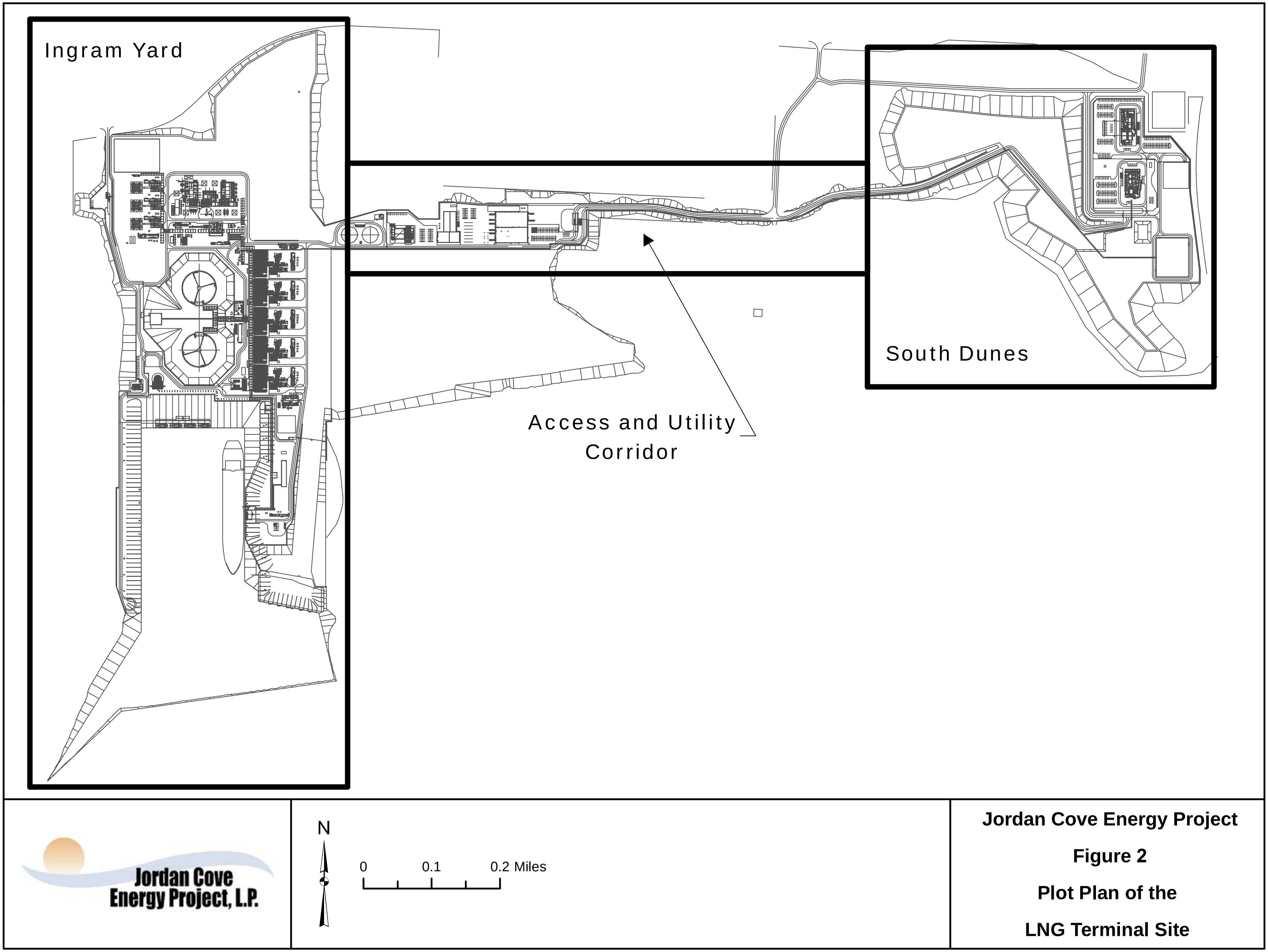
River Mile

City Limits

Jordan Cove Energy Project

Figure 1

Project Location Map



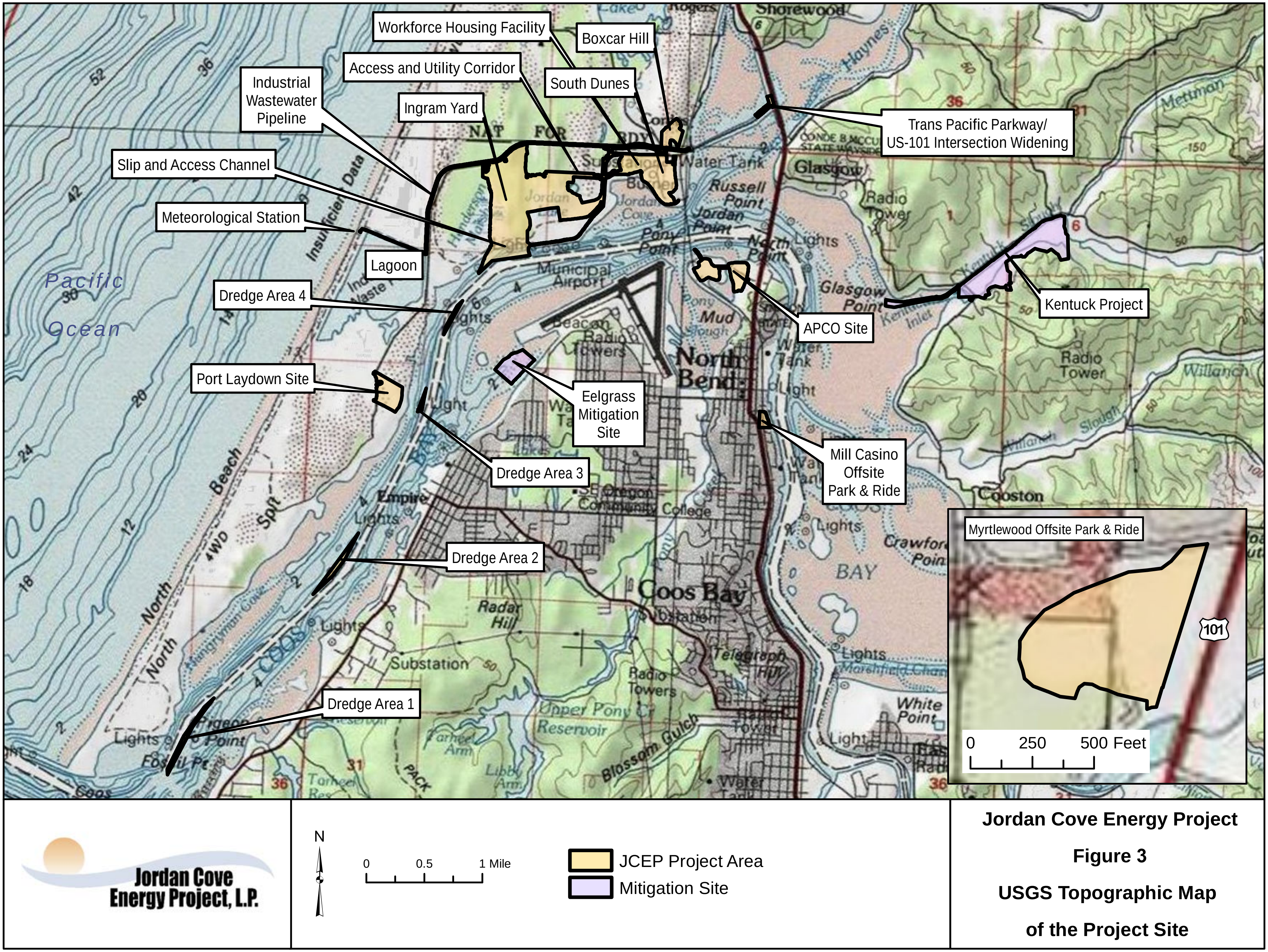
Jordan Cove Energy Project, L.P.

Jordan Cove Energy Project

Figure 2

Plot Plan of the

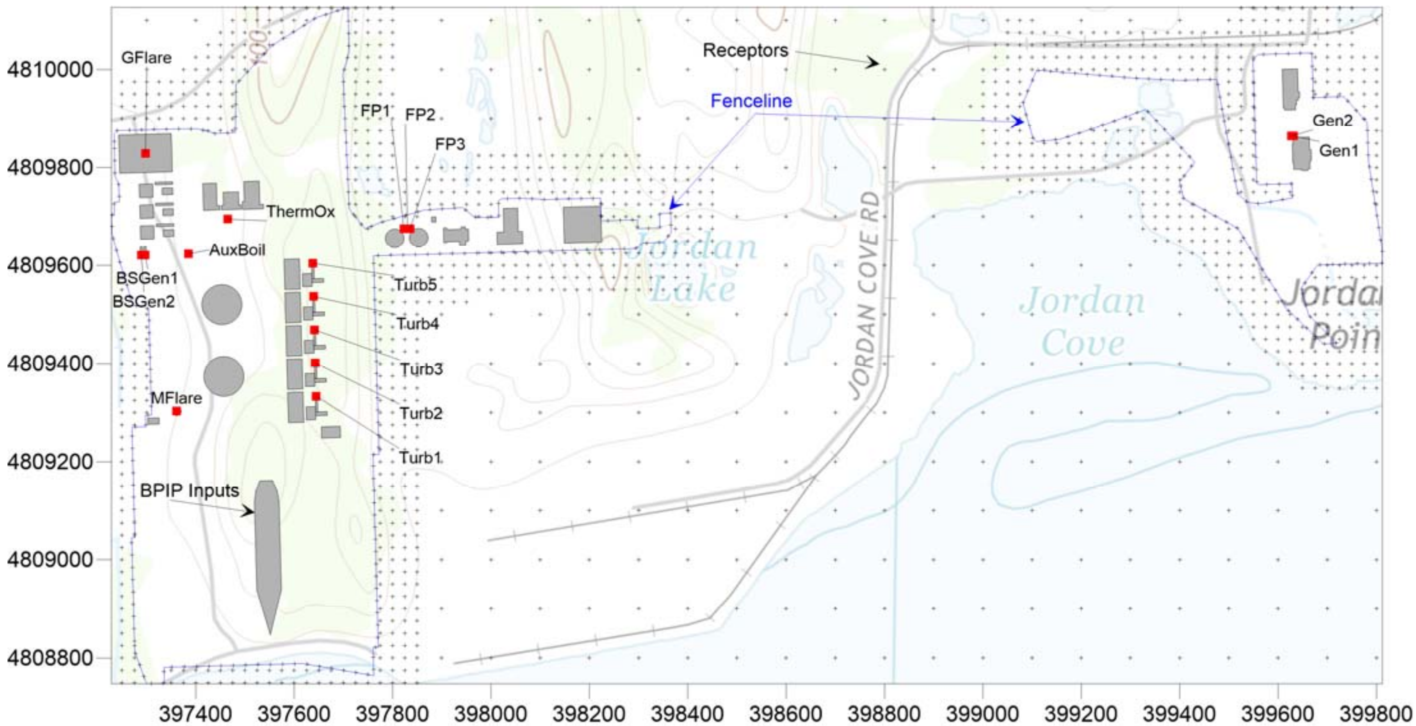
LNG Terminal Site



Jordan Cove Energy Project

Figure 3

USGS Topographic Map of the Project Site



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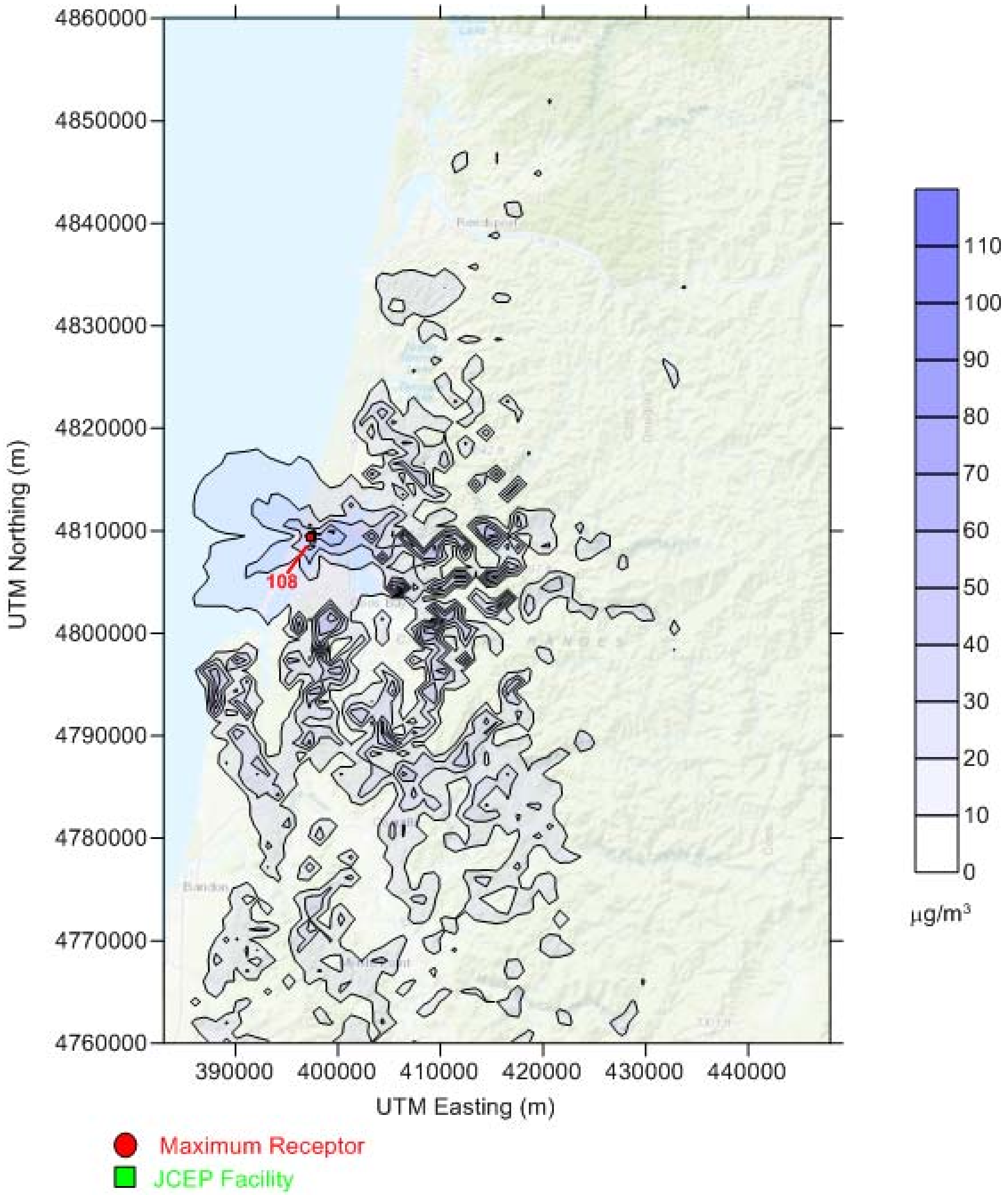
Drawing MODELED SITE LAYOUT		
Date	September 2017	Fig. No. **4**
Project No.	108.01593.00001	



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Drawing CO 1-HOUR SIGNIFICANCE ANALYSIS		
Date	September 2017	Fig. No. **5**
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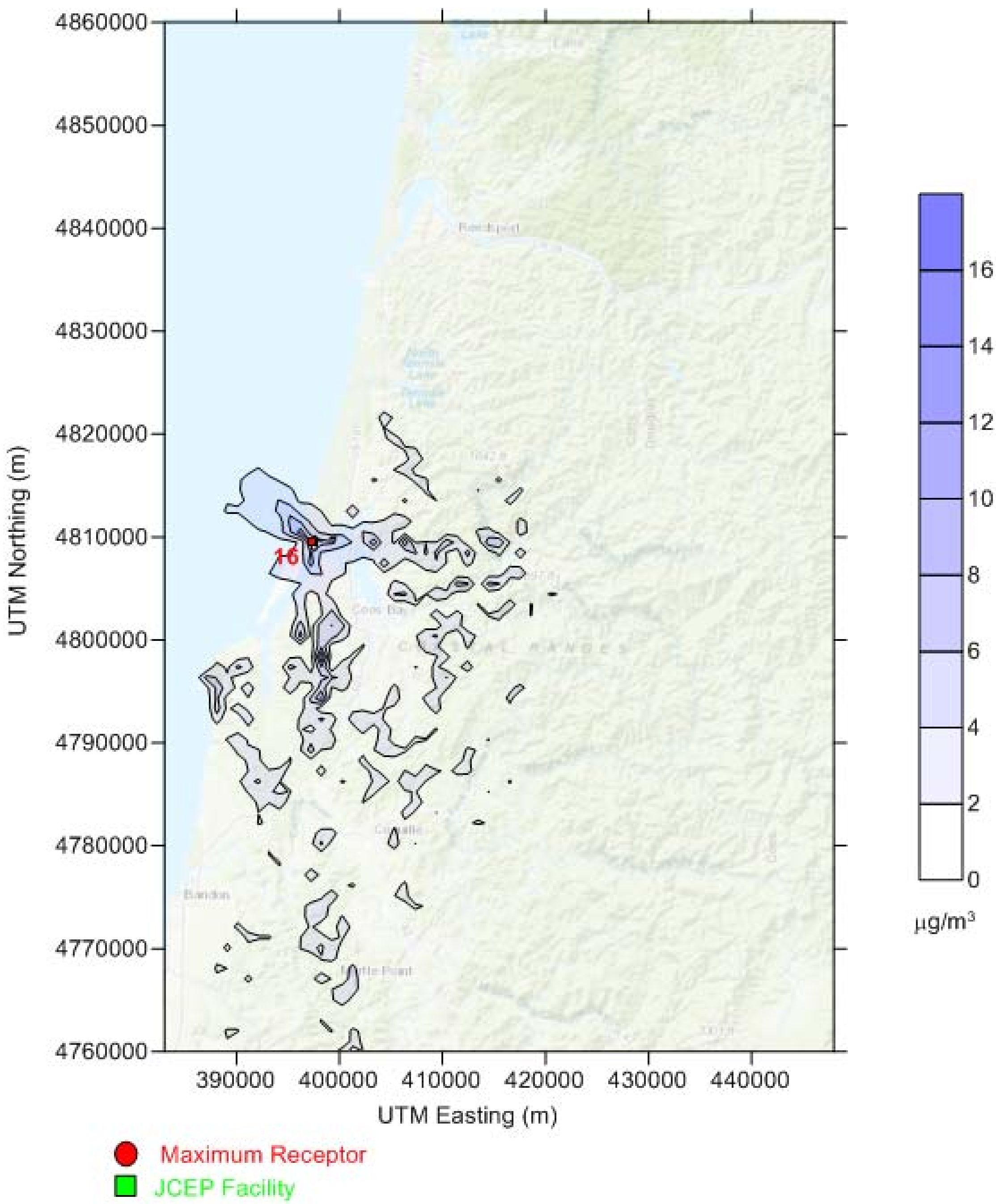

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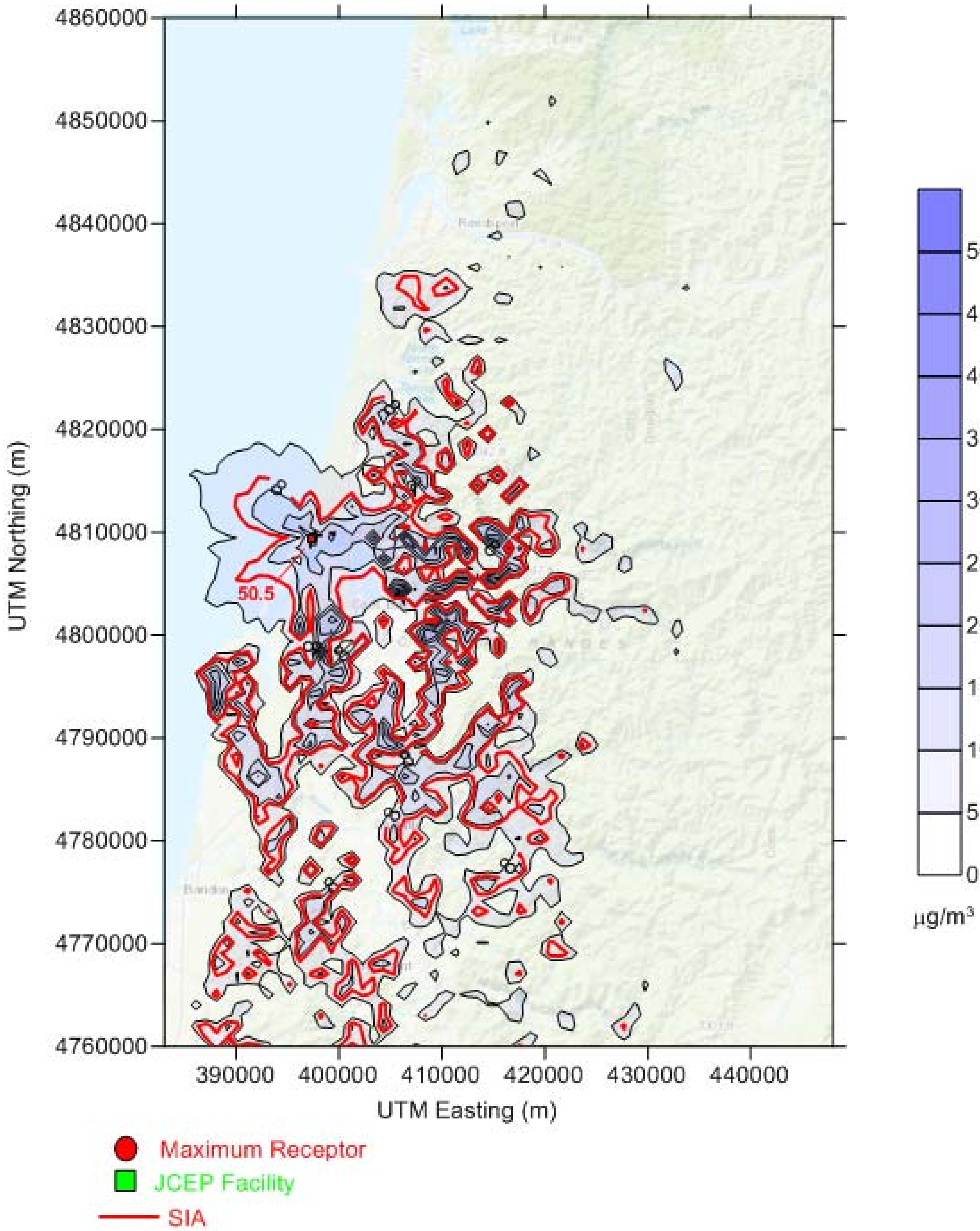

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NO_2 1-HOUR SIGNIFICANCE ANALYSIS

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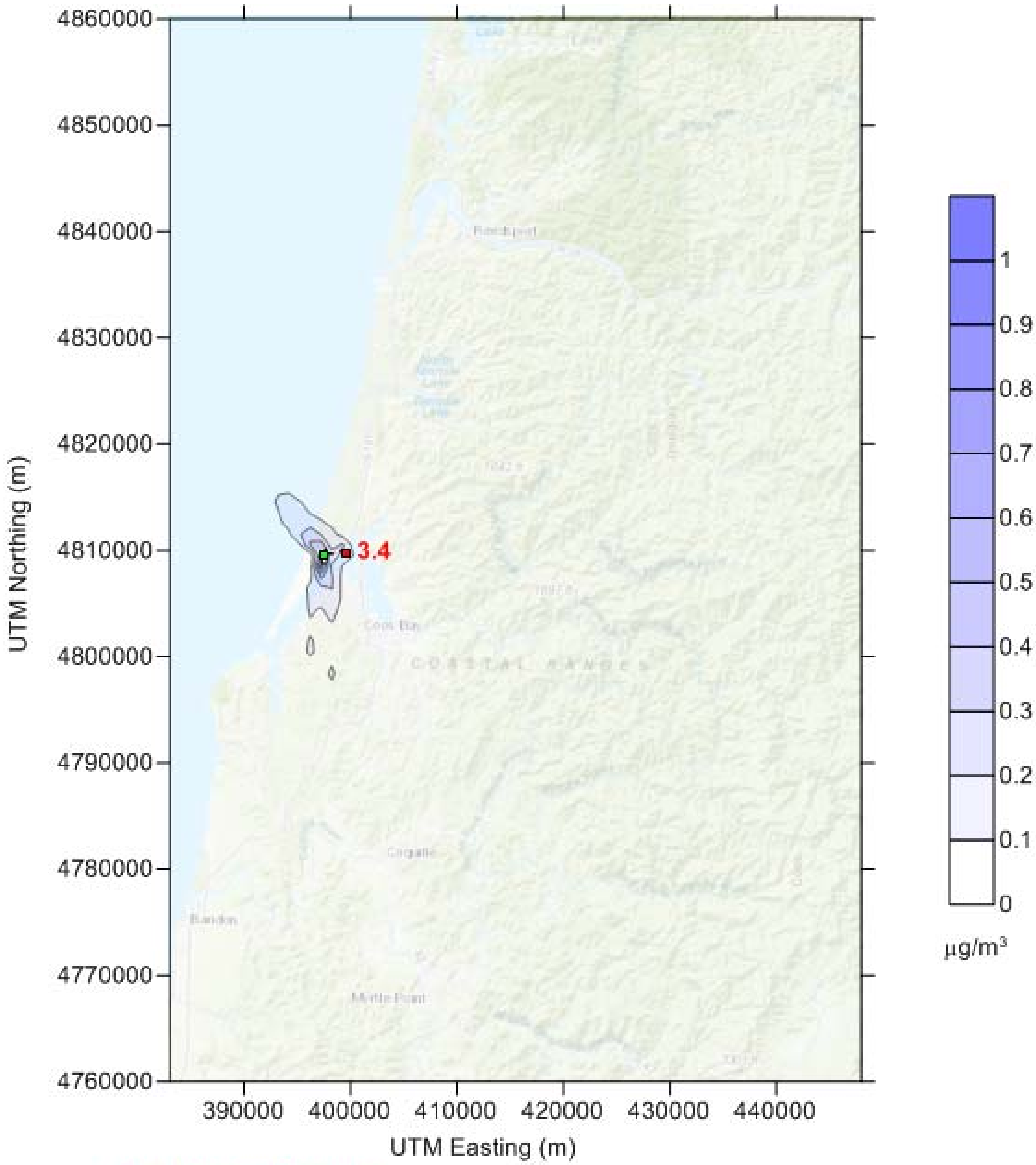

Maximum Receptor

JCEP Facility

SIA: Individual receptors near the facility are above the significant impact limit.

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Drawing NO_2 ANNUAL SIGNIFICANCE ANALYSIS	
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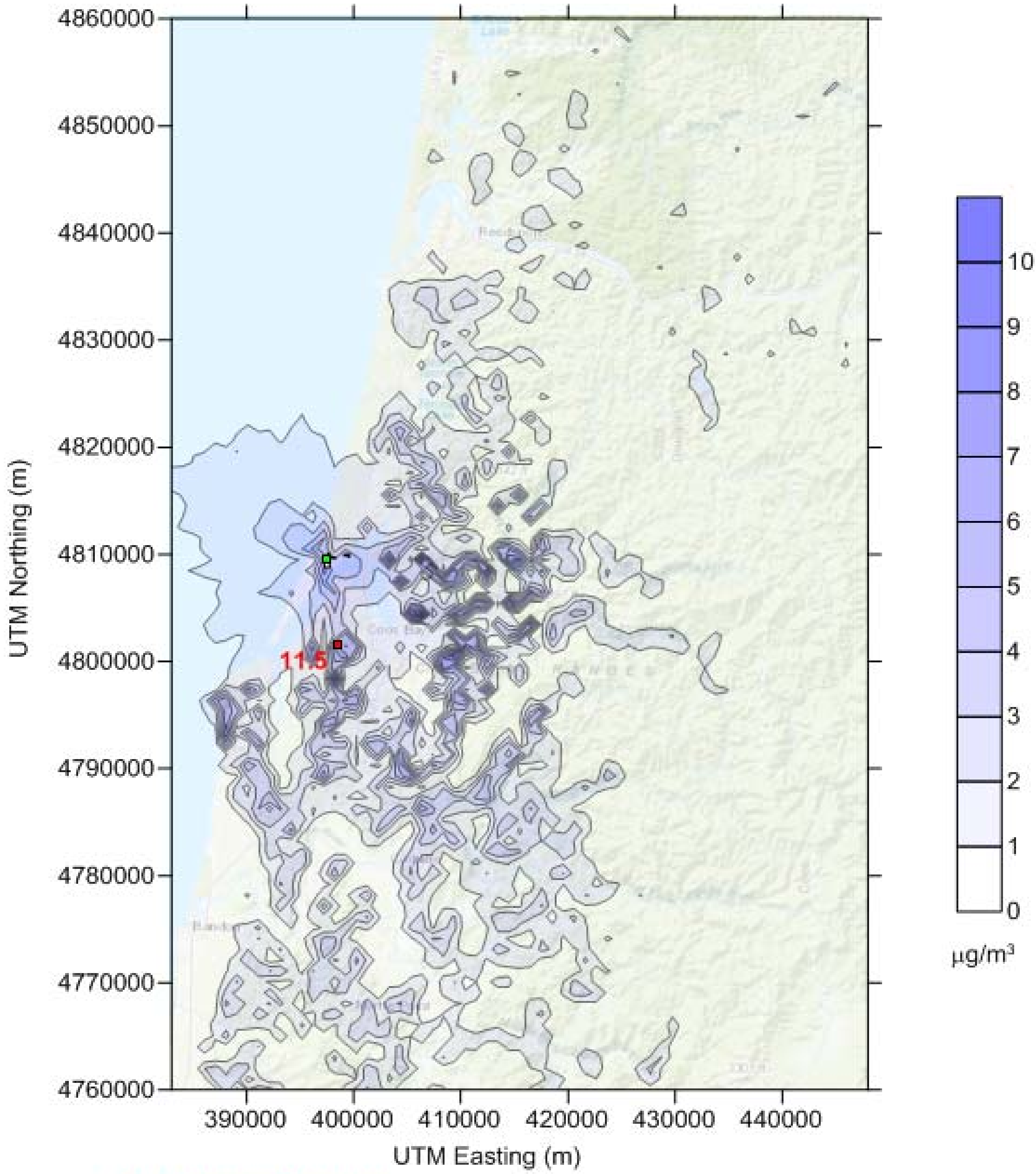

Maximum Receptor

JCEP Facility

SIA: Individual receptors near the facility and in the hills to the east and south of the facility are above the significant impact limit.

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Drawing SO_2 1-HOUR SIGNIFICANCE ANALYSIS		
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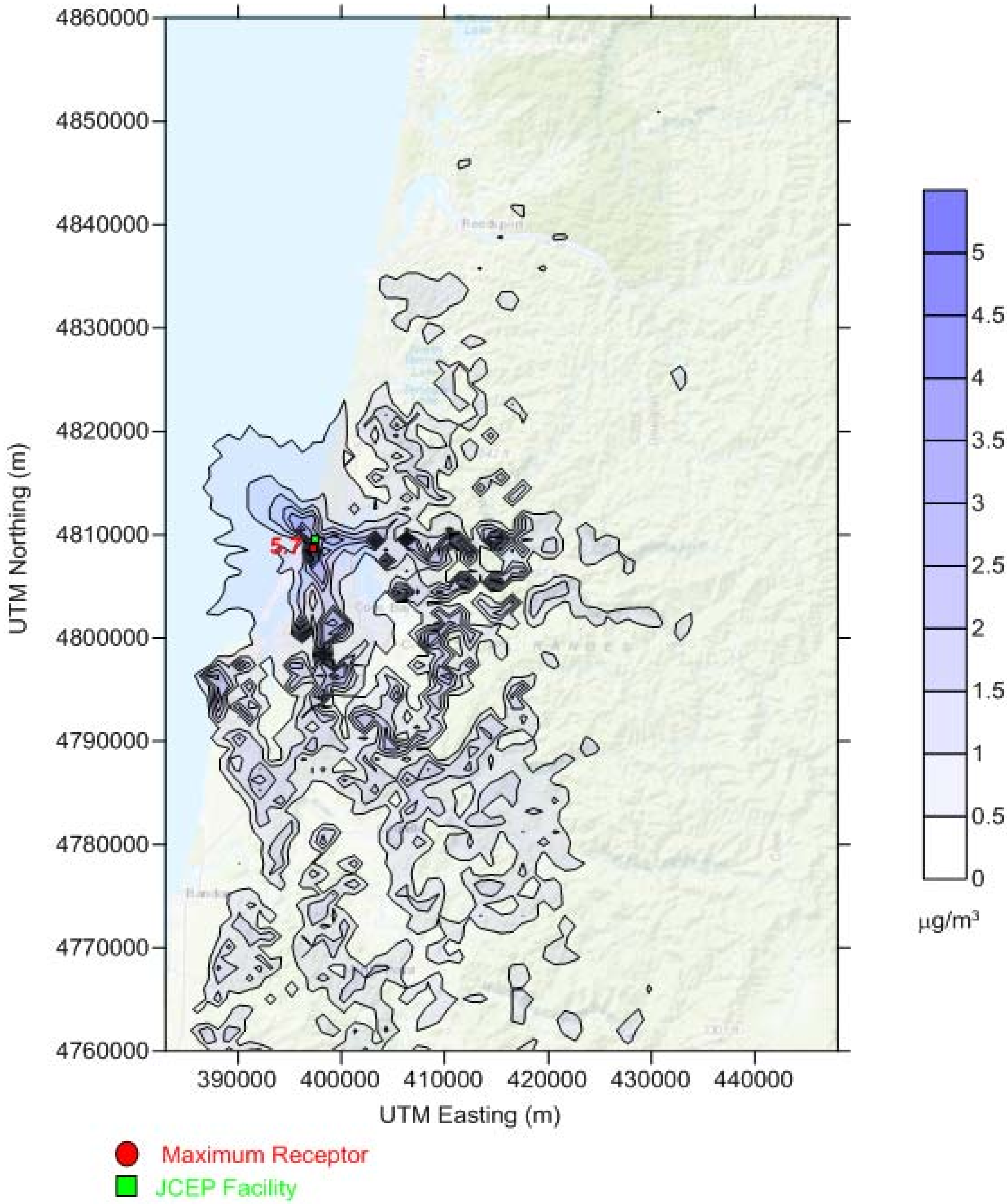

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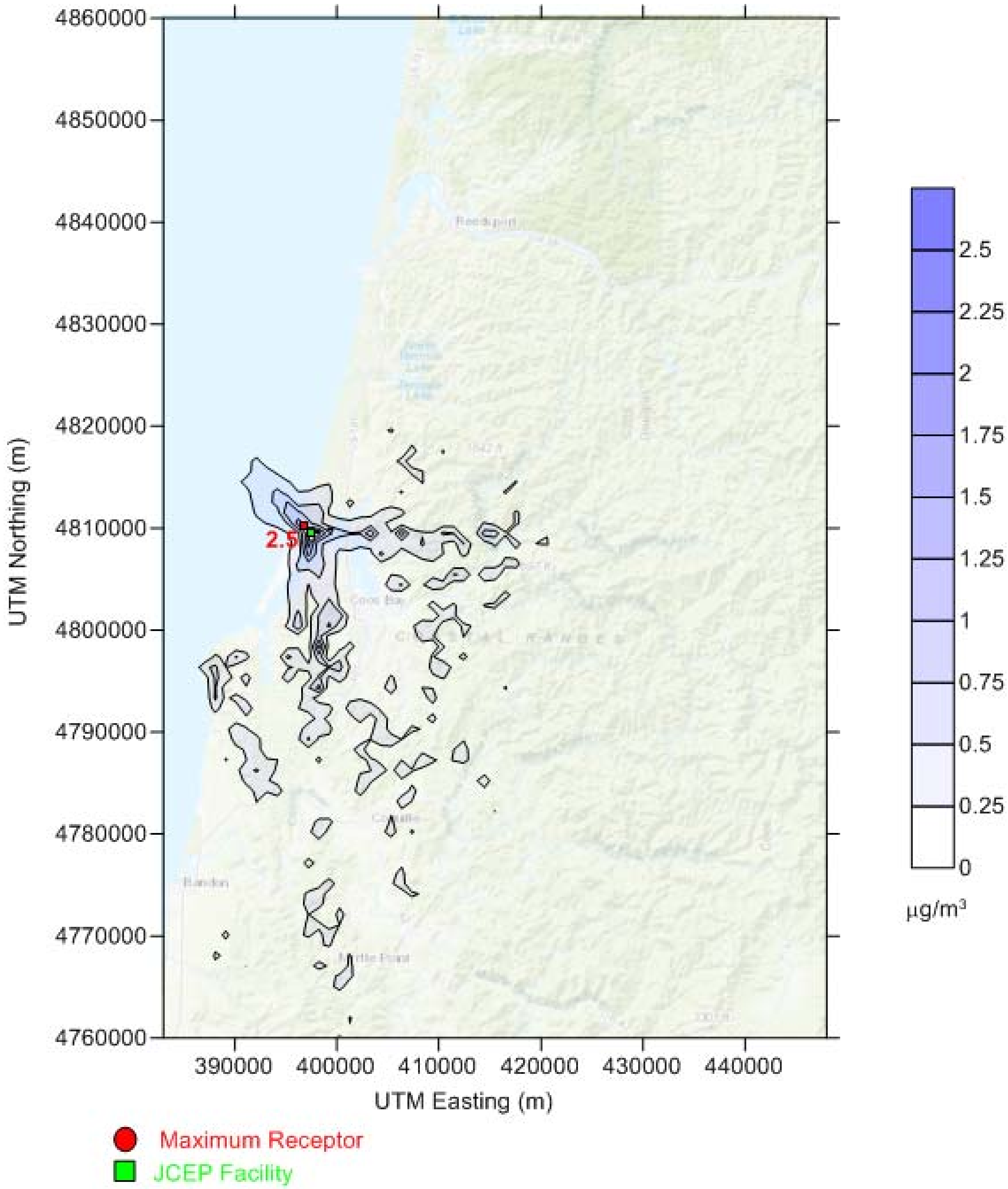

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SO_2 24-HOUR SIGNIFICANCE ANALYSIS

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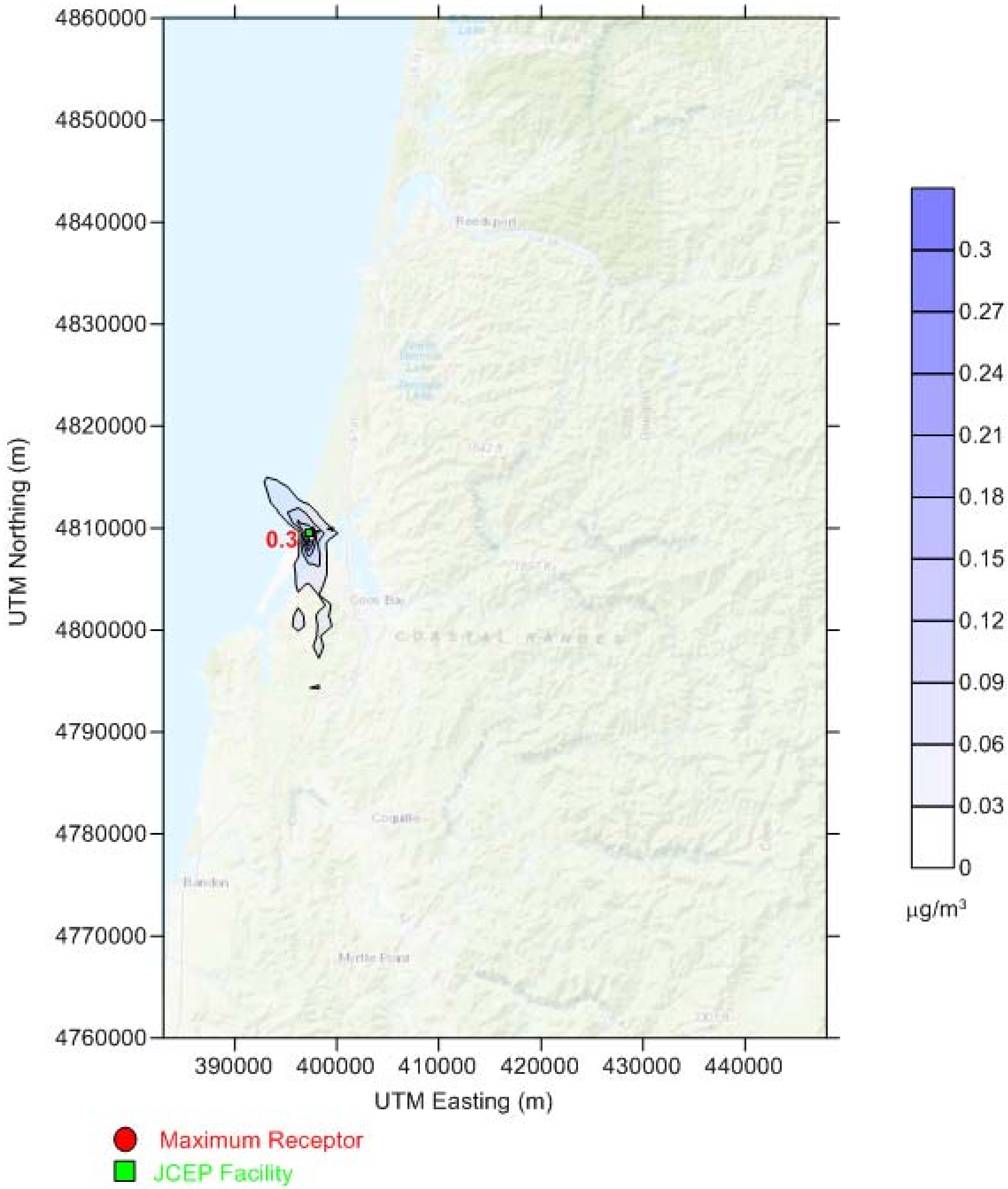
Project No.	108.01593.00001	**11**



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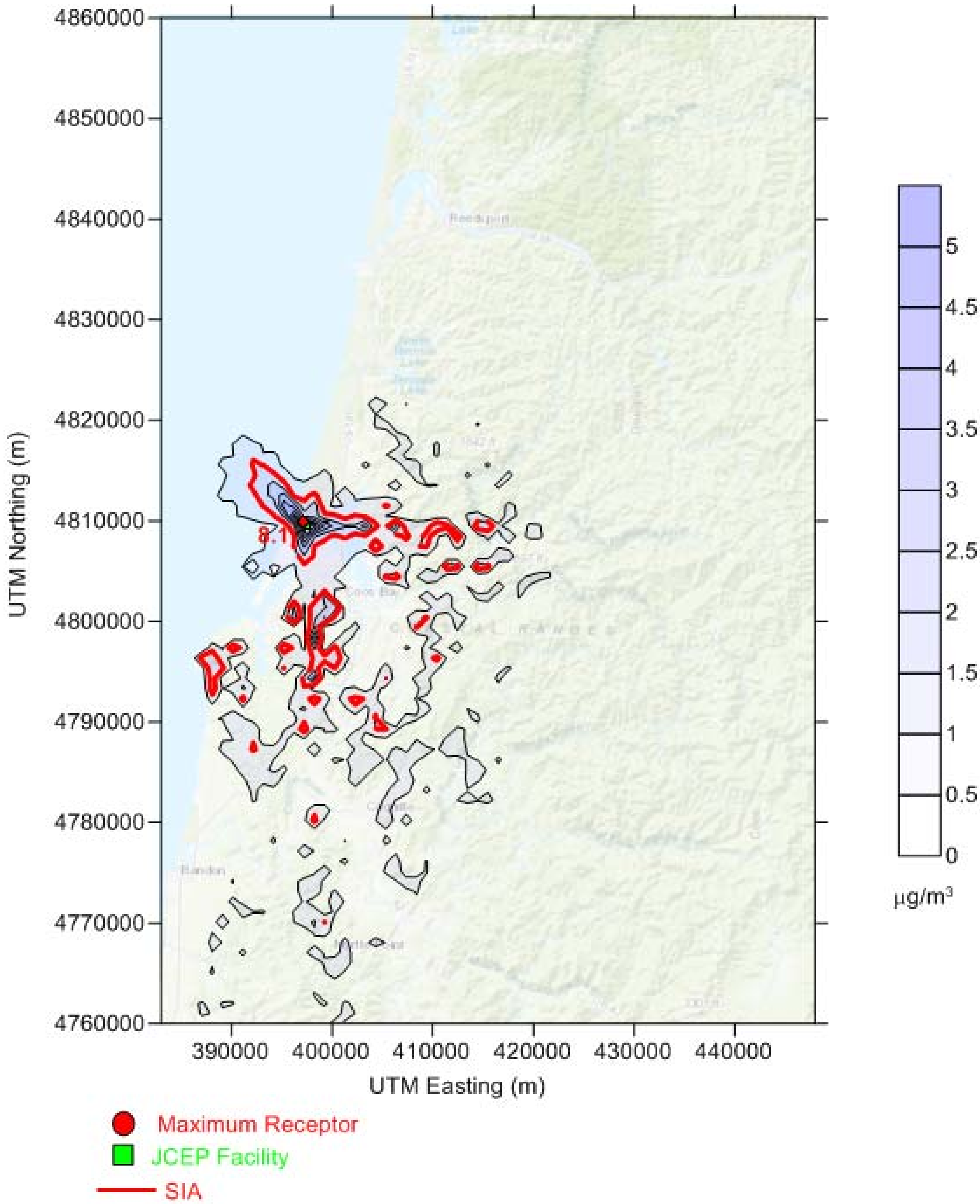

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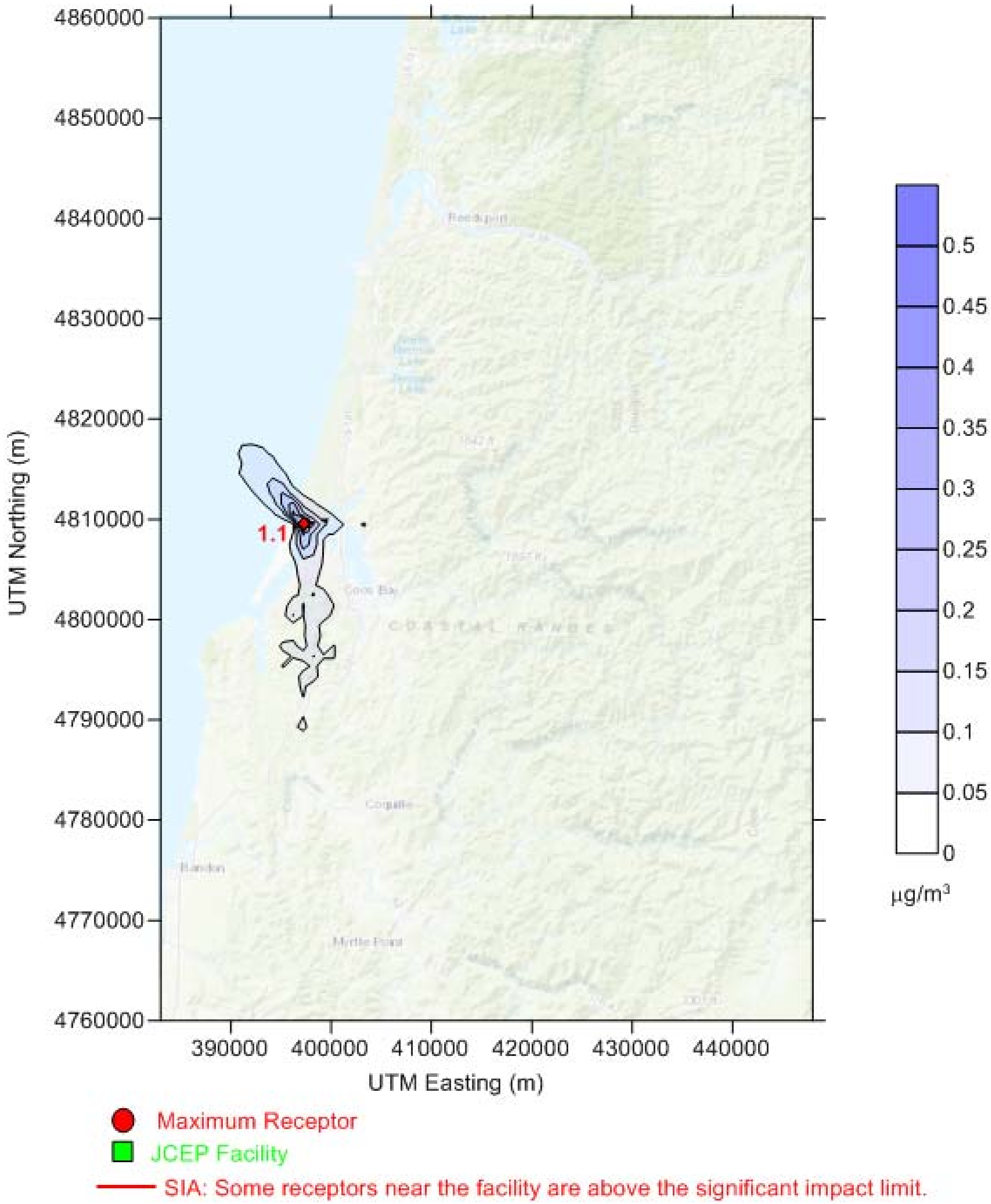

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PM_{10} ANNUAL SIGNIFICANCE ANALYSIS

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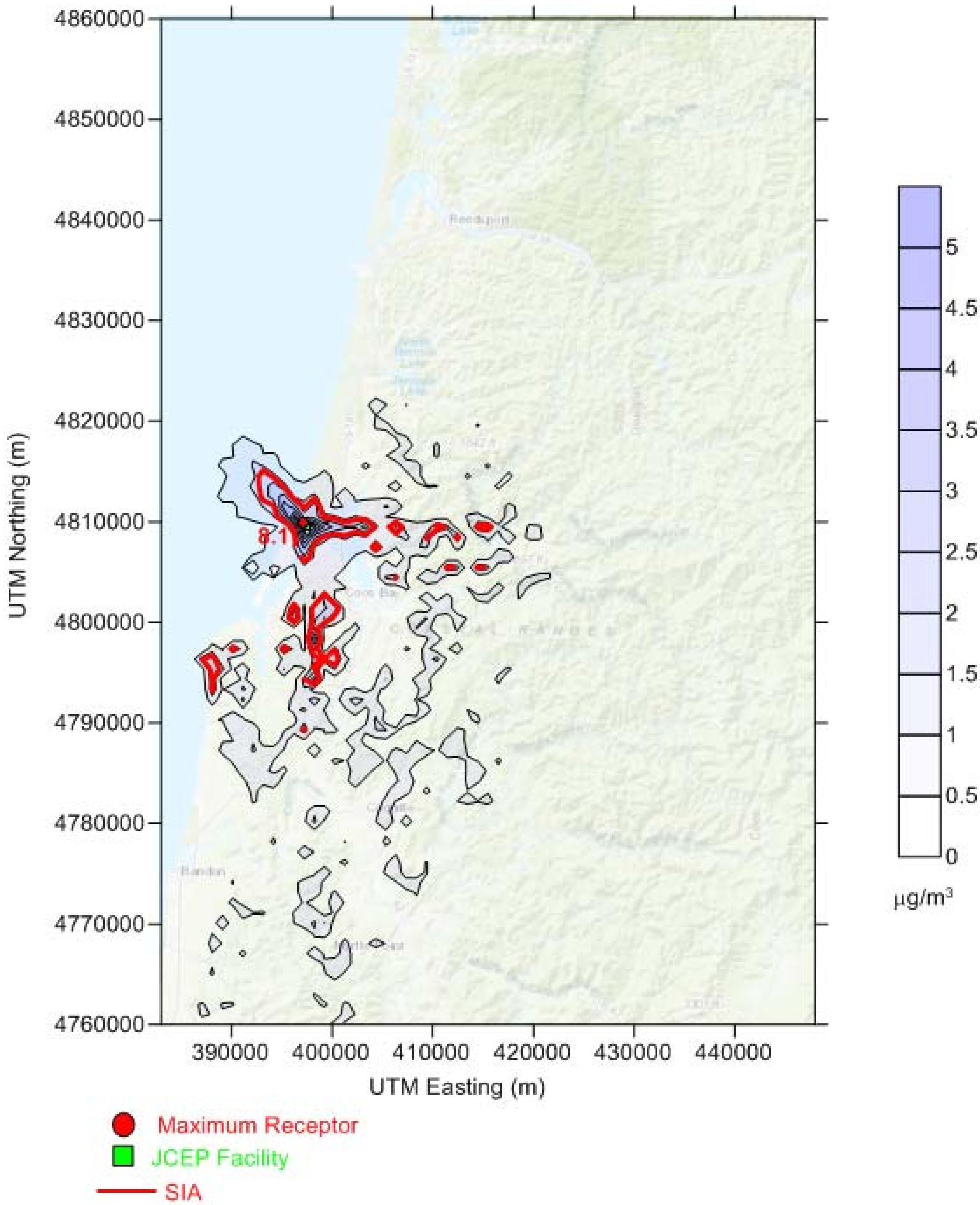

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$PM_{2.5}$ 24-HOUR SIGNIFICANCE ANALYSIS

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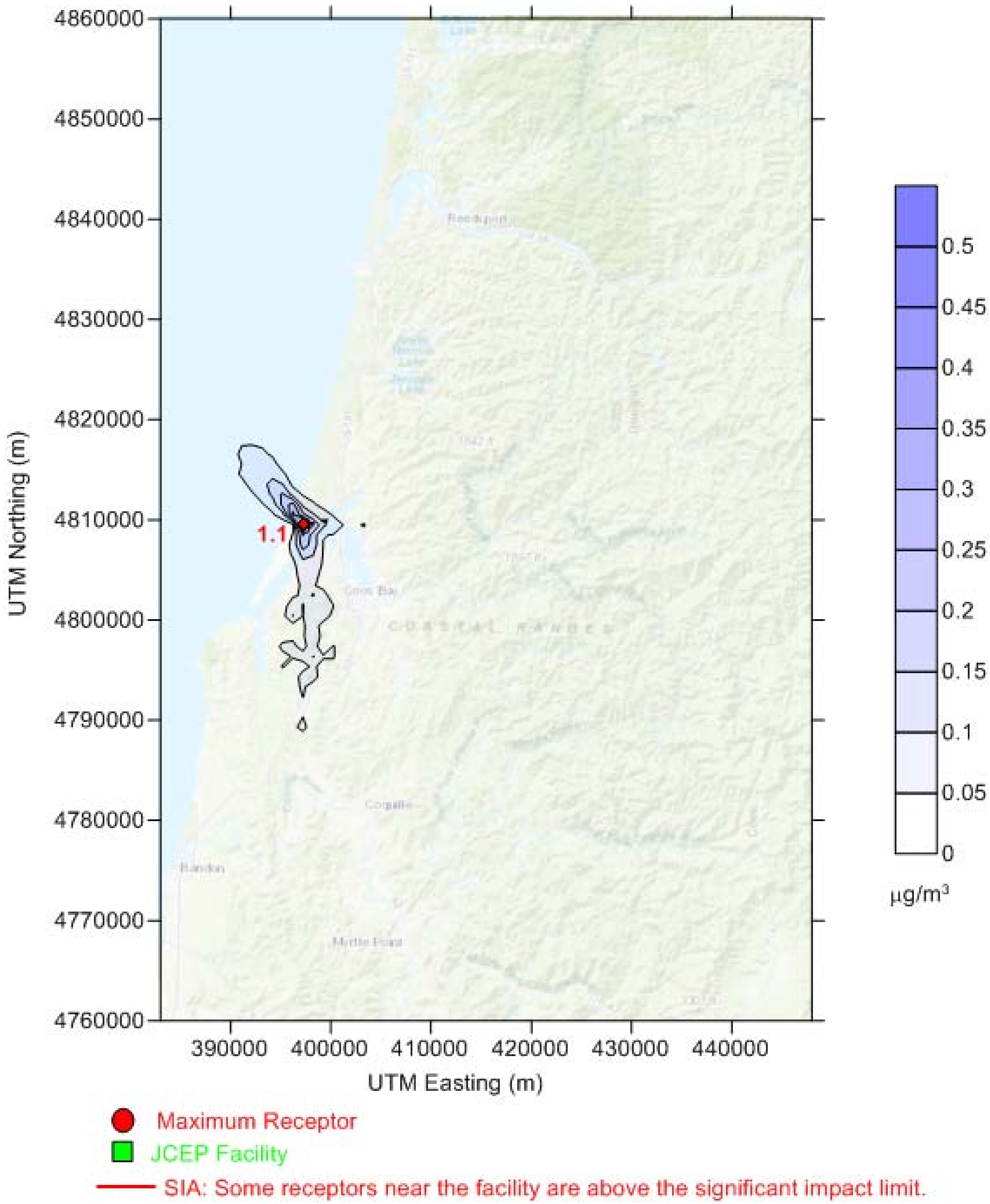

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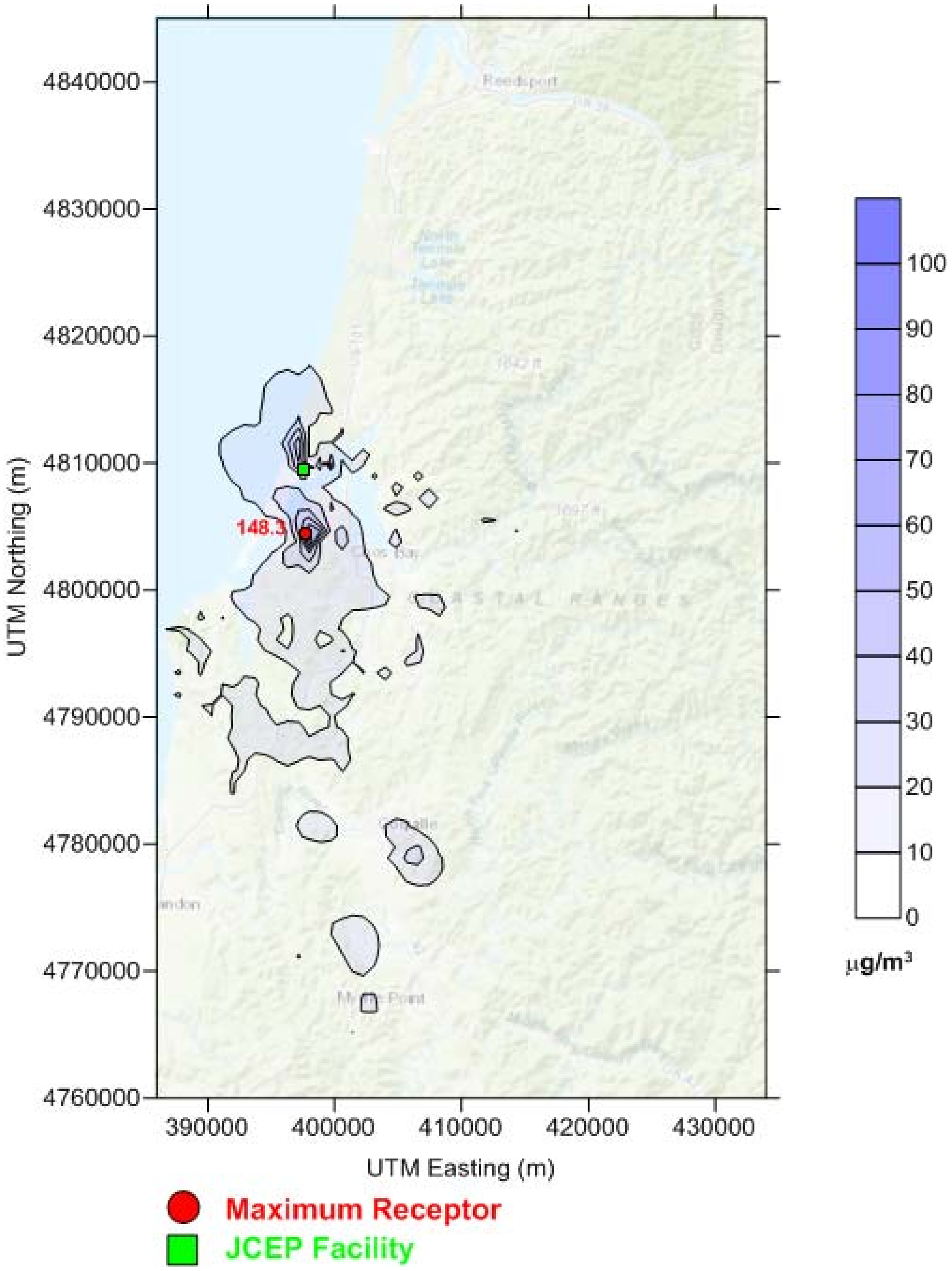
Project No. 108.01593.00001	



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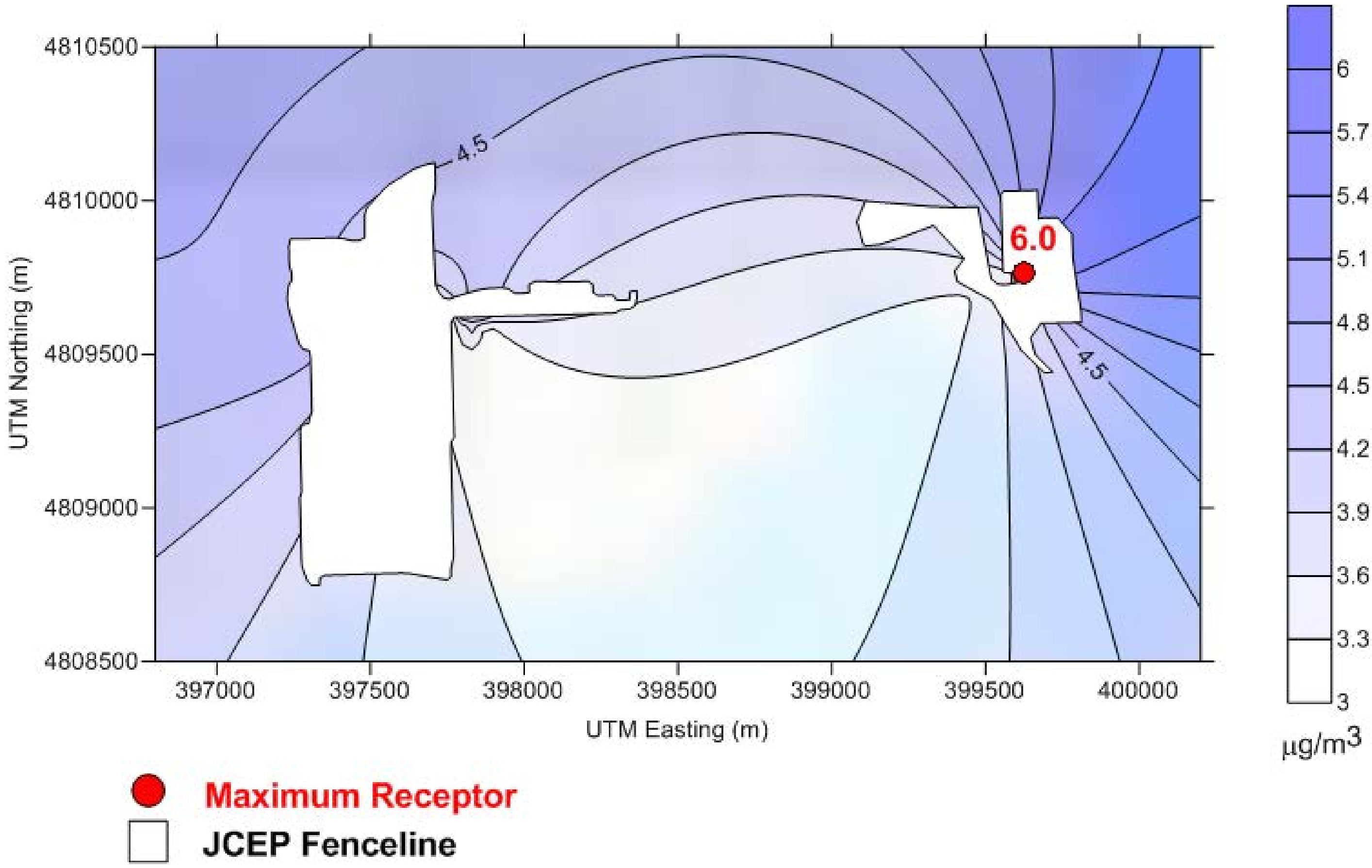
Project No. 108.01593.00001	17



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NO_2 ANNUAL NAAQS ANALYSIS

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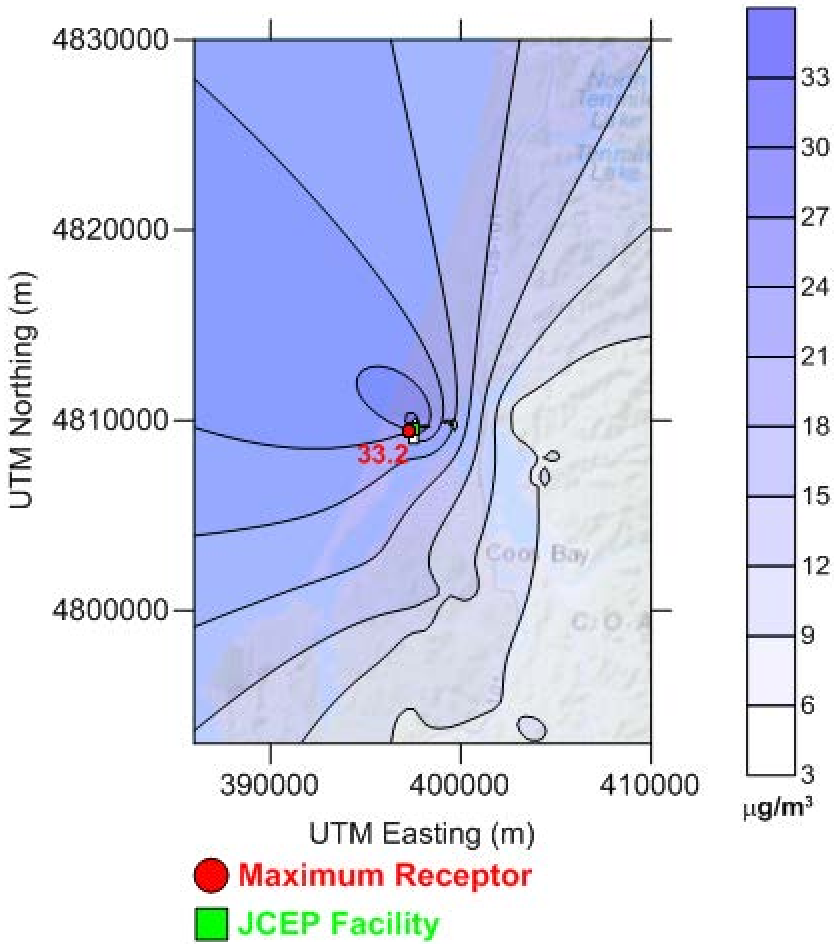

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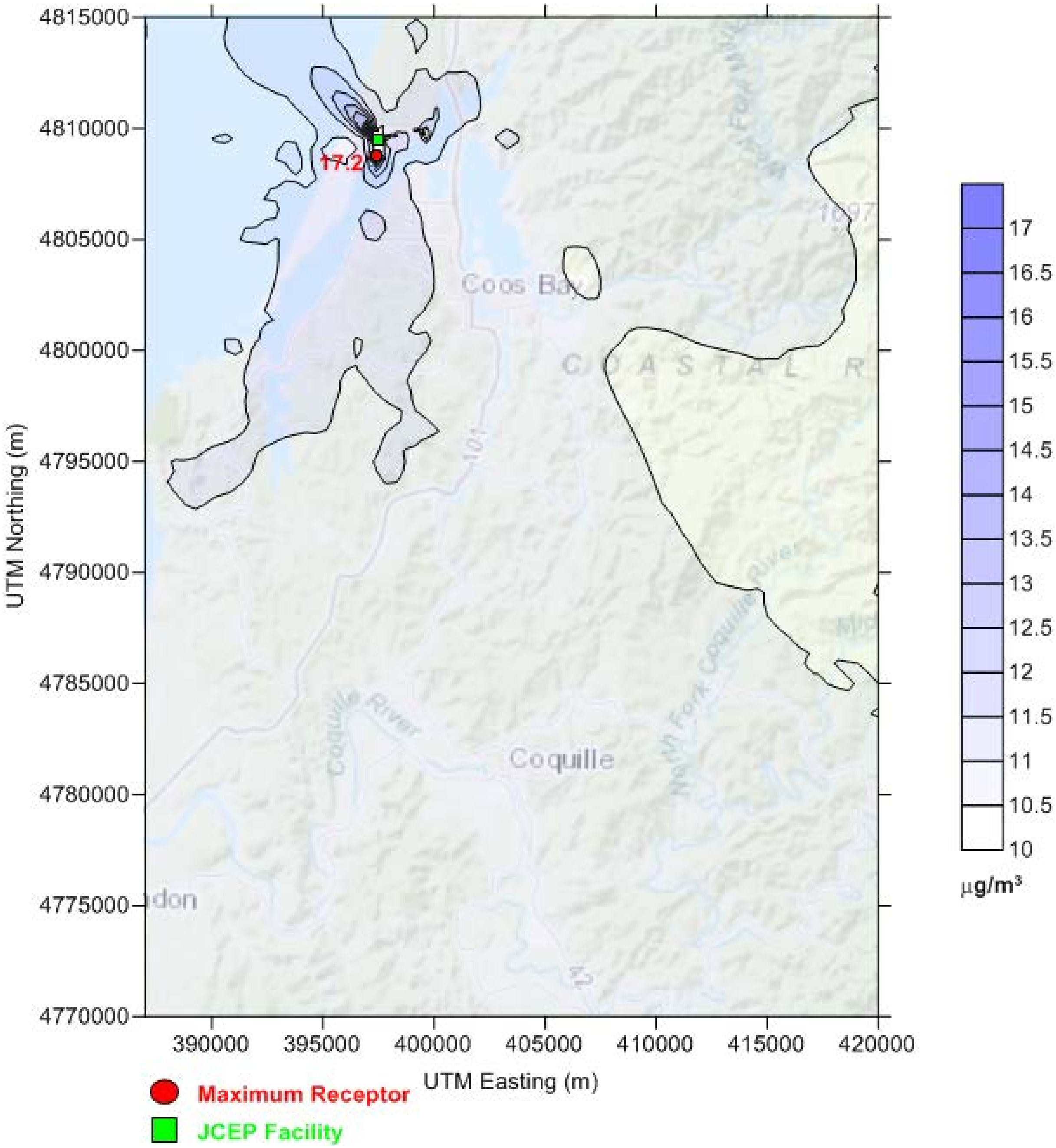
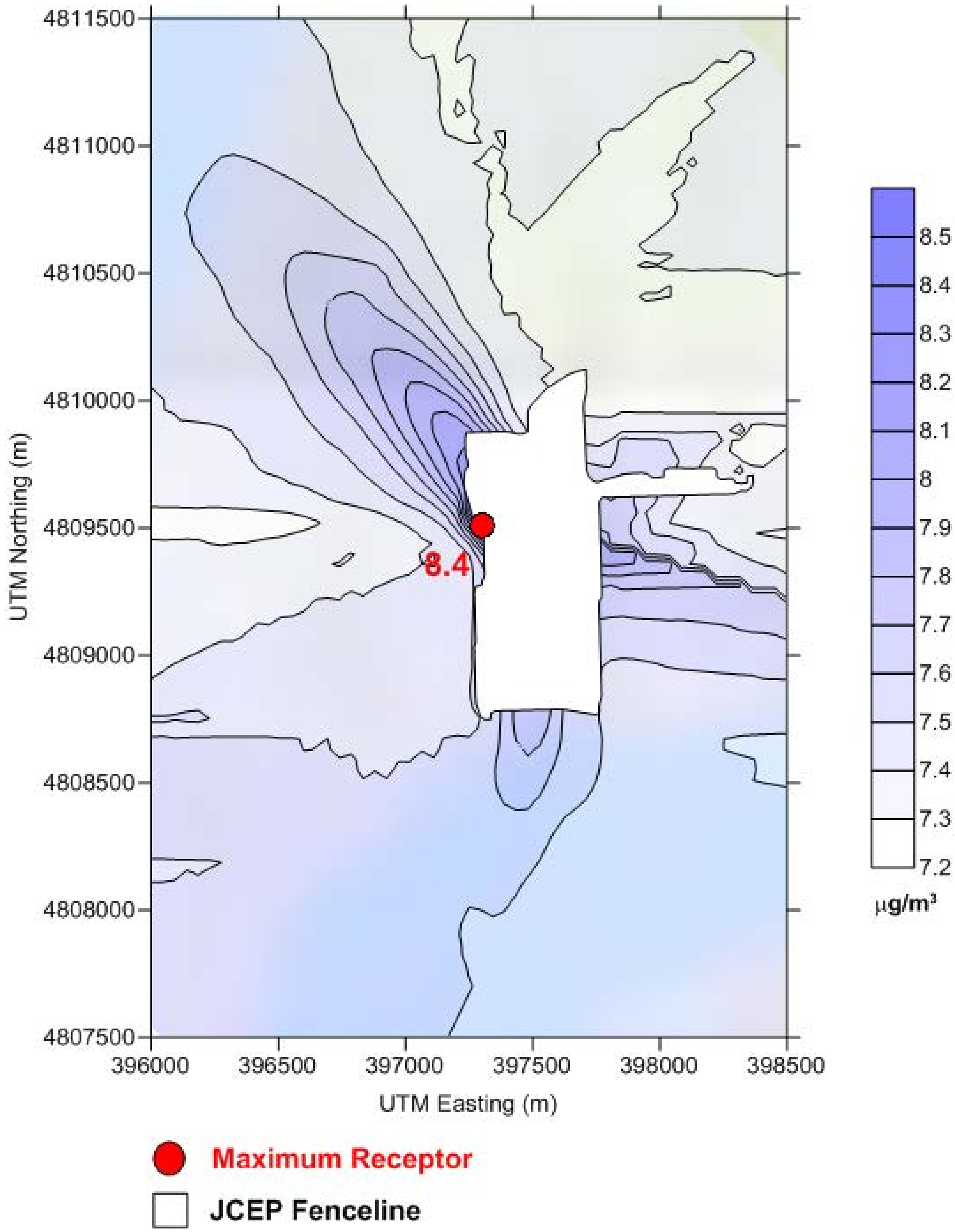
SO_2 1-HOUR NAAQS ANALYSIS

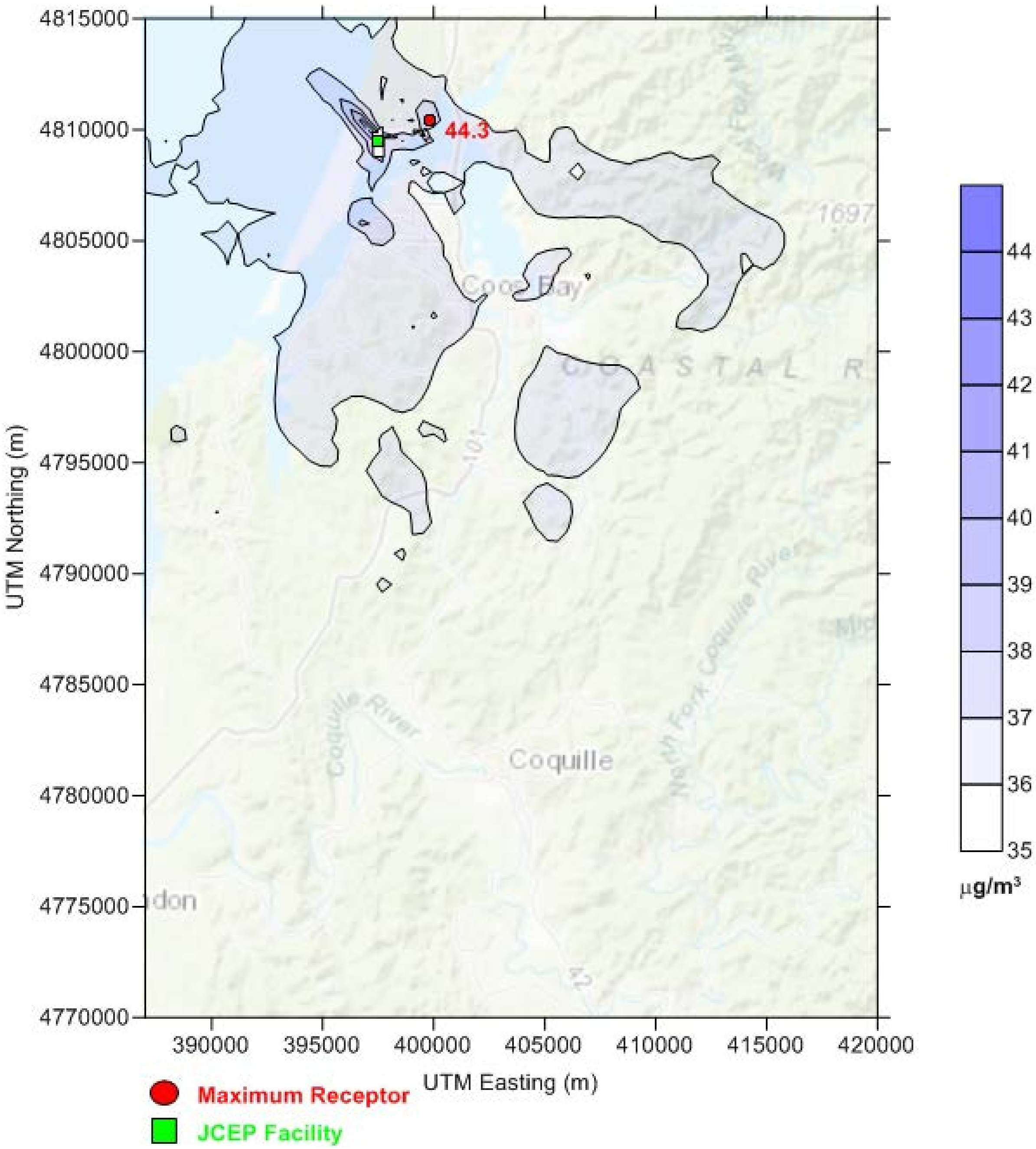
Date	September 2017	Fig. No.
Project No.	108.01593.00001	19



Report	
JORDAN COVE LNG TERMINAL JORDAN COVE ENERGY PROJECT, LP 125 CENTRAL AVENUE, SUITE 380 COOS BAY, OREGON 97240	
Drawing $PM_{2.5}$ 24-HOUR NAAQS ANALYSIS	
Date September 2017	Fig. No.
Project No. 108.01593.00001	20



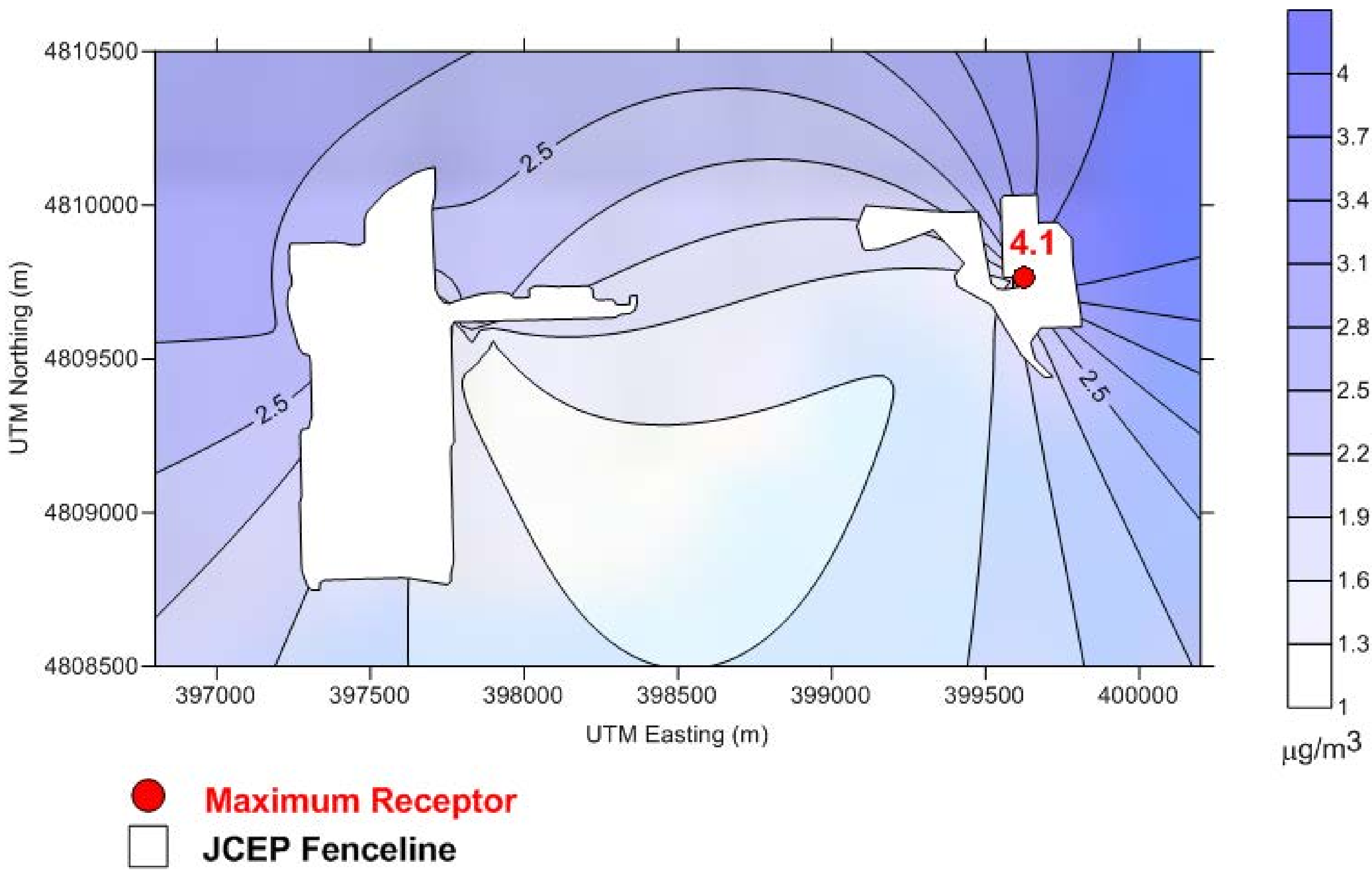
Report		
JORDAN COVE LNG TERMINAL JORDAN COVE ENERGY PROJECT, LP 125 CENTRAL AVENUE, SUITE 380 COOS BAY, OREGON 97240		
Drawing $PM_{2.5}$ ANNUAL NAAQS ANALYSIS		
Date	September 2017	Fig. No. **21**
Project No.	108.01593.00001	



Report
JORDAN COVE LNG TERMINAL
JORDAN COVE ENERGY PROJECT, LP
125 CENTRAL AVENUE, SUITE 380
COOS BAY, OREGON 97240

Drawing
PM_{10} 24-HOUR NAAQS ANALYSIS

Date	September 2017	Fig. No.
Project No.	108.01593.00001	**22**



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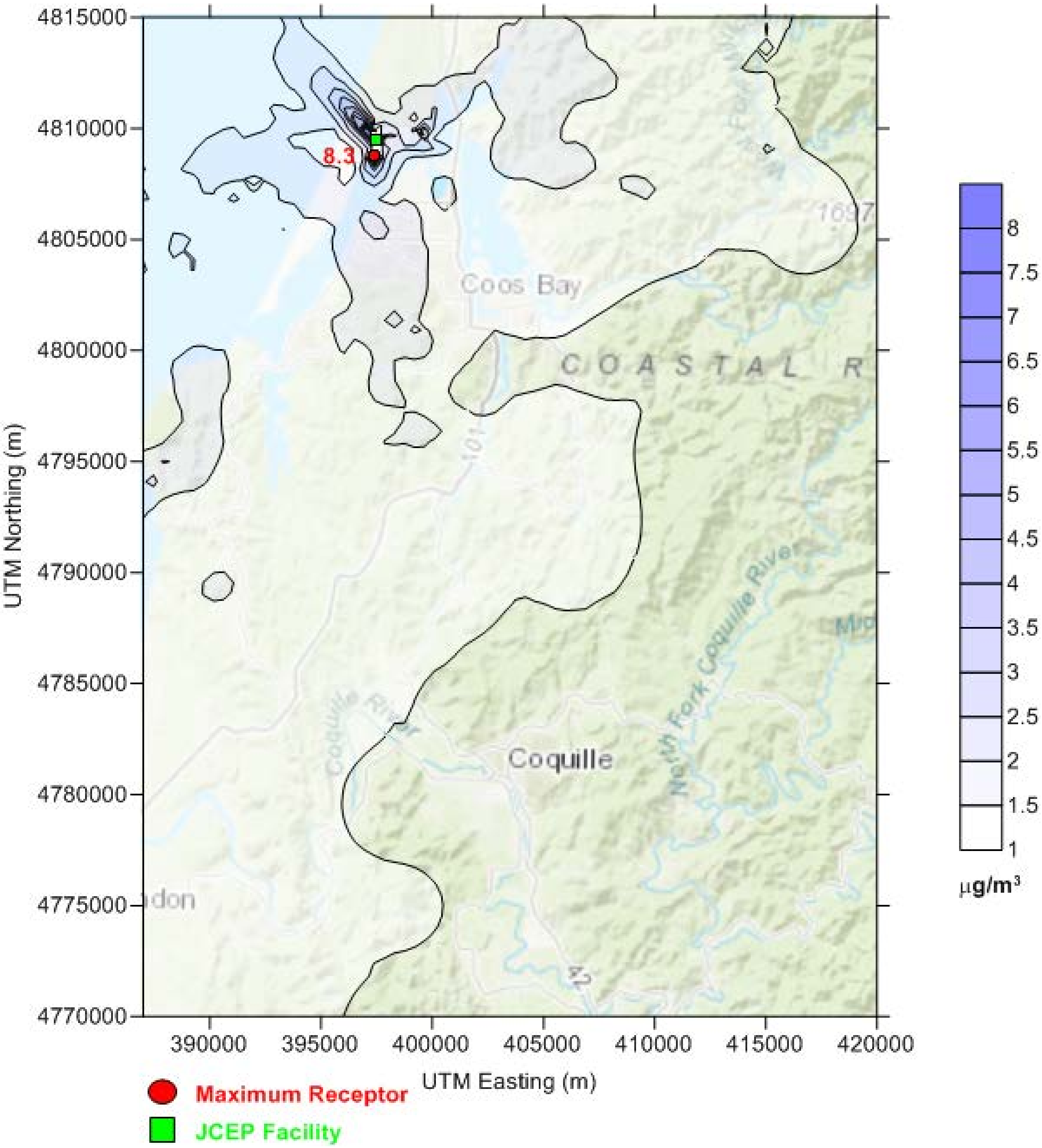
JORDAN COVE LNG TERMINAL
JORDAN COVE ENERGY PROJECT, LP
125 CENTRAL AVENUE, SUITE 380
COOS BAY, OREGON 97240

Drawing
NO_2 ANNUAL INCREMENT ANALYSIS

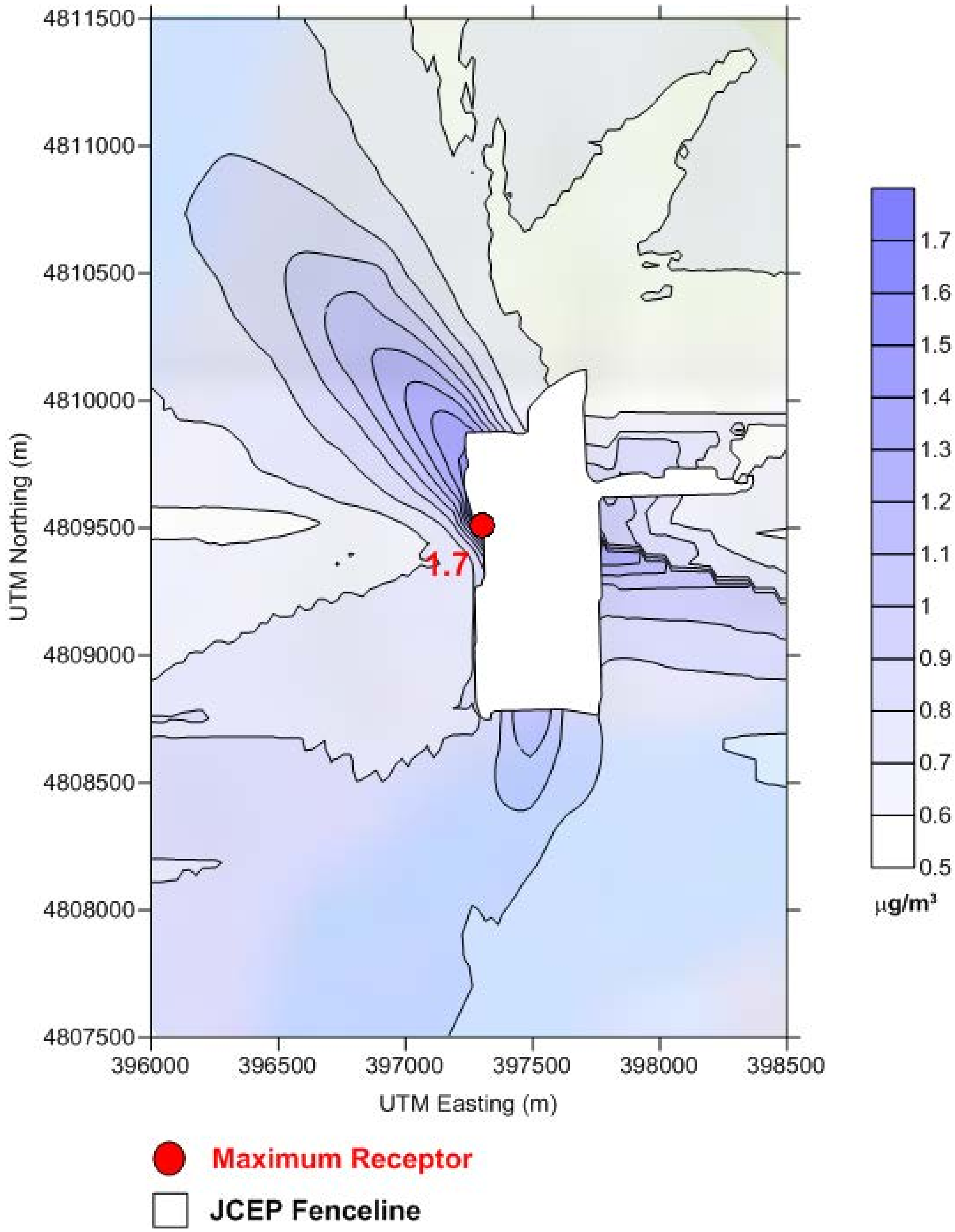
Date	September 2017	Fig. No.
Project No.	108.01593.00001	23



Report
JORDAN COVE LNG TERMINAL
JORDAN COVE ENERGY PROJECT, LP
125 CENTRAL AVENUE, SUITE 380
COOS BAY, OREGON 97240

Drawing
$PM_{2.5}$ 24-HOUR INCREMENT ANALYSIS

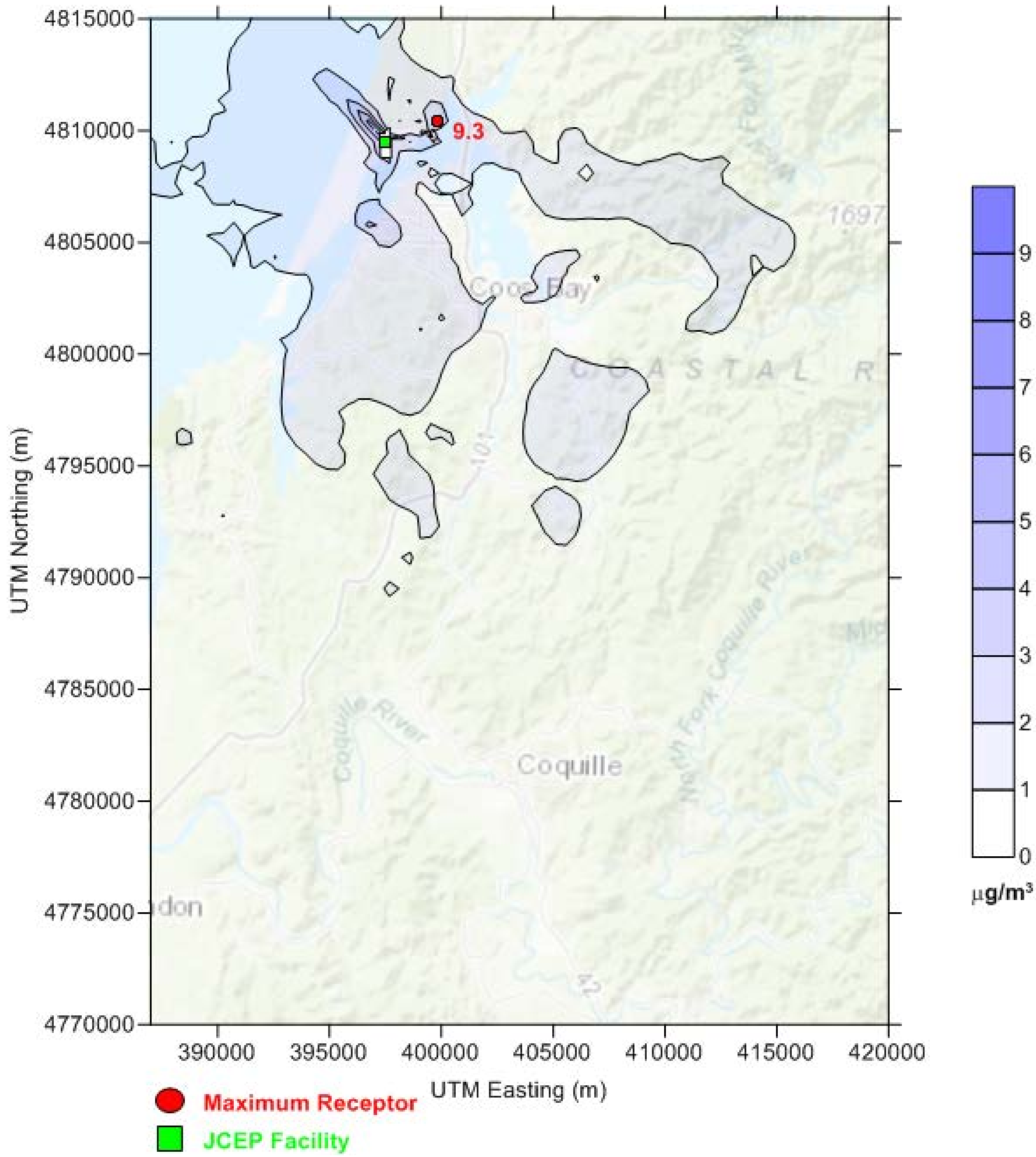
Date	September 2017	Fig. No.
Project No.	108.01593.00001	24



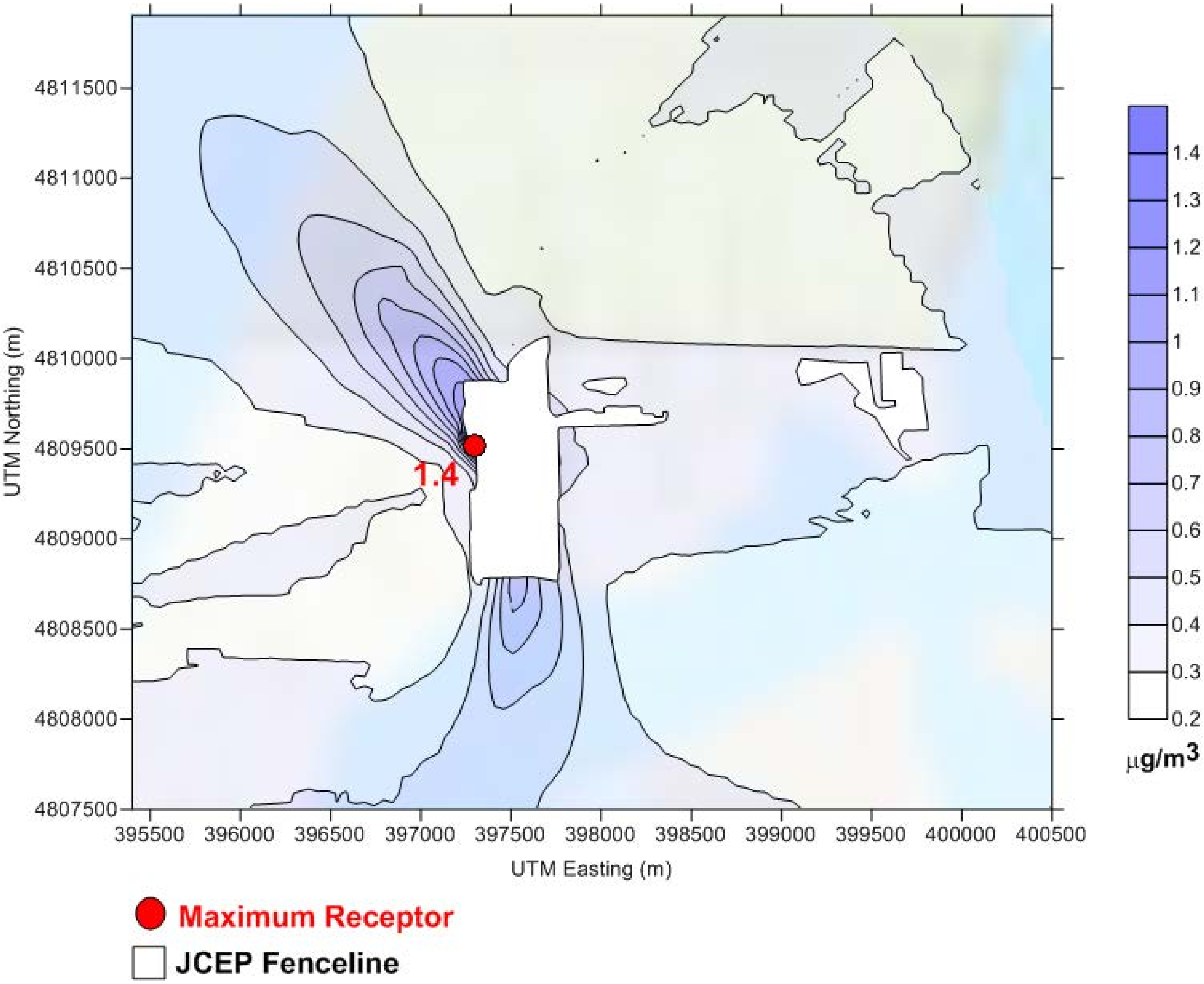
Report
JORDAN COVE LNG TERMINAL
JORDAN COVE ENERGY PROJECT, LP
125 CENTRAL AVENUE, SUITE 380
COOS BAY, OREGON 97240

Drawing
$PM_{2.5}$ ANNUAL INCREMENT ANALYSIS

Date	September 2017	Fig. No.
Project No.	108.01593.00001	25



Report	
JORDAN COVE LNG TERMINAL JORDAN COVE ENERGY PROJECT, LP 125 CENTRAL AVENUE, SUITE 380 COOS BAY, OREGON 97240	
Drawing	
PM_{10} 24-HOUR INCREMENT ANALYSIS	
Date: September 2017	Fig. No.
Project No.: 108.01593.00001	26



Report JORDAN COVE LNG TERMINAL JORDAN COVE ENERGY PROJECT, LP 125 CENTRAL AVENUE, SUITE 380 COOS BAY, OREGON 97240	
Drawing PM_{10} ANNUAL INCREMENT ANALYSIS	
Date September 2017 Project No. 108.01593.00001	Fig. No. 27

APPENDIX A

OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY PERMIT APPLICATION FORMS

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

JCEP Index to DEQ Forms and Emission Unit Identification

DEQ Form	Description	Emission Unit ID	Control Device IDs	Attachment(s)
AQ101wr	Administrative Information			
AQ102	Facility Description			Plot Plans and Figures A-1, A-2, A-3
AQ210, AQ307 (2)	Turbine	EU1.CT	CD.SCR1, CD.OC1	Turbine Emission Scenarios from Manufacturer
	Turbine	EU2.CT	CD.SCR2, CD.OC2	
	Turbine	EU3.CT	CD.SCR3, CD.OC3	
	Turbine	EU4.CT	CD.SCR4, CD.OC4	
	Turbine	EU5.CT	CD.SCR5, CD.OC5	
AQ208, AQ307 (2)	Auxiliary Boiler	EU6.AB	CD.SCR6, CD.OC6	
AQ210	Fire Pump Engines	EU7.FP		Engine Specification
AQ210	Black Start Generators	EU8.BSG		Engine Specification
AQ210	Emergency Generators	EU9.EG		Engine Specification
AQ230, AQ307	Gas Conditioning	EU10.GC	CD.TO	TO Specification
AQ230	Multi Point Ground Flare	EU11.MPGF		
AQ230	Marine Flare	EU12.MF		
--	Fugitive Emissions	EU13.FUG		
--	Aggregate Insignificant	EU14.AI		
AQ402	PSEL Detail Sheet			
AQ403	HAP Detail Sheet			
AQ404	Categorically Insignificant Activities			
LUCS	Land Use Compatibility Statement			

Print Form

ADMINISTRATIVE INFORMATION

FORM AQ101
ANSWER SHEET

FOR DEQ USE ONLY	
Permit Number:	Type of Application:
Application No:	RNW ☐ MOD ☐ NEW ☐ EXT ☐
Date Received :	
Regional Office:	Check No. Amount $

1. Company	2. Facility Location
Legal Name: Jordan Cove Energy Project, L.P.	Name: JCEP LNG Terminal Project
Mailing Address: 125 W. Central Avenue, Suite 250	Street Address: Jordan Cove Road
City, State, Zip Code: Coos Bay, OR 97240	City, County, Zip Code: Unincorporated Coos County, OR
Number of employees (corporate):	Number of employees (facility):
3. Facilty Contact Person	**4. Industrial Classification Code(s)**
Name: Rose Haddon	Primary SIC and NAICS: SIC 4922; NAICS 486210
Title: Director, Regulatory Affairs	Secondary SIC and NAICS:
Telephone number: 713-400-2834	**5. Other DEQ Permits**
Fax. number:	
e-mail address: rose.haddon@jordancovelng.com	

6. Permit Action:

- ☐ New Simple ACDP
- ☐ New Construction ACDP
- ☒ New Standard ACDP
- ☐ New Standard ACDP (PSD/NSR)
- ☐ Renewal of an existing permit without changes (include form AQ403 for Standard ACDPs)
- ☐ Renewal of an existing permit with changes (include form AQ403 for Standard ACDPs)
- ☐ Revision (or Modification) to an existing permit application

7. Signature

I hereby apply for permission to discharge air contaminants in the State of Oregon, as stated or described in this application, and certify that the information contained in this application and the schedules and exhibits appended hereto, are true and correct to the best of my knowledge and belief.

Elizabeth Spomer	President and CEO
Name of official (Printed or Typed)	Title of official and phone number
Signature of official	Date

FEE INFORMATION
(Make the check payable to DEQ)

Note: The initial application fees and annual fees specified below (OAR 340-216-8020, Table 2, Parts 1 and 2) are only required for initial permit applications. These fees are not required for an application to renew or modify an existing permit. The appropriate specific activity fee(s) specified below (OAR 340-216-8020, Table 2, Part 3) applies to permit modifications or may be in addition to initial permit application fees.

OAR 340-216-8020, Table 2, Part 1 – INITIAL PERMITTING APPLICATION FEES:		
Short Term Activity ACDP	☐	$3,600.00
Basic ACDP	☐	$144.00
Assignment to General ACDP	☐	$1,440.00
Simple ACDP	☐	$7,200.00
Construction ACDP	☐	$11,520.00
Standard ACDP	☒	$14,400.00
Standard ACDP (Major NSR or Type A State NSR)	☐	$50,400.00
OAR 340-216-8020, TABLE 2, PART 2 - ANNUAL FEES:		
Simple ACDP – Low Fee Class	☐	$2,304.00
Simple ACDP – High Fee Class	☐	$4,608.00
Standard ACDP	☒	$9,216.00
OAR 340-216-8020, TABLE 2, PART 3 - SPECIFIC ACTIVITY FEES:		
Non-Technical Permit Modification	☐	$432.00
Basic Technical Permit Modification	☐	$432.00
Simple Technical Permit Modification	☐	$1,440.00
Moderate Technical Permit Modification	☐	$7,200.00
Complex Technical Permit Modification	☐	$14,400.00
Major NSR or type A State NSR Permit Modification	☐	$50,400.00
Modeling review (outside Major NSR or Type A State NSR)	☒	$7,200.00
Public Hearing at Source's Request	☐	$2,880.00
State MACT Determination	☐	$7,200.00
TOTAL FEES		**$ 30,816.00**

SUBMIT TWO COPIES OF THE COMPLETED APPLICATION TO:

New or Modified Permits (include fees):	**Permit Renewals (no fees):**
Oregon Department of Environmental Quality Business Office 811 SW Sixth Avenue Portland, OR 97204-1390	Oregon Department of Environmental Quality Air Quality Program, Western Region Office 4026 Fairview Industrial Drive Salem, Oregon 97302

State of Oregon Department of Environmental Quality

CONTACT LIST

1. **Company Information:**

Legal Name:	Other company name (if different than legal name):
Jordan Cove Energy Project, L.P.	JCEP LNG Terminal Project

2. **Site Contact Person**: *(A person who deals with DEQ staff about equipment problems.)*

Name:	Telephone number:
Rose Haddon	
Title:	**E-mail address:**
Director, Regulatory Affairs	rose.haddon@jordancovelng.com

3. **Facility Contact Person:** *(If other than the site contact person, a person involved with all environmental issues at the facility although they may be housed at a different site.)*

Name:	Telephone number:
Rose Haddon	
Title:	**E-mail address:**
Director, Regulatory Affairs	rose.haddon@jordancovelng.com

4. **Mailing Contact Person:** *(If other than the site contact person, a person to whom the company would like all agency communications directed.)*

Name:	Telephone number:
Rose Haddon	
Title:	**E-mail address:**
Director, Regulatory Affairs	rose.haddon@jordancovelng.com

5. **Invoice Contact Person**: *(If other than the site contact person, a valid contact information to which invoices and communications related to resolving invoice questions can be directed.)*

Name:	Telephone number:
Rose Haddon	
Title:	**E-mail address:**
Director, Regulatory Affairs	rose.haddon@jordancovelng.com

Facility Name: JCEP LNG Terminal Project Permit Number: ______________

1. Description of facility and processes:

Jordan Cove Energy Project, L.P. (JCEP) is proposing to construct and operate a natural gas liquefaction and export facility (LNG Terminal or Project), located on the bay side of the North Spit of Coos Bay, Oregon. Natural gas will be delivered to the LNG Terminal via the proposed Pacific Connector Gas Pipeline (PCGP), which will connect the Project with existing interstate natural gas pipeline systems.

Natural gas received at the LNG Terminal will be cooled into liquid form at - 260 degrees F and stored in two 160,000 cubic meter full-containment LNG storage tanks. The Project facilities would have the capability to export up to 7.8 million tonnes per annum (MTPA) via LNG carriers.

The Project will consistent of the following facilities:
- A pipeline gas conditioning facility consisting of one feed gas cleaning and dehydration train with a combined natural gas throughput of approximately 1.19 billion standard cubic feet per day (Bscf/d);
- A thermal oxidizer to combust the acid gases produced by the gas conditioning unit;
- Five natural gas liquefaction trains, each with the export capacity of 1.56 MTPA;
- Five turbine-driven compressors with waste heat recovery;
- A refrigerant storage and resupply system;
- An Aerial Cooling System (Fin-Fan);
- An LNG storage system consisting of two full-containment LNG storage tanks, each with a net capacity of 160,000 m3 (42,232,000 gallons), and each equipped with three fully submerged LNG in-tank pumps sized for approximately 11,600 gallons per minute (gpm) each;
- An LNG transfer line consisting of one approximately 2,500-foot-long, 36-inch-diameter line that would connect the shore based storage system with the LNG loading system;
- An LNG carrier cargo loading system designed to load LNG at a rate of 10,000 m3 per hour (m3/hr) with a peak capacity of 12,000 m3/hr, consisting of three 16-inch loading arms and one 16-inch vapor return arm;
- A protected LNG carrier loading berth constructed on an Open Cell® technology sheet pile slip wall and capable of accommodating LNG carriers with a range of capacities;
- A boil off gas (BOG) recovery system used to control the pressure in the LNG storage tanks;
- Electrical, nitrogen, fuel gas, lighting, instrument/plant air and service water facility systems;
- An emergency relief system (a marine flare and warm and cold ground flares);
- An LNG spill containment system, a fire water system and various other hazard detection, control, and prevention systems; and
- Utilities, buildings and support facilities.

2. Attach plot plan. Please see Figures 1, 2, and 3 as well as attached plot plans.

3. Attach process flow diagram. Please see attached Figures A-1, A-2, and A-3.

4. Attach a city map or drawing showing the facility location. Please see Figure 1.

NOTES:
1. FOR LNG PLANT PLOT PLAN, SEE DRAWING 189980-0000-FG2001.
2. FOR SOUTH DUNES PLOT PLAN, SEE DRAWING 189980-0000-FG2002.

JORDAN COVE LNG

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DATE REG NO.

DRAWN HHS ECB
CHECKED
DATE 04/MAY/16

JORDAN COVE LNG PROJECT

OVERALL PLOT PLAN

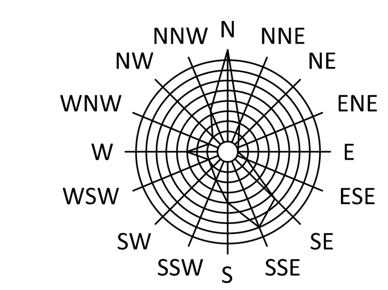
PROJECT DRAWING NUMBER: 189980-0000-FG2000 REV 1

JCLNG NUMBER: J1-000-TEC-PLT-KBJ-51000-01 REV 1

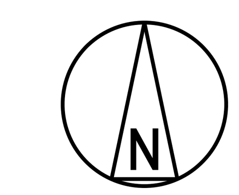
52 LOCATED OFF SITE

ITEM	FACILITIES LEGEND
1	FEED GAS HEADER
2	GAS CONDITIONING TRAIN
3	PROPERTY BOUNDARY
4	LNG LIQUEFACTION TRAIN #1 THROUGH #5
5	LNG EXPANDER (WITH SHELTER)
6	LNG FLASH DRUM
7	LNG RUNDOWN PUMPS (WITH SHELTER)
8	LNG STORAGE TANK
9	LNG TANK PUMPS
10	LNG LOADING PLATFORM
11	REFRIGERANT MAKE-UP
12	LP/HP BOG COMPRESSORS (WITH SHELTER)
13	COLD FLARE KO DRUM
14	MULTI POINT GROUND FLARE KO DRUM
15	NOT USED
16	MULTI POINT GROUND FLARE
17	ENCLOSED GROUND FLARE - MARINE
18	BOP AUXILIARY POWER STG
19	BOP AUXILIARY POWER STG CONTROL ENCLOSURE
20	AUXILIARY BOILER
21	DEAERATOR / BFW PUMPS
22	NOT USED
23	PLANT / INSTRUMENT AIR PACKAGES
24	NITROGEN GENERATION PACKAGE
25	LIQUID N2 STORAGE / VAPORIZATION
26	AMMONIA STORAGE TANKS AND PUMPS
27	AMINE STORAGE
28	LNG DRAINAGE CHANNEL
29	PROCESS AREA LNG IMPOUND BASIN
30	MARINE AREA LNG IMPOUND BASIN
31	FREE FIELD SEISMOMETER SHELTER
32	TRANSFORMERS
33	CONSTRUCTION LAYDOWN AREA
34	DIESEL STORAGE
35	FIREWATER STORAGE TANKS
36	LNG TANK ACCESS ROAD
37	PLANT SECURITY FENCE
38	RETAINING WALL
39	BACKUP GENERATOR
40	PIPERACK
41	IMPERMEABLE VAPOR BARRIER
42	RO PRODUCT TANK
43	CONST. MARINE OFF-LOADING FACILITIES AREA (CONST. MOF)
44	DEMIN WATER STORAGE TANK
45	WASTEWATER TREATMENT PACKAGE PLANT
46	LAYDOWN AREA
47	DUMP CONDENSER
48	BURIED STORM WATER INFILTRATION CHAMBER
49	BOG VFD ENCLOSURE
50	PERMEABLE VAPOR BARRIER
51	TSUNAMI WALL (ELEVATION VARIES TO SUIT THE DESIGN TSUNAMI)
52	METEOROLOGICAL MAST LOCATED WEST OF THE SITE NEAR INDUSTRIAL WASTEWATER LAGOON

ITEM	FACILITIES LEGEND
A	MAIN GUARD HOUSE / SECURITY BUILDING
B	TUG FACILITY BUILDING
C	PLANT WAREHOUSE
D	MAINTENANCE BUILDING
E	OPERATIONS BUILDING (INCLUDES CONTROL ROOM)
F	WATER TREATMENT BUILDING
G	FACILITY FIREWATER PUMPS WITH BUILDING
H	LUBE OIL, PAINT AND COMPRESSED GAS STORAGE
J	FACILITY AUX POWERHOUSE ENCLOSURE
K	POWERHOUSE ENCLOSURE
L	FIREWATER VALVE HOUSE
M	SECONDARY ENTRANCE SECURITY GATE/TERMINAL GUARD BUILDING
N	MARINE POWERHOUSE ENCLOSURE
P	FIRE DEPARTMENT
Q	GC TRAIN 1 POWERHOUSE ENCLOSURE
R	CEMS BUILDING (HRSG PKG)
S	INSPECTION STATION SHELTER
T	MARINE AREA GUARD HOUSE
U	TUG BOAT BERTH



WIND ROSE - ANNUAL
NORTH BEND MUNICIPAL AIRPORT
(PERCENT OF TIME)



NOTES:

1. ELEVATIONS NOTED ARE NAVD88.

LEGEND:

- SECURITY FENCE
- DEMARCATION FENCE
- PROPERTY BOUNDARY
- ASPHALT PAVED ROADS AND PARKING
- GRAVEL ROADS AND PARKING
- IMPERMEABLE VAPOR BARRIER WITH SECURITY
- PERMEABLE VAPOR BARRIER

300' 150' 0 300' 600'

1"=300'

KBJ
JORDAN COVE LNG

Jordan Cove LNG℠

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SIGNED

DATE REG NO.

DESIGNER HHS | DRAWN ECB
CHECKED | DATE 03/FEB/16

JORDAN COVE LNG PROJECT

LIQUEFACTION PLOT PLAN

PROJECT 189980-0000 | DRAWING NUMBER FG2001 | REV 1

JCLNG NUMBER J1-000-TEC-PLT-KBJ-51001-01 | REV 1

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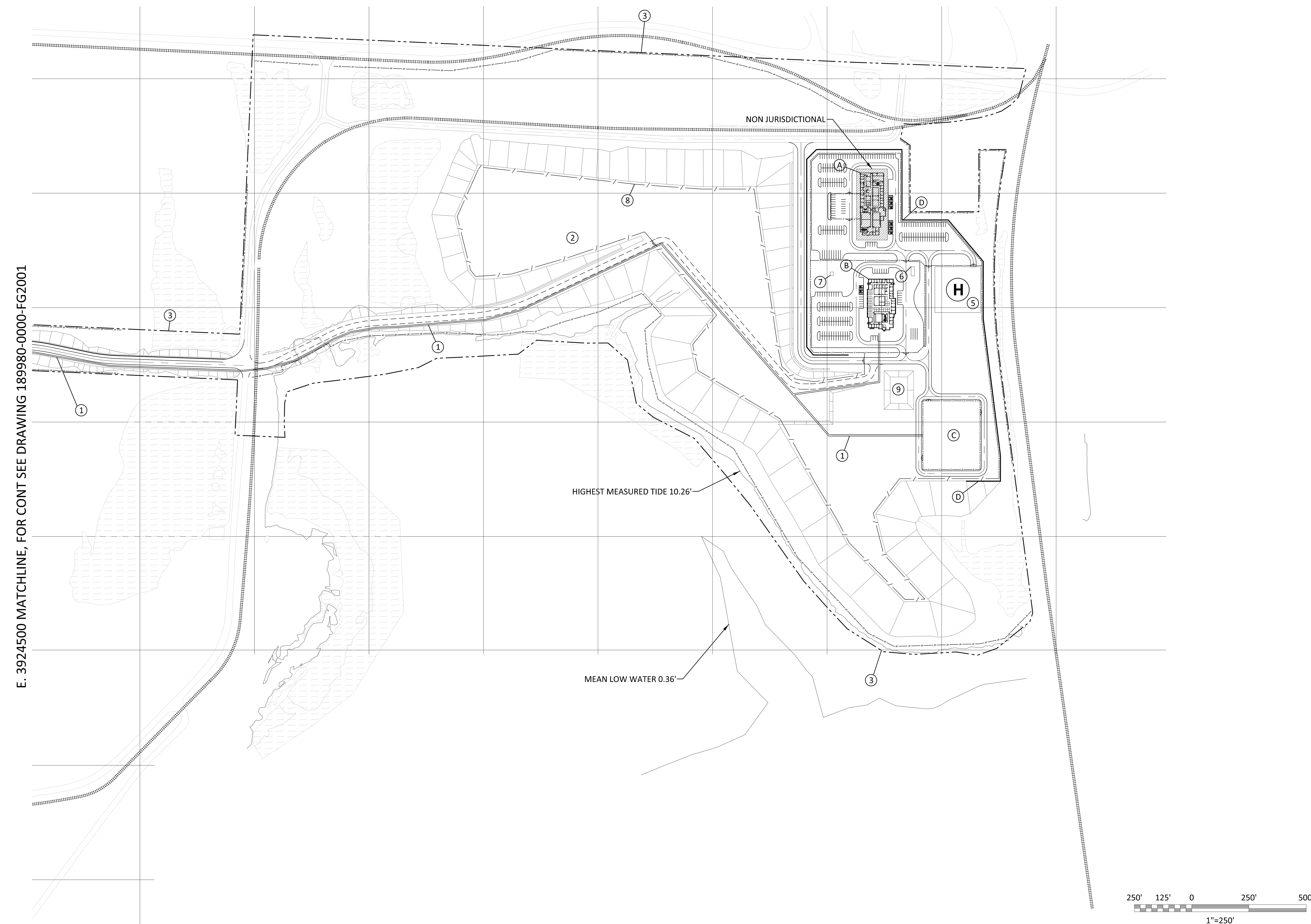
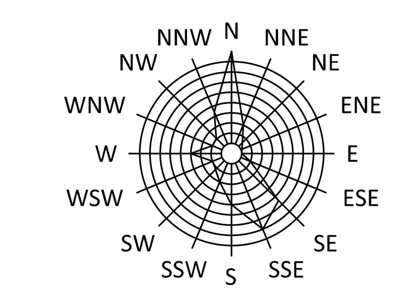
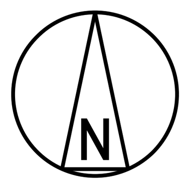


ITEM	FACILITIES LEGEND
A	SORSC BUILDING
B	ADMINISTRATION BUILDING
C	GAS METERING STATION
D	RETAINING WALL

ITEM	FACILITIES LEGEND
1	ACCESS AND UTILITY CORIDOR (SEE NOTE 3)
2	TEMPORARY CONSTRUCTION FACILITIES
3	PROPERTY BOUNDARY
4	PG&E SWITCHYARD EASEMENT
5	HELI-PAD
6	WASTEWATER TREATMENT PACKAGE PLANT
7	COMMUNICATIONS TOWER
8	PLANT SECURITY FENCE
9	VEGETATED INFILTRATION BASIN



WIND ROSE - ANNUAL
NORTH BEND MUNICIPAL AIRPORT
(PERCENT OF TIME)



NOTES:

1. ELEVATIONS NOTED ARE NAVD88.
2. FOR OVERALL PLOT PLAN, SEE DRAWING 189980-0000-FG2000.
3. THE ACCESS AND UTILITY CORRIDOR CONTAINS THE FOLLOWING BURIED LINES. CORRIDOR WILL BE ROUTED ON JCLNG LAND.
   * FEED GAS LINE
   * FIRE WATER SUPPLY TO ADMIN AND SORSC BUILDINGS
   * POWER TO ADMIN BUILDING
   * IT AND SECURITY TO ADMIN AND SORSC BUILDINGS
   * CONTROL CABLING FROM METERING STATION

LEGEND:

SECURITY FENCE

DEMARCATION FENCE

ASPHALT PAVED ROADS AND PARKING

GRAVEL ROADS AND PARKING

JORDAN COVE LNG

Jordan Cove LNG℠

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0	03/MAR/17	ISSUED FOR FERC DRAFT FILING	HHS	HHS	-	EAH	SPH	0	03/APR/17	ISSUED FOR FERC DRAFT FILING	HHS	HHS	-	EAH	SPH

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JORDAN COVE LNG PROJECT

SOUTH DUNES PLOT PLAN

PROJECT DRAWING NUMBER	REV
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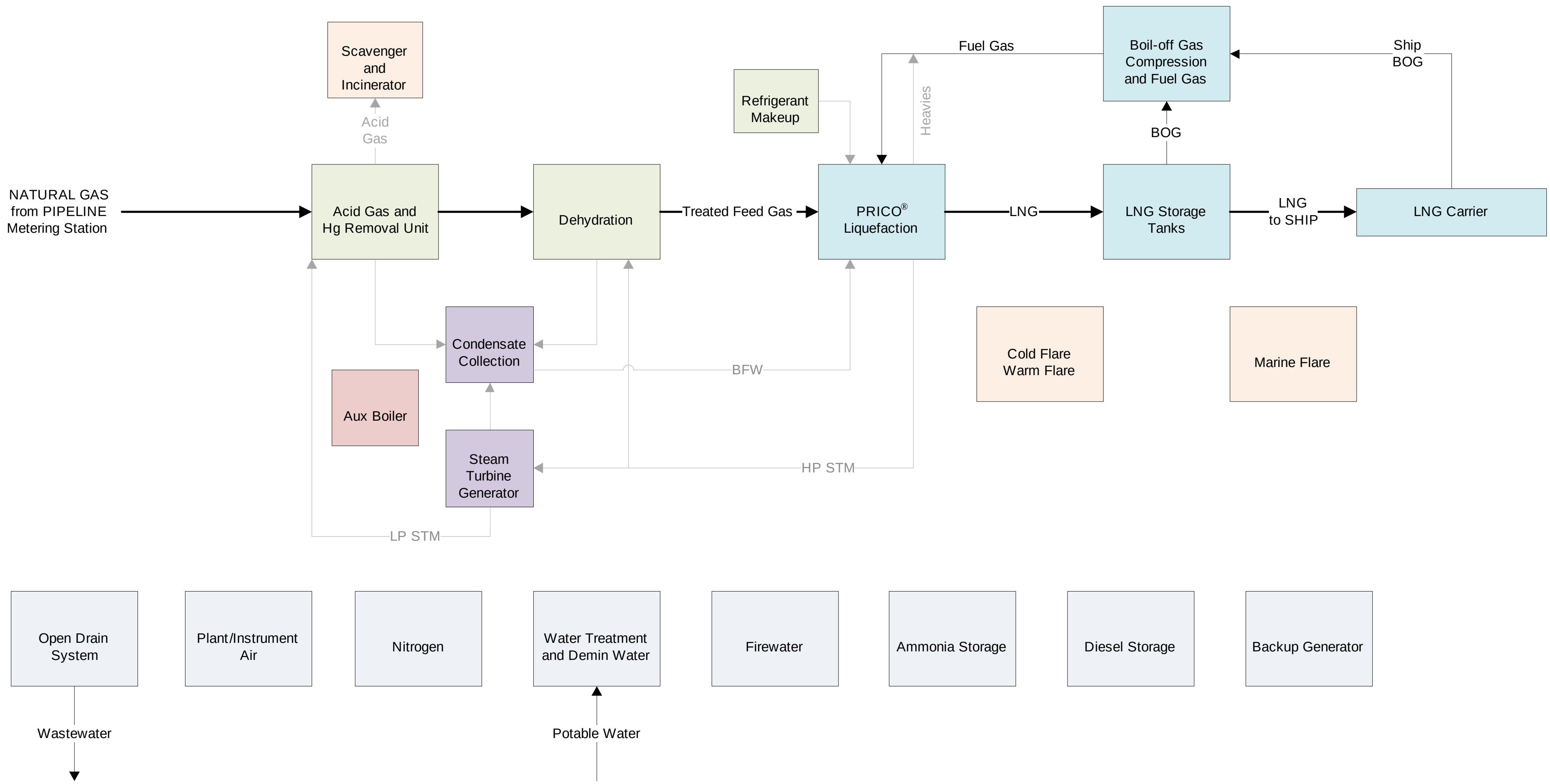
JCLNG NUMBER J1-000-TEC-PLT-KBJ-51002-01	1

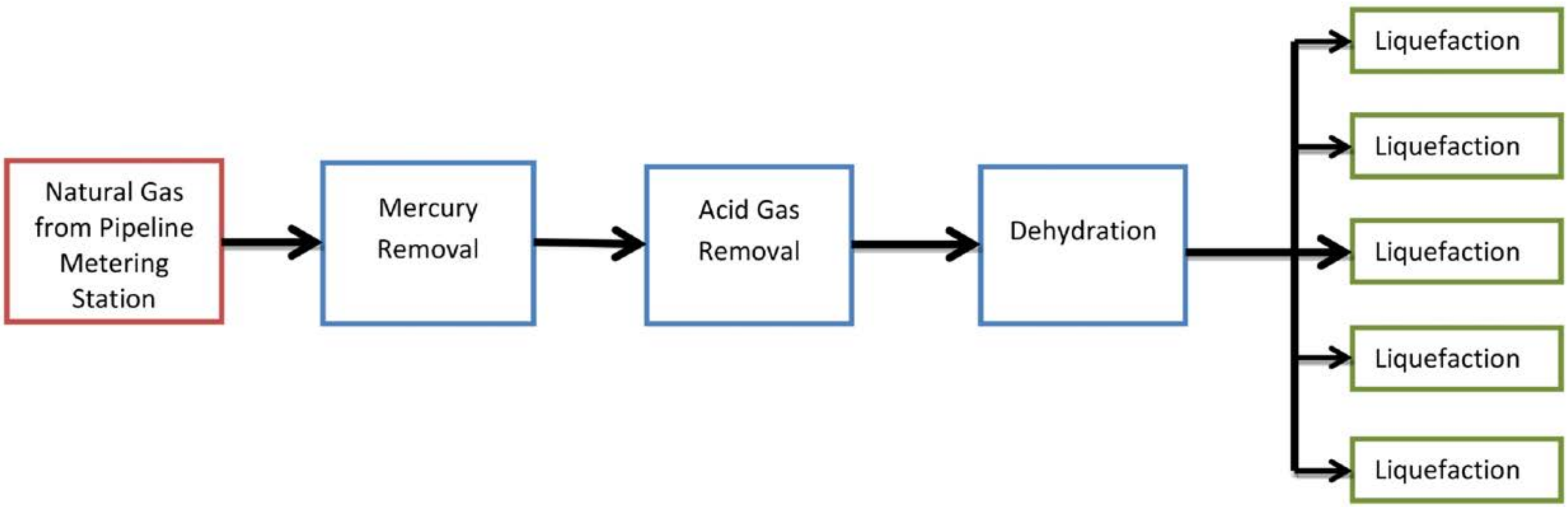


Jordan Cove Energy Project, L.P.

Jordan Cove Energy Project

Figure A-1

Block Flow Diagram

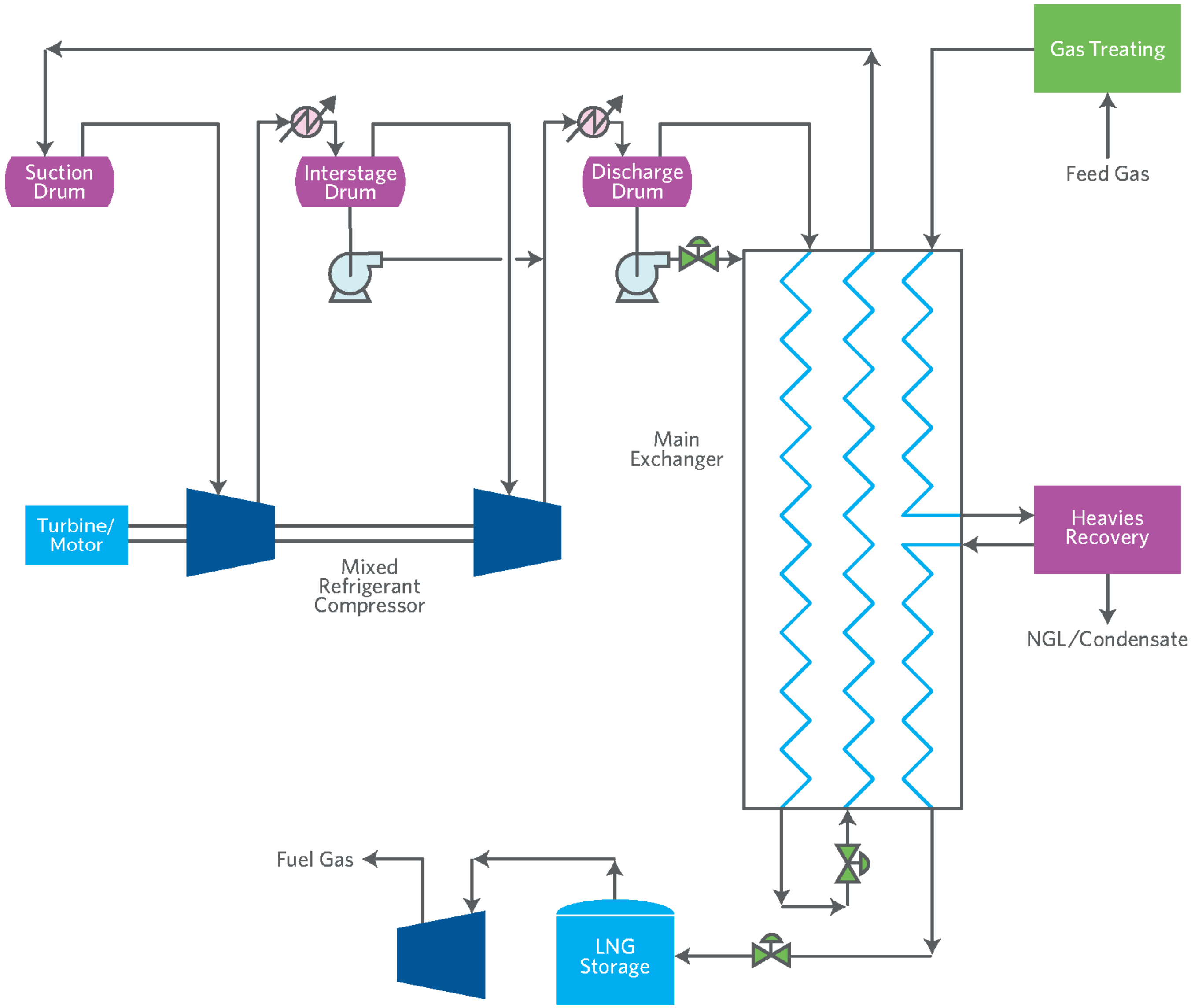


Jordan Cove Energy Project, L.P.

Jordan Cove Energy Project

Figure A-2

Gas Conditioning Train



Jordan Cove Energy Project, L.P.

Jordan Cove Energy Project

Figure A-3

PRICO LNG Process

Facility Name: JCEP LNG Terminal Project Permit Number:

Engine Information

1.	Device ID Number	EUs 1.CT through 5.CT (Turbines)
2.	Existing or future?	Future
3.	Date construction commenced	January 2019
4.	Date installed/completed	April 2022 (1.CT) - July 2022 (5.CT)
5.	Special controls (if applicable)	No
6.	Manufacturer	General Electric
7.	Date manufactured	
8.	Maximum rating (MMbtu/hr for turbines, Hp for others)	504.4 turbine, 19.7 duct burner
9.	Control device(s) (yes/no)	Yes
	If yes, enter the identification number(s)	CD.SCR1-5, CD.OC1-5
10.	Description of device:	

Natural gas/ boil off gas- fired, combined cycle General Electric LM6000PF+ turbines to drive refrigeration compressors for five liquefaction trains. Each turbine is equipped with a duct burner and operates in combined cycle mode with a heat recovery steam generator.

Operating Schedule

11.	Projected maximum hours/day	24
12.	Projected maximum hours/year	8,760

Fuel Information

13. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	Natural Gas/ BOG	0.530 MMscf/hr	4,641 MMscf
Back-up			
Other			

Stack Information

14.	Exit height (ft)	119
15.	Exit diameter (ft)	10
16.	Design flowrate (dscf/min)	

Monitoring Information

17. Monitoring equipment			
fuel flow (y/n)	Yes	recorder? (y/n)	Yes
engine load (y/n)	Yes	recorder? (y/n)	Yes
other (specify)	CEMS	recorder? (y/n)	Yes

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project

Permit Number:

1.	Control Device ID	CD.SCR1 through CD.SCR5 (Selective Catalytic Reduction)
2.	Process/Device(s) Controlled	EUs 1.CT through 5.CT (combined-cycle turbines)
3.	Year installed	2022
4.	Manufacturer/Model No.	
5.	Control Efficiency (%)	NOx reduction- 92.0 %wt
6.	Design inlet gas flow rate (acfm)	790,170 acfm
7.	Design parameter(s)	Exhaust gas flow rate and NOx concentration
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No
9.	Describe the control device	

Each combined cycle liquefaction turbine has an SCR system on the HRSG exhaust to reduce emissions of NOx.

MISCELLANEOUS **FORM AQ307**
CONTROL DEVICE INFORMATION **ANSWER SHEET**

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project Permit Number:

1.	Control Device ID	CD.OC1 through CD.OC5 (Oxidation Catalyst)
2.	Process/Device(s) Controlled	EUs 1.CT through 5.CT (combined-cycle turbines)
3.	Year installed	2022
4.	Manufacturer/Model No.	
5.	Control Efficiency (%)	CO reduction- 84.6%wt VOC reduction- 30.0%wt
6.	Design inlet gas flow rate (acfm)	790,170 acfm (CTG exhaust gas flow)
7.	Design parameter(s)	Exhaust flow rate and CO concentration
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No
9.	Describe the control device	

Each combined cycle liquefaction turbine has an oxidation catalyst on the HRSG exhaust to reduce emissions of CO and VOC.

JORDAN COVE
Turbine Stack Parameters

CASE NUMBER	1	2	5	6	7	8	13	14	15
Ambient Dry Bulb Temperature, ° F	42.0	42.0	59.0	59.0	59.0	59.0	90.0	90.0	90.0
CTG Manufacturer	OEM	OEM	OEM	OEM	OEM	OEM	OEM	OEM	OEM
CTG Model	GE LM6000PF+	GE LM6000PF+	GE LM6000PF+	GE LM6000PF+	GE LM6000PF+	GE LM6000PF+	GE LM6000PF+	GE LM6000PF+	GE LM6000PF+
CTG Combustor Type	0	0	0	0	0	0	0	0	0
CTG Load, percent of base load	BASE	BASE	50.0	75.0	BASE	BASE	50.0	75.0	BASE
CTG Fuel Type	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
CTG Inlet Air Cooling Type	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller
CTG Inlet Air Cooling Status, On/Off	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Duct Burner Fuel Type	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
HRSG Duct Firing	Fired	Unfired	Unfired	Unfired	Unfired	Fired	Unfired	Unfired	Unfired
Post Combustion NOx Emissions Control	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
Post Combustion CO Emissions Control	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst
Number Shutdowns/cold start events per year (per train)	12	12	12	12	12	12	12	12	12
Fuel Composition (Ultimate Analysis by Weight)									
Ar, % wt.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C, % wt.	65.87	65.87	68.20	68.20	68.20	68.20	68.20	68.20	68.20
H2, % wt.	22.09	22.09	22.67	22.67	22.67	22.67	22.67	22.67	22.67
N2, % wt.	12.02	12.02	8.60	8.60	8.60	8.60	8.60	8.60	8.60
O2, % wt.	0.01	0.01	0.29	0.29	0.29	0.29	0.29	0.29	0.29
S, % wt.	0.00329	0.00329	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333
Total, % wt.	100.00	100.00	99.76	99.76	99.76	99.76	99.76	99.76	99.76
Fuel Sulfur Content (grains/100 standard cubic feet)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fuel LHV, Btu/lb	18,911	18,911	19,359	19,359	19,359	19,359	19,359	19,359	19,359
Fuel HHV, Btu/lb	21,012	21,012	21,500	21,500	21,500	21,500	21,500	21,500	21,500
COMBUSTION TURBINE PERFORMANCE									
CTG Load Level, percent of base load	BASE	BASE	50.0	75.0	BASE	BASE	50.0	75.0	BASE
Gross CTG Output, kW	55,607	55,607	25,794	38,692	51,589	51,589	22,189	33,283	44,378
Gross CTG Heat Rate, Btu/kWh (LHV)	8,164	8,164	11,426	9,209	8,318	8,318	12,221	9,716	8,670
Gross CTG Heat Rate, Btu/kWh (HHV)	9,071	9,071	12,689	10,227	9,238	9,238	13,572	10,790	9,629
CTG Heat Input, MBtu/h (LHV)	454.0	454.0	294.7	356.3	429.1	429.1	271.2	323.4	384.7
CTG Heat Input, MBtu/h (HHV)	504.4	504.4	327.3	395.7	476.6	476.6	301.2	359.1	427.3
HRSG DUCT BURNERS									
Duct Burner Heat Input, MBtu/h (LHV)	17.7	0.0	0.0	0.0	0.0	7.8	0.0	0.0	0.0
Duct Burner Heat Input, MBtu/h (HHV)	19.7	0.0	0.0	0.0	0.0	8.7	0.0	0.0	0.0
Total Duct Burner Fuel Flow, lb/h	936	0	0	0	0	403	0	0	0
STACK PARAMETERS									
Stack Height (ft)	119	119	119	119	119	119	119	119	119
Exhaust Temperature (F)	242.8	242.8	420.0	420.0	420.0	420.0	420.0	420.0	420.0
Exhaust Velocity (ft/s)	71	71	60	73	85	85	55	66	76
Stack Diameter (ft)	10	10	10	10	10	10	10	10	10
Stack Orientation	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical	Vertical
Stack Capped?	No	No	No	No	No	No	No	No	No
Hours/Year (Each CT)	8760	8760	8760	8760	8760	8760	8760	8760	8760
Hours/Year (Duct Firing for each CT)	4000	N/A	N/A	N/A	N/A	4000	N/A	N/A	N/A
STACK EMISSIONS									
NOx (lb/hr)	3.8	3.7	2.4	2.9	3.5	3.5	2.2	2.6	3.1
NOx, ppmvd (dry, 15% O2)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
NOx, ppmvd (dry)	2.3	2.2	2.1	2.1	2.2	2.2	2.2	2.2	2.2
CO (lb/hr)	4.6	4.4	2.8	3.4	4.1	4.2	2.6	3.1	3.6
CO, ppmvd (dry, 15% O2)	4.0	4.0	3.8	3.8	3.8	3.9	3.8	3.8	3.8
CO, ppmvd (dry)	4.6	4.4	4.1	4.1	4.2	4.4	4.2	4.2	4.3
VOC (lb/hr)	1.7	1.3	0.9	1.1	1.3	1.4	0.8	1.0	1.1
VOC, ppmvd (dry, 15% O2)	2.5	2.1	2.1	2.1	2.1	2.3	2.1	2.1	2.1
VOC, ppmvd (dry)	2.9	2.3	2.2	2.2	2.3	2.6	2.3	2.3	2.4
PM (lb/hr)	5.4	4.9	4.0	4.1	4.2	4.7	4.0	4.0	4.1
PM_{10} (lb/hr)	5.4	4.9	4.0	4.1	4.2	4.7	4.0	4.0	4.1
$PM_{2.5}$ (lb/hr)	5.4	4.9	4.0	4.1	4.2	4.7	4.0	4.0	4.1
SO_2 (lb/hr)	1.64	1.58	1.01	1.22	1.48	1.5	0.93	1.11	1.32
H_2SO_4 (lb/hr)	0.50	0.48	0.37	0.45	0.54	0.73	0.34	0.41	0.48
CO_2 (lb/hr)	60,218	57,958	38,037	46,009	55,406	56,412	35,013	41,735	49,658
CO_2e (lb/hr)	61,393	59,093	38,775	46,901	56,482	57,490	35,689	42,535	50,609

PROJECT NAME: JORDAN COVE LNG

PROJECT NUMBER: 189920 | REVISION: 4 | DATE: 11-JUL-2016

CASE NUMBER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ambient Dry Bulb Temperature, ° F	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
Configuration	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC	CC
CTG Manufacturer	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE
CTG Model	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+	LM6000PF+
CTG Combustor Type	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN	DLN
CTG Load, percent of base load	50.0	75.0	100.0	100.0	50.0	75.0	100.0	100.0	50.0	75.0	100.0	100.0	50.0	75.0	100.0	100.0
CTG Fuel Type	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
CTG Inlet Air Cooling Type	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller	Chiller
CTG Inlet Air Cooling Status, On/Off	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
Duct Burner Fuel Type	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
HRSG Duct Firing	Unfired	Unfired	Unfired	Fired	Unfired	Unfired	Unfired	Fired	Unfired	Unfired	Unfired	Unfired	Unfired	Unfired	Unfired	Fired
Post Combustion NOx Emissions Control	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR	SCR
Post Combustion CO Emissions Control	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst	CO Catalyst
AMBIENT CONDITIONS																
Ambient Dry Bulb Temperature, ° F	59.0	59.0	59.0	59.0	59.0	59.0	59.0	59.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0	90.0
Ambient Relative Humidity, %	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0	85.0
Atmospheric Pressure, psia	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696	14.696
COMBUSTION TURBINE PERFORMANCE																
CTG Performance Reference	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE	GE
CTG Inlet Air Conditioning Effectiveness, percent	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CTG Compressor Inlet Dry Bulb Temperature, ° F	64.0	64.0	64.0	64.0	45.0	45.0	45.0	45.0	95.0	95.0	95.0	95.0	73.0	73.0	73.0	73.0
CTG Compressor Inlet Relative Humidity, percent	70.3	70.3	70.3	70.3	100.0	100.0	100.0	100.0	71.9	71.9	71.9	71.9	100.0	100.0	100.0	100.0
Inlet Loss, in. H2O	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Exhaust Loss, in. H2O	17.3	18.8	20.4	20.4	17.6	19.1	20.9	20.9	16.8	18.0	19.3	19.3	17.2	18.5	20.1	20.1
CTG Load Level, percent of base load	50.0	75.0	100.0	100.0	50.0	75.0	100.0	100.0	50.0	75.0	100.0	100.0	50.0	75.0	100.0	100.0
Gross CTG Output, kW	25,794	38,692	51,589	51,589	27,581	41,371	55,162	55,162	22,189	33,283	44,378	44,378	24,672	37,008	49,343	49,343
Gross CTG Heat Rate, Btu/kWh (LHV)	11,426	9,209	8,318	8,318	10,999	9,001	8,165	8,165	12,221	9,716	8,670	8,670	11,656	9,199	8,420	8,420
Gross CTG Heat Rate, Btu/kWh (HHV)	12,689	10,227	9,238	9,238	12,216	9,996	9,069	9,069	13,572	10,790	9,629	9,629	12,945	10,217	9,352	9,352
CTG Heat Input, MBtu/h (LHV)	294.7	356.3	429.1	429.1	303.4	372.4	450.4	450.4	271.2	323.4	384.7	384.7	287.6	340.5	415.5	415.5
CTG Heat Input, MBtu/h (HHV)	327.3	395.7	476.6	476.6	336.9	413.6	500.2	500.2	301.2	359.1	427.3	427.3	319.4	378.1	461.4	461.4
CTG Water/Steam Injection Flow, lb/h	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Injection Fluid/Fuel Ratio	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CTG Exhaust Flow, lb/h	754,596	912,888	1,057,932	1,057,932	790,200	953,028	1,108,152	1,108,152	680,868	816,948	944,100	944,100	732,384	884,808	1,024,200	1,024,200
CTG Exhaust Temperature, ° F	1,438	1,406	1,411	1,411	1,410	1,389	1,393	1,393	1,488	1,448	1,444	1,444	1,453	1,417	1,420	1,420
COMBUSTION TURBINE FUEL																
Total CTG Fuel Flow, lb/h	15,220	18,410	22,170	22,170	15,670	19,240	23,270	23,270	14,010	16,700	19,870	19,870	14,860	17,590	21,460	21,460
CTG Fuel Temperature, ° F	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0	150.0
CTG Fuel LHV, Btu/lb	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359
CTG Fuel HHV, Btu/lb	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500
HHV/LHV Ratio	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106	1.1106
CTG Fuel Composition (Ultimate Analysis by Weight)																
Ar, % wt.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C, % wt.	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20
H2, % wt.	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67
N2, % wt.	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60
O2, % wt.	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
S, % wt.	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333
Total, % wt.	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76
Fuel Sulfur Content (grains/100 standard cubic feet)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fuel Sulfur Content, ppm	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3	33.3

CASE NUMBER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
COMBUSTION TURBINE EXHAUST																
CTG EXHAUST ANALYSIS (VOLUME BASIS - WET)																
Ar, % vol.	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92
CO2, % vol.	3.25	3.25	3.38	3.38	3.20	3.26	3.39	3.39	3.29	3.27	3.36	3.36	3.26	3.19	3.36	3.36
H2O, % vol.	7.83	7.82	8.07	8.07	7.33	7.44	7.70	7.70	10.41	10.37	10.55	10.55	9.12	9.00	9.33	9.33
N2, % vol.	74.47	74.47	74.38	74.38	74.82	74.78	74.68	74.68	72.48	72.50	72.43	72.43	73.46	73.51	73.38	73.38
O2, % vol.	13.52	13.52	13.24	13.24	13.71	13.58	13.30	13.30	12.91	12.96	12.75	12.75	13.24	13.38	13.01	13.01
SO2, (after SO2 oxidation), % vol.	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006	0.00006
SO3, (after SO2 oxidation), % vol.	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Total, % vol.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Molecular Wt, lb/mol	28.40	28.40	28.39	28.39	28.45	28.45	28.43	28.43	28.12	28.13	28.11	28.11	28.26	28.27	28.25	28.25
Specific Volume, ft^3/lb	46.78	45.83	45.80	45.80	45.98	45.31	45.25	45.25	48.54	47.43	47.19	47.19	47.40	46.36	46.29	46.29
Specific Volume, scf/lb	13.36	13.36	13.36	13.36	13.33	13.34	13.34	13.34	13.49	13.49	13.49	13.49	13.42	13.42	13.43	13.43
Exhaust Gas Flow, acfm	588,333	697,294	807,555	807,555	605,557	719,695	835,731	835,731	550,822	645,797	742,535	742,535	578,583	683,662	790,170	790,170
Exhaust Gas Flow, scfm	168,023	203,270	235,566	235,566	175,556	211,890	246,379	246,379	153,082	183,677	212,265	212,265	163,810	197,902	229,250	229,250
CTG NOX EMISSIONS (WITHOUT POST COMBUSTION EMISSIONS CONTROL)																
NOx Massflow Added to Match CTG Manufacturer's NOx Emissio	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NOx, ppmvd (dry, 15% O2)	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
NOx, ppmvd (dry)	26.4	26.4	27.5	27.5	25.9	26.4	27.5	27.5	27.4	27.3	28.1	28.1	26.8	26.2	27.7	27.7
NOx, ppmvw (wet)	24.3	24.3	25.3	25.3	24.0	24.4	25.4	25.4	24.6	24.4	25.1	25.1	24.4	23.9	25.1	25.1
NOx, lb/h as NO2	29.7	36.0	43.3	43.3	30.6	37.6	45.5	45.5	27.4	32.6	38.8	38.8	29.0	34.4	41.9	41.9
NOx, lb/MBtu (LHV) as NO2	0.1009	0.1010	0.1010	0.1010	0.1010	0.1010	0.1010	0.1010	0.1010	0.1009	0.1009	0.1009	0.1010	0.1010	0.1010	0.1010
NOx, lb/MBtu (HHV) as NO2	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909
CTG CO EMISSIONS (WITHOUT POST COMBUSTION EMISSIONS CONTROL)																
CO Massflow Added to Match CTG Manufacturer's CO Emissions	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO, ppmvd (dry, 15% O2)	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
CO, ppmvd (dry)	26.4	26.4	27.5	27.5	25.9	26.4	27.5	27.5	27.4	27.3	28.1	28.1	26.8	26.2	27.7	27.7
CO, ppmvw (wet)	24.3	24.3	25.3	25.3	24.0	24.4	25.4	25.4	24.6	24.4	25.1	25.1	24.4	23.9	25.1	25.1
CO, lb/h	18.1	21.9	26.4	26.4	18.6	22.9	27.7	27.7	16.7	19.9	23.6	23.6	17.7	20.9	25.5	25.5
CO, lb/MBtu (LHV)	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615
CO, lb/MBtu (HHV)	0.0553	0.0554	0.0554	0.0554	0.0553	0.0554	0.0554	0.0554	0.0554	0.0553	0.0553	0.0553	0.0554	0.0554	0.0553	0.0553
CTG SO2 EMISSIONS (WITHOUT THE EFFECTS OF SO2 OXIDATION)																
SO2, ppmvd (dry, 15% O2)	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
SO2, ppmvd (dry)	0.65	0.65	0.67	0.67	0.63	0.64	0.67	0.67	0.67	0.67	0.69	0.69	0.66	0.64	0.68	0.68
SO2, ppmvw (wet)	0.60	0.59	0.62	0.62	0.59	0.60	0.62	0.62	0.60	0.60	0.61	0.61	0.60	0.58	0.61	0.61
SO2, lb/h	1.01	1.22	1.48	1.48	1.04	1.28	1.55	1.55	0.93	1.11	1.32	1.32	0.99	1.17	1.43	1.43
SO2, lb/MBtu (LHV)	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034
SO2, lb/MBtu (HHV)	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031

BLACK & VEATCH

CASE NUMBER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
CTG SO2 EMISSIONS (WITH THE EFFECTS OF SO2 OXIDATION, WITHOUT POST COMBUSTION EMISSIONS CONTROL)																
Assumed SO2 oxidation rate in CTG, vol%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SO2, ppmvd (dry, 15% O2)	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
SO2, ppmvd (dry)	0.63	0.63	0.66	0.66	0.62	0.63	0.66	0.66	0.66	0.65	0.67	0.67	0.64	0.63	0.66	0.66
SO2, ppmvw (wet)	0.58	0.58	0.61	0.61	0.57	0.58	0.61	0.61	0.59	0.59	0.60	0.60	0.58	0.57	0.60	0.60
SO2, lb/h	0.99	1.20	1.45	1.45	1.02	1.25	1.52	1.52	0.91	1.09	1.30	1.30	0.97	1.15	1.40	1.40
SO2, lb/MBtu (LHV)	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034
SO2, lb/MBtu (HHV)	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
CTG VOC EMISSIONS (WITHOUT POST COMBUSTION EMISSIONS CONTROL)																
VOC Massflow Added to Match CTG Manufacturer's VOC Emissi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VOC percentage of UHC	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
VOC, ppmvd (dry, 15% O2)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
VOC, ppmvd (dry)	3.2	3.2	3.3	3.3	3.1	3.2	3.3	3.3	3.3	3.3	3.4	3.4	3.2	3.1	3.3	3.3
VOC, ppmvw (wet)	2.9	2.9	3.0	3.0	2.9	2.9	3.0	3.0	3.0	2.9	3.0	3.0	2.9	2.9	3.0	3.0
VOC, lb/h as CH4	1.2	1.5	1.8	1.8	1.3	1.6	1.9	1.9	1.1	1.4	1.6	1.6	1.2	1.4	1.8	1.8
VOC, lb/MBtu as CH4 (LHV)	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042
VOC, lb/MBtu as CH4 (HHV)	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038
CTG CO2 EMISSIONS																
CO2, lb/h	38,037	46,009	55,406	55,406	39,161	48,083	58,155	58,155	35,013	41,735	49,658	49,658	37,137	43,960	53,631	53,631
CO2, lb/MBtu (LHV)	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129
CO2, lb/MBtu (HHV)	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116
CTG PARTICULATE EMISSIONS (WITHOUT THE EFFECTS OF SO2 OXIDATION)																
PARTICULATE EMISSIONS - FRONT HALF CATCH ONLY																
Particulate, lb/h	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
Particulate, lb/MBtu (LHV)	0.0059	0.0049	0.0041	0.0041	0.0058	0.0047	0.0039	0.0039	0.0064	0.0054	0.0045	0.0045	0.0061	0.0051	0.0042	0.0042
Particulate, lb/MBtu (HHV)	0.0053	0.0044	0.0037	0.0037	0.0052	0.0042	0.0035	0.0035	0.0058	0.0049	0.0041	0.0041	0.0055	0.0046	0.0038	0.0038
PARTICULATE EMISSIONS - FRONT AND BACK HALF CATCH																
Particulate, lb/h	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Particulate, lb/MBtu (LHV)	0.0119	0.0098	0.0081	0.0081	0.0115	0.0094	0.0078	0.0078	0.0129	0.0108	0.0091	0.0091	0.0122	0.0103	0.0084	0.0084
Particulate, lb/MBtu (HHV)	0.0107	0.0088	0.0073	0.0073	0.0104	0.0085	0.0070	0.0070	0.0116	0.0097	0.0082	0.0082	0.0109	0.0092	0.0076	0.0076
CTG PM10 EMISSIONS (WITHOUT THE EFFECTS OF SO2 OXIDATION)																
PM10 EMISSIONS - FRONT HALF CATCH ONLY																
PM10, lb/h	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
PM10, lb/MBtu (LHV)	0.0059	0.0049	0.0041	0.0041	0.0058	0.0047	0.0039	0.0039	0.0064	0.0054	0.0045	0.0045	0.0061	0.0051	0.0042	0.0042
PM10, lb/MBtu (HHV)	0.0053	0.0044	0.0037	0.0037	0.0052	0.0042	0.0035	0.0035	0.0058	0.0049	0.0041	0.0041	0.0055	0.0046	0.0038	0.0038
PM10 EMISSIONS - FRONT AND BACK HALF CATCH																
PM10, lb/h	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
PM10, lb/MBtu (LHV)	0.0119	0.0098	0.0081	0.0081	0.0115	0.0094	0.0078	0.0078	0.0129	0.0108	0.0091	0.0091	0.0122	0.0103	0.0084	0.0084
PM10, lb/MBtu (HHV)	0.0107	0.0088	0.0073	0.0073	0.0104	0.0085	0.0070	0.0070	0.0116	0.0097	0.0082	0.0082	0.0109	0.0092	0.0076	0.0076
CTG PM2.5 EMISSIONS (WITHOUT THE EFFECTS OF SO2 OXIDATION)																
PM2.5 EMISSIONS - FRONT HALF CATCH ONLY																
PM2.5, lb/h	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
PM2.5, lb/MBtu (LHV)	0.0059	0.0049	0.0041	0.0041	0.0058	0.0047	0.0039	0.0039	0.0064	0.0054	0.0045	0.0045	0.0061	0.0051	0.0042	0.0042
PM2.5, lb/MBtu (HHV)	0.0053	0.0044	0.0037	0.0037	0.0052	0.0042	0.0035	0.0035	0.0058	0.0049	0.0041	0.0041	0.0055	0.0046	0.0038	0.0038
PM2.5 EMISSIONS - FRONT AND BACK HALF CATCH																
PM2.5, lb/h	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
PM2.5, lb/MBtu (LHV)	0.0119	0.0098	0.0081	0.0081	0.0115	0.0094	0.0078	0.0078	0.0129	0.0108	0.0091	0.0091	0.0122	0.0103	0.0084	0.0084
PM2.5, lb/MBtu (HHV)	0.0107	0.0088	0.0073	0.0073	0.0104	0.0085	0.0070	0.0070	0.0116	0.0097	0.0082	0.0082	0.0109	0.0092	0.0076	0.0076

BLACK & VEATCH

CASE NUMBER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
HRSG DUCT BURNERS																
DUCT BURNER FUEL																
Duct Burner Heat Input, MBtu/h (LHV)	0.0	0.0	0.0	7.8	0.0	0.0	0.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Duct Burner Heat Input, MBtu/h (HHV)	0.0	0.0	0.0	8.7	0.0	0.0	0.0	20.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Total Duct Burner Fuel Flow, lb/h	0	0	0	403	0	0	0	973	0	0	0	0	0	0	0	144
Duct Burner Fuel LHV, Btu/lb	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359	19,359
Duct Burner Fuel HHV, Btu/lb	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500	21,500
Duct Burner Fuel Composition (Ultimate Analysis by Weight)																
Ar, % wt.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C, % wt.	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20	68.20
H2, % wt.	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67	22.67
N2, % wt.	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60	8.60
O2, % wt.	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29
S, % wt.	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333	0.00333
Total, % wt.	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76	99.76
Fuel Sulfur Content (grains/100 standard cubic feet)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
DUCT BURNER EMISSIONS																
Duct Burner NOx, lb/MBtu (HHV)	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800	0.0800
Duct Burner CO, lb/MBtu (HHV)	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000
Duct Burner VOC (as CH4), lb/MBtu (HHV)	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240
Duct Burner Particulate, lb/MBtu (HHV) (front half catch only)	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Duct Burner Particulate, lb/MBtu (HHV) (front and back half ca	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240
Duct Burner PM10, lb/MBtu (HHV) (front half catch only)	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Duct Burner PM10, lb/MBtu (HHV) (front and back half catch)	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240
Duct Burner PM2.5, lb/MBtu (HHV) (front half catch only)	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100	0.0100
Duct Burner PM2.5, lb/MBtu (HHV) (front and back half catch)	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240	0.0240
Assumed SO2 oxidation rate in Duct Burner, vol%	0.0	0.0	0.0	10.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0
Total SO2, lb/h from Duct Burner Fuel only (after SO2 oxidatior	0.0000	0.0000	0.0000	0.0241	0.0000	0.0000	0.0000	0.0582	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0086
Total SO3, lb/h from Duct Burner Fuel only (after SO2 oxidatior	0.0000	0.0000	0.0000	0.0033	0.0000	0.0000	0.0000	0.0081	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012
Duct Burner NOx, lb/h	0.00	0.00	0.00	0.69	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25
Duct Burner CO, lb/h	0.00	0.00	0.00	0.87	0.00	0.00	0.00	2.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Duct Burner VOC (as CH4), lb/h	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07
Duct Burner Particulate, lb/h (front half catch only)	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Duct Burner Particulate, lb/h (front and back half catch)	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Duct Burner PM10, lb/h (front half catch only)	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Duct Burner PM10, lb/h (front and back half catch)	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Duct Burner PM2.5, lb/h (front half catch only)	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Duct Burner PM2.5, lb/h (front and back half catch)	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
STACK EMISSIONS																
STACK EXHAUST ANALYSIS (VOLUME BASIS - WET)																
Ar, % vol.	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.93	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92
CO2, % vol.	3.25	3.25	3.38	3.44	3.20	3.26	3.39	3.53	3.29	3.27	3.36	3.36	3.26	3.19	3.36	3.38
H2O, % vol.	7.83	7.82	8.07	8.19	7.33	7.44	7.70	7.96	10.41	10.37	10.55	10.55	9.12	9.00	9.33	9.37
N2, % vol.	74.47	74.47	74.38	74.33	74.82	74.78	74.68	74.58	72.48	72.50	72.43	72.43	73.46	73.51	73.38	73.37
O2, % vol.	13.52	13.52	13.24	13.11	13.71	13.58	13.30	13.00	12.91	12.96	12.75	12.75	13.24	13.38	13.01	12.96
SO2, (after SO2 oxidation), % vol.	0.00005	0.00005	0.00005	0.00004	0.00004	0.00005	0.00005	0.00004	0.00005	0.00005	0.00005	0.00005	0.00005	0.00004	0.00005	0.00004
SO3, (after SO2 oxidation), % vol.	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002
Total, % vol.	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Stack Exit Temperature, ° F	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0	420.0
Stack Diameter, ft (estimated)	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Stack Flow, lb/h	754,560	912,844	1,057,879	1,058,281	790,163	952,982	1,108,096	1,109,067	680,835	816,908	944,053	944,053	732,348	884,766	1,024,149	1,024,292
Stack Flow, scfm	168,023	203,270	235,566	235,832	175,556	211,890	246,379	246,780	153,082	183,677	212,265	212,265	163,810	197,902	229,250	229,282
Stack Flow, acfm	284,357	344,007	398,840	399,169	297,247	358,656	417,219	417,770	259,184	310,849	359,387	359,387	277,329	335,047	388,001	388,226
Stack Exit Velocity, ft/s	60	73	85	85	63	76	89	89	55	66	76	76	59	71	82	82
STACK NOX EMISSIONS WITHOUT THE EFFECTS OF SELECTIVE CATALYTIC REDUCTION (SCR) †																
NOx, ppmvd (dry, 15% O2)	25.0	25.0	25.0	24.9	25.0	25.0	25.0	24.9	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
NOx, ppmvd (dry)	26.4	26.4	27.5	28.0	25.9	26.4	27.5	28.5	27.4	27.3	28.1	28.1	26.8	26.2	27.7	27.9
NOx, ppmvw (wet)	24.3	24.3	25.3	25.7	24.0	24.4	25.4	26.3	24.6	24.4	25.1	25.1	24.4	23.9	25.1	25.3
NOx, lb/h as NO2	29.7	36.0	43.3	44.0	30.6	37.6	45.5	47.2	27.4	32.6	38.8	38.8	29.0	34.4	41.9	42.2
NOx, lb/MBtu (LHV) as NO2	0.1009	0.1010	0.1010	0.1008	0.1010	0.1010	0.1010	0.1005	0.1010	0.1009	0.1009	0.1009	0.1010	0.1010	0.1010	0.1009
NOx, lb/MBtu (HHV) as NO2	0.0909	0.0909	0.0909	0.0907	0.0909	0.0909	0.0909	0.0905	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0909	0.0908

† Note: includes NOx massflow added to match CTG manufacturer estimate and duct burner NOx.

CASE NUMBER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
STACK NOX EMISSIONS WITH THE EFFECTS OF SELECTIVE CATALYTIC REDUCTION (SCR) †																
NOx, ppmvd (dry, 15% O2)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
NOx, ppmvd (dry)	2.1	2.1	2.2	2.2	2.1	2.1	2.2	2.3	2.2	2.2	2.2	2.2	2.1	2.1	2.2	2.2
NOx, ppmvw (wet)	1.9	1.9	2.0	2.1	1.9	2.0	2.0	2.1	2.0	2.0	2.0	2.0	1.9	1.9	2.0	2.0
NOx, lb/h as NO2	2.4	2.9	3.5	3.5	2.5	3.0	3.6	3.8	2.2	2.6	3.1	3.1	2.3	2.8	3.4	3.4
NOx, lb/MBtu (LHV) as NO2	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081	0.0081
NOx, lb/MBtu (HHV) as NO2	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073
SCR NH3 slip, ppmvd (dry, 15% O2)	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
SCR NH3 slip, lb/h	2.20	2.66	3.21	3.27	2.27	2.78	3.37	3.51	2.03	2.42	2.88	2.88	2.15	2.55	3.11	3.13
† Note: includes NOx massflow added to match CTG manufacturer estimate and duct burner NOx.																
STACK CO EMISSIONS WITHOUT THE EFFECTS OF CATALYTIC REDUCTION (CO CATALYST) †																
CO, ppmvd (dry, 15% O2)	25.0	25.0	25.0	25.4	25.0	25.0	25.0	25.8	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.1
CO, ppmvd (dry)	26.4	26.4	27.5	28.4	25.9	26.4	27.5	29.6	27.4	27.3	28.1	28.1	26.8	26.2	27.7	28.1
CO, ppmvw (wet)	24.3	24.3	25.3	26.1	24.0	24.4	25.4	27.2	24.6	24.4	25.1	25.1	24.4	23.9	25.1	25.4
CO, lb/h	18.1	21.9	26.4	27.2	18.6	22.9	27.7	29.8	16.7	19.9	23.6	23.6	17.7	20.9	25.5	25.8
CO, lb/MBtu (LHV)	0.0615	0.0615	0.0615	0.0624	0.0615	0.0615	0.0615	0.0635	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0615	0.0618
CO, lb/MBtu (HHV)	0.0553	0.0554	0.0554	0.0561	0.0553	0.0554	0.0554	0.0571	0.0554	0.0553	0.0553	0.0553	0.0554	0.0554	0.0553	0.0556
† Note: includes CO massflow added to match CTG manufacturer estimate and duct burner CO.																
STACK CO EMISSIONS WITH THE EFFECTS OF CATALYTIC REDUCTION (CO CATALYST) †																
CO, ppmvd (dry, 15% O2)	3.8	3.8	3.8	3.9	3.8	3.8	3.8	4.0	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.9
CO, ppmvd (dry)	4.1	4.1	4.2	4.4	4.0	4.1	4.2	4.6	4.2	4.2	4.3	4.3	4.1	4.0	4.3	4.3
CO, ppmvw (wet)	3.7	3.7	3.9	4.0	3.7	3.8	3.9	4.2	3.8	3.8	3.9	3.9	3.8	3.7	3.9	3.9
CO, lb/h	2.8	3.4	4.1	4.2	2.9	3.5	4.3	4.6	2.6	3.1	3.6	3.6	2.7	3.2	3.9	4.0
CO, lb/MBtu (LHV)	0.0095	0.0095	0.0095	0.0096	0.0095	0.0095	0.0095	0.0098	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095
CO, lb/MBtu (HHV)	0.0085	0.0085	0.0085	0.0086	0.0085	0.0085	0.0085	0.0088	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0086
† Note: includes CO massflow added to match CTG manufacturer estimate and duct burner CO.																
STACK SO2 EMISSIONS WITHOUT THE EFFECTS OF SO2 OXIDATION †																
SO2, ppmvd (dry, 15% O2)	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
SO2, ppmvd (dry)	0.65	0.65	0.67	0.68	0.63	0.64	0.67	0.70	0.67	0.67	0.69	0.69	0.66	0.64	0.68	0.68
SO2, ppmvw (wet)	0.60	0.59	0.62	0.63	0.59	0.60	0.62	0.65	0.60	0.60	0.61	0.61	0.60	0.58	0.61	0.62
SO2, lb/h	1.01	1.22	1.48	1.50	1.04	1.28	1.55	1.61	0.93	1.11	1.32	1.32	0.99	1.17	1.43	1.44
SO2, lb/MBtu (LHV)	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034	0.0034
SO2, lb/MBtu (HHV)	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
† Note: SO2 from CTG and and duct burner SO2.																
STACK SO2 EMISSIONS WITH THE EFFECTS OF SO2 OXIDATION †																
Assumed SO2 oxidation rate in CO Catalyst, vol%	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0
Assumed SO2 oxidation rate in SCR, vol%	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
SO2, ppmvd (dry, 15% O2)	0.46	0.46	0.46	0.42	0.46	0.46	0.46	0.42	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.42
SO2, ppmvd (dry)	0.49	0.49	0.51	0.47	0.48	0.49	0.51	0.48	0.51	0.51	0.52	0.52	0.50	0.49	0.52	0.47
SO2, ppmvw (wet)	0.45	0.45	0.47	0.43	0.45	0.45	0.47	0.44	0.46	0.45	0.47	0.47	0.45	0.44	0.47	0.42
SO2, lb/h	0.77	0.93	1.12	1.03	0.79	0.97	1.18	1.10	0.71	0.85	1.01	1.01	0.75	0.89	1.09	0.98
SO2, lb/MBtu (LHV) (incl. duct burner fuel)	0.0026	0.0026	0.0026	0.0024	0.0026	0.0026	0.0026	0.0024	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0026	0.0024
SO2, lb/MBtu (HHV) (incl. duct burner fuel)	0.0024	0.0024	0.0024	0.0021	0.0024	0.0024	0.0024	0.0021	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0021
† Note: Also includes assumed SO2 oxidation rate in CTG.																
STACK VOC EMISSIONS WITHOUT THE EFFECT OF OXIDATION IN CO CATALYST †																

CASE NUMBER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
VOC, ppmvd (dry, 15% O2)	3.0	3.0	3.0	3.3	3.0	3.0	3.0	3.6	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1
VOC, ppmvd (dry)	3.2	3.2	3.3	3.7	3.1	3.2	3.3	4.2	3.3	3.3	3.4	3.4	3.2	3.1	3.3	3.5
VOC, ppmvw (wet)	2.9	2.9	3.0	3.4	2.9	2.9	3.0	3.8	3.0	2.9	3.0	3.0	2.9	2.9	3.0	3.1
VOC, lb/h as CH4	1.2	1.5	1.8	2.0	1.3	1.6	1.9	2.4	1.1	1.4	1.6	1.6	1.2	1.4	1.8	1.8
VOC, lb/MBtu (LHV) as CH4	0.0042	0.0042	0.0042	0.0046	0.0042	0.0042	0.0042	0.0051	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0042	0.0044
VOC, lb/MBtu (HHV) as CH4	0.0038	0.0038	0.0038	0.0042	0.0038	0.0038	0.0038	0.0046	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0039
† Note: includes VOC massflow added to match CTG manufacturer estimate and duct burner VOC.																
STACK VOC EMISSIONS WITH THE EFFECTS OF CATALYTIC REDUCTION (CO CATALYST) †																
VOC, ppmvd (dry, 15% O2)	2.1	2.1	2.1	2.3	2.1	2.1	2.1	2.5	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2
VOC, ppmvd (dry)	2.2	2.2	2.3	2.6	2.2	2.2	2.3	2.9	2.3	2.3	2.4	2.4	2.3	2.2	2.3	2.4
VOC, ppmvw (wet)	2.0	2.0	2.1	2.4	2.0	2.0	2.1	2.7	2.1	2.1	2.1	2.1	2.0	2.0	2.1	2.2
VOC, lb/h as CH4	0.9	1.1	1.3	1.4	0.9	1.1	1.3	1.7	0.8	1.0	1.1	1.1	0.9	1.0	1.2	1.3
VOC, lb/MBtu (LHV) as CH4	0.0030	0.0030	0.0030	0.0032	0.0030	0.0030	0.0030	0.0036	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0031
VOC, lb/MBtu (HHV) as CH4	0.0027	0.0027	0.0027	0.0029	0.0027	0.0027	0.0027	0.0032	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0028
† Note: includes VOC massflow added to match CTG manufacturer estimate and duct burner VOC.																
STACK CO2 EMISSIONS †																
CO2, lb/h	38,037	46,009	55,406	56,412	39,161	48,083	58,155	60,585	35,013	41,735	49,658	49,658	37,137	43,960	53,631	53,991
CO2, lb/MBtu (LHV)	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129	129
CO2, lb/MBtu (HHV)	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116
† Note: includes CO2 emissions from CTG and duct burner.																
PARTICULATE WITH THE EFFECTS OF SO2 OXIDATION [INCLUDES MAX. (NH4)2-(SO4)] †																
PARTICULATE EMISSIONS - FRONT HALF CATCH ONLY																
Particulate, lb/h	2.2	2.4	2.5	2.8	2.3	2.4	2.5	3.0	2.2	2.3	2.4	2.4	2.2	2.3	2.5	2.7
Particulate, lb/MBtu (LHV) (incl. duct burner fuel)	0.0076	0.0066	0.0058	0.0064	0.0075	0.0064	0.0056	0.0064	0.0081	0.0071	0.0062	0.0062	0.0078	0.0068	0.0059	0.0065
Particulate, lb/MBtu (HHV) (incl. duct burner fuel)	0.0069	0.0059	0.0052	0.0058	0.0067	0.0058	0.0050	0.0058	0.0073	0.0064	0.0056	0.0056	0.0070	0.0062	0.0053	0.0058
PARTICULATE EMISSIONS - FRONT AND BACK HALF CATCH																
Particulate, lb/h	4.0	4.1	4.2	4.7	4.0	4.1	4.3	5.0	4.0	4.0	4.1	4.1	4.0	4.1	4.2	4.5
Particulate, lb/MBtu (LHV) (incl. duct burner fuel)	0.0136	0.0115	0.0098	0.0107	0.0132	0.0111	0.0095	0.0108	0.0146	0.0125	0.0108	0.0108	0.0139	0.0120	0.0101	0.0108
Particulate, lb/MBtu (HHV) (incl. duct burner fuel)	0.0122	0.0104	0.0089	0.0096	0.0119	0.0100	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097
† Note: PM based on CTG manufacturer estimate and includes duct burner PM, and (NH4)2(SO4) as front half catch (assuming 100% conversion from SO3 to (NH4)2(SO4)).																
PM10 WITH THE EFFECTS OF SO2 OXIDATION [INCLUDES MAX. (NH4)2-(SO4)] †																
PM10 EMISSIONS - FRONT HALF CATCH ONLY																
PM10, lb/h	2.2	2.4	2.5	2.8	2.3	2.4	2.5	3.0	2.2	2.3	2.4	2.4	2.2	2.3	2.5	2.7
PM10, lb/MBtu (LHV) (incl. duct burner fuel)	0.0076	0.0066	0.0058	0.0064	0.0075	0.0064	0.0056	0.0064	0.0081	0.0071	0.0062	0.0062	0.0078	0.0068	0.0059	0.0065
PM10, lb/MBtu (HHV) (incl. duct burner fuel)	0.0069	0.0059	0.0052	0.0058	0.0067	0.0058	0.0050	0.0058	0.0073	0.0064	0.0056	0.0056	0.0070	0.0062	0.0053	0.0058
PM10 EMISSIONS - FRONT AND BACK HALF CATCH																
PM10, lb/h	4.0	4.1	4.2	4.7	4.0	4.1	4.3	5.0	4.0	4.0	4.1	4.1	4.0	4.1	4.2	4.5
PM10, lb/MBtu (LHV) (incl. duct burner fuel)	0.0136	0.0115	0.0098	0.0107	0.0132	0.0111	0.0095	0.0108	0.0146	0.0125	0.0108	0.0108	0.0139	0.0120	0.0101	0.0108
PM10, lb/MBtu (HHV) (incl. duct burner fuel)	0.0122	0.0104	0.0089	0.0096	0.0119	0.0100	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097

BLACK & VEATCH

CASE NUMBER	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
† Note: PM10 based on CTG manufacturer estimate and includes duct burner PM10, and (NH4)2(SO4) as front half catch (assuming 100% conversion from SO3 to (NH4)2(SO4)).																
PM2.5 WITH THE EFFECTS OF SO2 OXIDATION [INCLUDES MAX. (NH4)2-(SO4)] †																
PM2.5 EMISSIONS - FRONT HALF CATCH ONLY																
PM2.5, lb/h	2.2	2.4	2.5	2.8	2.3	2.4	2.5	3.0	2.2	2.3	2.4	2.4	2.2	2.3	2.5	2.7
PM2.5, lb/MBtu (LHV) (incl. duct burner fuel)	0.0076	0.0066	0.0058	0.0064	0.0075	0.0064	0.0056	0.0064	0.0081	0.0071	0.0062	0.0062	0.0078	0.0068	0.0059	0.0065
PM2.5, lb/MBtu (HHV) (incl. duct burner fuel)	0.0069	0.0059	0.0052	0.0058	0.0067	0.0058	0.0050	0.0058	0.0073	0.0064	0.0056	0.0056	0.0070	0.0062	0.0053	0.0058
PM2.5 EMISSIONS - FRONT AND BACK HALF CATCH																
PM2.5, lb/h	4.0	4.1	4.2	4.7	4.0	4.1	4.3	5.0	4.0	4.0	4.1	4.1	4.0	4.1	4.2	4.5
PM2.5, lb/MBtu (LHV) (incl. duct burner fuel)	0.0136	0.0115	0.0098	0.0107	0.0132	0.0111	0.0095	0.0108	0.0146	0.0125	0.0108	0.0108	0.0139	0.0120	0.0101	0.0108
PM2.5, lb/MBtu (HHV) (incl. duct burner fuel)	0.0122	0.0104	0.0089	0.0096	0.0119	0.0100	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097
† Note: PM2.5 based on CTG manufacturer estimate and includes duct burner PM2.5, and (NH4)2(SO4) as front half catch (assuming 100% conversion from SO3 to (NH4)2(SO4)).																
TOTAL EFFECTS OF SO2 OXIDATION																
Total SO2 to SO3 conversion rate, %vol	24.0	24.0	24.0	31.5	24.0	24.0	24.0	31.5	24.0	24.0	24.0	24.0	24.0	24.0	24.0	31.5
Total Amount of SO2 converted to SO3, lb/h	0.24	0.29	0.35	0.47	0.25	0.31	0.37	0.51	0.22	0.27	0.32	0.32	0.24	0.28	0.34	0.45
Maximum Stack Ammonium Sulfate [(NH4)2-(SO4)] (assuming	0.50	0.61	0.73	0.98	0.52	0.63	0.76	1.05	0.46	0.55	0.65	0.65	0.49	0.58	0.71	0.94
Maximum Stack Sulfur Mist [H2SO4] (assuming 100% conversi	0.37	0.45	0.54	0.73	0.38	0.47	0.57	0.78	0.34	0.41	0.48	0.48	0.36	0.43	0.52	0.69
POST COMBUSTION EMISSIONS CONTROL EQUIPMENT																
CATALYTIC CONVERSION IN CO CATALYST																
CO removed in CO Catalyst, %wt	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6	84.6
CO removed in CO Catalyst, lb/h	15.3	18.5	22.3	23.1	15.8	19.4	23.4	25.2	14.1	16.8	20.0	20.0	15.0	17.7	21.6	21.9
VOC removed in CO Catalyst, %wt	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
VOC removed in CO Catalyst, lb/h	0.4	0.5	0.5	0.6	0.4	0.5	0.6	0.7	0.3	0.4	0.5	0.5	0.4	0.4	0.5	0.5
SELECTIVE CATALYTIC REDUCTION (SCR)																
NOx Removed in SCR, %wt	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0	92.0
NOx removed in SCR, lb/h	27.4	33.1	39.9	40.5	28.2	34.6	41.8	43.4	25.2	30.0	35.7	35.7	26.7	31.6	38.6	38.8
Ammonia Slip, lb/h	2.2	2.7	3.2	3.3	2.3	2.8	3.4	3.5	2.0	2.4	2.9	2.9	2.2	2.5	3.1	3.1
NH3 Reagent Type	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)	Aqueous (19%)
Assumed stoichiometric ratio for NH3 consumption	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Total NH3 Reagent Consumption, lb/h	86	104	126	128	89	109	132	137	79	95	113	113	84	100	122	122

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project

Permit Number:

1. Boiler Information:				
Boiler identification	EU6.AB (Aux Boiler)			
Manufacturer	Rentech			
Date manufactured (month/year)				
Date construction commenced (month/year)	January 2019			
Date installed (month/year)	October 2021			
Rated design heat input capacity (million Btu per hour)	296.2			
Rated steam production capacity (pounds per hour)	200,000			
Primary fuel type	Natural Gas			
Max. fuel quantity used per hour (include units)	289,100 scf/hr			
Max. fuel quantity used per year (include units)	253.3MMscf/yr			
If oil is used, sulfur content (% by wt.)				
Secondary fuel type	None			
Max. fuel quantity used per hour (include units)				
Max. fuel quantity used per year (include units)				
If oil is used, sulfur content (% by wt.)				
Stack identification	AuxBoil			
Stack height (feet)	100 ft			
Stack gas flow rate at maximum load (dscf/minute)				
Control device(s) identification from AQ300	CD.SCR6, CD.OC6			
Continuous monitoring systems	Yes			

2. Describe how the boilers(s) is operated. (Refer to instructions for guidance)

Auxiliary boiler will be used to produce steam for liquefaction train startup. Emission controls include SCR and a CO catalyst.

MISCELLANEOUS **FORM AQ307**
CONTROL DEVICE INFORMATION **ANSWER SHEET**

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project Permit Number:

1.	Control Device ID	CD.SCR6 (Selective Catalytic Reduction)
2.	Process/Device(s) Controlled	EU6.AB (Auxiliary Boiler)
3.	Year installed	2021
4.	Manufacturer/Model No.	
5.	Control Efficiency (%)	NOx reduction- 94.0 %wt
6.	Design inlet gas flow rate (acfm)	51,215 acfm
7.	Design parameter(s)	Exhaust gas flow rate and NOx concentration
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No
9.	Describe the control device	
	The auxiliary boiler has an SCR system to reduce emissions of NOx.	

MISCELLANEOUS
CONTROL DEVICE INFORMATION

FORM AQ307
ANSWER SHEET

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project

Permit Number:

1.	Control Device ID	CD.OC6 (Oxidation Catalyst)
2.	Process/Device(s) Controlled	EU6.AB (Auxiliary Boiler)
3.	Year installed	2021
4.	Manufacturer/Model No.	
5.	Control Efficiency (%)	CO reduction- 92%wt
6.	Design inlet gas flow rate (acfm)	51,215 acfm
7.	Design parameter(s)	Exhaust flow rate and CO concentration
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No
9.	Describe the control device	
	The auxiliary boiler has an oxidation catalyst to reduce emissions of CO.	

Boilers

D-Type

RENTECH

Proposal To:

BLACK & VEATCH

For:

Jordan Cove LNG[SM]

Auxiliary Boiler 189980.67.6150 - Located in Coos Bay, OR
Rentech Proposal No.: DFB-DTB-4983-CY-16-R0

Boilers for people who know and care

TO: Black & Veatch Corporation July 8, 2016
11401 Lamar Avenue
Overland Park, KS 66211

Attn: Venkoba Sah Pawar Narayana Sah, P.E

Based upon the request for an auxiliary boiler to be installed in the Jordan Cove LNG facility, located in Coos Bay, Oregon, RENTECH is pleased to furnish our proposal for:

ONE (1) 200,000 LB/HR, FULLY ASSEMBLED, "D-STYLE", Watertube BOILER, with BURNER, ECONOMIZER, FAN, SELECTIVE CATALYTIC REDUCTION, STACK, TRIM, and LADDERS & PLATFORMS to be designed and built in accordance with the requirements of Section I of the ASME Boiler and Pressure Vessel Code and described in the following pages.

Page No.

RENTECH is offering a ***completely custom boiler*** system, based on the specification provided.

Thank you for your interest in doing business with **RENTECH BOILER SYSTEMS, INC.** We look forward to providing a prompt response to all of your questions, attention to all details, and a top quality boiler. Please don't hesitate to contact me if you have any questions.

Sincerely,

Clayton Young

Rentech Boiler Systems, Inc.
cmyoung@rentechboilers.com
(325) 794-5631

Cc: Jez Vaughn - B&V
Don Skaggs - B&V
Jeff Meyer - John C. Hayes & Associates, Inc.

PROPOSAL SUMMARY

With over 500 boilers installed in 25 different countries it is no wonder that more than ever people who need steam are turning to ***RENTECH Boiler Systems, Inc***. Each RENTECH boiler is custom designed by our engineers and built by a team of our experienced employees to perform efficiently and safely in its unique application. We offer excellent technical solutions to the unique needs of our customers for steam with a focus on custom design and service, competitive prices, and ***reliable delivery schedules***. You will benefit from the years of combined experience of our employees in the boiler industry.

1. **Reliability and Availability**: We understand that these boilers will form a critical part of the steam system for the facility and that reliability is key. **This reliability is evident in RENTECH's 5-year parts and labor warranty covering the design and workmanship of the boiler pressure parts.**

2. **Life Expectancy:** Rentech understands that users are looking for the best possible quality and craftsmanship. This translates directly into an extended life expectancy of the installed equipment.

3. **Emissions:** We understand that providing an environmentally friendly boiler is critical to any new installation today.

Every boiler manufactured by RENTECH Boiler Systems is ***custom engineered***, giving us the flexibility to assure that the equipment fits your needs rather than ***forcing*** your needs into a ***pre-designed boiler model***.

RENTECH Solution:

The following are features that we have included in this proposal to meet specific requirements for this boiler project:

1. We have proposed a boiler with a conservative furnace design, as noted in the below discussion regarding furnace heat release rate. This design assures that the equipment will fit your needs, minimize emissions and provide the longest life expectance possible.

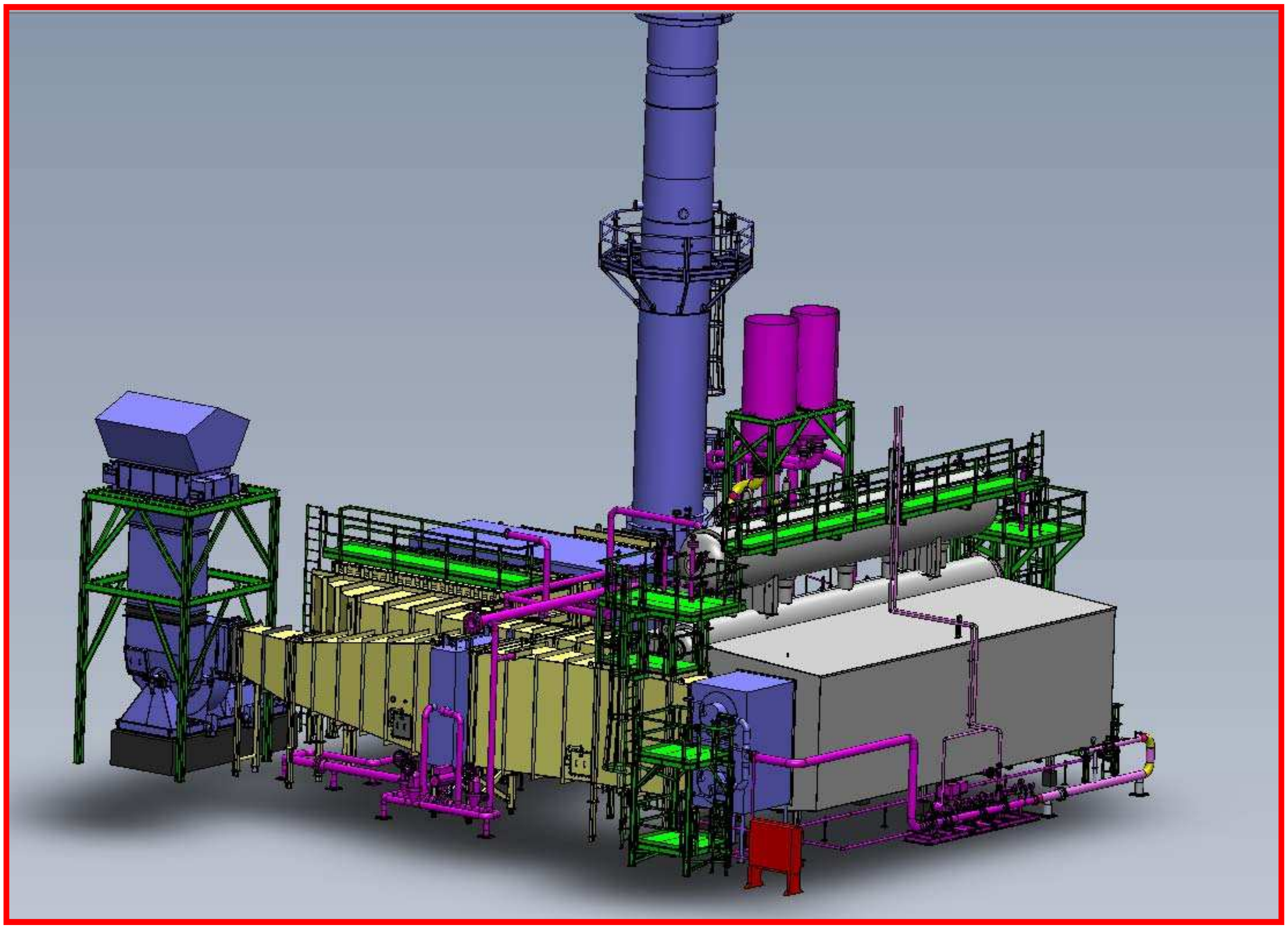
2. This design maximizes the shop fabrication of the boilers.

3. We have offered a 100% membrane wall construction furnace for this boiler, including the front and rear walls. This design is essential in minimizing the need for refractory in the furnace. Rentech's headered wall construction in the furnace assures that furnace gas seals do not fail due to high furnace temperatures and refractory failure.

This will significantly reduce downtime and maintenance cost over the life of the equipment.

4. Rentech will pre-fit all structural steel including ladders and platforms in our shop. Once they are assembled, photos will be taken and they will be disassembled for shipment. This added process is unique to Rentech and we have found will significantly save on field fit-up issues which could result in costly delays.

5. Rentech will utilize 3-D modeling in the engineering and design of your system. This will significantly improve fit up accuracy and avoid costly field modifications.



*Example of 3-D modeling software with entire boiler system.

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Lincoln Office: 145 North 46th Street • Lincoln, NE 68503 • Phone: 325-672-3400 Fax: 402-474-4243

Package Boiler Scope of Supply and Installation Breakdown

Supply		ITEM	Installation	
Rentech	**Buyer**		**Rentech**	**Buyer**
X		One Fully Assembled Packaged D-Type Boiler		X
Not Required		Boiler (field) assembly		
X		Boiler hydrostatic test (shop)		
X		Superheater, single stage inverted loop type	X	
X		Downstream desuperheater		X
X		Low NO_x Burner:	X	
X		Main fuel gas train		X
X		Pilot fuel train		X
	X	Interconnecting piping to windbox		X
X		PLC based Burner Management System (BMS)		X
X		PLC based logic for combustion controls		X
	X	Configuration of DCS		
X		One Arr. #7, API 673 FD Fan:		X
X		Inlet silencer		X
X		Motor drive		X
	X	VFD		X
	X	Motor controls and starter		X
X		Coupling		X
X		Dampers		X
X		Insulation clips on fan housing	X	
X		Forced Oil Lubrication System		X
	X	Vibration Monitoring System		X
Not Furnished		Steam coil air heater		
X		Fresh air ductwork from inlet silencer to windbox		X
X		Expansion joints in ductwork supplied		X
Not Required		FGR dampers and ductwork,		
X		Boiler Outlet (SCR Inlet) Transition		X
		Aqueous Ammonia SCR system:		
X		Ammonia Flow Control Unit (AFCU)		X
X		PLC based controls		X
X		SCR catalyst		X
X		Catalyst housing		X
X		Ammonia Injection Grid (AIG)		X
	X	Ammonia forwarding pumps		X
	X	Ammonia storage tank		X

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Package Boiler Scope of Supply and Installation Breakdown

Supply		ITEM	Installation	
Rentech	Buyer		Rentech	Buyer
X		SCR Outlet (Economizer Inlet) Transition		X
X		CO catalyst		X
X		Economizer (Factory Assembled)		X
X		Economizer Outlet Transition		X
X		Individual stack extending to 100' above grade		X
	X	CEMS		X
		Insulation and lagging:		
X		Boiler insulation and lagging	X	
Not Furnished		Windbox front plate		
	X	FD Fan acoustic insulation		X
X		Economizer insulation and lagging	X	
X		Flue gas duct insulation and lagging	X	
Not Required		FGR ductwork insulation and lagging		
	X	Removable insulation for drum heads		X
	X	Insulation and lagging of interconnecting piping		X
		Ladders, stairs, and platforms, galvanized, with no welds required, to provide access to:		
X		Burner/windbox		X
X		Steam drum		X
X		Observation ports		X
X		Stack testing platform		X
		Support steel (galvanized):		
X		Inlet Silencer		X
X		Fresh air ductwork, inlet silencer to windbox		X
X		Flue gas ductwork		X
X		SCR catalyst housing		X
X		Economizer		X
Not Required		FGR ductwork		
X		Piping supplied by Rentech		X

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Package Boiler Scope of Supply and Installation Breakdown

Supply		ITEM	Installation	
Rentech	Buyer		Rentech	Buyer
		Piping:		
X		Feedwater piping from feedwater control valve to boiler inlet		X
X		Steam piping from boiler outlet to superheater outlet		X
Not Furnished		Economizer bypass		
	X	Ammonia from AFCU to AIG		X
	X	Piping external of terminal points		X
X		Boiler trim, including safety relief valves as described in the below tables, shipped loose		X
X		O_2 analyzer		X
X		Sample Panel		X
Not Furnished		Mud drum heating coil		
Not Furnished		Sootblowers		
	X	Deaerator		X
	X	Boiler feedwater pumps		X
Option		Chemical feed system		X
	X	Blow down tank(s)		X
	X	Foundation, anchor bolts, concrete, grout		X
	X	Slide plates, bearing plates, and shim plates		X
Option		Freight from Abilene, Texas to the jobsite		
	X	Unloading boiler and auxiliary equipment at Jobsite		
	X	Boil-Out chemicals, including disposal		
	X	Interconnecting wiring or cabling, all instrument and scanner cooling/purge air tubing		X
	X	Electrical Power Supply and Lighting Protection		
	X	Heat tracing		X
	X	Spare Parts		X
	X	Installation Consultant (see Per Diem rates)		
	X	Start-Up Service (see Per Diem rates)		
	X	Field Testing Labor, Equipment and Consumables		
X		Documentation		
X		Operation & Maintenance Manuals (3 sets)		

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TECHNICAL DISCUSSION

To meet your process and mechanical requirements, we are pleased to offer one (1), **100% membrane wall construction**, D-Type watertube boiler. The boiler has been designed for natural gas firing and will have a design pressure of **875 psig**. The unit will generate 200,000 lbs/hr of superheated steam at 740 psig and 725°F while firing NG. This is assuming the feedwater is supplied at **281°F**. Please refer to the attached Data Sheets for performance at the design conditions.

The boiler will be designed with ***complete membrane wall construction of the furnace***, including the front wall. This design minimizes the need for refractory and refractory seals, even in the corners. By minimizing the refractory, ***faster start-ups are possible***. Slow ramp-up time required to sustain the refractory at a constant temperature is not necessary. Of course, ***the absence of refractory rules out the possibility for cracking and crumbling*** problems that traditionally are associated with refractory in packaged boilers. The water-cooled front and rear walls also allow the furnace to operate at a lower temperature, which helps to reduce the formation of NO_x.

RADIANT FURNACE

The furnace section of the proposed boilers is of ***100% membrane wall design*** and is constructed of ***2.0"OD x 0.135"MW ERW SA-178A*** tubes on 4" centers. The tubes are connected by ¼" x 2**"** carbon steel membranes to form a totally water cooled enclosure, including the front and rear walls. This design avoids the traditional problems that package boilers have with firebrick and refractory maintenance. Membrane walls will be constructed as multiple tube panels maximizing machine welding and eliminating a fin to fin weld between tubes**.** The membrane wall construction is unique in that it utilizes a headered construction, which

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eliminates the need for, and traditional problems associated with gas seals in the corners of the furnace. Our competition would utilize steel box seals at the locations where one furnace wall joins another. These gas seals require the use of refractory or ceramic fiber to protect them from the high temperatures in the furnace. Problems with gas seal failures arise over time as the refractory or ceramic fiber fails, exposing the gas seals to 2,000°F temperatures. ***With RENTECH'S headered wall design, the water cooled header forms the corners. It simply cannot fail by overheating.***

The furnace will have two observation ports located on each side wall to allow for viewing the flame in the furnace. The front of the furnace can be viewed through ports located on the burner. The rear wall of the furnace will have a davited 15"x18" access door, with a 9" refractory lining.

FURNACE DATA

Item	Units	Natural Gas
Furnace Dimensions	Ft – in	Height: 10'-9" ; Width: 7'-7"; Length: 38'-6"
Total Heat Input	MMBtu/Hr	269.3
Furnace Volume	Ft^3	3,125
Flat Projected Furnace Surface	Ft^2	1,549
Volumetric Heat Release Rate	$Btu/Hr\text{-}ft^3$	84,856
Square Foot Heat Release Rate	$Btu/Hr\text{-}ft^2$	171,164

Notes:

- Volumetric Heat Release Rate = Total Heat Input (includes all losses from the boiler) at MCR / Actual Furnace Volume Available for Combustion (This would exclude any volume occupied by a radiant superheater if such a design were offered). The heat input is a known value and will change depending on unit efficiency and fuel fired. The furnace volume is simply a calculation of the open volume in the furnace. This results in a value in $Btu/Hr\text{-}ft^3$.
- Square Foot Heat Release Rate = Total Heat Input at MCR / Flat Projected Furnace Heating Surface. The Flat Projected Furnace Heating Surface is the heating in the furnace not taking into account the curvature of the tubes. If one were to look at the furnace membrane wall, it a square foot of Flat Projected Heating Surface would simple be a 1 foot by 1 foot square.

CONVECTION TUBES

The convection tubes are ***2.0"OD x 0.135"MW ERW SA-178A*** and attach to the drums by rolling. Each tube hole will be serrated and carefully cleaned and polished just prior to tube installation. The ends of each tube will also be polished just prior to installation.

Please refer to the attached Mechanical Data for details of the convection section tube layout. This tube layout was specifically selected to meet your process and space requirements.

Rentech performs an acoustic analysis on all sections of the boiler at various loads to determine if longitudinal, vertical baffles are required to eliminate problems associated with acoustic vibration. Rentech will include these when necessary.

DRUMS

The steam drum is 54" ID and approximately 41'-0" in length, seam to seam. This combination of diameter and length has been optimized for the capacity of the boiler. This steam drum will allow the boiler to react to load swings while reducing the likelihood of excess moisture carryover or nuisance trips due to high or low water level. The drum is provided with primary belly pan and chevrons to assure that steam leaving the drum contains less than 1.0 PPM TDS carryover. Any steam purity guarantee will not include vaporous silica carryover. All other drum internal piping is also included as needed to make the unit operational. Each steam drum head will have a 12"X16" elliptical manway with davited cover, to provide access for inspection.

The lower drum will be 26" ID. The mud drum is complete with bottom blowdown connections to allow for the proper intermittent blowdown of solids that accumulate in the bottom of the drums. The mud drum will have two 12" X 16" elliptical manways. The boiler is supported from grade on channel saddles. It will be fixed on the burner end and the other end will free to slide and accommodate thermal expansion

DOWNCOMERS

Two unheated downcomers are included, one located at either end of the steam drum. They will stabilize the drum level during rapid changes in firing rate without the use of conventional convection tubes being used as downcomers. The downcomers also support the steam drum to reduce stresses on the tubes.

SUPERHEATER

The superheater is an inverted loop, fully drainable, type design. It will be constructed as a separate module and shop hydrostatically tested prior to installation in the boiler. The superheater will be located behind the division wall and behind the screen tubes so that it will be protected from direct radiation.

This is a single stage superheater with a desuperheater downstream the main steam outlet that uses boiler feedwater as a cooling medium. This two stage superheater will provide a guaranteed constant steam temperature of 725°F (+/- 10°F) over the operating range of 50% to 100% MCR.

BURNER

RENTECH is offering a single ZEECO Free Jet low NO_x burner for the auxiliary boiler. The maximum emission levels, **NOT using FGR**, from the burner when firing natural gas from 25% to 100% MCR, with all concentrations corrected to 3% oxygen, on a dry basis:

NOx	35 ppm
CO	50 ppm

The following scope related to the burner is included:

One (1) Zeeco Free Jet burner for a total of 1 boiler, each consisting of the following:

1. Zeeco non-insulated front plate, equipped with:
    a. Zeeco register assembly fabricated with carbon steel
    b. Zeeco carbon steel removable center equipped with center-fired gas gun assembly equipped with stainless steel tip assembly and swirler
    c. Two (2) sight ports
    d. One (1) **Fireye** scanner with swivel mount and 10m cable
2. Zeeco staged gas firing assembly equipped with carbon steel gas ring
3. Zeeco refractory throat tile, one (1) per burner

Zeeco ZA2 Igniter

One (1) ZA2 igniter constructed out of CS, equipped with:

1. One (1) spark electrode
2. One (1) ionization sensing rod
3. One (1) high tension direct spark rod
4. One (1) Ignition transformer and ionization amplifier to provide the spark and flame detection signals
5. One (1) three foot long stainless steel flexible hose for gas supplied to the igniter
6. One (1) six foot long HT/ionization cable to connect the ignition transformer and the ionization amplifier to the igniter lance

Windbox

1. Zeeco standard construction windbox non-insulated, fabricated with ¼" A36 steel plate including distribution baffles as required per the Zeeco Physical Air Flow Modeling study.
2. Windbox Mounted Devices
    a. **Three (3)** purge air and combustion air proving transmitter
    b. **Three (3)** High steam drum pressure transmitter
    c. NEMA 4X junction box(es) for devices and scanners

Valve Trains for Free Jet burner

1. Natural gas
    a. One (1) pressure gauge with isolation valve
    b. Six (6) pressure transmitters, **three (3)** low and **one (3)** high pressure
    c. Two (2) automatic safety shutoff valves
    d. One (1) automatic vent valve
    e. One (1) manual vent valve
    f. One (1) manual shutoff valve
    g. Two (2) flow control valves (CFG and outer ring)
    h. Two (2) pressure gauges with isolation valves (CFG and outer ring)
    i. Two (2) flex hoses (CFG and outer ring)

Igniter for the Free Jet burner

a. Two (2) manual shutoff valves
b. One (1) inlet wye strainer
c. One (1) pressure regulating valve
d. Two (2) automatic safety shutoff valves
e. One (1) automatic vent valve
f. Two (2) pressure gauges with isolation valves
g. One (1) flex hose

Components for Natural Gas Train

a. One (1) manual shutoff valve
b. One (1) wye strainer
c. One (1) pressure gauge with isolation valve
d. One (1) pressure regulating valve
e. One (1) manual vent valve
f. One (1) gas flow meter

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General Construction and Wiring for Rack Mounted Valve Trains

1. Basic instrument air system comprised of **three (3)** low pressure transmitter (VT mounted), one pressure gauge, and individual component hand valves
2. Conduit and wire electrical (vs. cable and tray)
3. Base Valve Train Construction:
   a. Piping 2" and under shall be A-106 seamless pipe, schedule 80, socket welded end connections, 3000lb fittings
   b. Piping 2 ½" and larger will be A-106 seamless pipe, schedule 40, CL150 flanged or butt welded connections
   c. All valve rack lifting lugs 100% dye penetration inspection testing
   d. Bolts shall be ASTM A-193 Grade B7 – Zinc Plated
   e. Nuts shall be ASTM A-194 Grade 2H – Zinc Plated
   f. Flat-washer: (2) per Stud, (1) per bolt, Type F436 – Zinc Plated
   g. Gaskets shall be Garlock Blue-Gard 3000, 1/16" thick, or equal
4. NEMA 4X junction box(es)

FD FAN

An arrangement #7, 1780 rpm API 673 draft fan with a **600 HP** motor drive has been included for the auxiliary boiler. The fan being offered is an **Airfoil** design to help with efficiency of the fan and to decrease the required motor HP. Mechanical dampers, air silencer and the necessary air inlet ducting supports are also included.

Test block for the fan and drives is based on 110% of volumetric flow and 121% of static pressure. Fan performance is summarized below

Fan Blade Type		**Airfoil**	
Fan Model		***A55S-5875***	
Condition	Units	Test Block	Max Fire Case
Inlet Volume Flow Rate	acfm	58,948	51,215
Inlet Temperature	°F	105	80
Inlet Density	lb/ft³	0.0703	0.0736
Inlet Total Pressure	in.wg	0.00	0.00
Outlet Static Pressure	in.wg	42.60	35.20
Fan Static Pressure Rise	in.wg	42.60	35.20
Fan Speed	rpm	1,780	1,780
Power Consumption	HP	538	428
Approximate VIV Angle	°	90	43

NOTE - The fan will also include a **forced oil lubrication system**, designed per API-614. This system will ensure the bearings on the fan and motor are cooled for equipment longevity.

ECONOMIZER

A horizontal gas flow economizer has been included for each boiler. The tubes are horizontal and fully drainable, finned with 6 fins/in, 0.75" H x 0.05" W and serrated fins.

The economizer casing inner casing is ¼" carbon steel, and is gas tight and externally insulated with mineral fiber block insulation and lagged to match the boiler.

SCR & CO SYSTEM

This proposal includes a standard medium temperature **SCR catalyst** system for to reduce NOx emissions from the burner. The system is designed to utilize 19% aqueous ammonia as a reagent in the SCR process.

NOx emissions will be reduced as depicted in the following table:

	From Burner	SCR Outlet
NO_x, ppm	35 ppm	2 ppm

SCR CATALYST DESCRIPTION	
SCR Catalyst Manufacturer	Cormetech CM-21™
Catalyst Type	Homogeneous Honeycomb
Active Catalyst Material	Ti-V-W
Catalyst Flow Passage (pitch)	2.1 mm
Gas Flow	Horizontal
Module Arrangement	14 X 12.75
Flue Gas Maldistribution at Inlet to Catalyst:	
Velocity	+/- 15% RMS normal
Temperature	+/- 20°F
N_3 to NO_x Molar Ratio	+/- 10% RMS normal
Number of SCR Modules	4
Total SCR Catalyst Weight	2,400 lbs.
Guarantee Life	43,800 hours
Ammonia Slip	10 ppmvdc @ 3% O_2

An **ammonia package control unit (APCU)** is included with dilution components for aqueous ammonia per the following:

- Stainless steel structural skid base with lifting and grounding lugs
- Two regenerative blowers, one primary and one secondary, rated at 130 SCFM @ 42"WC, Electric motor rated 460/3/60, 3 HP, IEEE-841, 1.15 SF; inlet filter/silencers are included.
- Stainless steel dilution air line with expansion joints, check valves, automated damper vale assemblies, pressure gauges with a block and bleed valve, orifice flange assembly with a manifold/flow transmitter
- Two 100 kW 480/3/60 immersion heaters, one primary and one secondary, housed in stainless steel pipe, with type K thermocouples on each circuit. Vertical down flow; insulated and jacketed. Stainless steel piping downstream of the heaters will include expansion joints, automated damper valve assemblies, and a thermocouple/thermo well assembly with a temperature transmitter.
- One upward flow, stainless steel vertical vaporizer with internal mixing element and injection nozzle. The outlet stainless steel piping will have a thermocouple/thermo well assembly with a temperature transmitter.
- Class 150 stainless steel aqueous ammonia line, including manual isolation valves, duplex strainers with a common differential pressure gauge, a Micro Motion Coriolis mass meter, automated isolation ball valve assemblies with open/close limit switches, pressure gauges with block and bleed valves, a Fisher/Baumann flow control valve with a globe valve bypass, and a flex line to the injection nozzle
- Class 150 stainless steel instrument air header with manual isolation valves, a pressure switch, and a pressure gauge w/block and bleed valve to provide actuation of pneumatic valves
- NEMA 4X junction box for the termination of analog and discrete instrumentation
- NEMA 4X heater power panel containing components for modulated heater control and safety interlocks; with PLC based Compact Logix, I/O modules for control, and a 10" color touch screen; includes an A/C unit and Z purge.

Ammonia will be injected into the flue gas via distribution manifold header and an ammonia injection grid (AIG). The distribution manifold header consists of one header with an inlet intake and take off branches. Each branch contains a manual gate valve, orifice plate, and Dwyer Capsuhelic pressure gage for balancing flow. The ammonia injection grid consists of assemblies with three 3" lances per assembly. A total of twenty one stainless steel lances are provided.

- CFD modeling of the flue gas flow path and AIG has been included.

An **Allen Bradley PLC system** is included and is housed in a NEMA 4X enclosure located on APCU skid. It will consist of the following:

- Compact Logix PLC platform
- Redundant processors
- I/O modules for control of SCR system
- 10" color touch screen with sun shade

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This proposal includes a standard medium temperature **CO catalyst** system for to reduce carbon monoxide emissions from the burner from 50 ppm down to 4 ppm, a destruction of 91.76%.

BOILER AND BURNER CONTROLS

Zeeco will provide a new Burner Management System (BMS) utilizing a redundant Allen Bradley Control Logix processors. The BMS will control the automatic sequencing during light off of the burner on Natural Gas and continuously monitor all safety interlocks to ensure safe firing of the boiler. If a hazardous situation does occur, the BMS will shut down the boiler automatically. A Control Narrative and SAMA Diagram showing the Combustion Control System Logic will be provided (to be programmed into the DCS by others).

Zeeco will provide all new hardware which will be mounted inside a NEMA 12 Free Standing enclosure. A 12" Red Lion HMI will be mounted on the door. The enclosure is not rated for any hazardous areas and must be installed in an unclassified climate controlled area. The BMS shall not be provided with any provisions for Intrinsically Safe instrumentation as Zeeco's standard is Ex d and Ex e.

The BMS can be controlled with the HMI or remotely through the DCS. "First Out" and alarm conditions will be displayed locally as well as annunciated to the DCS. Alarm and Indication communication with the DCS shall be done over redundant Fiber Optic Ethernet (using 1756-EN2F modules); permissives and control will be done through dry contacts.

A programming laptop with the latest version of Studio 5000 and the HMI software will be provided.

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Notes:

- BMS shall meet all the latest NFPA 85 2015 standards
- The BMS is engineered utilizing an external safety watchdog timer to continuously monitor the PLC for processor faults.
- All critical PLC Input and Outputs shall be continuously monitored for faults during operation.
- Programming and Screen development for HMI screens.
- All BMS outputs shall be fused. Terminals will be Phoenix Contact.
- All digital I/O (switches, valves, etc.) shall be 24 VDC.
- Technical control package will include the following documents:
    a) BMS Panel Arrangement
    b) BMS Electrical Equipment List
    c) BMS Electrical Wiring Schematics
    d) BMS Sequence of Operations
    e) BMS Boolean Diagrams
    f) CCS Control Narrative
    g) CCS SAMA Diagram
    h) I/O List
    i) Install (Hook Up) Diagrams
    j) DCS Communication Map
    k) Utility Consumption List
    l) HMI Screen Shots
    m) Certifications for Hazardous Area

BMS Exceptions:

- Loop Drawings (Information will be presented in the wiring diagrams)
- Interconnect Drawings
- Cause and Effect Drawings (Information is better presented as Booleans)
- SAT Procedure
- The BMS will not accept any pneumatic (3-15 PSIG) signals.
- A Blower will not be installed in the BMS panel.
- A printer will not be provided.

STACK

Individual single wall freestanding stacks, extending to 100' above grade are included. The stack diameter is 72" at the discharge, sized for a discharge velocity of 50 ft/sec with both boilers operating at 100% MCR.

One 360° x 3'- 6" OSHA approved test platform will be included to access the test ports. Expanded metal personnel protection will be provided, 6' - 0", at the test platform, and behind the caged ladder.

DUCTWORK

The boiler outlet transition (SCR inlet), SCR and CO catalyst housing, SCR outlet (economizer inlet) and economizer outlet transition will be fabricated of 0.25" carbon steel material, stiffened as required. All ductwork will be insulated and lagged prior to shipment. Access doors will be provided.

BOILER TRIM AND INSTRUMENTATION

The boiler trim included in the base pricing is itemized on the trim list. Boiler trim appurtenances and instrumentation will be crated and shipped for safe delivery to site where it will be mounted by end user and/or his site contractor. Wiring in the field is supplied by others.

PIPING

We have included the piping as indicated in the above scope table. All piping supplied by RENTECH will analyzed for stresses and will come with the necessary supports to properly carry the loads. Field welds will be required to complete the feedwater piping installation.

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INSULATION, LAGGING, AND PAINTING

The mud drum, excluding the drum heads, and all of the walls of the unit will be insulated with 3-4" mineral fiber insulation and protected with steel lagging. The roof of the furnace will be covered with steel casing. The steam drum, excluding the heads, will be insulated and lagged with steel. The drum heads will be provided with removable insulation covers. Exterior surfaces that will not be insulated will be cleaned and painted with one coat of inorganic zinc primer. Vendor supplied equipment will receive their standard paint application. Piping components, ductwork interior and surfaces that will be insulated will not be painted.

FIELD SERVICE

All field service is available at the below per diem rates.

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Boiler Trim

Safety Relief Valves

2	Boiler		Drip pan elbows
1	Superheater	X	Vent stacks
0	Economizer	2	Silencer(s)
	Gags	X	Silencer supports
X	Spring covers		

Water Columns

1	**Qty.**			**Level Switches**			
X	Probe Type		Float Type	Column 1		Column 2	
	Valves			X	HI-HI		HI-HI
X	Process block			X	HI		HI
X	Drain			X	LO		LO
	Vent			X	LO-LO		LO-LO

Aux. LWCO

1	Qty.		Valves
X	Probe type	X	Process block
	Float type	X	Drain
			Vent

Water Level Gage Glass

Water Level Gage Glass	Glass 1	Glass 2
Prismatic		
Flat glass	X	X
Bi-Color		
Illuminator	X	X
Direct vision hood		
Remote viewing hood with mirrors		
Fiber optic remote		
Valves		
Water gage	X	X
Drain	X	X
Vent		

Remote Level Indicator

Probe Type	1
Number of remote indicators	1
Number of lights per indicator	
Valves	10
Process block	
Drain	
Vent	

Controllers / Analyzers

	Drum level controller		Conductivity analyzer (steam)
	Desuperheater controller		Conductivity analyzer (water)
1	Desuperheater		PH analyzer (water)
1	O2 Analyzer	4	Sample Coolers (one panel)

Flow Elements

Service	Orifice Plate	Flow Nozzle	Venturi	Piezometer
Steam	1	0	0	0
Water	1	0	0	0
Combustion air	0	0	0	1
Flue gas	0	0	0	0
Fuel gas	1	0	0	0
Fuel oil	0	0	0	0

Boilers Trim

Sootblowers – Qty.

Service	Retractable	Manual Rotary	Electric Rotary		Controls
Boiler	0	0	0		Motor starters
Superheater	0	0	0		Piping
Economizer	0	0	0		

Description	PI	PT	TI	TT	TC/TW	PS	LT	FT
Flue Gas								
Fresh air inlet				1	1			3 (*)
FGR								
Air preheater outlet								
Mix – Fan inlet								
Fan discharge		1						
Burner windbox								
Furnace	1	3						
Convection section								
SH inlet								
SH intermediate								
SH outlet								
Boiler outlet								
Economizer inlet	1		1	1	1			
Economizer outlet	1		1	1	1			
Water								
Upstream control valve station	1							1
Downstream control valve station								
Upstream economizer	1		1	1	1			
Downstream economizer	1		1	1	1			
Steam								
Boiler outlet								
SH Interstage								
SH outlet	1	1		1	1			1
Steam drum	1	3					4 (*)	
Continuous blowdown								
SH Tubes					4			
Fuel								
Gas								1
Oil								

PI = Pressure Indicator
PT = Pressure Transmitter
TI = Temperature Indicator
TT = Temperature Transmitter
TC/TW = Thermocouple/Thermowell
PS = Pressure Switch
LT =Level Transmitter
FT = Flow Transmitter

- NOTE WE ARE INCLUDING 2-o-o-3 TRANSMITTERS FOR SIL-2 BMS
- AIR FLOW METERS WILL BE PIEZOMETER TUBE + DP TRANSMITTER (2 UNITS) + 1 THERMAL DISPERSION MASS FLOW TRANSMITTER
- LEVEL TRANSMITTERS WILL BE DP (2 UNITS) + 1 GUIDED WAVE RADAR LEVEL TRANSMITTER AS SPECIFIED

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Boiler Trim

Valves	Qty.	Manual	Actuated
Feedwater			
Stop	1	X	
Check	1	X	
Level control	1		X
Control valve block	2	X	
Control valve by-pass	1	X	
Control valve drain	4	X	
Economizer block	0		
Economizer by-pass	0		
Steam non-return	1	X	
Steam stop	1		X
Free blow drain	1	X	
Continuous blowdown control	1		X
Continuous blowdown block	1	X	
Intermittent blowdown	4	X	
Boiler vent	2	X	
Chemical feed block	1	X	
Chemical feed check	1	X	
Superheater start-up	1		X
Start-up block	1	X	
Superheater vent	2	X	
Superheater drain	2	X	
Economizer vent	2	X	
Economizer drain	2	X	
Sootblower steam block	0		
Desuperheater spray water			
Control valve	1		X
Control valve block	1	X	
Control valve by-pass	0		
Control valve drain	4	X	
Power operated block	0		
Stop valve	1	X	
Check valve	1	X	
Boiler drain	2	X	
Steam sample	2	X	
Water sample	0		
Acid clean	0		

PROCESS SUMMARY SHEET
Normal Operation – 100% MCR

	FURNACE	SCREEN	SUPERHEATER	EVAPORATOR	ECONOMIZER
Flue Gas Flow Rate, lb/hr	237,717 @ 15% excess air (1)				
Inlet Temperature,°F	Combustion	2,422	2,300	1,838	731
Outlet Temperature,°F	2,422	2,300	1,838	731	330
Fouling, ft²°F/ BTU	0.001				
Heat Loss, %	1.5				
Heat Duty, mmBTU/hr	68.18	9.81	36.63	80.98	26.74
Pressure Drop, " WC	15.5				1.0
STEAM SIDE					
Design Pressure, psig	875				950
Operating Pressure, psig	795 (4)		750	795 (4)	805
Pressure Drop, psi	--		35	--	10
Inlet Temperature, °F	408		520	408	281
Outlet Temperature, °F	520		777 (6)	520	408
Blowdown, %	3		--	3	--
Fouling, ft²°F/ BTU	0.001				
Flow Rate, lb/hr	194,500 (5)		200,000	194,500	200,550
Heating Surface, ft²	1,549	214	964	11,320	34,847

Notes:

(1) Includes **NO** FGR
(2) Predicted HHV Efficiency - 83.01%, Heat Input 269.26 mmBTU/hr
(3) Flue Gas Analysis, % Volume: CO_2 - 8.36 H_2O - 18.14 N_2 - 71.05 O_2 - 2.46
(4) Piping and NRV pressure drop of 12 psi
(5) Desuperheater spray flow of 5,500 lb/hr at 281°F
(6) Outlet at the SH, desuperheater spray will control steam temperature to 725°F

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MECHANICAL DATA SHEET

TUBES

	FURNACE	SCREEN	SUPERHEATER	CONVECTIVE	ECONOMIZER
Diameter, in.	2.0	2.0	2.0	2.0	1.5
Thickness, in.	0.135	0.135	0.150	0.135	0.120
Material	SA-178A	SA-178A	SA-213 T22	SA-178A	SA-178A
Length, ft	--	10.5	7.67	10.5 / 9.55 / 9.55	15.75
Tubes / Row	1	13	12	13 / 12 / 12	30
Rows Deep	117	3	20	39 / 6 / 12	14
Arrangement	Inline	Inline	Inline/ Parallel flow	Inline	Inline / Counter flow
Transverse Pitch, in.		4.75	4.75	4.75	3.5
Longitudinal Pitch, in.	4.0	4.0	5.0	4.0	4.5
Fins	1/4" membrane	--	--	39 rows bare. 6 rows: 3.0 FPI, Solid, 0.50" H, 0.06" W 12 rows: 4.0 FPI, Solid, 0.75" H, 0.06" W	6 fins/inch 0.75"H x 0.05"W CS serrated

DRUMS

	STEAM DRUM	MUD DRUM
Diameter (in.)	54	26
Length, seam-seam, (ft.)	41' - 0"	41' - 0"
Thickness, (in.)	**Per ASME**	**Per ASME**
Material	SA 516 Gr. 70	SA 516 Gr. 70
Manways	Two 12" x 16"	Two 12" x 16"
Corrosion Allowance	0.125"	0.125"

UNIT DIMENSIONS AND WEIGHTS

	UNIT
Height to Steam Outlet, ft	17' - 10"
Width, ft	14' - 0"
Length (including burner), ft	52' - 0"
D-Type Boiler Dry Weight, lbs.	250,000
Economizer, lbs.	60,000

PERFORMANCE GUARANTEES

The performance of the packaged boiler is guaranteed as detailed below:

Fuel Fired		**Natural Gas**	
DESCRIPTION	**UNITS**		
System Performance			
Steam Flow (Net)	lb/hr	200,000	
Steam Pressure	PSIG	740	
Steam Quality @ Drum Outlet	%	0.05	
System Efficiency	**%**	**83.01**	
Emissions			
NOx	ppm	2	
CO	ppm	4	

Notes:

1. System performance guarantees are at 100% MCR only.
2. Feedwater temperature to boiler is 281°F.
3. Ambient temperature is 80°F.
4. The blowdown rate is as defined in the attached Predicted Operating Performance Tables.
5. Feedwater analysis must meet suggested Water Quality Limits per latest edition of ASME.
6. Boiler performance will be measured by a performance test based upon the principles of ASME PTC 4.1. Testing is to be by others.
7. The steam conditions are at the Rentech terminal points.
8. Emission guarantees are from 25% to 100% MCR.

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project   Permit Number:

Engine Information

1.	Device ID Number	EU7.FP (Fire Pump Engines)
2.	Existing or future?	Future
3.	Date construction commenced	January 2019
4.	Date installed/completed	April 2021
5.	Special controls (if applicable)	Tier 3
6.	Manufacturer	Caterpillar
7.	Date manufactured	
8.	Maximum rating (MMbtu/hr for turbines, Hp for others)	700 hp
9.	Control device(s) (yes/no)	No
	If yes, enter the identification number(s)	
10.	Description of device:	

Two Caterpillar C18 diesel-fired fire pump engines.

Operating Schedule

11.	Projected maximum hours/day	2
12.	Projected maximum hours/year	200

Fuel Information

13. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	35.9 gal/hr	7,180 gal
Back-up			
Other			

Stack Information

14.	Exit height (ft)	18
15.	Exit diameter (ft)	0.67
16.	Design flowrate (dscf/min)	

Monitoring Information

17. Monitoring equipment

fuel flow (y/n)		recorder? (y/n)	
engine load (y/n)		recorder? (y/n)	
other (specify)	Hour meter	recorder? (y/n)	Yes

PERFORMANCE DATA [DM9853]

JUNE 06, 2016

For Help Desk Phone Numbers Click here

Perf No: DM9853 **Change Level:** 03

General Heat Rejection Emissions Regulatory Altitude Derate Cross Reference Perf Param Ref

View PDF

SALES MODEL:	C18	**COMBUSTION:**	DI
ENGINE POWER (BHP):	700	**ENGINE SPEED (RPM):**	1,750
COMPRESSION RATIO:	16.3	**ASPIRATION:**	TA
RATING LEVEL:	STANDBY - FMS/ULI	**AFTERCOOLER TYPE:**	SCAC
PUMP QUANTITY:	1	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, AC
FUEL TYPE:	DIESEL	**AFTERCOOLER TEMP (F):**	95
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (F):**	192.2
GOVERNOR TYPE:	ELEC	**TURBO CONFIGURATION:**	PARALLEL
INJECTOR TYPE:	EUI	**TURBO QUANTITY:**	2
REF EXH STACK DIAMETER (IN):	6	**TURBOCHARGER MODEL:**	80BMI87N/39DH-DM1.10VO
MAX OPERATING ALTITUDE (FT):	302	**CERTIFICATION YEAR:**	2008
		PISTON SPD @ RATED ENG SPD (FT/MIN):	2,101.4

INDUSTRY	SUB INDUSTRY	APPLICATION
INDUSTRIAL	FIRE PUMP	INDUSTRIAL

General Performance Data Top

PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
100	700	286	0.359	35.9	60.9	120.0	1,307.1	48.6	948.3
90	630	258	0.366	32.9	57.1	118.0	1,271.0	45.4	928.0
80	560	229	0.371	29.7	52.5	114.6	1,215.2	41.1	888.6
75	525	215	0.373	28.0	50.0	112.7	1,185.6	38.9	867.4
70	490	200	0.378	26.4	47.6	111.3	1,163.2	36.6	853.0
60	420	172	0.389	23.3	42.1	108.5	1,117.1	32.1	825.0
50	350	143	0.400	20.0	35.9	105.5	1,059.3	27.2	790.0
40	280	115	0.399	15.9	25.9	101.0	972.4	20.2	735.3
30	210	86	0.396	11.9	15.9	97.1	855.9	13.7	658.9
25	175	72	0.398	9.9	11.5	95.7	786.3	10.9	612.4
20	140	57	0.410	8.2	8.2	95.1	700.3	8.8	550.2
10	70.0	29	0.493	4.9	3.2	95.2	497.0	5.9	399.5

PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN

PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
100	700	66	388.8	1,435.0	4,042.6	6,454.9	6,706.1	1,411.7	1,286.3
90	630	62	374.1	1,384.4	3,826.3	6,217.0	6,447.4	1,355.7	1,239.8
80	560	57	354.2	1,327.3	3,528.7	5,921.0	6,128.4	1,286.8	1,181.4
75	525	55	343.5	1,296.1	3,380.3	5,758.1	5,953.9	1,252.4	1,152.1
70	490	52	333.0	1,263.9	3,232.1	5,595.3	5,779.9	1,210.6	1,115.7
60	420	46	309.9	1,188.4	2,936.8	5,225.0	5,387.3	1,124.0	1,039.7
50	350	40	283.3	1,096.0	2,635.8	4,786.2	4,926.3	1,037.0	962.9
40	280	29	234.8	937.9	2,142.7	4,057.7	4,169.3	881.6	822.1
30	210	18	185.0	776.8	1,641.2	3,326.2	3,409.4	721.4	675.9
25	175	14	162.3	703.8	1,408.2	2,998.8	3,068.4	645.9	606.8
20	140	10	144.4	646.6	1,214.1	2,747.1	2,804.4	591.1	558.0
10	70.0	5	114.6	553.2	876.1	2,347.9	2,382.4	501.4	478.9

Heat Rejection Data Top

PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
100	700	10,045	5,379	29,941	17,110	4,100	6,949	29,686	76,976	81,999
90	630	9,499	4,754	27,920	15,840	3,763	6,377	26,717	70,657	75,267
80	560	8,360	4,843	25,188	13,964	3,391	5,681	23,748	63,667	67,821
75	525	7,742	4,916	23,776	13,000	3,201	5,320	22,264	60,098	64,019
70	490	7,351	4,769	22,590	12,246	3,023	4,967	20,780	56,754	60,457
60	420	6,700	4,397	20,164	10,736	2,664	4,214	17,811	50,023	53,288
50	350	6,110	3,868	17,466	9,055	2,285	3,408	14,843	42,895	45,694
40	280	5,203	3,564	13,629	6,669	1,822	2,174	11,874	34,212	36,445
30	210	4,262	2,985	9,844	4,338	1,358	1,171	8,906	25,503	27,167
25	175	3,801	2,578	8,137	3,301	1,137	799	7,421	21,344	22,736
20	140	3,382	2,308	6,555	2,285	936	542	5,937	17,576	18,723
10	70.0	2,590	1,756	3,770	472	563	183	2,969	10,577	11,267

Emissions Data Top

Units Filter All Units

RATED SPEED POTENTIAL SITE VARIATION: 1750 RPM

ENGINE POWER		BHP	700	525	350	175	70.0
PERCENT LOAD		%	100	75	50	25	10
TOTAL NOX (AS NO2)		G/HR	2,407	1,339	795	451	852
TOTAL CO		G/HR	988	1,217	283	456	336
TOTAL HC		G/HR	35	68	59	58	50
PART MATTER		G/HR	135.0	101.8	77.2	80.5	25.5
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	1,517.5	1,082.1	889.0	976.1	3,551.0
TOTAL CO	(CORR 5% O2)	MG/NM3	622.9	979.5	326.2	990.5	1,409.8
TOTAL HC	(CORR 5% O2)	MG/NM3	19.4	47.6	57.6	109.7	182.5
PART MATTER	(CORR 5% O2)	MG/NM3	70.3	69.2	74.9	152.8	97.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	739	527	433	475	1,730
TOTAL CO	(CORR 5% O2)	PPM	498	784	261	792	1,128
TOTAL HC	(CORR 5% O2)	PPM	36	89	108	205	341
TOTAL NOX (AS NO2)		G/HP-HR	3.48	2.57	2.29	2.59	12.20
TOTAL CO		G/HP-HR	1.43	2.34	0.81	2.61	4.82
TOTAL HC		G/HP-HR	0.05	0.13	0.17	0.33	0.72
PART MATTER		G/HP-HR	0.20	0.20	0.22	0.46	0.37
TOTAL NOX (AS NO2)		LB/HR	5.31	2.95	1.75	0.99	1.88

Exhibit 34

ENGINE POWER		BHP	700	525	350	175	70.0
PERCENT LOAD		%	100	75	50	25	10
TOTAL CO		LB/HR	2.18	2.68	0.62	1.01	0.74
TOTAL HC		LB/HR	0.08	0.15	0.13	0.13	0.11
PART MATTER		LB/HR	0.30	0.22	0.17	0.18	0.06

RATED SPEED NOMINAL DATA: 1750 RPM

ENGINE POWER		BHP	700	525	350	175	70.0
PERCENT LOAD		%	100	75	50	25	10
TOTAL NOX (AS NO2)		G/HR	2,229	1,240	736	418	789
TOTAL CO		G/HR	528	651	151	244	180
TOTAL HC		G/HR	19	36	31	31	27
TOTAL CO2		KG/HR	352	272	193	98	48
PART MATTER		G/HR	69.2	52.2	39.6	41.3	13.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	1,405.1	1,001.9	823.2	903.8	3,288.0
TOTAL CO	(CORR 5% O2)	MG/NM3	333.1	523.8	174.4	529.7	753.9
TOTAL HC	(CORR 5% O2)	MG/NM3	10.2	25.2	30.5	58.1	96.6
PART MATTER	(CORR 5% O2)	MG/NM3	36.0	35.5	38.4	78.4	50.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	684	488	401	440	1,602
TOTAL CO	(CORR 5% O2)	PPM	266	419	140	424	603
TOTAL HC	(CORR 5% O2)	PPM	19	47	57	108	180
TOTAL NOX (AS NO2)		G/HP-HR	3.22	2.38	2.12	2.39	11.30
TOTAL CO		G/HP-HR	0.76	1.25	0.44	1.40	2.58
TOTAL HC		G/HP-HR	0.03	0.07	0.09	0.18	0.38
PART MATTER		G/HP-HR	0.10	0.10	0.11	0.24	0.19
TOTAL NOX (AS NO2)		LB/HR	4.91	2.73	1.62	0.92	1.74
TOTAL CO		LB/HR	1.16	1.43	0.33	0.54	0.40
TOTAL HC		LB/HR	0.04	0.08	0.07	0.07	0.06
TOTAL CO2		LB/HR	777	600	426	215	105
PART MATTER		LB/HR	0.15	0.12	0.09	0.09	0.03
OXYGEN IN EXH		%	8.9	10.4	11.8	13.4	16.1
DRY SMOKE OPACITY		%	1.9	1.6	1.4	2.6	0.6
BOSCH SMOKE NUMBER			1.22	1.06	0.96	1.60	0.28

Regulatory Information Top

EPA TIER 3 **2005 - 2010**

GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 89 SUBPART D AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE NON-ROAD REGULATIONS.

Locality	Agency	Regulation	Tier/Stage	Max Limits - G/BKW - HR
U.S. (INCL CALIF)	EPA	NON-ROAD	TIER 3	CO: 3.5 NOx + HC: 4.0 PM: 0.20

EPA EMERGENCY STATIONARY **2011 - ----**

GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE EMERGENCY STATIONARY REGULATIONS.

Locality	Agency	Regulation	Tier/Stage	Max Limits - G/BKW - HR
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 4.0 PM: 0.20

Altitude Derate Data Top

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	50	60	70	80	90	100	110	120	130	NORMAL
ALTITUDE (FT)										
0	700	700	700	700	691	679	667	655	644	700
1,000	700	700	691	678	666	654	642	631	621	684
2,000	691	678	665	653	641	629	618	608	597	663

AMBIENT OPERATING TEMP (F)	50	60	70	80	90	100	110	120	130	NORMAL
3,000	665	652	640	628	617	606	595	585	575	643
4,000	640	628	616	604	593	583	573	563	553	622
5,000	615	604	592	581	571	560	551	541	532	603
6,000	592	580	569	559	549	539	529	520	511	583
7,000	569	558	547	537	527	518	509	500	492	565
8,000	546	536	526	516	507	498	489	480	472	546
9,000	525	515	505	496	487	478	469	461	454	528
10,000	504	494	485	476	467	459	451	443	435	511
11,000	483	474	465	456	448	440	432	425	418	494
12,000	464	455	446	438	430	422	415	408	401	477
13,000	445	436	428	420	412	405	398	391	384	461
14,000	426	418	410	402	395	388	381	375	368	445
15,000	408	400	393	386	379	372	365	359	353	429

Cross Reference Top

Engine Arrangement

Arrangement Number	Effective Serial Number	Engineering Model	Engineering Model Version
3149713	NBB00003	E978	-

Test Specification Data

Test Spec	Setting	Effective Serial Number	Engine Arrangement
0K8977	PP6861	NBB00003	3149713

Performance Parameter Reference Top

Parameters Reference: DM9600 - 08

PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600

APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.

PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%

Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%

Heat Rejection values based on using treated water.

Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.

On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.

These values do not apply to C280/3600. For these models, see the tolerances listed below.

C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%

TEST CELL TRANSDUCER TOLERANCE FACTORS:

Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa

OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.

REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.

FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.

MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.

REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.

REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 29 (84.2), where the density is 838.9 G/Liter (7.001 Lbs/Gal).

GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.

ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.

ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.

Standard temperature values versus altitude could be seen on TM2001.

When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.

Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.

Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.

REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.

Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.

EMISSIONS DEFINITIONS:
Emissions : DM1176

HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500

HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500

RATING DEFINITIONS:
Agriculture : TM6008

Fire Pump : TM6009

Generator Set : TM6035

Generator (Gas) : TM6041

Industrial Diesel : TM6010

Industrial (Gas) : TM6040

Irrigation : TM5749

Locomotive : TM6037

Marine Auxiliary : TM6036

Marine Prop (Except 3600) : TM5747

Marine Prop (3600 only) : TM5748

MSHA : TM6042

Oil Field (Petroleum) : TM6011

Off-Highway Truck : TM6039

On-Highway Truck : TM6038

SOUND DEFINITIONS:
Sound Power : DM8702

Sound Pressure : TM7080

Date Released : 7/7/15

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project   Permit Number:

Engine Information

1.	Device ID Number	EU8.BSG (Black Start Generators)
2.	Existing or future?	Future
3.	Date construction commenced	January 2019
4.	Date installed/completed	July 2021
5.	Special controls (if applicable)	Tier 2
6.	Manufacturer	Caterpillar
7.	Date manufactured	
8.	Maximum rating (MMbtu/hr for turbines, Hp for others)	4,376, each
9.	Control device(s) (yes/no)	No
	If yes, enter the identification number(s)	
10.	Description of device:	

Caterpillar C175-16EL 3,000 KW diesel-fired black start engine generators will provide power for turbine startups and essential site functions during power loss.

Operating Schedule

11.	Projected maximum hours/day	
12.	Projected maximum hours/year	200

Fuel Information

13. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	219 gal/hr	42,840 gal
Back-up			
Other			

Stack Information

14.	Exit height (ft)	18
15.	Exit diameter (ft)	1.67
16.	Design flowrate (dscf/min)	25,620 acfm

Monitoring Information

17. Monitoring equipment			
fuel flow (y/n)		recorder? (y/n)	
engine load (y/n)		recorder? (y/n)	
other (specify)	Hour meter	recorder? (y/n)	Yes

PERFORMANCE DATA[DM8956]

Sound Data (Continued)

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ	800 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2,997.5	110	4,376	127.5	110.8	118.5	115.4	117.4	115.5	115.7	116.9	116.3	113.6	113.2
2,725.0	100	3,988	127.1	111.7	118.3	116.2	114.9	116.1	116.0	116.7	115.0	113.2	111.9
2,452.5	90	3,619	127.5	111.8	118.5	116.6	115.0	116.0	115.2	116.2	114.6	113.2	111.8
2,180.0	80	3,256	127.6	110.9	118.6	117.1	116.1	117.2	115.4	116.3	114.7	112.7	111.6
2,043.8	75	3,077	127.3	110.5	118.5	117.2	115.9	116.9	115.1	116.1	114.8	112.6	111.4
1,907.5	70	2,894	127.0	110.2	118.4	117.2	115.8	116.7	114.8	115.8	114.8	112.5	111.2
1,635.0	60	2,531	126.4	109.6	118.1	117.1	115.4	116.2	114.2	114.9	114.8	112.2	110.7
1,362.5	50	2,165	125.8	109.2	117.5	116.7	115.0	115.7	113.7	113.9	114.6	111.9	110.1
1,090.0	40	1,798	125.3	108.3	116.5	116.0	114.6	115.3	113.3	113.9	114.0	111.6	109.7
817.5	30	1,421	124.7	107.3	115.3	115.1	114.2	114.8	112.8	114.0	113.3	111.3	109.4
681.2	25	1,226	124.4	106.8	114.7	114.6	113.9	114.5	112.6	114.0	113.0	111.1	109.3
545.0	20	1,024	124.1	106.3	114.1	114.2	113.7	114.3	112.4	114.0	112.7	110.9	109.2
272.5	10	596	123.5	105.7	113.3	113.6	113.1	113.7	112.1	114.1	112.7	110.4	109.2

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ	10000 HZ
EKW	%	BHP	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
2,997.5	110	4,376	111.4	111.7	112.8	110.6	112.3	111.2	110.0	110.4	110.9	113.0	116.1
2,725.0	100	3,988	110.8	111.5	112.6	110.6	111.7	110.1	108.3	109.2	108.9	110.4	115.4
2,452.5	90	3,619	111.1	111.1	111.9	110.3	111.4	109.8	108.3	110.0	108.4	110.0	120.3
2,180.0	80	3,256	111.1	111.0	111.4	110.1	111.2	109.4	108.3	109.9	108.5	110.2	119.7
2,043.8	75	3,077	110.9	111.0	111.3	109.8	111.1	109.2	108.0	109.6	108.2	110.2	118.5
1,907.5	70	2,894	110.7	110.9	111.1	109.6	110.9	109.0	107.8	109.4	107.9	110.1	117.3
1,635.0	60	2,531	110.1	110.8	110.8	109.1	110.6	108.5	107.2	108.7	107.1	109.7	114.8
1,362.5	50	2,165	109.5	110.6	110.3	108.6	110.1	108.1	106.5	107.8	106.1	108.9	112.3
1,090.0	40	1,798	109.4	109.9	109.4	108.1	109.2	107.4	105.4	106.3	104.3	107.0	109.8
817.5	30	1,421	109.4	109.2	108.4	107.6	108.1	106.7	104.3	104.8	102.4	104.8	107.2
681.2	25	1,226	109.4	108.9	108.0	107.4	107.7	106.3	103.7	104.0	101.5	103.8	105.9
545.0	20	1,024	109.4	108.7	107.5	107.1	107.3	105.9	103.3	103.3	100.7	102.8	104.5
272.5	10	596	109.3	108.7	107.0	106.6	106.8	105.3	102.8	102.1	99.5	101.3	101.5

Emissions Data

EMISSIONS VALUES ARE TAILPIPE OUT WITH AFTERTREATMENT. VALUES SHOWN AS ZERO MAY BE GREATER THAN ZERO BUT WERE BELOW THE DETECTION LEVEL OF THE EQUIPMENT USED AT TIME OF MEASUREMENT.

CATERPILLAR EMISSIONS CERTIFIED ENGINES TESTED WITHIN EPA SPECIFIED TEST CONDITIONS, AND USING TITLE 40 CFR PART 1065 TEST PROTOCOL, MEET THE NEW SOURCE PERFORMANCE STANDARDS. POTENTIAL SITE VARIATION DATA ACCOUNT FOR PRODUCTION ENGINE AND SYSTEM VARIABILITY IN ADDITION TO MEASUREMENT VARIABILITY FOR TYPICAL FIELD TEST METHODS AS DESCRIBED IN DM1176. THIS DATA ASSUMES SITE CORRECTIONS FOR AMBIENT HUMIDITY TO 75 GRAINS, AND STANDARD CONDITIONS OF 25 C (77 F) AIR TO TURBO TEMPERATURE AND 152.4 M (500 FT) ALTITUDE. GUIDANCE ON HUMIDITY CORRECTION METHODS ARE AVAILABLE IN TITLE 40 CFR SECTION 1065.670. FOR APPLICATIONS WITH GEOGRAPHIC OR AMBIENT CONDITIONS BEYOND THESE PUBLISHED VALUES, CONSULT CATERPILLAR (APPLICATION SUPPORT CENTER) FOR ADDITIONAL VARIABILITY INFORMATION.

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	2,997.5	2,725.0	2,043.8	1,362.5	681.2
PERCENT LOAD		%	110	100	75	50	25
ENGINE POWER		BHP	4,376	3,988	3,077	2,165	1,226
TOTAL NOX (AS NO2)		G/HR	3,372	2,971	1,701	953	615
TOTAL CO		G/HR	470	439	262	224	161
TOTAL HC		G/HR	206	192	171	145	104
PART MATTER		G/HR	104.8	77.9	88.6	103.8	92.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	342.8	335.0	236.5	167.6	172.1
TOTAL CO	(CORR 5% O2)	MG/NM3	50.9	52.8	38.4	41.7	47.0
TOTAL HC	(CORR 5% O2)	MG/NM3	19.3	20.0	21.7	23.4	26.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	167	163	115	82	84
TOTAL CO	(CORR 5% O2)	PPM	41	42	31	33	38
TOTAL HC	(CORR 5% O2)	PPM	36	37	40	44	49
TOTAL NOX (AS NO2)		G/HP-HR	0.78	0.75	0.56	0.44	0.50
TOTAL CO		G/HP-HR	0.11	0.11	0.09	0.10	0.13
TOTAL HC		G/HP-HR	0.05	0.05	0.06	0.07	0.09

PERFORMANCE DATA[DM8956]

PART MATTER		G/HP-HR	0.02	0.02	0.03	0.05	0.08
TOTAL NOX (AS NO2)		LB/HR	7.43	6.55	3.75	2.10	1.36
TOTAL CO		LB/HR	1.04	0.97	0.58	0.49	0.36
TOTAL HC		LB/HR	0.45	0.42	0.38	0.32	0.23
PART MATTER		LB/HR	0.23	0.17	0.20	0.23	0.20

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		**EKW**	**2,997.5**	**2,725.0**	**2,043.8**	**1,362.5**	**681.2**
PERCENT LOAD		**%**	**110**	**100**	**75**	**50**	**25**
ENGINE POWER		**BHP**	**4,376**	**3,988**	**3,077**	**2,165**	**1,226**
TOTAL NOX (AS NO2)		G/HR	2,294	2,021	1,157	648	418
TOTAL CO		G/HR	49	46	28	24	17
TOTAL HC		G/HR	9	8	7	6	5
TOTAL CO2		KG/HR	2,043	1,843	1,494	1,155	733
PART MATTER		G/HR	38.7	28.7	32.7	38.3	34.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	233.2	227.9	160.9	114.0	117.0
TOTAL CO	(CORR 5% O2)	MG/NM3	5.3	5.6	4.0	4.4	4.9
TOTAL HC	(CORR 5% O2)	MG/NM3	0.8	0.9	0.9	1.0	1.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	114	111	78	56	57
TOTAL CO	(CORR 5% O2)	PPM	4	4	3	4	4
TOTAL HC	(CORR 5% O2)	PPM	2	2	2	2	2
FORMALDEHYDE	(CORR 15% O2)	PPM	0.01	0.01	0.01	0.01	0.01
ACROLEIN	(CORR 15% O2)	PPM	0.00	0.00	0.00	0.00	0.00
ACETALDEHYDE	(CORR 15% O2)	PPM	0.00	0.00	0.00	0.00	0.00
METHANOL	(CORR 15% O2)	PPM	0.00	0.00	0.00	0.00	0.00
TOTAL NOX (AS NO2)		G/HP-HR	0.53	0.51	0.38	0.30	0.34
TOTAL CO		G/HP-HR	0.01	0.01	0.01	0.01	0.01
TOTAL HC		G/HP-HR	0.00	0.00	0.00	0.00	0.00
PART MATTER		G/HP-HR	0.01	0.01	0.01	0.02	0.03
TOTAL NOX (AS NO2)		LB/HR	5.06	4.46	2.55	1.43	0.92
TOTAL CO		LB/HR	0.11	0.10	0.06	0.05	0.04
TOTAL HC		LB/HR	0.02	0.02	0.02	0.01	0.01
TOTAL CO2		LB/HR	4,505	4,064	3,295	2,546	1,615
PART MATTER		LB/HR	0.09	0.06	0.07	0.08	0.08
OXYGEN IN EXH		%	9.8	10.2	11.1	11.9	12.9
DRY SMOKE OPACITY		%	0.2	0.2	0.3	0.4	0.5
BOSCH SMOKE NUMBER			0.09	0.10	0.13	0.17	0.20

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project Permit Number:

Engine Information

1.	Device ID Number	EU9.EG (Backup Gen Engines)
2.	Existing or future?	Future
3.	Date construction commenced	January 2019
4.	Date installed/completed	October 2021
5.	Special controls (if applicable)	Tier 2
6.	Manufacturer	Caterpillar
7.	Date manufactured	
8.	Maximum rating (MMbtu/hr for turbines, Hp for others)	1,214, each
9.	Control device(s) (yes/no)	No
	If yes, enter the identification number(s)	
10.	Description of device:	

Two Caterpillar C27 SR5 800 eKW diesel-fired emergency backup engine generators.

Operating Schedule

11.	Projected maximum hours/day	2
12.	Projected maximum hours/year	200

Fuel Information

13. Fuel usage:	a. Type	b. Hourly usage	c. Annual usage
Primary	ULSD	57.3 gal/hr	11,460 gal
Back-up			
Other			

Stack Information

14.	Exit height (ft)	13
15.	Exit diameter (ft)	0.67
16.	Design flowrate (dscf/min)	6011.7 acfm

Monitoring Information

17. Monitoring equipment			
fuel flow (y/n)		recorder? (y/n)	
engine load (y/n)		recorder? (y/n)	
other (specify)	Hour meter	recorder? (y/n)	Yes

JORDAN COVE LNG
EQUIPMENT SUBMITTAL FOR APPROVAL

PREPARED FOR
BLACK & VEATCH

TWO (2) CATERPILLAR MODEL C27, FEDERAL EPA TIER II RATED 800KW/1000KVA, 480/277VAC, THREE PHASE, FOUR WIRE, 60 HZ, .8PF STANDBY DIESEL ENGINE GENERATOR SET AND THREE (3) ATS

PROVIDED BY
PETERSON POWER SYSTEMS, INC.
PROJECT NUMBER 160383
JULY 12, 2016

Since 1936

4421 NE Columbia Blvd. Portland, OR 97218 Telephone (503) 288-6411 www.petersonpower.com
Project Manager: Scott Posey 503.718.8650 Fax 503.280.1552 SMPosey@PetersonPower.com

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
2015 MODEL YEAR
CERTIFICATE OF CONFORMITY
WITH THE CLEAN AIR ACT OF 1990

OFFICE OF TRANSPORTATION AND AIR QUALITY
ANN ARBOR, MICHIGAN 48105

Certificate Issued To: **Caterpillar Inc.**
(U.S. Manufacturer or Importer)

Certificate Number: FCPXL27.0NZS-005

Effective Date: 07/01/2014

Expiration Date: 12/31/2015

Byron J. Bunker, Division Director
Compliance Division

Issue Date: 07/01/2014

Revision Date: N/A

Model Year: 2015
Manufacturer Type: Original Engine Manufacturer
Engine Family: FCPXL27.0NZS

Mobile/Stationary Indicator: Stationary
Emissions Power Category: 560<kW<=2237
Fuel Type: Diesel
After Treatment Devices: No After Treatment Devices Installed
Non-after Treatment Devices: Electronic Control, Engine Design Modification

Pursuant to Section 111 and Section 213 of the Clean Air Act (42 U.S.C. sections 7411 and 7547) and 40 CFR Part 60, and subject to the terms and conditions prescribed in those provisions, this certificate of conformity is hereby issued with respect to the test engines which have been found to conform to applicable requirements and which represent the following engines, by engine family, more fully described in the documentation required by 40 CFR Part 60 and produced in the stated model year.

This certificate of conformity covers only those new compression-ignition engines which conform in all material respects to the design specifications that applied to those engines described in the documentation required by 40 CFR Part 60 and which are produced during the model year stated on this certificate of the said manufacturer, as defined in 40 CFR Part 60.

It is a term of this certificate that the manufacturer shall consent to all inspections described in 40 CFR 1068 and authorized in a warrant or court order. Failure to comply with the requirements of such a warrant or court order may lead to revocation or suspension of this certificate for reasons specified in 40 CFR Part 60. It is also a term of this certificate that this certificate may be revoked or suspended or rendered void *ab initio* for other reasons specified in 40 CFR Part 60.

This certificate does not cover engines sold, offered for sale, or introduced, or delivered for introduction, into commerce in the U.S. prior to the effective date of the certificate.

Caterpillar is leading the power generation marketplace with Power Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost-effectiveness.

Specifications

Generator Set Specifications	
Minimum Rating	680 ekW
Maximum Rating	800 ekW
Voltage	208 to 600
Frequency	60 Hz
Speed	1800 RPM

Generator Set Configurations	
Emissions/Fuel Strategy	Low Fuel Consumption, U.S. EPA Certified for Stationary Emergency Use Only (Tier 2 Nonroad Equivalent Emission Standards)

Engine Specifications		
Engine Model	C27 ATAAC, V-12, 4-Stroke, Water-Cooled Diesel	
Compression Ratio	16.5:1	
Aspiration	TA	
Governor Type	Adem™A4	
Fuel System	MEUI	
Bore	137.2 mm	5.4 in
Displacement	27.03 L	1649.47 in³
Stroke	152.4 mm	6 in

Benefits And Features

Cat Diesel Engine

- Reliable, rugged, durable design
- Field-proven in thousands of applications worldwide
- Four-stroke-cycle diesel engine combines consistent performance and excellent fuel economy with minimum weight

Generator

- Matched to the performance and output characteristics of Cat engines
- Industry leading mechanical and electrical design
- Industry leading motor starting capabilities
- High Efficiency

Cat EMCP Control Panel

The EMCP controller features the reliability and durability you have come to expect from your Cat equipment. EMCP4 is a scalable control platform designed to ensure reliable generator set operation, providing extensive information about power output and engine operation. EMCP4 systems can be further customized to meet your needs through programming and expansion modules.

Seismic Certification

- Seismic Certification available.
- Anchoring details are site specific, and are dependent on many factors such as generator set size, weight, and concrete strength.
- IBC Certification requires that the anchoring system used is reviewed and approved by a Professional Engineer
- Seismic Certification per Applicable Building Codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007, CBC 2010
- Pre-approved by OSHPD and carries an OSP-0321-10 for use in healthcare projects in California

Design Criteria

The generator set accepts 100% rated load in one step per NFPA 110 and meets ISO 8528-5 transient response.

UL 2200 / CSA - Optional

- UL 2200 listed packages
- CSA Certified
- Certain restrictions may apply.
- Consult with your Cat® Dealer.

Single-Source Supplier

Fully prototype tested with certified torsional vibration analysis available

World Wide Product Support

Cat Dealers provide extensive post sale support including maintenance and repair agreements. Cat dealers have over 1,800 dealer branch stores operating in 200 countries. The Cat® SOSSM program cost effectively detects internal engine component condition, even the presence of unwanted fluids and combustion by-products.

Standard Equipment

Air Inlet

- Air Cleaner

Cooling

- Package mounted radiator

Exhaust

- Exhaust flange outlet

Fuel

- Primary fuel filter with integral water separator
- Secondary fuel filter
- Fuel priming pump

Generator

- Matched to the performance and output characteristics of Cat engines
- Load adjustment module provides engine relief upon load impact and improves load acceptance and recovery time
- IP23 Protection

Power Termination

- Bus Bar

Control Panel

- EMCP 4 Genset Controller

General

- Paint - Caterpillar Yellow except rails and radiators gloss black

Optional Equipment

Exhaust

- Exhaust mufflers

Generator

- Anti-condensation heater
- Excitation: [ ] Permanent Magnet Excited (PM) [ ] Internally Excited (IE)
- Oversize and premium generators

Power Termination

- Circuit breakers, UL listed
- Circuit breakers, IEC compliant

Control Panels

- EMCP (4.2) (4.3) (4.4)
- Generator temperature monitoring & protection
- Load share module
- Digital I/O module
- Remote monitoring software

Mounting

- Rubber anti-vibration mounts
- Spring-type vibration isolator
- IBC isolators

Starting/Charging

- Battery chargers
- Oversize batteries
- Jacket water heater
- Heavy-duty starting system
- Charging alternator
- Air starting motor with control and silencer

General

- The following options are based on regional and product configuration:
- Seismic Certification per applicable building codes: IBC 2000, IBC 2003, IBC 2006, IBC 2009, CBC 2007
- UL 2200 package
- EU Certificate of Conformance (CE)
- CSA Certification
- EEC Declaration of Conformity
- Enclosures: sound attenuated, weather protective
- Automatic transfer switches (ATS)
- Integral & sub-base fuel tanks
- Integral & sub-base UL listed dual wall fuel tanks

ELECTRIC POWER - Technical Spec Sheet
STANDARD

C27 ACERT
800 ekW/ 1000 kVA/ 60 Hz/ 1800 rpm/ 480 V/ 0.8 Power Factor

Rating Type: STANDBY

Emissions: U.S. EPA Certified for Stationary Emergency Use Only (Tier 2 Nonroad Equivalent Emission Standards)

Image shown may not reflect actual configuration

C27 ACERT
800 ekW/ 1000 kVA
60 Hz/ 1800 rpm/ 480 V

	Metric	English
Package Performance		
Genset Power Rating with Fan @ 0.8 Power Factor	800 ekW	
Genset Power Rating	1000 kVA	
Aftercooler (Separate Circuit)	N/A	N/A
Fuel Consumption		
100% Load with Fan	216.9 L/hr	57.3 gal/hr
75% Load with Fan	171.7 L/hr	45.4 gal/hr
50% Load with Fan	122.3 L/hr	32.3 gal/hr
25% Load with Fan	73.9 L/hr	19.5 gal/hr
Cooling System[1]		
Engine Coolant Capacity	55.0 L	14.5 gal
Inlet Air		
Combustion Air Inlet Flow Rate	62.8 m³/min	2216.4 cfm
Max. Allowable Combustion Air Inlet Temp	49 ° C	121 ° F
Exhaust System		
Exhaust Stack Gas Temperature	511.4 ° C	952.5 ° F
Exhaust Gas Flow Rate	170.3 m³/min	6011.7 cfm
Exhaust System Backpressure (Maximum Allowable)	6.7 kPa	27.0 in. water

C27 ACERT
800 ekW/ 1000 kVA/ 60 Hz/ 1800 rpm/ 480 V/ 0.8 Power Factor

Rating Type: STANDBY

Emissions: U.S. EPA Certified for Stationary Emergency Use Only (Tier 2 Nonroad Equivalent Emission Standards)

Heat Rejection		
Heat Rejection to Jacket Water	330 kW	18785 Btu/min
Heat Rejection to Exhaust (Total)	796 kW	45257 Btu/min
Heat Rejection to Aftercooler	162 kW	9235 Btu/min
Heat Rejection to Atmosphere from Engine	110 kW	6240 Btu/min
Heat Rejection to Atmosphere from Generator	40 kW	2292 Btu/min

Alternator[2] See Generator Data		

Emissions (Nominal)[3]		
NOx	2580.0 mg/Nm^3	5.2 g/hp-hr
CO	115.1 mg/Nm^3	0.2 g/hp-hr
HC	12.5 mg/Nm^3	0.0 g/hp-hr
PM	9.7 mg/Nm^3	0.0 g/hp-hr

DEFINITIONS AND CONDITIONS

1. For ambient and altitude capabilities consult your Cat dealer. Air flow restriction (system) is added to existing restriction from factory.

2. UL 2200 Listed packages may have oversized generators with a different temperature rise and motor starting characteristics. Generator temperature rise is based on a 40° C ambient per NEMA MG1-32.

3. Emissions data measurement procedures are consistent with those described in EPA CFR 40 Part 89, Subpart D & E and ISO8178-1 for measuring HC, CO, PM, NOx. Data shown is based on steady state operating conditions of 77° F, 28.42 in HG and number 2 diesel fuel with 35° API and LHV of 18,390 btu/lb. The nominal emissions data shown is subject to instrumentation, measurement, facility and engine to engine variations. Emissions data is based on 100% load and thus cannot be used to compare to EPA regulations which use values based on a weighted cycle.

C27 ACERT
800 ekW/ 1000 kVA/ 60 Hz/ 1800 rpm/ 480 V/ 0.8 Power Factor

Rating Type: STANDBY

Emissions: U.S. EPA Certified for Stationary Emergency Use Only (Tier 2 Nonroad Equivalent Emission Standards)

Applicable Codes and Standards:
AS1359, CSA C22.2 No100-04, UL142,UL489, UL869, UL2200,
NFPA37, NFPA70, NFPA99, NFPA110, IBC, IEC60034-1, ISO3046, ISO8528,
NEMA MG1-22,NEMA MG1-33, 2006/95/EC, 2006/42/EC, 2004/108/EC.

Note: Codes may not be available in all model configurations. Please consult your local Cat Dealer representative for availability.

STANDBY: Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Ratings are based on SAE J1349 standard conditions. These ratings also apply at ISO3046 standard conditions

Fuel Rates are based on fuel oil of 35º API [16º C (60º F)] gravity having an LHV of 42 780 kJ/kg (18,390 Btu/lb) when used at 29º C (85º F) and weighing 838.9 g/liter (7.001 lbs/U.S. gal.). Additional ratings may be available for specific customer requirements, contact your Cat representative for details. For information regarding Low Sulfur fuel and Biodiesel capability, please consult your Cat dealer.

www.Cat-ElectricPower.com

Performance No.: DM7696-02

Feature Code: C27DR70

Generator Arrangement: 3850624

Date: 07/04/2016

Source Country: U.S.

Systems Data

Reference Number: DM7696

CATERPILLAR®

July 11, 2016
For Help Desk Phone Numbers [Click Here]

AIR INTAKE SYSTEM		
THE INSTALLED SYSTEM MUST COMPLY WITH THE SYSTEM LIMITS BELOW FOR ALL EMISSIONS CERTIFIED ENGINES TO ASSURE REGULATORY COMPLIANCE.		
MAXIMUM ALLOWABLE INTAKE RESTRICTION WITH CLEAN ELEMENT	15	IN-H20
MAXIMUM ALLOWABLE INTAKE RESTRICTION WITH DIRTY ELEMENT	25	IN-H20
MAXIMUM PRESSURE DROP FROM COMPRESSOR OUTLET TO MANIFOLD INLET (OR MIXER INLET FOR EGR)	4.4	IN-HG
MAXIMUM TURBO INLET AIR TEMPERATURE	122	DEG F
MAXIMUM AIR FILTER INLET AIR TEMPERATURE	122	DEG F
CHARGE AIR FLOW AT RATED SPEED	166.7	LB/MIN
TURBO COMPRESSOR OUTLET PRESSURE AT RATED SPEED (ABSOLUTE)	90.6	IN-HG
COOLING SYSTEM		
ENGINE ONLY COOLANT CAPACITY	14.5	GAL
MAXIMUM ALLOWABLE JACKET WATER OUTLET TEMPERATURE	210	DEG F
REGULATOR LOCATION FOR JW (HT) CIRCUIT	OUTLET	
MAXIMUM UNINTERRUPTED FILL RATE	5.0	G/MIN
MINIMUM ALLOWABLE COOLANT LOSS (PERCENTAGE OF TOTAL)	12	PERCENT
COOLANT LOSS-MAXIMUM PERCENTAGE OF PUMP PRESSURE RISE LOSS	15	PERCENT
ENGINE SPEC SYSTEM		
CYLINDER ARRANGEMENT	VEE	
NUMBER OF CYLINDERS	12	
CYLINDER BORE DIAMETER	5.4	IN
PISTON STROKE	6.0	IN
TOTAL CYLINDER DISPLACEMENT	1649	CU IN
STANDARD CRANKSHAFT ROTATION FROM FLYWHEEL END	CCW	
STANDARD CYLINDER FIRING ORDER	1-10-9-6-5-12-11-4-3-8-7-2	
NUMBER 1 CYLINDER LOCATION	LEFT FRONT	
STROKES/COMBUSTION CYCLE	4	
EXHAUST SYSTEM		
THE INSTALLED SYSTEM MUST COMPLY WITH THE SYSTEM LIMITS BELOW FOR ALL EMISSIONS CERTIFIED ENGINES TO ASSURE REGULATORY COMPLIANCE.		
MAXIMUM ALLOWABLE SYSTEM BACK PRESSURE	27	IN-H20
MANIFOLD TYPE	DRY	
MAXIMUM ALLOWABLE STATIC WEIGHT ON EXHAUST CONNECTION	110.2	LB
MAXIMUM ALLOWABLE STATIC BENDING MOMENT ON EXHAUST CONNECTION	0	LB-FT

FUEL SYSTEM		
MAXIMUM FUEL FLOW FROM TRANSFER PUMP TO ENGINE	227.2	G/HR
MAXIMUM ALLOWABLE FUEL SUPPLY LINE RESTRICTION	8.9	IN-HG
MAXIMUM ALLOWABLE FUEL TEMPERATURE AT TRANSFER PUMP INLET	149	DEG F
MAXIMUM FUEL FLOW TO RETURN LINE FROM ENGINE	198.1	G/HR
MAXIMUM ALLOWABLE FUEL RETURN LINE RESTRICTION	10.2	IN-HG
NORMAL FUEL PRESSURE IN A CLEAN SYSTEM	90.9	PSI
FUEL SYSTEM TYPE	DI	
MAXIMUM TRANSFER PUMP PRIMING LIFT WITHOUT PRIMING PUMP	12.1	FT
LUBE SYSTEM		
CRANKCASE VENTILATION TYPE	TO ATM	
MOUNTING SYSTEM		
CENTER OF GRAVITY LOCATION - X DIMENSION - FROM REAR FACE OF BLOCK - (REFERENCE TM7077)	23.0	IN
CENTER OF GRAVITY LOCATION - Y DIMENSION - FROM CENTERLINE OF CRANKSHAFT - (REFERENCE TM7077)	11.5	IN
CENTER OF GRAVITY LOCATION - Z DIMENSION - FROM CENTERLINE OF CRANKSHAFT - (REFERENCE TM7077)	0.0	IN
DRY WEIGHT - ENGINE ONLY (REFERENCE VALUE)	6462	LB
STARTING SYSTEM		
MINIMUM CRANKING SPEED REQUIRED FOR START-RPM	100	
LOWEST AMBIENT START TEMPERATURE WITHOUT AIDS	32	DEG F

PACKAGE DATA [DM7696]

JULY 11, 2016

For Help Desk Phone Numbers Click here

Feature Code:	C27DR70	**Rating Type:**	STANDBY	**Sales model Package:**	C27 SR5
Engine Sales Model:	C27 T2/ESE	**Engine Arrangement Number:**	3495619	**Hertz:**	60
EKW W/F:	800.0	**Noise Reduction:**	0 dBA	**Back Pressure:**	0.0 inH2O

Engine Package Information

Engine Package Data

Package Cooling Information

SA Level 2 Canopy Cooling Data

% Load	Airflow Rate scfm	Ambient Capability Sea Level (Deg F)	Ambient Capability 300 m (Deg F)	Ambient Capability 600 m (Deg F)	Ambient Capability 900 m (Deg F)
100.0	N/A	N/A	111	107	105

Package Sound Information

Sound Comments :

Open Sound Data

Distance: 3.3 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	108.0	98.3	107.1	102.5	102.5	104.0	100.8	96.5	97.3
600.0	75.0	107.6	97.2	106.9	101.9	102.4	104.0	100.5	95.3	92.8
400.0	50.0	107.3	96.5	106.6	101.6	102.2	104.0	100.3	94.4	89.9
200.0	25.0	107.2	96.2	106.1	101.7	102.2	104.0	100.2	94.1	88.3

Distance: 23.0 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	98.0	88.3	97.1	92.5	92.6	94.0	90.8	86.5	87.3
600.0	75.0	97.6	87.2	96.9	91.9	92.4	94.0	90.5	85.3	82.8
400.0	50.0	97.3	86.5	96.6	91.6	92.2	94.0	90.3	84.4	79.8
200.0	25.0	97.2	86.2	96.1	91.7	92.2	94.0	90.2	84.1	78.3

Distance: 49.2 Feet

EKW	%	OVERALL	OBCF	OBCF	OBCF	OBCF	OBCF	OBCF	OBCF	OBCF

W/F	LOAD	SOUND DB(A)	63HZ DB	125HZ DB	250HZ DB	500HZ DB	1000HZ DB	2000HZ DB	4000HZ DB	8000HZ DB
800.0	100.0	92.0	82.3	91.1	86.5	86.6	88.0	84.8	80.5	81.3
600.0	75.0	91.6	81.2	90.9	85.9	86.4	88.0	84.5	79.3	76.8
400.0	50.0	91.3	80.5	90.6	85.6	86.2	88.0	84.3	78.4	73.8
200.0	25.0	91.2	80.2	90.1	85.7	86.2	88.0	84.2	78.1	72.3

SA Level 2 Canopy Sound Data

Distance: 3.3 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	88.6	89.7	94.3	91.1	87.5	81.4	75.8	70.1	67.8
600.0	75.0	87.5	87.4	73.3	89.6	87.2	79.6	74.2	67.9	64.4
400.0	50.0	88.2	86.0	93.8	88.1	88.2	81.2	75.9	69.6	65.9
200.0	25.0	87.2	85.0	94.5	87.0	86.5	80.6	75.2	67.9	63.9

Distance: 23.0 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	75.0	84.3	81.6	78.0	73.2	67.2	62.4	56.5	56.5
600.0	75.0	74.8	82.8	81.7	76.8	74.1	66.5	61.6	55.5	52.8
400.0	50.0	75.1	81.2	83.6	77.1	73.6	67.7	62.1	56.8	52.0
200.0	25.0	74.7	79.0	83.8	77.1	72.4	67.3	62.2	55.8	50.6

Distance: 49.2 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	73.7	75.3	82.9	76.4	72.7	63.6	59.4	53.4	52.7
600.0	75.0	73.6	74.4	81.7	74.9	73.7	63.2	58.7	52.9	49.5
400.0	50.0	73.1	73.5	82.0	74.4	72.7	64.0	59.3	53.7	49.0
200.0	25.0	72.8	72.4	82.4	75.0	71.5	63.6	59.2	52.9	48.0

Open Exhaust Sound Data

Distance: 3.3 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	110.0	73.8	100.1	109.7	105.9	104.7	104.3	95.0	75.8

Open Mechanical Sound Data

Distance: 3.3 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	101.6	88.7	95.2	94.6	95.6	96.9	94.7	91.8	90.4

Distance: 23.0 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	91.4	80.2	86.8	85.6	85.7	87.0	84.7	80.5	78.5

Distance: 49.2 Feet

EKW W/F	% LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
800.0	100.0	85.0	76.6	81.6	80.7	79.1	81.1	77.7	73.9	68.5

PERFORMANCE DATA[DM7696]

Performance Number: DM7696 **Change Level: 02**

SALES MODEL:	C27	**COMBUSTION:**	DI
ENGINE POWER (BHP):	1,214	**ENGINE SPEED (RPM):**	1,800
GEN POWER WITH FAN (EKW):	800.0	**HERTZ:**	60
COMPRESSION RATIO:	16.5	**FAN POWER (HP):**	39.3
RATING LEVEL:	STANDBY	**ADDITIONAL PARASITICS (HP):**	52.2
PUMP QUANTITY:	1	**ASPIRATION:**	TA
FUEL TYPE:	DIESEL	**AFTERCOOLER TYPE:**	ATAAC
MANIFOLD TYPE:	DRY	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
GOVERNOR TYPE:	ADEM4	**INLET MANIFOLD AIR TEMP (F):**	120
ELECTRONICS TYPE:	ADEM4	**JACKET WATER TEMP (F):**	210.2
IGNITION TYPE:	CI	**TURBO CONFIGURATION:**	PARALLEL
INJECTOR TYPE:	EUI	**TURBO QUANTITY:**	2
REF EXH STACK DIAMETER (IN):	10	**TURBOCHARGER MODEL:**	GTA5008BS-56T-1.60
MAX OPERATING ALTITUDE (FT):	7,999	**CERTIFICATION YEAR:**	2010
		PISTON SPD @ RATED ENG SPD (FT/MIN):	1,800.0

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET
OIL AND GAS	LAND PRODUCTION	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BHP	PSI	LB/BHP-HR	GAL/HR	IN-HG	DEG F	DEG F	IN-HG	DEG F
800.0	100	1,214	324	0.330	57.3	58.6	120.5	1,230.6	41.1	952.5
720.0	90	1,100	294	0.334	52.5	53.7	115.2	1,195.3	37.5	932.4
640.0	80	988	264	0.339	47.8	48.4	113.4	1,168.6	33.4	919.7
600.0	75	932	249	0.341	45.4	45.5	113.0	1,155.3	31.2	913.8
560.0	70	876	234	0.342	42.9	42.2	111.6	1,138.9	28.8	906.0
480.0	60	765	204	0.344	37.6	34.9	107.3	1,095.6	23.9	882.8
400.0	50	654	175	0.346	32.3	27.3	102.5	1,039.6	19.1	850.4
320.0	40	545	145	0.349	27.1	20.4	98.3	967.7	14.9	804.3
240.0	30	436	116	0.355	22.1	14.5	95.0	875.5	11.4	739.0
200.0	25	380	101	0.359	19.5	11.7	93.6	822.1	9.9	699.4
160.0	20	324	86	0.366	17.0	9.1	92.4	763.2	8.5	654.7
80.0	10	210	56	0.402	12.0	5.1	92.2	626.6	6.3	544.7

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	WET EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)	DRY EXH VOL FLOW RATE (32 DEG F AND 29.98 IN HG)
EKW	%	BHP	IN-HG	DEG F	CFM	CFM	LB/HR	LB/HR	FT3/MIN	FT3/MIN
800.0	100	1,214	61	362.1	2,216.4	6,011.7	9,543.1	9,944.2	2,093.1	1,894.9
720.0	90	1,100	57	341.6	2,124.9	5,659.3	9,125.9	9,493.8	1,998.8	1,815.5
640.0	80	988	51	320.7	2,001.3	5,260.8	8,572.1	8,906.9	1,875.2	1,707.1
600.0	75	932	48	309.9	1,930.4	5,042.0	8,257.4	8,575.1	1,805.0	1,645.1
560.0	70	876	44	295.4	1,851.1	4,797.3	7,907.3	8,207.3	1,727.2	1,576.0
480.0	60	765	37	264.1	1,678.1	4,260.9	7,148.0	7,411.6	1,560.5	1,427.2
400.0	50	654	29	233.3	1,497.7	3,697.0	6,361.6	6,588.0	1,387.5	1,272.0
320.0	40	545	22	203.3	1,329.0	3,157.0	5,630.4	5,820.5	1,228.0	1,129.6
240.0	30	436	16	173.6	1,175.4	2,643.8	4,970.3	5,124.7	1,084.4	1,003.3
200.0	25	380	13	158.7	1,102.8	2,392.1	4,660.7	4,797.2	1,014.7	942.2
160.0	20	324	10	143.8	1,032.8	2,142.5	4,363.5	4,482.1	945.3	881.3
80.0	10	210	6	121.2	926.9	1,716.6	3,911.4	3,995.6	840.3	792.1

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXHUAST RECOVERY TO 350F	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BHP	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN	BTU/MIN
800.0	100	1,214	18,785	6,240	45,257	25,637	6,549	9,235	51,468	122,961	130,984
720.0	90	1,100	18,137	5,061	42,000	23,586	6,007	8,276	46,664	112,779	120,138
640.0	80	988	17,141	4,437	38,642	21,600	5,462	7,119	41,902	102,550	109,241
600.0	75	932	16,243	4,573	36,868	20,559	5,186	6,513	39,533	97,376	103,729
560.0	70	876	15,133	4,950	34,899	19,383	4,898	5,822	37,162	91,965	97,965
480.0	60	765	13,933	4,599	30,563	16,728	4,301	4,488	32,445	80,759	86,028
400.0	50	654	12,297	4,489	26,024	13,914	3,694	3,331	27,748	69,364	73,890
320.0	40	545	10,665	4,336	21,575	11,109	3,103	2,367	23,120	58,261	62,063
240.0	30	436	9,960	3,213	17,222	8,311	2,521	1,564	18,469	47,340	50,429
200.0	25	380	9,576	2,592	15,113	6,955	2,231	1,215	16,122	41,885	44,618
160.0	20	324	9,057	2,021	13,057	5,639	1,939	898	13,745	36,402	38,778
80.0	10	210	7,177	1,693	9,288	3,167	1,375	455	8,885	25,814	27,498

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1800 RPM

GENSET POWER WITH FAN		EKW	800.0	600.0	400.0	200.0	80.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	1,214	932	654	380	210
TOTAL NOX (AS NO2)		G/HR	7,541	4,507	2,865	1,989	1,253
TOTAL CO		G/HR	517	644	630	514	567
TOTAL HC		G/HR	66	83	90	71	85
PART MATTER		G/HR	55.4	52.1	86.3	99.7	101.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,121.8	2,374.5	2,149.1	2,626.2	2,606.8
TOTAL CO	(CORR 5% O2)	MG/NM3	215.2	343.4	483.1	717.2	1,372.2
TOTAL HC	(CORR 5% O2)	MG/NM3	23.7	38.9	59.2	87.9	183.2
PART MATTER	(CORR 5% O2)	MG/NM3	18.9	22.9	55.1	113.5	210.1
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,521	1,157	1,047	1,279	1,270
TOTAL CO	(CORR 5% O2)	PPM	172	275	386	574	1,098
TOTAL HC	(CORR 5% O2)	PPM	44	73	111	164	342
TOTAL NOX (AS NO2)		G/HP-HR	6.27	4.86	4.40	5.25	6.00
TOTAL CO		G/HP-HR	0.43	0.69	0.97	1.36	2.72
TOTAL HC		G/HP-HR	0.05	0.09	0.14	0.19	0.41
PART MATTER		G/HP-HR	0.05	0.06	0.13	0.26	0.49
TOTAL NOX (AS NO2)		LB/HR	16.63	9.94	6.32	4.38	2.76
TOTAL CO		LB/HR	1.14	1.42	1.39	1.13	1.25
TOTAL HC		LB/HR	0.15	0.18	0.20	0.16	0.19
PART MATTER		LB/HR	0.12	0.11	0.19	0.22	0.22

RATED SPEED NOMINAL DATA: 1800 RPM

GENSET POWER WITH FAN		EKW	800.0	600.0	400.0	200.0	80.0
PERCENT LOAD		%	100	75	50	25	10
ENGINE POWER		BHP	1,214	932	654	380	210
TOTAL NOX (AS NO2)		G/HR	6,233	3,725	2,368	1,644	1,036
TOTAL CO		G/HR	276	344	337	275	303
TOTAL HC		G/HR	35	44	48	37	45
TOTAL CO2		KG/HR	563	445	315	188	116
PART MATTER		G/HR	28.4	26.7	44.2	51.1	52.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,580.0	1,962.4	1,776.1	2,170.4	2,154.4
TOTAL CO	(CORR 5% O2)	MG/NM3	115.1	183.6	258.3	383.5	733.8
TOTAL HC	(CORR 5% O2)	MG/NM3	12.5	20.6	31.3	46.5	96.9
PART MATTER	(CORR 5% O2)	MG/NM3	9.7	11.8	28.3	58.2	107.7
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,257	956	865	1,057	1,049
TOTAL CO	(CORR 5% O2)	PPM	92	147	207	307	587
TOTAL HC	(CORR 5% O2)	PPM	23	38	58	87	181
TOTAL NOX (AS NO2)		G/HP-HR	5.18	4.02	3.63	4.34	4.96
TOTAL CO		G/HP-HR	0.23	0.37	0.52	0.72	1.45
TOTAL HC		G/HP-HR	0.03	0.05	0.07	0.10	0.22

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PART MATTER	G/HP-HR	0.02	0.03	0.07	0.13	0.25
TOTAL NOX (AS NO2)	LB/HR	13.74	8.21	5.22	3.62	2.28
TOTAL CO	LB/HR	0.61	0.76	0.74	0.61	0.67
TOTAL HC	LB/HR	0.08	0.10	0.11	0.08	0.10
TOTAL CO2	LB/HR	1,240	982	694	414	255
PART MATTER	LB/HR	0.06	0.06	0.10	0.11	0.12
OXYGEN IN EXH	%	8.9	10.0	11.1	13.1	15.4
DRY SMOKE OPACITY	%	0.2	1.1	2.6	4.3	5.3
BOSCH SMOKE NUMBER		0.14	0.39	0.96	1.51	1.69

Regulatory Information

EPA TIER 2		2006 - 2010		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 89 SUBPART D AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE NON-ROAD REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	NON-ROAD	TIER 2	CO: 3.5 NOx + HC: 6.4 PM: 0.20

EPA EMERGENCY STATIONARY		2011 - ----		
GASEOUS EMISSIONS DATA MEASUREMENTS PROVIDED TO THE EPA ARE CONSISTENT WITH THOSE DESCRIBED IN EPA 40 CFR PART 60 SUBPART IIII AND ISO 8178 FOR MEASURING HC, CO, PM, AND NOX. THE "MAX LIMITS" SHOWN BELOW ARE WEIGHTED CYCLE AVERAGES AND ARE IN COMPLIANCE WITH THE EMERGENCY STATIONARY REGULATIONS.				
Locality	**Agency**	**Regulation**	**Tier/Stage**	**Max Limits - G/BKW - HR**
U.S. (INCL CALIF)	EPA	STATIONARY	EMERGENCY STATIONARY	CO: 3.5 NOx + HC: 6.4 PM: 0.20

Altitude Derate Data

ALTITUDE CORRECTED POWER CAPABILITY (BHP)

AMBIENT OPERATING TEMP (F)	50	60	70	80	90	100	110	120	130	NORMAL
ALTITUDE (FT)										
0	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214
1,000	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214
2,000	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214
3,000	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214
4,000	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214
5,000	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214
6,000	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,214	1,197	1,214
7,000	1,214	1,214	1,214	1,214	1,214	1,212	1,191	1,170	1,150	1,214
8,000	1,214	1,214	1,214	1,207	1,185	1,164	1,144	1,124	1,105	1,214
9,000	1,214	1,204	1,181	1,159	1,138	1,118	1,098	1,079	1,061	1,214
10,000	1,178	1,155	1,134	1,113	1,092	1,073	1,054	1,036	1,018	1,195
11,000	1,130	1,109	1,088	1,067	1,048	1,029	1,011	994	977	1,154
12,000	1,084	1,063	1,043	1,024	1,005	987	970	953	937	1,115
13,000	1,039	1,019	1,000	981	964	946	930	914	898	1,077
14,000	996	977	958	940	923	907	891	876	861	1,039
15,000	954	935	918	901	884	869	853	839	824	1,003

Cross Reference

Engine Arrangement			
Arrangement Number	**Effective Serial Number**	**Engineering Model**	**Engineering Model Version**
2671232	MJE00001	GS327	-
3495619	MJE00001	GS603	LS
3541450	PEN00001	GS582	-

Test Specification Data						
Test Spec	**Setting**	**Effective Serial Number**	**Engine Arrangement**	**Governor Type**	**Default Low Idle Speed**	**Default High Idle Speed**
0K7925	PP5660	MJE00001	2671232			
3704841	GG0523	MJE00001	3495619			
0K4031	GG0383	PEN00001	3541450			

Performance Parameter Reference

Parameters Reference:DM9600-08
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600

APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test

cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.

PERFORMANCE PARAMETER TOLERANCE FACTORS:

Power	+/- 3%
Torque	+/- 3%
Exhaust stack temperature	+/- 8%
Inlet airflow	+/- 5%
Intake manifold pressure-gage	+/- 10%
Exhaust flow	+/- 6%
Specific fuel consumption	+/- 3%
Fuel rate	+/- 5%
Specific DEF consumption	+/- 3%
DEF rate	+/- 5%
Heat rejection	+/- 5%
Heat rejection exhaust only	+/- 10%
Heat rejection CEM only	+/- 10%

Heat Rejection values based on using treated water.

Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.

On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.

These values do not apply to C280/3600. For these models, see the tolerances listed below.

C280/3600 HEAT REJECTION TOLERANCE FACTORS:

Heat rejection	+/- 10%
Heat rejection to Atmosphere	+/- 50%
Heat rejection to Lube Oil	+/- 20%
Heat rejection to Aftercooler	+/- 5%

TEST CELL TRANSDUCER TOLERANCE FACTORS:

Torque	+/- 0.5%
Speed	+/- 0.2%
Fuel flow	+/- 1.0%
Temperature	+/- 2.0 C degrees
Intake manifold pressure	+/- 0.1 kPa

OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.

REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.

FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.

MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.

REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.

REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 29 (84.2), where the density is 838.9 G/Liter (7.001 Lbs/Gal).

GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.

ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.

ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.

Standard temperature values versus altitude could be seen on TM2001.

When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.

Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.

Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.

REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.

Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.

EMISSIONS DEFINITIONS:
Emissions : DM1176

HEAT REJECTION DEFINITIONS:

PERFORMANCE DATA[DM7696]

Diesel Circuit Type and HHV Balance : DM9500

HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500

RATING DEFINITIONS:
Agriculture : TM6008

Fire Pump : TM6009

Generator Set : TM6035

Generator (Gas) : TM6041

Industrial Diesel : TM6010

Industrial (Gas) : TM6040

Irrigation : TM5749

Locomotive : TM6037

Marine Auxiliary : TM6036

Marine Prop (Except 3600) : TM5747

Marine Prop (3600 only) : TM5748

MSHA : TM6042

Oil Field (Petroleum) : TM6011

Off-Highway Truck : TM6039

On-Highway Truck : TM6038

SOUND DEFINITIONS:
Sound Power : DM8702

Sound Pressure : TM7080

Date Released : 7/7/15

STANDARD FEATURES

Generator Monitoring	• Voltage (L-L, L-N) • Current (Phase) • Average Volt, Amp, Frequency • kW, kVAr, kVA (Average, Phase, %) • Power Factor (Average, Phase) • kW-hr, kVAr-hr (total) • Excitation voltage and current (with CDVR) • Generator stator and bearing temp (with optional module)
Generator Protection	• Generator phase sequence • Over/Under voltage (27/59) • Over/Under frequency (81 O/U) • Reverse Power (kW) (32) • Reverse Reactive Power (kVAr) (32RV) • Overcurrent (50/51)
Engine Monitoring	• Coolant temperature • Oil pressure • Engine speed (RPM) • Battery voltage • Run hours • Crank attempt and successful start counter • Enhanced engine monitoring (with electronic engines)
Engine Protection	• Control switch not in auto (alarm) • High coolant temp (alarm and shutdown) • Low coolant temp (alarm) • Low coolant level (alarm) • High engine oil temp (alarm and shutdown) • Low, high, and weak battery voltage • Overspeed • Overcrank
Control	• Run / Auto / Stop control • Speed and voltage adjust • Local and remote emergency stop • Remote start/stop • Cycle crank
Inputs & Outputs	• Two dedicated digital inputs • Six programmable digital inputs • Six programmable form A dry contacts • Two programmable form C dry contacts • Two digital outputs
Communications	• Primary and accessory CAN data links • RS-485 annunciator data link • Modbus RTU (RS-485 Half duplex)
Language Support	Arabic, Bulgarian, Chinese, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Hungarian, Icelandic, Italian, Latvian, Lithuanian, Japanese, Norwegian, Polish, Portuguese, Romanian, Russian, Slovak, Slovene, Spanish, Swedish, Turkish
Environmental	• Control module operating temperature: -40°C to 70°C • Display operating temperature: -20°C to 70°C • Humidity: 100% condensing 30°C to 60°C • Storage temperature: -40°C to 85°C • Vibration: Random profile, 24-1000 Hz, 4.3G rms

State of Oregon Department of Environmental Quality

MISCELLANEOUS PROCESS OR DEVICE

Facility Name: JCEP LNG Terminal Project   Permit Number:

Process Information

1. ID Number	EU10.GC (Gas Conditioning)
2. Descriptive name	Acid Gas Thermal Oxidizer
3. Existing or future?	Future
4. Date commenced	January 2019
5. Date installed/completed	October 2021

6. Description of process:

The Gas Conditioning train includes a system for mercury removal via sulfur impregnated activated carbon, carbon dioxide (CO2) and acid gas removal via an amine system, and dehydration via a molecular sieve adsorbent system. A thermal oxidizer combusts the acid gas from the amine process.

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	Continuous
9. Projected maximum hours/day	24
10. Projected maximum hours/year	8,760

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Pipeline Natural Gas	50,000	MMBtu/hr		
Products				
Fuel Gas	3,905	lb/hr		
Acid Gas	124,710	lb/hr		
Flash Gas	1.276	lb/hr		

12. Control devices(s) (yes/no) Yes

If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).

Thermal Oxidizer CD.TO on AQ307

DEQ
State of Oregon Department of Environmental Quality

MISCELLANEOUS
CONTROL DEVICE INFORMATION

FORM AQ307
ANSWER SHEET

Facility Name: JCEP LNG Terminal Project   Permit Number:

1.	Control Device ID	CD.TO (Thermal Oxidizer)
2.	Process/Device(s) Controlled	EU10.GC (Gas Conditioning)
3.	Year installed	2021
4.	Manufacturer/Model No.	Zeeco, custom design
5.	Control Efficiency (%)	99.9%
6.	Design inlet gas flow rate (acfm)	177,370 acfm
7.	Design parameter(s)	238,142 lb/hr inlet with 102 MMBtu/ hr heat release, 1,600 degrees F, 1 second residence time
8.	Inlet gas pretreatment? (yes/no) If yes, list control device ID and complete a separate control device form	No
9.	Describe the control device	
	Thermal oxidizer to control emissions from the acid gas removal system. The thermal oxidizer has a destruction efficiency of 99.9 percent for H2S, VOC, and HC.	

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Broken Arrow, OK 74014 USA
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Fax: 918-251-5519
www.zeeco.com
sales@zeeco.com

May 18, 2016

JGC Corporation
Yokohama World Operations Center
3-1, Minato Mirai 2-Chome, Nishi-Ku, Yokohama 220-6001

Attention: Hajime Kudo
Kudo.hajime@jgc.com

Reference: Thermal Oxidizers
Jordan Cove LNG Project
Oregon, USA
RFQ E0-7271-67.6320
Zeeco Proposal No. 2016-03002IN-01 Rev. 0

Gentlemen:

Thank you for your continued interest in Zeeco. We appreciate this opportunity to provide a technical description/proposal for the equipment described in the above referenced inquiry.

The attached proposal describes the specific operating conditions and mechanical features of the combustion equipment. The design and materials of construction have been chosen to maximize on-line time and operational life while minimizing the capital cost of the equipment. In addition, the proposed equipment is in accordance with our understanding of data sheets and specifications.

Zeeco has unique capabilities and experience in delivering large incineration systems. The experience lists attached to our proposal include incinerators larger than those in this proposal, and we have experience with large gas-gas heat exchangers with waste gas as the heated media. We can provide *in-house* Computational Fluid Dynamics (CFD) modeling for the purpose of fluid flow analysis, gas mixing, and temperature profiles inside the incinerator chamber, and dynamic vortex shedding, and standing-wave analysis to avoid vibration problems in the preheaters. Zeeco has a license and engineers with experience using FEM software to analyze natural frequency problems. Zeeco can do in-house 3D modeling using Autodesk Inventor software.

Again, we appreciate the opportunity to provide our quotation in full accordance with your requirements. After you have had an opportunity to review our proposal, should you have any questions or require additional information, please contact me using the contact information noted below.

Sincerely,

P. M. Pickard

Peter Pickard
Senior Applications Engineer
Email: peter_pickard@zeeco.com
Phone: 918-893-8421

TABLE OF CONTENTS

1.0 INTRODUCTION

Zeeco, Inc. has been designing and manufacturing burners, flares, incinerators, air preheaters, and combustion systems for world wide use since 1980. Zeeco, Inc., headquartered in the Tulsa, Oklahoma area, is privately held by a family who has successfully designed, developed and supplied combustion equipment for over 80 years.

Zeeco's Engineering Staff offers over 1,000 years of experience in the development, design, and testing of Combustion Systems. Zeeco has the proven skills and innovative abilities to design a practical and environmentally friendly combustion system to thermally treat virtually any industrial waste. This learned "art" gained by research and design efforts which are refined by testing and field experience has been implemented in the process plants of numerous industries throughout the world.

From project planning through design, procurement, manufacturing, installation, and even start-up, Zeeco, Inc. will provide project management and support as deemed necessary. It is our world class HANDS ON type design skills, quality products, experienced staff, and especially our responsiveness to our customers needs that truly set Zeeco apart from our competition.

Quality. Our customers expect it; we demand it.

4.0 DESIGN SUMMARY

4.1 Site Conditions

Wind Loading Code	ASCE/SEI 7-10
Maximum Hourly Sustained Peak Wind (Design)	150mph
3 second gust	183 mph
Occupancy category	IV
Importance factor	1.0
Exposure category	C
Wind Topographic Factor	1.0
Seismic Loading Code	ASCE/SEI 7-10 and IBC 2010
FERC Seismic Structural Category	II
Site classification	D
Importance factor (seismic loads) for structures (I)	1.5
Importance factor for Systems/Components (Ip)	1.5
Occupancy category	IV
Ss	1.50g
S1	1.00g
SDS	1.00g
SD1	1.00g
Site location	Coos Bay, Oregon
Elevation	Unknown
Atmospheric Pressure	Unknown
Ambient Temperature	Unknown
Electrical Area Classification	Class 1, Division 2, Group C & D

4.2 Waste Stream Summary – See attached excerpt from the spec

4.3 Process Summary

Case Name:	Max Case
FLOW RATE:	**lb/hr**
Acid Gas	124,710
Flash Gas	1276
Fuel Gas	3905
Combustion air	108,251
TOTAL, lb/hr	**238,142**
HEAT RELEASE:	**MMBtu/hr**
Acid Gas	1
Flash Gas	22
HP Fuel Gas	79
TOTAL, MMBtu/hr	**102**
Incinerator Temperature, ^{o}F	1600
Residence time, seconds	1
Flue Gas Mole Weight	34.29
FLUE GAS COMPOSITION:	**mol %**
CO_2	44.84
H_2O	10.05
N_2	42.39
O_2	2.72*
SO_2	< 10 ppm
TOTAL Flue Gas, mol %	**100**

*3% O2 on dry basis

4.4 Utilities

Instrument air, psig	60
Instrument air, usage	15 SCFM
Max Fuel gas usage, lb/hr	3905
Fuel gas at burner, psig	15
Connected HP for combustion air fan	50 at 480 volts, 3ph, 60 hz

4.5 System Performance

Emissions @ Stack Conditions	Guaranteed, less than:
VOC	99.9% DRE
NOx	< 50 ppm
CO	< 50 ppm
SO2	3.22 lb/hr
Correction basis for above	3% O2, dry volume

These values are understood to apply only when the system is operated in accordance with the operating conditions stipulated in the design summary and for the waste(s) stipulated in the design basis sections of this proposal and when the system is operated according to Zeeco's instructions.

Special note regarding SO2 emissions:
According to Zeeco calculation, the SO2 content in the flue gas at maximum condition is 3.43 lb/hr instead of 3.22 lb/hr. Zeeco assumes that JGC does not want to add an SO2 scrubber in order to account for a small difference in calculated SO2 quantity. Therefore, Zeeco is willing to guarantee the SO2 emission provided that it is understood that Zeeco will not be required to make any equipment modification if the SO2 emissions are exceeded. This is because there is nothing in the burner/thermal oxidizer that can be changed in order to reduce SO2 emissions. SO2 emissions are a direct result of the sulfur content in the feed gas. The only way to decrease the emissions without a change in feed condition is to add a scrubber which would roughly double or triple the cost of the system.

5.0 EQUIPMENT DESCRIPTION

5.1 Thermal Oxidizer

One (1) vertical, up-fired thermal oxidizer/stack designed to operate at 1600°F with excess air to ensure complete combustion of the waste gas combustible components. Each Incinerator has the following features:

- Nominal 9'-6" OD x 85 feet tall from grade
- ASME Section VIII, Div 1 design
- ASME STS-1
- No hydrotest
- No Code stamp
- Shell material SA-516-70N carbon steel
- 1/8" corrosion allowance
- Designed to be supported by concrete tabletop foundation (by others)
- All Carbon Steel External Surfaces Sandblasted SSPC-SP6
- Thermal shroud 360 degree carbon steel galvanized 26 gauge (panels ship loose for field assembly)
- Ladders and Platforms are provided to sampling port elevation
- 360 degree sample port platform
- Connections per GA Drawing
- Refractory lining per refractory schedule shown on GA drawing
- Refractory material is shipped loose for field installation by others
- Top 10'-0" of stack shell is 316 stainless steel
- Damping pad
- Stainless steel rain cap for protection of refractory at stack exit
- Assembly designed to ship as one piece, approximately 60 feet long
- Flanged burner connection
- Oregon PE stamped applicable documents

5.2 Burner

One (1) Zeeco Combination Waste Gas, Flash Gas and Fuel Gas Burner is offered per system and has the following features:

- 110 MMBtu/hr maximum fuel gas heat release (includes 10% safety factor)
- Zeeco AR/GS pilot for burner ignition
- High Energy Electric Spark Ignition System
- A-36 carbon steel construction
- See additional information about pilots here: http://www.zeeco.com/incinerators/incinerators-pilots.php

5.4 Combustion Air Fans

Two (2) Combustion Air Fans (one 100% installed spare) are offered and have the following features and preliminary design details:

Case	Mass Flow, lb/hr	Outlet Static Press., in WC	Power, BHP
Test Block	26,231	7.3	46
Operating Case	23,846	6.0	34

Preliminary design details:

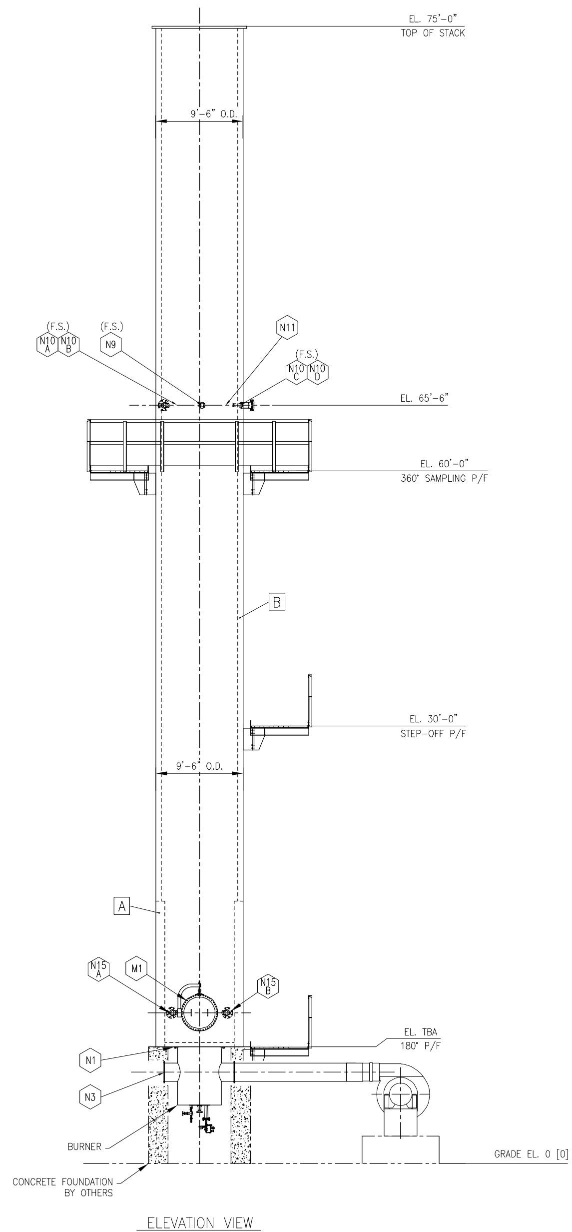
- API 560 Design, Annex E
- Direct drive
- Fan antifriction bearings, grease lube
- Coupling guard
- Nameplate - Quantity per fan (1)
- A-36 or equivalent housing construction
- Paint Specification; Manufacturer's standard
- Motor drive: 50 HP, 3600 RPM, TEFC, 460 V / 3 phase / 60 Hz electric motor

5.5 Instrumentation & Controls

Zeeco scope of supply is depicted on the attached P&ID and includes the following:

- Fuel gas skid with valves, instruments and wiring
- Local control panel with pushbuttons and lights
- Ship loose instrumentation and valves as shown on P&ID
- Designed for analog control to be in customer's DCS
- Logic control hardware for burner management function, such as a PLC is NOT included.
- Cause and effect diagrams
- Logic diagrams
- Process control narrative descriptions of control loops

Attachment E
General Arrangement Drawing



– NOZZLE LEGEND –

ITEM	QTY	DESCRIPTION	SIZE	RATING	TYPE	FLG. MATERIAL
N1	1	BURNER CONNECTION	TBD	150#	RFWN	
N2	1	DRAIN W/ BLIND	2"	150#	RFWN	
N3	1	WASTE GAS CONNECTION	24"	150#	RFWN	
N9	1	ANALYZER CONNECTION	4"	150#	RFWN	
N10A~D	4	FLUE GAS SAMPLING CONNECTION	4"	150#	RFWN	
N11	1	TEMPERATURE ELEMENT	2"	150#	RFWN	
N14A/B	2	TEMPERATURE ELEMENT	2"	150#	RFWN	
N15A/B	2	SIGHT GLASS	4"	150#	RFWN	
M1	1	MANWAY	30"	--	--	

– REFRACTORY LEGEND –

REFRACTORY TO BE INSTALLED BY OTHERS.

A	4" [102] THK 3000°F RATED CASTABLE BACKED W/ 3" [76] THK INSULATING CASTABLE W/ 310SS ANCHORS
B	4" [102] THK CASTABLE RATED FOR 2500°F W/ 310SS ANCHORS

– GENERAL NOTES –

1. ALL NOZZLE BOLTING SHOULD STRADDLE TRUE VERTICAL AND TRUE HORIZONTAL.
2. ALL FABRICATION IN ACCORDANCE WITH A.I.S.C. STANDARDS UNLESS OTHERWISE NOTED.
3. ALL PAINTING/COATING PER CUSTOMER SPECIFICATIONS.
4. ALL BUTT WELDS CONTINUOUS WITH FULL PENETRATION.
5. LADDERS AND PLATFORMS TO BE HOT-DIPPED GALVANIZED. (SHOP TRIAL FIT & DISASSEMBLED FOR SHIPMENT.)

– MATERIALS –

SHELL	SA516-70N
NOZZLE PIPE	A106B
FLANGE FORGINGS	A105
PLATE FLANGES	A-36
STUD BOLTS/NUTS	–
GASKETS	COMP. NON-ASB.
L&P STRUCTURAL SHAPES	A-36
RAINSHIELD RING/CLIPS	A-36
WELDED FITTINGS	–
S.W. FITTING	–
TAILING LUGS	A-36
LIFTING TRUNNIONS	A-36

*** PRELIMINARY DRAWING, NOT TO SCALE ***

JOBSITE: COOS BAY, OREGON

END USER: JORDAN COVE LNG

S.O. NO.: 2016-03002IN-01 P.O. NO.: APP PPK

ZEECO, INC.
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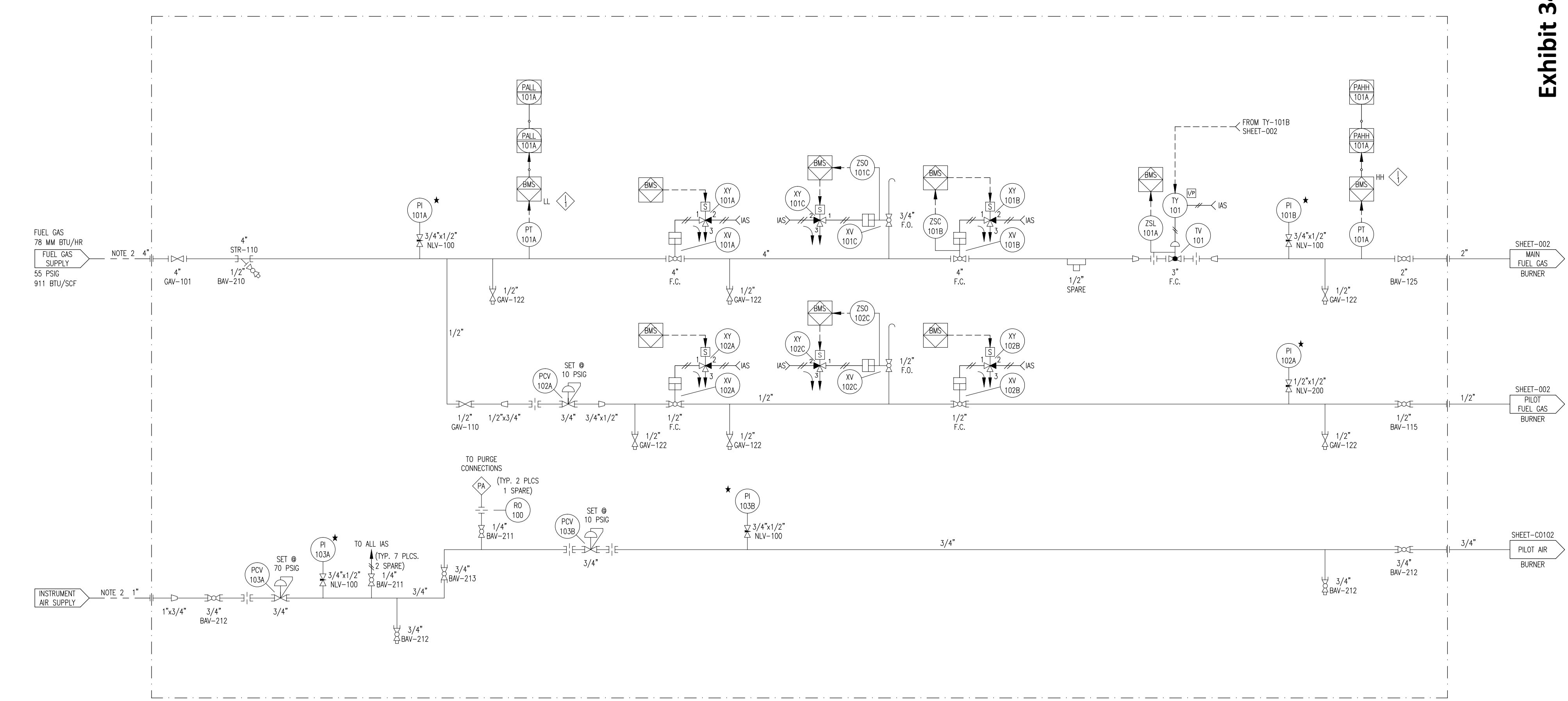
GENERAL ARRANGEMENT
THERMAL OXIDIZERS

FOR: KBJ J.V.

DRAWN BLC | DATE 19MAY16 | CHK PP | APP PP | SCALE NONE | REV A

DRAWING NUMBER 03008IN-G01001

Attachment F
Piping & Instrumentation Diagram



LEGEND:

- PIPING
- PIPING BY OTHERS
- WIRING
- SOFTWARE
- SKID LIMITS
- 316SS TUBING & FITTINGS (SWAGELOK OR EQUAL) 3/8" UNLESS NOTED OTHERWISE
- ★ ITEMS SHIPPED LOOSE
- ★★ ITEMS FURNISHED AND INSTALLED BY OTHERS
- ★★★ OPTIONAL
- INSTRUMENT (LOCALLY MOUNTED)
- INSTRUMENT (MOUNTED ON MAIN PANEL)
- INSTRUMENT (MOUNTED ON LOCAL PANEL)
- INSTRUMENT (MOUNTED INSIDE PANEL)
- DCS-CONTROL ROOM BY OTHERS
- BMS-HMI (BY ZEECO)
- BMS PLC-PROGRAMMABLE LOGIC CONTROL (BY ZEECO)

NOTES

1. INCINERATOR: UNCLASSIFIED
   REMOTE CONTROL PANEL: CLASS I, DIV II, GROUP D
2. MOUNTED ON FUEL SKID / RACK.
3. FIELD PIPING, TUBING, WIRING FURNISHED AND INSTALLED BY OTHERS.

** PRELIMINARY/TYPICAL DRAWRING **

CUSTOMER: KBJ J.V.
JOBSITE: COOS BAY, OREGON
END USER: JORDAN COVE LNG
P.O. NO.: 2016-03002IN-01

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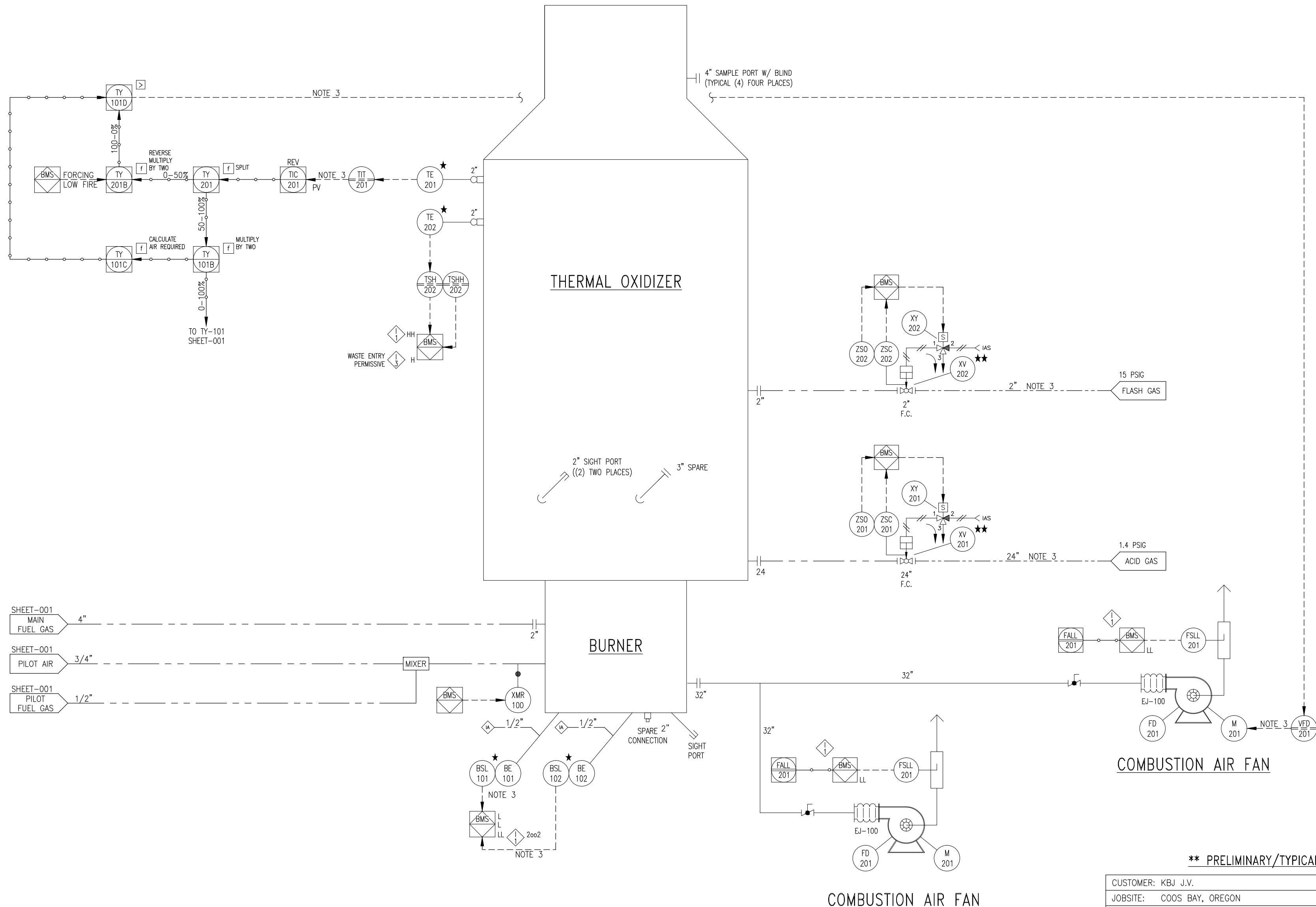
P&I DIAGRAM
THERMAL OXIDIZERS

DRAWN	DATE
BLC	19MAY16
CHK PP	APP PP
SCALE N.T.S	APP PP

S.O. NO.	GROUP	DWG. & SUB CAT.	SYSTEM NO.	DWG. NO.	REV. NO.
03002IN	04	110	01	001	A



** PRELIMINARY/TYPICAL DRAWRING **

CUSTOMER: KBJ J.V.			
JOBSITE: COOS BAY, OREGON			
END USER: JORDAN COVE LNG			
P.O. NO.: 2016-03002IN-01			
ZEECO, INC. 22151 EAST 91st STREET BROKEN ARROW, OK 74014 PHONE: (918) 258-8551 FAX: (918) 251-5519 www.zeeco.com sales@zeeco.com	P&I DIAGRAM THERMAL OXIDIZERS	DRAWN BLC / CHK PP / SCALE N.T.S	DATE 19MAY16 / APP PP / APP PP
PROPRIETARY DATA IS INCLUDED IN THE INFORMATION DISCLOSED HEREIN AND IS THE PROPERTY OF ZEECO,INC. THIS INFORMATION IS SUBMITTED IN CONFIDENCE AND MUST BE USED IN CONNECTION WITH WORK DONE FOR ZEECO, INC. AND ALL RIGHTS OF DESIGN OR INVENTION ARE RESERVED. UNAUTHORIZED DISCLOSURE OR USE IS PROHIBITED BY LAW.	S.O. NO. 03002IN / GROUP 04 / DWG. & SUB CAT. 110 / SYSTEM NO. 01	DWG. NO. 002	REV. NO. A

SEE SHEET-001 FOR LEGEND AND NOTES

Attachment G
Waste Feed Conditions

DATA SHEET FOR THERMAL OXIDIZER PACKAGE 10-PK-0103

Rev.			Acid Gas To BeThermal Oxidized (DGLT) (% MOL)	Fuel Gas Sources (NOTE6)								
				Flash Gas (%MOL)	Feed Gas (Note 7, 12)				BOG			
					Acid Gas Design case (% MOL)	Design case (% MOL)	Rich case (% MOL)	Lean case (% MOL)	Acid Gas Design case (% MOL)	Design case (% MOL)	Rich case (% MOL)	Lean case (%MOL)
	51											
	52	Composition										
	53	CO2	97.656352	7.009624	2.000000	0.748500	0.288800	0.858500	0.000000	0.000000	0.000000	0.000000
	54	Nitrogen	0.000069	0.150292	0.445200	0.450900	0.332400	0.979600	5.574295	5.500124	4.051529	10.439232
	55	Methane	0.106577	85.851157	94.132500	95.334600	92.934400	96.732800	93.186305	92.998682	83.142649	88.770083
	56	Ethane	0.007724	4.158075	3.136200	3.176300	5.174600	1.266500	0.005646	0.112709	2.395021	0.002223
	57	Propane	0.000000	0.209259	0.156100	0.158100	0.915500	0.083200	0.000000	0.132390	5.661934	0.000000
	58	i-Butane	0.000050	0.024366	0.017200	0.017400	0.110600	0.004500	0.000000	0.037980	1.344879	0.000000
	59	n-Butane	0.000050	0.025828	0.018300	0.018500	0.129800	0.004000	0.000000	0.052895	1.826311	0.000000
	60	C5 (neopentane, i-pentane, n-pentane, cyclopentane)	0.000023	0.010136	0.006500	0.006600	0.054500	0.000000	0.000000	0.034136	0.949844	0.000000
	61	C6 (2.2-dimethylbutane, 2-Methylpentane, 3-methylpentane, n-hexane, Methylcyclopentane, Cyclohexane)	0.000004	0.001657	0.001001	0.001013	0.013818	0.000159	0.000000	0.015684	0.262360	0.000000
	62	C7 (2-methylhexane, 3-methylhexane, n-heptane, mMethylcyclohexane)	0.000008	0.002924	0.001333	0.001350	0.003743	0.000073	0.000000	0.021527	0.083582	0.000000
	63	C8 (2,2,4-Trimethylpentane, 2-methylheptane, 3-Methylheptane, n-octane)	0.000004	0.001170	0.000487	0.000494	0.000822	0.000026	0.000000	0.006612	0.019532	0.000000
	64	n-C9	0.000004	0.000292	0.000112	0.000113	0.000123	0.000006	0.000000	0.001845	0.001936	0.000000
	65	n-C10	0.000000	0.000000	0.000012	0.000012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	66	n-C13	0.000000	0.000000	0.000012	0.000012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	67	Helium		0.000000	0.049031	0.049657	0.012995	0.037473	0.989699	0.870609	0.196550	0.601176
	68	Hydrogen		0.000000	0.009766	0.009891	0.000000	0.006895	0.200708	0.166218	0.000000	0.145188
	69	Oxygen			0.009874	0.010000	0.010000	0.010000	0.043347	0.045360	0.039943	0.042098
	70	H2S	0.000000	0.000487	0.000395	0.000400	0.000400	0.000400	0.000000	0.000000	0.000000	0.000000
	71	COS	0.000050	0.002924	0.000395	0.000400	0.000400	0.000400	0.000000	0.000000	0.000000	0.000000
	72	CH3SH (Methyl Mercaptan)	0.000924	0.008577	0.000465	0.000471	0.000471	0.000471	0.000000	0.002922	0.011438	0.000000
	73	C2H5SH (Ethyl Mercaptan)	0.000342	0.003216	0.000186	0.000188	0.000188	0.000188	0.000000	0.000000	0.000000	0.000000
	74	Other mercaptans (Propyl / Butyl Mercaptan, methyl ethyl sulfide)	0.000036	0.001267	0.000138	0.000141	0.000141	0.000141	0.000000	0.000000	0.000000	0.000000
	75	Benzene	0.000489	0.001657	0.000027	0.000027	0.000740	0.000005	0.000000	0.000308	0.012493	0.000000
	76	Toluene	0.000489	0.001462	0.000075	0.000076	0.000535	0.000005	0.000000	0.000000	0.000000	0.000000
	77	Ethylbenzene	0.000061	0.000161	0.000012	0.000012	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	78	p-Xylene	0.000196	0.000487	0.000027	0.000027	0.000082	0.000002	0.000000	0.000000	0.000000	0.000000
	79	m-Xylene	0.000196	0.000487	0.000027	0.000027	0.000082	0.000002	0.000000	0.000000	0.000000	0.000000
	80	o-Xylene / 1,2,4-Trimethylbenzene	0.000084	0.000161	0.000024	0.000024	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	81	MDEA	(Note 14)	(Note 14)	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	82	H2O	2.226271	2.534331	0.014559	0.014745	0.014745	0.014745	0.000000	0.000000	0.000000	0.000000
	83											
	84	Total	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000	100.000
	85											
	86											
	87	Mol Weight lb/lbmol	43.40	18.76	17.16	16.81	16.73	20.59	16.57	16.73	20.59	17.21
	88	Weight Flow lb/hr	124,710	1275.5	VTS (Note 1, 6)							
	89	Temperature oF	104.6	110	50.0				149.7	148.4	137.7	149.7
	90	Pressure @Inlet psia	16.1	VTS (Note 1, 6)								

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project

Permit Number:

Process Information

1. ID Number	EU11.MPGF (Multipoint Ground Flares)
2. Descriptive name	Warm and Cold Flares
3. Existing or future?	Future
4. Date commenced	January 2019
5. Date installed/completed	October 2021
6. Description of process:	

Warm and cold ground flares used to burn gas released from the process during emergencies or while purging equipment in preparation for maintenance. Each flare system has seven stages with 2 pilots per stage. Together these warm and cold flare lines comprise a multi-point ground flare (MPGF) where the array of burners is arranged in a grid surrounded by barrier walls.

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	Continuous (pilot and purge gas)
9. Projected maximum hours/day	24
10. Projected maximum hours/year	8,760

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Pilot Gas	1.82	MMBtu/hr	15,943	MMBtu/yr
Purge Gas	0.31	MMBtu/hr	2,715.6	MMBtu/yr
Products				
NA				

12. Control devices(s) (yes/no): No

If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).

Facility Name: JCEP LNG Terminal Project

Permit Number:

Process Information

1. ID Number	EU12.MF (Marine Flare)
2. Descriptive name	Marine Flare
3. Existing or future?	Future
4. Date commenced	January 2019
5. Date installed/completed	July 2022
6. Description of process:	
One enclosed marine flare.	

Operating Schedule

7. Seasonal or year-round?	Year-round
8. Batch or continuous operation?	Continuous (pilot and purge gas)
9. Projected maximum hours/day	24
10. Projected maximum hours/year	8,760

11. Process/device capacity:	Short term capacity		Annual usage	
Raw materials	Amount	Units	Amount	Units
Pilot Gas	0.39	MMBtu/hr	3,416	MMBtu/yr
Purge Gas	0.35	MMBtu/hr	3,066	MMBtu/yr
Products				
NA				

12. Control devices(s) (yes/no)	No
If yes, provide the ID number and complete and attached the applicable series AQ300 form(s).	

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project Permit Number:

Table 1

1. Emissions Point	Production Rates		4. Pollutant	Emissions Factors			Emissions	
	2. Short-term (Specify units)	3. Annual (Specify units)		5. Short-term	6. Long-term	7. Reference(s)	8. Short-term (Specify units)	9. Annual (tons/year)
			Please see	Appendix B.				
Example	200 tons of rock/hr	400,000 tons	PM	0.04 lb/ton	0.04 lb/ton	DEQ	8.0 lb/hr	8.0

State of Oregon Department of Environmental Quality

Facility Name: JCEP LNG Terminal Project
Permit Number:

Table 2

1. Device/process ID	2. PM_{10} PSEL (tons/year)	3. $PM_{2.5}$ fraction (f)	4. Reference	5. $PM_{2.5}$ PSEL (tons/yr)
Please see Appendix B.				
TOTAL	0.0			0.0

Facility Name: JCEP LNG Terminal Project Permit Number:

Emissions Data

1. Emissions Point	2. Annual Production Rate (specify units)	3. Pollutant	4. Emission Factor	5. EF reference	6. Annual Emissions (tons/yr)
		Please see	Appendix B		

Applications for Standard ACDPs must also include the most recent Toxics Release Inventory report, if applicable (see instructions).

Facility name: JCEP LNG Terminal Project Permit Number:

Indicate which of the following categorically insignificant activities are present at the facility by placing an "X" in the "Yes" or "No" column.

Yes	No	Type of activity — Categorically Insignificant Activities
✓		Constituents of a chemical mixture present at less than 1 percent by weight of any chemical or compound regulated under divisions 200 through 268 excluding divisions 248 and 262 of this chapter, or less than 0.1 percent by weight of any carcinogen listed in the U.S. Department of Health and Human Service's Annual Report on Carcinogens when usage of the chemical mixture is less than 100,000 pounds/year
✓		Evaporative and tail pipe emissions from on-site motor vehicle operation
	✓	Distillate oil, kerosene, gasoline, natural gas or propane burning equipment, provided the aggregate expected actual emissions of the equipment identified as categorically insignificant do not exceed the de minimis level for any regulated pollutant, based on the expected maximum annual operation of the equipment. If a source's expected emissions from all such equipment exceed the de minimis levels, then the source may identify a subgroup of such equipment as categorically insignificant with the remainder not categorically insignificant. The following equipment may never be included as categorically insignificant: A. Any individual distillate oil, kerosene or gasoline burning equipment with a rating greater than 0.4 million Btu/hour; B. Any individual natural gas or propane burning equipment with a rating greater than 2.0 million Btu/hour
	✓	Distillate oil, kerosene, gasoline, natural gas or propane burning equipment brought on site for six months or less for maintenance, construction or similar purposes, such as but not limited to generators, pumps, hot water pressure washers and space heaters, provided that any such equipment that performs the same function as the permanent equipment, must be operated within the source's existing PSEL
✓		Office activities
✓		Food service activities
✓		Janitorial activities
✓		Personal care activities
✓		Grounds keeping activities, including, but not limited to building painting and road and parking lot maintenance
✓		On-site laundry activities
	✓	On-site recreation facilities
✓		Instrument calibration
✓		Maintenance and repair shop
	✓	Automotive repair shops or storage garages;
✓		Air cooling or ventilating equipment not designed to remove air contaminants generated by or released from associated equipment
✓		Refrigeration systems with less than 50 pounds of charge of ozone depleting substances regulated under Title VI, including pressure tanks used in refrigeration systems but excluding any combustion equipment associated with such systems
✓		Bench scale laboratory equipment and laboratory equipment used exclusively for chemical and physical analysis, including associated vacuum producing devices but excluding research and development facilities

Yes	No	Type of activity
✓		Temporary construction activities
	✓	Warehouse activities
	✓	Accidental fires
✓		Air vents from air compressors
✓		Air purification systems
✓		Continuous emissions monitoring vent lines
	✓	Demineralized water tanks
	✓	Pre-treatment of municipal water, including use of deionized water purification systems
	✓	Electrical charging stations
	✓	Fire brigade training
✓		Instrument air dryers and distribution
	✓	Process raw water filtration systems
	✓	Pharmaceutical packaging
✓		Fire suppression
	✓	Blueprint making
✓		Routine maintenance, repair, and replacement such as anticipated activities most often associated with and performed during regularly scheduled equipment outages to maintain a plant and its equipment in good operating condition, including but not limited to steam cleaning, abrasive use, and woodworking
✓		Electric motors
✓		Storage tanks, reservoirs, transfer and lubricating equipment used for ASTM grade distillate or residual fuels, lubricants, and hydraulic fluids
✓		On-site storage tanks not subject to any New Source Performance Standard (NSPS), including underground storage tanks (UST), storing gasoline or diesel used exclusively for fueling of the facility's fleet of vehicles
✓		Natural gas, propane, and liquefied petroleum gas (LPG) storage tanks and transfer equipment
✓		Pressurized tanks containing gaseous compounds
	✓	Vacuum sheet stacker vents
✓		Emissions from wastewater discharges to publicly owned treatment works (POTW) provided the source is authorized to discharge to the POTW, not including on-site wastewater treatment and/or holding facilities
	✓	Log ponds
✓		Storm water settling basins
✓		Fire suppression and training
	✓	Paved roads and paved parking lots within an urban growth boundary
✓		Hazardous air pollutant emissions in fugitive dust from paved and unpaved roads except for those sources that have processes or activities that contribute to the deposition and entrainment of hazardous air pollutants from surface soils
✓		Health, safety, and emergency response activities

Yes	No	Type of activity
	✓	Emergency generators and pumps used only during loss of primary equipment or utility service due to circumstances beyond the reasonable control of the owner or operator, or to address a power emergency, provided that the aggregate horsepower rating of all stationary emergency generator and pump engines is not more than 3,000 horsepower. If the aggregate horsepower rating of all stationary emergency generator and pump engines is more than 3,000 horsepower, then no emergency generators and pumps at the source may be considered categorically insignificant
✓		Non-contact steam vents and leaks and safety and relief valves for boiler steam distribution systems
✓		Non-contact steam condensate flash tanks
✓		Non-contact steam vents on condensate receivers, deaerators and similar equipment
✓		Boiler blow down tanks
	✓	Industrial cooling towers that do not use chromium-based water treatment chemicals
	✓	Ash piles maintained in a wetted condition and associated handling systems and activities
	✓	Uncontrolled oil/water separators in effluent treatment systems, excluding systems with a throughput of more than 400,000 gallons per year of effluent located at the following sources: A. Petroleum refineries; B. Sources that perform petroleum refining and re-refining of lubricating oils and greases including asphalt production by distillation and the reprocessing of oils and/or solvents for fuels; or C. Bulk gasoline plants, bulk gasoline terminals, and pipeline facilities
✓		Combustion source flame safety purging on startup
	✓	Broke beaters, pulp and repulping tanks, stock chests and pulp handling equipment, excluding thickening equipment and repulpers
	✓	Stock cleaning and pressurized pulp washing, excluding open stock washing systems
	✓	White water storage tanks

Oregon Department of Environmental Quality

Land Use Compatibility Statement

State of Oregon Department of Environmental Quality

What is a land use compatibility statement?

A LUCS is a form developed by DEQ to determine whether a DEQ permit or approval will be consistent with local government comprehensive plans and land use regulations.

Why is a LUCS required?

DEQ and other state agencies with permitting or approval activities that affect land use are required by Oregon law to be consistent with local comprehensive plans and have a process for determining consistency. DEQ activities affecting land use and the requirement for a LUCS may be found in Oregon Administrative Rules (OAR) Chapter 340, Division 18.

When is a LUCS required?

A LUCS is required for nearly all DEQ permits and certain approvals of plans or related activities that affect land use prior to issuance of a DEQ permit or approval. These permits and activities are listed in section 1.D on p. 2 of this form. A single LUCS can be used if more than one DEQ permit or approval is being applied for concurrently.

Permit modifications or renewals also require a LUCS when any of the following applies:

1. Physical expansion on the property or proposed use of additional land;
2. Alterations, expansions, improvements or changes in method or type of disposal at a solid waste disposal site as described in OAR 340-093-0070(4)(b);
3. A significant increase in discharges to water;
4. A relocation of an outfall outside of the source property; or
5. Any physical change or change of operation of an air pollutant source that results in a net significant emission rate increase as defined in OAR 340-200-0020.

How to complete a LUCS:

Step	Who Does It?	What Happens?
1	Applicant	Applicant completes Section 1 of the LUCS and submits it to the appropriate city or county planning office.
2	City or County Planning Office	City or county planning office completes Section 2 of the LUCS to indicate whether the activity or use is compatible with the acknowledged comprehensive plan and land use regulations, attaches written findings supporting the decision of compatibility, and returns the signed and dated LUCS to the applicant.
3	Applicant	Applicant submits the completed LUCS and any supporting information provided by the city or county to DEQ along with the DEQ permit application or approval request.

Where to get help:

For questions about the LUCS process, contact the DEQ staff responsible for processing the permit or approval. DEQ staff may be reached at 1-800-452-4011 (toll-free, inside Oregon) or 503-229-5630. For general questions, please contact DEQ land use staff listed on our Land Use Compatibility Statement page online.

***CULTURAL RESOURCES PROTECTION LAWS**: Applicants involved in ground-disturbing activities should be aware of federal and state cultural resources protection laws. ORS 358.920 prohibits the excavation, injury, destruction, or alteration of an archeological site or object or removal of archeological objects from public and private lands without an archeological permit issued by the State Historic Preservation Office. 16 USC 470, Section 106, National Historic Preservation Act of 1966 requires a federal agency, prior to any undertaking, to take into account the effect of the undertaking that is included on or eligible for inclusion in the National Register. For further information, contact the State Historic Preservation Office at 503-378-4168, ext. 232.*

SECTION 1 - TO BE COMPLETED BY APPLICANT	
1A. Applicant Name: Jordan Cove Energy Project, L.P.	1B. Project Name: JCEP LNG Terminal Project
Contact Name: Rose Haddon	Physical Address: Jordan Cove Road
Mailing Address: Suite 500, 5615 Kirby	City, State, Zip: Unincorporated Coos County, OR
City, State, Zip: Houston, TX 77005	Tax Lot #: Not yet partitioned
Telephone: 713-400-2834	Township: T25S Range: R13W Section: 5
Tax Account #:	Latitude: 43.434024 N
	Longitude: 124.243219 W

1C. Describe the project, include the type of development, business, or facility and services or products provided (attach additional information if necessary):

Jordan Cove Energy Project is a natural gas liquefaction and export terminal in Coos County, Oregon to serve overseas markets around the Pacific Rim. Natural gas will be delivered to the terminal by pipeline from the Malin hub located in southern Oregon. The liquefaction and export facility will have an LNG production capacity of 7.8 mtpa. The facility will be developed on approximately 265 acres of industrial-zoned land owned by affiliates of JCEP.

1D. Check the type of DEQ permit(s) or approval(s) being applied for at this time.

- ☐ Air Quality Notice of Construction
- ☑ Air Contaminant Discharge Permit *(excludes portable facility permits)*
- ☐ Air Quality Title V Permit
- ☐ Air Quality Indirect Source Permit
- ☐ Parking/Traffic Circulation Plan
- ☐ Solid Waste Land Disposal Site Permit
- ☐ Solid Waste Treatment Facility Permit
- ☐ Solid Waste Composting Facility Permit (includes Anaerobic Digester)
- ☐ Conversion Technology Facility Permit
- ☐ Solid Waste Letter Authorization Permit
- ☐ Solid Waste Material Recovery Facility Permit
- ☐ Solid Waste Energy Recovery Facility Permit
- ☐ Solid Waste Transfer Station Permit
- ☐ Waste Tire Storage Site Permit
- ☐ Pollution Control Bond Request
- ☐ Hazardous Waste Treatment, Storage, or Disposal Permit
- ☐ Clean Water State Revolving Fund Loan Request
- ☐ Wastewater/Sewer Construction Plan/Specifications *(includes review of plan changes that require use of new land)*
- ☐ Water Quality NPDES Individual Permit
- ☐ Water Quality WPCF Individual Permit *(for onsite construction-installation permits use the DEQ Onsite LUCS form)*
- ☐ Water Quality NPDES Stormwater General Permit *(1200-A, 1200-C, 1200-CA, 1200-COLS, and 1200-Z)*
- ☐ Water Quality General Permit *(all general permits, except 600, 700-PM, 1700-A, and 1700-B when they are mobile.)*
- ☐ Water Quality 401 Certification for federal permit or license

1E. This application is for: ☐ Permit Renewal ☑ New Permit ☐ Permit Modification ☐ Other:

SECTION 2 - TO BE COMPLETED BY CITY OR COUNTY PLANNING OFFICIAL

Instructions: Written findings of fact for all local decisions are required; written findings from previous actions are acceptable. For uses allowed outright by the acknowledged comprehensive plan, DEQ will accept written findings in the form of a reference to the specific plan policies, criteria, or standards that were relied upon in rendering the decision with an indication of why the decision is justified based on the plan policies, criteria, or standards.

2A. The project proposal is located: ☐ Inside city limits ☐ Inside UGB ☐ Outside UGB

2B. Name of the city or county that has land use jurisdiction (the legal entity responsible for land use decisions for the subject property or land use):

SECTION 2 - TO BE COMPLETED BY CITY OR COUNTY PLANNING OFFICIAL	
Applicant Name:	**Project Name:**

2C. Is the activity allowed under Measure 49 (2007)? ☒ No, Measure 49 is not applicable ☐ Yes; if yes, then check one:

☐ Express; approved by DLCD order #:

☐ Conditional; approved by DLCD order #:

☐ Vested; approved by local government decision or court judgment docket or order #:

2D. Is the activity a composting facility?
☒ No ☐ Yes; Senate Bill 462 (2013) notification requirements have been met.

2E. Is the activity or use compatible with your acknowledged comprehensive plan as required by OAR 660-031?
Please complete this form to address the activity or use for which the applicant is seeking approval (see 1.C on the previous page). If the activity or use is to occur in multiple phases, please ensure that your approval addresses the phases described in 1.C. For example, if the applicant's project is described in 1.C as a subdivision and the LUCS indicates that only clearing and grading are allowed outright but does not indicate whether the subdivision is approved, DEQ will delay permit issuance until approval for the subdivision is obtained from the local planning official.

☐ The activity or use is specifically exempt by the acknowledged comprehensive plan; explain:

☐ **Yes**, the activity or use is pre-existing nonconforming use allowed outright by *(provide reference for local ordinance)*:

☐ **Yes**, the activity or use is allowed outright by *(provide reference for local ordinance)*:

☒ **Yes**, the activity or use received preliminary approval that includes requirements to fully comply with local requirements; findings are attached.

☐ **Yes**, the activity or use is allowed; findings are attached.

☐ **No**, see 2.C above, activity or use allowed under Measure 49; findings are attached.

☐ **No**, *(complete below or attach findings for noncompliance and identify requirements the applicant must comply with before compatibility can be determined)*:
Relevant specific plan policies, criteria, or standards:

Provide the reasons for the decision:

Additional comments (attach additional information as needed):

Planning Official Signature: Jill Rolfe		**Title:** Planning Director
Print Name: Jill Rolfe	**Telephone #:** 541-396-7770	**Date:** 9/20/17

If necessary, depending upon city/county agreement on jurisdiction outside city limits but within UGB:

Planning Official Signature:		**Title:**
Print Name:	**Telephone #:**	**Date:**

Coos County Planning Department
Coos County Courthouse Annex, Coquille, Oregon 97423
Mailing Address: 250 N. Baxter, Coos County Courthouse, Coquille, Oregon 97423
Physical Address: 225 N. Adams, Coquille, Oregon
(541) 396-7770
Fax (541) 396-1022/TDD (800) 735-2900
Jill Rolfe, Planning Director

NOTICE OF ADOPTION

August 31, 2016

Re: Coos County Planning Department File No. HBCU-15-05/FP-15-09
Final Decision and Order No. 16-08-071PL

On August 30, 2016, the Board of Commissioners Adopted Final Decision and Order No. 16-08-071PL in the matter of approving conditional use application for Jordan Cove Energy Project L.P. file Numbers HBCU-15-05/FP-15-09.

The final decision and order that was adopted can be found on the Coos County Planning Department webpage at:
http://www.co.coos.or.us/Departments/Planning/2015Applications.aspx.

The adoption of these final decisions and orders can be appealed to the Land Use Board of Appeals (LUBA), pursuant to ORS 197.830 to 197.845, by filing a Notice of Intent to Appeal within 21 days of the date of the final decision and order. For more information on this process, contact LUBA by telephone at 503-373-1265, or in writing at 775 Summer St. NE #330, Salem, Oregon 97301.

All documents related to this file are available for inspection, at no cost, in the Planning Department located at 225 North Adams Street, Coquille, Oregon. Copies may be purchased at a cost of 50 cents per page.

If you have any questions, please contact the Planning Department by telephone at (541) 396-7770, or visit the Planning Department at 225 North Adams Street, Coquille, Oregon, Monday through Friday, 8:00 AM - 5:00 PM (closed Noon - 1:00 PM).

COOS COUNTY PLANNING DEPARTMENT

Jill Rolfe

Jill Rolfe, Planning Director

C: Planning Commission
Parties
File

EC: Planning Commission
Sam Sprague
Sarah Robertson
Dave Perry, DLCD
Board of Commissioners
Curt Clay
Richard Knablin
Rob Taylor

CERTIFICATE OF MAILING

I hereby certify that on August 31, 2016, I deposited the attached NOTICE OF ADOPTION into the U.S. mail, in an envelope with first class postage affixed thereto to the parties listed out below.

Dated: August 31, 2016

Troy May, Planning Assistant

Andrew Napell 28750 Loma Chiquita Rd Los Gatos CA 95033-8122	Asialee Crumley 1012 Michigan Ave Coos Bay, OR 97420	Barb Shamet PO Box 212 Allegany,OR 97407
Barbara Gimlin 65357 East Bay Rd North Bend, OR 97459	Beverly Segner PO Box 191 Coos Bay, OR 97420	Bill Gow 4943 Clarks Brand Rd Roseburg, OR 97470
Barry Winters PO Box 706 Bandon, OR 97411	Bill Walsh & Shirley Weathers 1020 Butte Falls Highway Eagle Point, OR 97524	
Carl Johnson 93376 Hillcrest Lane North Bend, OR 97459	Carol Sanders 664 S. Empire Blvd Coos Bay OR 97420	Charles A Ruddell 57155 School Yard Rd Bandon, OR 97411
Charles B Miller 1320 NW 30th Street Corvallis, OR 97330	Christina Riggs 229 N Main St. Coos Bay, OR 97420	Clarence Adams 2039 Ireland Rd Winston, OR 97496

Courtney Johnson 917 SW Oak St Suite 417 Portland, OR 97205	Cindy Smith 69792 Stage Rd. North Bend, OR 97459	Craig Spinning 5600 SW 152nd Ave Beaverton, OR 97007
Dan Prahl 93680 Easy Lane Coos Bay, OR 97420	Doug Heiken PO Box 11648 Eugene, OR 97440	David Ludlam PO Box 89 Grand Junction, CO 81501
Dennis, Kathryn & Andrew Netter 979 South 5th St Coos Bay, OR 97420		Doc Slyter 1245 Fulton Ave Coos Bay, OR 97420
Deb Evans & Ron Schaaf 9687 Highway 66 Ashland, OR 97520	David M Kelly & Pam DeJong 2150 Pine Street North Bend, OR 97459	Emmalyn Garrett 880 Franklin Ave Bandon, OR 97411
Eldon Rollins 985 N. Collier St Coquille, OR 97423	Elizabeth Brown po box 5181 Eugene, OR 97405	Gary Smitt 94283 Kentuck Way Ln North Bend, OR 97459
Hannah Sohl 684 Normal Ave Ashland, OR 97520	James T. Meunier, DVM po box 102 North Bend, OR 97459	Jan Dilley 1223 Winsor Ave North Bend, OR 97459
JC Williams 66642 E. Bay Rd. North Bend, OR 97459	Jack Hackett 57131 Fuller Rd Bandon, OR 97411	Jared M. Margolis 2852 Willamette St. #171 Eugene, OR 97405
Jennifer Vandatta 2962 Anderson Cr Rd Talent, OR 97540	Janet Moore 2031 Maine St North Bend, OR 97459	Jeff Harms 2345 1/2 5th St Springfield, OR 97477

Jessica Engelke 2457 Marion North Bend, OR 97459	Jody McCaffree PO Box 1113 North Bend, OR 97459	Jeffery Carlisle Eberwein 555 13th CT Coos Bay, OR 97420
John Clarke 1102 Twin Oaks Lane Winston, OR 97496	Eugene W. LaRochelle 1148 California Ave Coos Bay, OR 97420	Joe Metzler 1475 Myrtle Ave Coos Bay, OR 97420
John Jones 49380 Myrtle Creek Rd. Myrtle Point, OR 97458	Kathryn Hemperly 94572 Carlson Hts North Bend, OR 97459	John Fields 399 W 11th PL Coquille OR 97423
Jordan Cove Energy Project L.P. c/o Perkins Coie LLP Attn: Steve Pfeiffer 1120 NW Couch St, 10th Floor Portland OR 97209		Keith Comstock 93543 Pleasant Valley Lane Myrtle Point, OR 97458
Kassandra Rippee, Cultural Resource Program Coquille Indian Tribe 495 Miluk Drive Coos Bay OR 97420		Linda Sweatt 1170 Winsor North Bend, OR 97459
Katy Eymann 1256 Newport Ave. SW Bandon, OR 97411	Mark Wall 93687 Pickett Ln Coos Bay, OR 97420	Lilli Clausen 93488 Promise Lane Coos Bay, OR 97420
Linda Gonzales 66690 Raven Road North Bend, OR 97459	Lynn Mystic Healer PO Box 614 North Bend, OR 97459	Marian Crumley 1012 Michigan Ave Coos Bay, OR 97420
Maryann Rohrer 93558 Hollow Stump Lane North Bend, OR 97459	Ms. A. Velinty 419 Sherwood Loop Florence, OR 97439-8886	Naomi Johnson PO Box 915 Creswell, OR 97426

Natalie Ranker 414 Simpson Ave North Bend OR 97459	Nonda Henderson 58375 Fairview Rd Coquille, OR 97423	
Oregon Department of Aviation Planning Division 3040 25th St SE Salem OR 97302		R.L. Goergen 92799 Trans-Pacific Parkway North Bend, OR 97459
Richard Leshley 93581 Bay Park Lane Coos Bay, OR 97420	Rick Riggs 229 N Main St. Coos Bay, OR 97420	Rick Skinner 1069 Canyon Dr Coos Bay, OR 97420
Sarah Westock 204 2nd St Phoenix, OR 97535	Stacey McLaughin 799 Glory Lane Myrtle Creek, OR 97457	
Stacy Scott Confederated Tribes of Coos, Lower Umpqua, & Siuslaw 1245 Fulton Ave Coos Bay OR 97420		
Steve Scheer Planning Commissioner PO Box 5617	Susan P. Smith PO Box 1464 Coos Bay, OR 97420	Teresa Rigg 1290 Yew Coos Bay, OR 97420
Tobe Burdett 1349 Bayview Ave North Bend, OR 97459	Tonia L. Moro 19 S. Orange Street Medford, OR 97501	Wayne Miller 88908 Gretna Green Ln Bandon, OR 97411
Wim De Friend 573 South 12th Coos Bay, OR 97420		

APPENDIX B

DETAILED EMISSION CALCULATIONS

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

Table 1. Annual Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Source	NO_X (tpy)	CO (tpy)	SO_2 (tpy)	VOC (tpy)	$PM/PM_{10}/PM_{2.5}$ (tpy)	H_2SO_4 (tpy)	NH_3 (tpy)	Lead (tpy)	CO_2e (tpy)	HAPs (tpy)
Turbines	81.99	97.82	35.19	32.72	112.26	23.61	75.43	---	1,292,706	5.06
Turbines Startup/Shutdown	0.23	0.73	4.4E-03	0.10	0.11	--	--	---	188	6.2E-04
Oxidizer	63.25	38.50	19.84	1.08	3.85	--	--	2.5E-04	622,154	0.96
Auxiliary Boiler	0.96	1.16	0.36	0.67	1.30	2.4E-01	0.87	6.3E-05	15,193	0.24
Fire-Water Pumps	1.59	0.80	2.1E-03	4.5E-02	9.0E-02	1.6E-04	--	2.1E-05	241	3.6E-03
Backup Generators	3.33	0.28	2.5E-03	0.04	0.04	1.9E-04	--	2.4E-05	278	4.1E-03
Black Start Generators	1.49	0.21	8.8E-03	0.09	0.05	6.8E-04	--	8.6E-05	1,002	1.5E-02
Flares	0.86	3.90	3.9E-02	8.31	0.38	3.0E-03	--	7.3E-06	2,177	4.3E-02
Gas Up	2.09	9.5	0.16	17.53	1.12	1.3E-02	--	2.1E-05	4,351	3.8E-02
Fugitives	--	--	--	7.98	--	--	--	--	13,116	1.77
AIE	1.00	1.00	1.00	1.00	1.00	0.70	--	--	--	--
Potential Emissions	**156.8**	**153.9**	**56.6**	**69.5**	**120.2**	**24.6**	**76.3**	**4.8E-04**	**1,951,406**	**8.1**
PSD ACDP PSELs	**221.0**	**156.1**	**63.5**	**209.3**	**181.9**	**55.8**	**196.9**	**7.8E-03**	**2,165,917**	**8.9**
Percent Change (%)	**-29**	**-1**	**-11**	**-67**	**-34**	**-56**	**-61**	**-94**	**-10**	**-9**
Federal Major Source Threshold	**250**	**250**	**250**	**250**	**250**					
SER	**40**	**100**	**40**	**40**	**25/15/10**	**7**		**0.6**	**75,000**	
New Source Review/PSD?	Type B State NSR	Type B State NSR	Type B State NSR	Type B State NSR	Type B State NSR	Type B State NSR			No GHG State NSR	

Table 2. Combustion Unit Rates and Operational Characteristics
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Parameter		Turbines	Thermal Oxidizer	Auxiliary Boiler	Marine Enclosed Flare	Multipoint Ground Flare	Firewater Pumps	Black Start Generator Engines	Backup Generators
Fuel	(1)	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Diesel	Diesel	Diesel
Fuel Type	(2)	Pipeline	Pipeline	Pipeline	Pipeline	Pipeline	ULSD	ULSD	ULSD
Sulfur Content	(3)	0.01 grains/dscf	0.01 grains/dscf	0.01 grains/dscf	0.01 grains/dscf	0.01 grains/dscf	15 ppmvd	15 ppmvd	15 ppmvd
Heating Value of Fuel, HHV	(3)	952 Btu/scf	952 Btu/scf	1024.6 Btu/scf	868 Btu/scf	868 Btu/scf	140,005 Btu/gal	140,005 Btu/gal	140,005 Btu/gal
Number of Units	(1)	5	1	1	6	28	3	2	2
Hours of Operation	(1)	8,760	8,760	876	8,760	8,760	200	200	200
Rating	(1)	524.1 MMBtu/hr	110 MMBtu/hr	296.2 MMBtu/hr	0.74 MMBtu/hr	2.13 MMBtu/hr	700 hp	4,376 hp	800 kW
Stack Inside Diameter (ft)	(1)	10	9.5	6	45	Wall Heights = 85' on E+S and 60' on N+W	0.67	1.67	0.67
Stack Height (ft)	(1)	119	131	100	100	Field Dimensions = 259' E-W x 227' N-S	18	18	13
Exhaust Flowrate (acfm)	(1)								
Exit Velocity (ft/sec)	(1)	71	42	49	30		193	177	287
Exit Temperature (˚F)	(1)	243	1,600	330	1832	ambient	948.3	873.6	952.5

Notes:
(1) Provided by KBJ.
(2) Engines are required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.
(3) Site-specific data provided by KBJ.

Table 3. Natural Gas Turbines Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon
Scenario: 4000 hours 100% load DB, 4760 hours 100% load no DB

Pollutant		Emission Factor			Hourly Emissions per Unit [a] (lb/hr)	Annual Emissions [b] (tons/yr)
Criteria Pollutants						
NO_X	100% Load - DB fired	3.8	lb/hr	(1)	3.75	81.99
	100% Load - DB unfired	3.7	lb/hr			
CO	100% Load - DB fired	4.6	lb/hr	(1)	4.47	97.82
	100% Load - DB unfired	4.4	lb/hr			
SO_2	100% Load - DB fired	1.64	lb/hr	(1), (2)	1.61	35.19
	100% Load - DB unfired	1.58	lb/hr			
VOC	100% Load - DB fired	1.7	lb/hr	(1)	1.49	32.72
	100% Load - DB unfired	1.3	lb/hr			
$PM/PM_{10}/PM_{2.5}$	100% Load - DB fired	5.4	lb/hr		5.13	112.26
	100% Load - DB unfired	4.9	lb/hr	(1)		
H_2SO_4	100% Load - DB fired	1.10	lb/hr	(1)	1.08	23.61
	100% Load - DB unfired	1.06	lb/hr			
NH_3	100% Load - DB fired	3.5	lb/hr	(1)	3.45	75.43
	100% Load - DB unfired	3.4	lb/hr			
Lead		---		(3)	---	---
CO_2e		---		(4)	59,053	1,292,706
CO_2	100% Load - DB fired	60,218	lb/hr	(1)	58,990	1,291,320
	100% Load - DB unfired	57,958	lb/hr			
CH_4		0.001	kg/MMBtu	(5)	1.155	25.293
N_2O		0.0001	kg/MMBtu	(5)	0.116	2.529
Hazardous Air Pollutants						
Acetaldehyde - Turbine		4.0E-05	lb/MMBtu	(6)	2.0E-02	4.4E-01
Acrolein - Turbine		6.4E-06	lb/MMBtu	(6)	3.2E-03	7.1E-02
Benzene - Turbine		1.2E-05	lb/MMBtu	(6)	6.1E-03	1.3E-01
Benzene - Duct Burner		2.1E-03	lb/MMscf	(7)	4.3E-05	4.3E-04
1,3-Butadiene - Turbine		4.3E-07	lb/MMBtu	(6)	2.2E-04	4.7E-03
Dichlorobenzene - Duct Burner		1.2E-03	lb/MMscf	(7)	2.5E-05	2.5E-04
Ethylbenzene - Turbine		3.2E-05	lb/MMBtu	(6)	1.6E-02	3.5E-01
Formaldehyde - Turbine		1.0E-04	lb/MMBtu	(8)	5.0E-02	1.1E+00
Formaldehyde - Duct Burner		7.5E-02	lb/MMscf	(7)	1.6E-03	1.6E-02
Hexane - Duct Burner		1.8E+00	lb/MMscf	(7)	3.7E-02	3.7E-01
Naphthalene - Turbine		1.3E-06	lb/MMBtu	(6)	6.6E-04	1.4E-02
Naphthalene - Duct Burner		6.1E-04	lb/MMscf	(7)	1.3E-05	1.3E-04
PAH - Turbine		2.2E-06	lb/MMBtu	(6)	1.1E-03	2.4E-02
PAH - Duct Burner		8.9E-05	lb/MMscf	(7)	1.8E-06	1.8E-05
Propylene Oxide - Turbine		2.9E-05	lb/MMBtu	(6)	1.5E-02	3.2E-01
Toluene - Turbine		1.3E-04	lb/MMBtu	(6)	6.6E-02	1.4E+00
Toluene - Duct Burner		3.4E-03	lb/MMscf	(7)	7.0E-05	7.0E-04
Xylenes - Turbine		6.4E-05	lb/MMBtu	(6)	3.2E-02	7.1E-01
Arsenic		2.0E-04	lb/MMscf	(3)	1.1E-04	2.4E-03
Beryllium		1.2E-05	lb/MMscf	(3)	6.6E-06	1.4E-04
Cadmium		1.1E-03	lb/MMscf	(3)	6.1E-04	1.3E-02
Chromium		1.4E-03	lb/MMscf	(3)	7.7E-04	1.7E-02
Cobalt		8.4E-05	lb/MMscf	(3)	4.6E-05	1.0E-03

Pollutant	Emission Factor		Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Manganese	3.8E-04 lb/MMscf	(3)	2.1E-04	4.6E-03
Mercury	2.6E-04 lb/MMscf	(3)	1.4E-04	3.1E-03
Nickel	2.1E-03 lb/MMscf	(3)	1.2E-03	2.5E-02
Selenium	2.4E-05 lb/MMscf	(3)	1.3E-05	2.9E-04
Total HAPs			**0.25**	**5.06**
Maximum Individual HAP				**1.44**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor for 100% load (lb/hr)] x [Time at 100% load (%) / 100] + [Emission Factor for 75% load (lb/hr)] x [Time at 75% load (%) / 100]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (MMBtu/hr)] x [2.20462 (lb/kg)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Heat Rate (MMBtu/hr)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Heat Rate (MMBtu/hr)] / [Fuel Heat Content (MMBtu/MMscf)]

Hours at 100% load DB fired (%) =	4000	(9)
Hours at 100% load DB unfired (%) =	4760	(9)
Turbine Maximum Heat Rate (MMBtu/hr) =	504.4	(10)
Duct Burner Maximum Heat Rate (MMBtu/hr) =	19.7	(10)
Maximum Heat Rate (MMBtu/hr) =	524.1	(10)
Fuel Heat Content (Btu/scf) =	952	(11)

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Turbine Hours of Operation (hr/yr) - Startup/Shutdown Hours (hr/yr)] x [Number of Units] / [2,000 (lb/ton)]

Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Duct Burner Hours of Operation (hr/yr)] x [Number of Units] / [2,000 (lb/ton)]

Number of Units =	5	(9)
Duct Burner Hours of Operation (hr/yr) =	4,000	(12)
Turbine Hours of Operation (hr/yr) =	8,760	(9)
Startup/Shutdown Hours (hr/yr) =	3.8	(13)

Notes:

(1) Emission estimates provided by manufacturer.

(2) SO_2 emissions include assumptions of 20 percent by volume oxidation rate in CO catalyst and 3 percent by volume oxidation rate in SCR.

(3) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998. Note emission factor for lead is ND as indicated in AP-42, Chapter 3.1-2a, Table 3.1, Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines.

(4) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(5) Emission Factors from Table C-2 to Subpart C of 40 CFR Part 98 - Default CH_4 and N_2O Emission Factors for Various Types of Fuel.

(6) AP-42, Chapter 3.1, Table 3.1-3. Emission Factors for Hazardous Air Pollutants from Natural Gas-Fired Stationary Gas Turbines, April 2000.

(7) AP-42, Chapter 1.4, Table 1.4-3. Emission Factors for Speciated Organic Compounds from Natural Gas Combustion, July 1998. HAP emission factors used for Duct Burners.

(8) California Air Resource Board (CARB) emission inventory for NG turbine.

(9) Percentage of time at specific loads, number of units, and hours of operation provided by KBJ.

(10) Maximum heat rate at 100% load with duct burners provided by manufacturer (see Table 13).

(11) Provided by KBJ.

(12) Provided by KBJ.

(13) KBJ estimates 12 startup per year at 10 minutes per startup and 12 shutdowns per year at 9 minutes per shutdown. See Table 4 for additional startup and shutdown calculations.

Table 4. Natural Gas Turbines Startup/Shutdown Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Startup Emission Factor per Event		Shutdown Emission Factor per Event		Emissions per Startup Event [a] (lb)	Emissions per Shutdown Event [a] (lb)	Annual Emissions [b] (tons/yr)
Criteria Pollutants							
NO_X	3.8 lb	(1)	3.7 lb	(1)	3.80	3.70	0.23
CO	11.5 lb	(1)	12.8 lb	(1)	11.50	12.80	0.73
SO_2	7.7E-02 lb	(2)	6.9E-02 lb	(2)	7.7E-02	6.9E-02	4.4E-03
VOC	1.6 lb	(1)	1.8 lb	(1)	1.60	1.80	0.10
$PM/PM_{10}/PM_{2.5}$	0.40 lb	(1)	3.3 lb	(1)	0.40	3.30	0.11
H_2SO_4	---		---		---	---	---
NH_3	---		---		---	---	---
Lead	---	(3)	---	(3)	---	---	---
CO_2e	---	(4)	---	(4)	3,319	2,948	188.02
CO_2	3,316 lb	(1)	2,945 lb	(1)	3,316	2,945	187.83
CH_4	0.001 kg/MMBtu	(5)	0.001 kg/MMBtu	(5)	5.7E-02	5.7E-02	3.4E-03
N_2O	0.0001 kg/MMBtu	(5)	0.0001 kg/MMBtu	(5)	5.7E-03	5.7E-03	3.4E-04
Hazardous Air Pollutants							
Acetaldehyde	4.0E-05 lb/MMBtu	(6)	4.0E-05 lb/MMBtu	(6)	1.0E-03	9.2E-04	5.8E-05
Acrolein	6.4E-06 lb/MMBtu	(6)	6.4E-06 lb/MMBtu	(6)	1.7E-04	1.5E-04	9.4E-06
Benzene	1.2E-05 lb/MMBtu	(6)	1.2E-05 lb/MMBtu	(6)	3.1E-04	2.8E-04	1.8E-05
1,3-Butadiene	4.3E-07 lb/MMBtu	(6)	4.3E-07 lb/MMBtu	(6)	1.1E-05	9.9E-06	6.3E-07
Ethylbenzene	3.2E-05 lb/MMBtu	(6)	3.2E-05 lb/MMBtu	(6)	8.3E-04	7.3E-04	4.7E-05
Formaldehyde	1.0E-04 lb/MMBtu	(8)	1.0E-04 lb/MMBtu	(8)	2.6E-03	2.3E-03	1.5E-04
Naphthalene	1.3E-06 lb/MMBtu	(6)	1.3E-06 lb/MMBtu	(6)	3.4E-05	3.0E-05	1.9E-06
PAH	2.2E-06 lb/MMBtu	(6)	2.2E-06 lb/MMBtu	(6)	5.7E-05	5.0E-05	3.2E-06
Propylene Oxide	2.9E-05 lb/MMBtu	(6)	2.9E-05 lb/MMBtu	(6)	7.5E-04	6.6E-04	4.2E-05
Toluene	1.3E-04 lb/MMBtu	(6)	1.3E-04 lb/MMBtu	(6)	3.4E-03	3.0E-03	1.9E-04
Xylenes	6.4E-05 lb/MMBtu	(6)	6.4E-05 lb/MMBtu	(6)	1.7E-03	1.5E-03	9.4E-05
Arsenic	2.0E-04 lb/MMscf	(3)	2.0E-04 lb/MMscf	(3)	5.4E-06	4.8E-06	3.1E-07
Beryllium	1.2E-05 lb/MMscf	(3)	1.2E-05 lb/MMscf	(3)	3.3E-07	2.9E-07	1.8E-08
Cadmium	1.1E-03 lb/MMscf	(3)	1.1E-03 lb/MMscf	(3)	3.0E-05	2.7E-05	1.7E-06
Chromium	1.4E-03 lb/MMscf	(3)	1.4E-03 lb/MMscf	(3)	3.8E-05	3.4E-05	2.2E-06
Cobalt	8.4E-05 lb/MMscf	(3)	8.4E-05 lb/MMscf	(3)	2.3E-06	2.0E-06	1.3E-07
Manganese	3.8E-04 lb/MMscf	(3)	3.8E-04 lb/MMscf	(3)	1.0E-05	9.2E-06	5.8E-07
Mercury	2.6E-04 lb/MMscf	(3)	2.6E-04 lb/MMscf	(3)	7.0E-06	6.3E-06	4.0E-07
Nickel	2.1E-03 lb/MMscf	(3)	2.1E-03 lb/MMscf	(3)	5.7E-05	5.1E-05	3.2E-06
Selenium	2.4E-05 lb/MMscf	(3)	2.4E-05 lb/MMscf	(3)	6.5E-07	5.8E-07	3.7E-08
Total HAPs					**0.01**	**0.01**	**6.2E-04**
Maximum Individual HAP							**1.9E-04**

Calculations:

(a) Emission Factor (lb/Event) = [Sulfur Content (grains/scf)] / [7,000 (grains/lb)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] \ [Molecular Weight S (lb/lb-mole)]

Emission Factor (lb/Event) = [Emission Factor (kg/MMBtu)] x [2.20462 (lb/kg)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

Emission Factor (lb/Event) = [Emission Factor (lb/MMscf)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] / [1,000,000 (scf/MMscf)]

Emission Factor (lb/Event) = [Emission Factor (lb/MMBtu)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

Fuel Sulfur Content (grains/scf) =	0.01	(2)
Startup Fuel Consumption (lb) =	1,200	(1)
Shutdown Fuel Consumption (lb) =	1,067	(1)
Fuel Heat Content (Btu/scf) =	952	(8)
Fuel Density (lb/scf) =	0.044	(9)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	

(b) Annual Emissions (tons/yr) = {[Emissions per Startup Event (lb/Event)] x [Count of Startup Events (Event)] + [Emissions per Shutdown Event (lb/Event)] x [Count of Shutdown Events (Event)]} x [Number of Units] / [2,000 (lb/ton)]

Count of Startup Events =	12	(10)

Pollutant	Startup Emission Factor per Event	Shutdown Emission Factor per Event	Emissions per Startup Event [a] (lb)	Emissions per Shutdown Event [a] (lb)	Annual Emissions [b] (tons/yr)

Count of Shutdown Events = 12 (10)
Number of Units = 5 (11)

Notes:
(1) Emission estimates and fuel use provided by manufacturer.
(2) Sulfur content provided by KBJ as site data.
(3) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998. Note emission factor for lead is ND as indicated in AP-42, Chapter 3.1, Table 3.1-2a, Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines.
(4) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.
(5) Emission Factors from Table C-2 to Subpart C of 40 CFR Part 98 - Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(6) AP-42, Chapter 3.1, Table 3.1-3. Emission Factors for Hazardous Air Pollutants from Natural Gas-Fired Stationary Gas Turbines, April 2000.
(7) California Air Resource Board (CARB) emission inventory.
(8) Provided by KBJ
(9) Provided by KBJ
(10) KBJ estimates 12 startup per year at 10 minutes per startup and 12 shutdowns per year at 9 minutes per shutdown.
(11) Number of units provided by KBJ.

Table 5. Zeeco Natural Gas Thermal Oxidizer Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [a] (lb/hr)	Annual Emissions [b] (tons/yr)
Criteria Pollutants					
NO_X	14.44	lb/hr	(1)	14.44	63.25
CO	8.79	lb/hr	(1)	8.79	38.50
SO_2	4.53	lb/hr	(1)	4.53	19.84
VOC	0.01	lb/hr	(1)	0.01	0.03
VOC (venting)	6.00	lb/hr	(1)	6.00	1.05
$PM/PM_{10}/PM_{2.5}$	7.6	lb/MMscf	(2)	0.88	3.85
H_2SO_4	---			---	---
NH_3	---			---	---
Lead	5.0.E-04	lb/MMscf	(2)	5.78E-05	2.5E-04
CO_2e	---		(3)	261,758	622,154
CO_2	137,049	lb/hr	(1)	137,049	600,274
CO_2 (venting)	123,471	lb/hr		123,471	21,607
CH_4	0.001	kg/MMBtu	(4)	0.24	1.06
CH_4 (venting)	49.00	lb/hr		49.00	8.57
N_2O	0.0001	kg/MMBtu	(4)	2.4E-02	1.1E-01
Hazardous Air Pollutants					
Benzene	2.1E-03	lb/MMscf	(5)	2.4E-04	1.1E-03
Dichlorobenzene	1.2E-03	lb/MMscf	(5)	1.4E-04	6.1E-04
Formaldehyde	7.5E-02	lb/MMscf	(5)	8.7E-03	3.8E-02
Hexane	1.8E+00	lb/MMscf	(5)	0.21	0.91
Naphthalene	6.1E-04	lb/MMscf	(5)	7.1E-05	3.1E-04
Polycyclic Organic Matter	8.8E-05	lb/MMscf	(5)	1.0E-05	4.5E-05
Toluene	3.4E-03	lb/MMscf	(5)	3.9E-04	1.7E-03
Arsenic	2.0E-04	lb/MMscf	(6)	2.3E-05	1.0E-04
Beryllium	1.2E-05	lb/MMscf	(6)	1.4E-06	6.1E-06
Cadmium	1.1E-03	lb/MMscf	(6)	1.3E-04	5.6E-04
Chromium	1.4E-03	lb/MMscf	(6)	1.6E-04	7.1E-04
Cobalt	8.4E-05	lb/MMscf	(6)	9.7E-06	4.3E-05
Manganese	3.8E-04	lb/MMscf	(6)	4.4E-05	1.9E-04
Mercury	2.6E-04	lb/MMscf	(6)	3.0E-05	1.3E-04
Nickel	2.1E-03	lb/MMscf	(6)	2.4E-04	1.1E-03
Selenium	2.4E-05	lb/MMscf	(6)	2.8E-06	1.2E-05
Total HAPs				**0.22**	**0.96**
Maximum Individual HAP					**0.91**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Heat Rate (MMBtu/hr)] / [Fuel Heat Content (MMBtu/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (MMBtu/hr)] x [2.20462 (lb/kg)]

Maximum Heat Rate (MMBtu/hr) = 110 (7)

Fuel Heat Content (Btu/scf) = 952 (8)

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	1	(9)
Hours of Operation (hr/yr) =	8,760	(9)

Notes:

(1) Emission estimates provided by KBJ. VOC emissions include 350 hours of venting.

(2) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998.

(3) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(4) Emission Factors from Table C-2 to Subpart C of 40 CFR Part 98 - Default CH_4 and N_2O Emission Factors for Various Types of Fuel.

(5) AP-42, Chapter 1.4, Table 1.4-3. Emission Factors for Speciated Organic Compounds from Natural Gas Combustion, July 1998.

(6) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998.

(7) Manufacturer specification sheet.

(8) Fuel gas system heat content.

(9) Number of units and hours of operation provided by KBJ.

Table 6. Natural Gas Auxiliary Boiler Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	2	ppmvd @ 15% O_2	(1)	2.18	0.96
CO	4	ppmvd @ 15% O_2	(1)	2.66	1.16
SO_2	0.01	grains S/scf	(2),(3)	0.83	0.36
VOC	4	ppmvd @ 15% O_2	(1)	1.52	0.67
$PM/PM_{10}/PM_{2.5}$	0.01	lb/MMBtu	(2)	2.96	1.30
H_2SO_4	---		(3)	0.56	0.24
NH_3	0.0067	lb/MMBtu	(1)	1.98	0.87
Lead	0.0005	lb/MMscf	(4)	1.45E-04	6.3E-05
CO_2e	---		(5)	34,688	15,193
CO_2	53.06	kg/MMBtu	(6)	34,652	15,178
CH_4	0.001	kg/MMBtu	(6)	0.65	0.29
N_2O	0.0001	kg/MMBtu	(6)	0.07	2.9E-02
Hazardous Air Pollutants					
Benzene	2.1E-03	lb/MMscf	(7)	6.1E-04	2.7E-04
Dichlorobenzene	1.2E-03	lb/MMscf	(7)	3.5E-04	1.5E-04
Formaldehyde	7.5E-02	lb/MMscf	(7)	2.2E-02	9.5E-03
Hexane	1.8E+00	lb/MMscf	(7)	0.52	0.23
Naphthalene	6.1E-04	lb/MMscf	(7)	1.8E-04	7.7E-05
Polycyclic Organic Matter	8.8E-05	lb/MMscf	(7)	2.6E-05	1.1E-05
Toluene	3.4E-03	lb/MMscf	(7)	9.8E-04	4.3E-04
Arsenic	2.0E-04	lb/MMscf	(8)	5.8E-05	2.5E-05
Beryllium	1.2E-05	lb/MMscf	(8)	3.5E-06	1.5E-06
Cadmium	1.1E-03	lb/MMscf	(8)	3.2E-04	1.4E-04
Chromium	1.4E-03	lb/MMscf	(8)	4.0E-04	1.8E-04
Cobalt	8.4E-05	lb/MMscf	(8)	2.4E-05	1.1E-05
Manganese	3.8E-04	lb/MMscf	(8)	1.1E-04	4.8E-05
Mercury	2.6E-04	lb/MMscf	(8)	7.5E-05	3.3E-05
Nickel	2.1E-03	lb/MMscf	(8)	6.1E-04	2.7E-04
Selenium	2.4E-05	lb/MMscf	(8)	6.9E-06	3.0E-06
Total HAPs				**0.55**	**0.24**
Maximum Individual HAP					**0.23**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Concentration (ppmvd @ 15% O_2)] x [Conversion Factor (lb/scf-ppm)] x [F_d (dscf/MMBtu)] x [20.9 / (20.9 - 15) (%)] x [Maximum Heat Rate (MMBtu/hr)]
Hourly Emissions (lb/hr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] / [Molecular Weight S (lb/lb-mole) x [Pilot and Purge Fuel Consumption (scf/hr)] / [7000 (grains/lb)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]
Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Heat Rate (MMBtu/hr)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Heat Rate (MMBtu/hr)] / [Fuel Heat Content (MMBtu/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (MMBtu/hr)] x [2.20462 (lb/kg)]

Maximum Heat Rate, LHV (MMBtu/hr) =	269.3	(9)
Maximum Heat Rate, HHV (MMBtu/hr) =	296.2	(9)
Fuel Heat Content (Btu/scf) =	1,024.6	(10)
F_d (dscf/MMBtu) =	8,710	(11)
NO_X Conversion Factor (lb/scf-ppm) =	1.194E-07	(11)
CO Conversion Factor (lb/scf-ppm) =	7.268E-08	(11)
VOC Conversion Factor (lb/scf-ppm) =	4.153E-08	(11)
Conversion of SO_2 to H_2SO_4 (percent) =	44	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	1	(12)
Hours of Operation (hr/yr) =	876	(12)

Notes:

(1) Emission estimates provided by manufacturer.

(2) Provided by KBJ.

(3) Assume conversion of SO_2 to SO_3 of 44 percent by volume as provided by KBJ.

(4) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 1.4, Table 1.4-3. Emission Factors for Speciated Organic Compounds from Natural Gas Combustion, July 1998.

(8) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998.

(9) Maximum heat rate in LHV is supplied by KBJ. HHV is assumed to be 10% higher.

(10) Pipeline feed gas fuel heat content provided by JCLNG.

(11) See EPA Method 19 Tables 19-1 - Conversion Factors for Concentration, and 19-2 - F Factors for Various Fuels. Conversion factor for CO and VOC calculated used identical basis.

(12) Number of units and hours of operation provided by KBJ.

Table 7. Diesel Firewater Pump Engine Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit (a) (lb/hr)	Annual Emissions (b) (tons/yr)
Criteria Pollutants					
NO_X	5.31	lb/hr	(1)	5.31	1.59
CO	2.68	lb/hr	(1)	2.68	0.80
SO_2	0.0015	weight percent S	(2)	7.1E-03	2.1E-03
VOC	0.15	lb/hr	(1)	0.15	0.05
$PM/PM_{10}/PM_{2.5}$	0.30	lb/hr	(1)	0.30	9.0E-02
H_2SO_4	---		(3)	5.4E-04	1.6E-04
NH_3	---			---	---
Lead	1.40E-05	lb/MMBtu	(4)	6.9E-05	2.1E-05
CO_2e	---		(5)	802	241
CO_2	73.96	kg/MMBtu	(6)	799	240
CH_4	0.003	kg/MMBtu	(6)	3.2E-02	9.7E-03
N_2O	0.0006	kg/MMBtu	(6)	6.5E-03	1.9E-03
Hazardous Air Pollutants					
Acetaldehyde	2.52E-05	lb/MMBtu	(7)	1.2E-04	3.7E-05
Acrolein	7.88E-06	lb/MMBtu	(7)	3.9E-05	1.2E-05
Benzene	7.76E-04	lb/MMBtu	(7)	3.8E-03	1.1E-03
Formaldehyde	7.89E-05	lb/MMBtu	(7)	3.9E-04	1.2E-04
Naphthalene	1.30E-04	lb/MMBtu	(8)	6.4E-04	1.9E-04
Polycyclic Organic Matter	8.20E-05	lb/MMBtu	(8)	4.0E-04	1.2E-04
Toluene	2.81E-04	lb/MMBtu	(7)	1.4E-03	4.1E-04
Xylenes	1.93E-04	lb/MMBtu	(7)	9.5E-04	2.8E-04
Arsenic	1.1E-05	lb/MMBtu	(9)	5.4E-05	1.6E-05
Beryllium	3.1E-07	lb/MMBtu	(9)	1.5E-06	4.6E-07
Cadmium	4.8E-06	lb/MMBtu	(9)	2.4E-05	7.1E-06
Chromium	1.1E-05	lb/MMBtu	(9)	5.4E-05	1.6E-05
Manganese	7.9E-04	lb/MMBtu	(9)	3.9E-03	1.2E-03
Mercury	1.2E-06	lb/MMBtu	(9)	5.9E-06	1.8E-06
Nickel	4.6E-06	lb/MMBtu	(9)	2.3E-05	6.8E-06
Selenium	2.5E-05	lb/MMBtu	(9)	1.2E-04	3.7E-05
Total HAPs				**0.01**	**3.6E-03**
Maximum Individual HAP					**1.2E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [S (wt%) / 100] x [Fuel Density (lb/gal)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr) / [Fuel Heat Content (Btu/gal)] x [SO_2 Molecular Weight (lb/lb-mol)] / [S Molecular Weight (lb/lb-mol)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] x

[2.20462 (lb/kg)] / [1,000,000 (Btu/MMBtu)]

Maximum Rate (hp) =	700	(10)
Fuel Density (lb/gal) =	7.1	(11)
Fuel Heat Content (Btu/gal) =	140,005	(11)
Engine Heat Rate (Btu/hp-hr) =	7,000	(12)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	3	(13)
Hours of Operation (hr/yr) =	200	(13)

Notes:

(1) Emissions performance data provided by manufacturer at rated speed potential site variation (1750 rpm). Maximum value at 50% of load or greater. Conservative to use lower load (highest) emission rates for CO, VOC, and PM.

(2) Engine is required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.

(3) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(4) AP-42, Chapter 3.1, Table 3.1-2a. Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines, April 2000. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 3.4, Table 3.4-3. Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(8) AP-42, Chapter 3.4, Table 3.4-4. PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(9) AP-42, Chapter 3.1, Table 3.1-5. Emission Factors for Metallic Hazardous Air Pollutants from Distillate Oil-Fired Stationary Gas Turbines, April 2000.

(10) Maximum engine rate supplied by KBJ.

(11) Site specific fuel heat content and fuel density provided by KBJ.

(12) AP-42, Chapter 3.3, Table 3.1-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, footnote a, October 1996.

(13) Number of units and hours of operation provided by KBJ.

Table 8. Backup Diesel Generator Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	16.63	lb/hr	(1)	16.63	3.33
CO	1.42	lb/hr	(1)	1.42	0.28
SO_2	0.0015	weight percent S	(2)	1.2E-02	2.5E-03
VOC	0.20	lb/hr	(1)	0.20	0.04
$PM/PM_{10}/PM_{2.5}$	0.19	lb/hr	(1)	0.19	0.04
H_2SO_4	---		(3)	9.4E-04	1.9E-04
NH_3	---			---	---
Lead	1.40E-05	lb/MMBtu	(4)	1.2E-04	2.4E-05
CO_2e	---		(5)	1,390	278
CO_2	73.96	kg/MMBtu	(6)	1,386	277
CH_4	0.003	kg/MMBtu	(6)	0.06	1.1E-02
N_2O	0.0006	kg/MMBtu	(6)	1.1E-02	2.2E-03
Hazardous Air Pollutants					
Acetaldehyde	2.52E-05	lb/MMBtu	(7)	2.1E-04	4.3E-05
Acrolein	7.88E-06	lb/MMBtu	(7)	6.7E-05	1.3E-05
Benzene	7.76E-04	lb/MMBtu	(7)	6.6E-03	1.3E-03
Formaldehyde	7.89E-05	lb/MMBtu	(7)	6.7E-04	1.3E-04
Naphthalene	1.30E-04	lb/MMBtu	(8)	1.1E-03	2.2E-04
Polycyclic Organic Matter	8.20E-05	lb/MMBtu	(8)	7.0E-04	1.4E-04
Toluene	2.81E-04	lb/MMBtu	(7)	2.4E-03	4.8E-04
Xylenes	1.93E-04	lb/MMBtu	(7)	1.6E-03	3.3E-04
Arsenic	1.1E-05	lb/MMBtu	(9)	9.3E-05	1.9E-05
Beryllium	3.1E-07	lb/MMBtu	(9)	2.6E-06	5.3E-07
Cadmium	4.8E-06	lb/MMBtu	(9)	4.1E-05	8.2E-06
Chromium	1.1E-05	lb/MMBtu	(9)	9.3E-05	1.9E-05
Manganese	7.9E-04	lb/MMBtu	(9)	6.7E-03	1.3E-03
Mercury	1.2E-06	lb/MMBtu	(9)	1.0E-05	2.0E-06
Nickel	4.6E-06	lb/MMBtu	(9)	3.9E-05	7.8E-06
Selenium	2.5E-05	lb/MMBtu	(9)	2.1E-04	4.2E-05
Total HAPs				**0.02**	**4.1E-03**
Maximum Individual HAP					**1.3E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [S (wt%) / 100] x [Fuel Density (lb/gal)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr) / [Fuel Heat Content (Btu/gal)] x [SO_2 Molecular Weight (lb/lb-mol)] / [S Molecular Weight (lb/lb-mol)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] x

[2.20462 (lb/kg)] / [1,000,000 (Btu/MMBtu)]

Maximum Rate (kW) =	800	(10)
Maximum Rate (hp) =	1,214	(10)
Fuel Density (lb/gal) =	7.1	(11)
Fuel Heat Content (Btu/gal) =	140,005	(11)
Engine Heat Rate (Btu/hp-hr) =	7,000	(12)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	2	(13)
Hours of Operation (hr/yr) =	200	(13)

Notes:

(1) Emissions performance data provided by manufacturer at rated speed potential site variation (1800 rpm). Maximum value at 50% of load or greater. Conservative to use lower load (highest) emission rates for CO, VOC, and PM.

(2) Engine is required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.

(3) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(4) AP-42, Chapter 3.1, Table 3.1-2a. Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines, April 2000. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 3.4, Table 3.4-3. Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(8) AP-42, Chapter 3.4, Table 3.4-4. PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(9) AP-42, Chapter 3.1, Table 3.1-5. Emission Factors for Metallic Hazardous Air Pollutants from Distillate Oil-Fired Stationary Gas Turbines, April 2000.

(10) Maximum engine rate supplied by KBJ.

(11) Site specific fuel heat content and fuel density provided by KBJ.

(12) AP-42, Chapter 3.3, Table 3.1-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, footnote a, October 1996.

(13) Number of units and hours of operation provided by KBJ.

Table 9. Black Start Diesel Generator Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	7.43	lb/hr	(1)	7.43	1.49
CO	1.04	lb/hr	(1)	1.04	0.21
SO_2	0.0015	weight percent S	(2)	4.4E-02	8.8E-03
VOC	0.45	lb/hr	(1)	0.45	0.09
$PM/PM_{10}/PM_{2.5}$	0.23	lb/hr	(1)	0.23	0.05
H_2SO_4	---		(3)	3.4E-03	6.8E-04
NH_3	---			---	---
Lead	1.40E-05	lb/MMBtu	(4)	4.3E-04	8.6E-05
CO_2e	---		(5)	5,012	1,002
CO_2	73.96	kg/MMBtu	(6)	4,995	999
CH_4	0.003	kg/MMBtu	(6)	0.20	4.1E-02
N_2O	0.0006	kg/MMBtu	(6)	4.1E-02	8.1E-03
Hazardous Air Pollutants					
Acetaldehyde	2.52E-05	lb/MMBtu	(7)	7.7E-04	1.5E-04
Acrolein	7.88E-06	lb/MMBtu	(7)	2.4E-04	4.8E-05
Benzene	7.76E-04	lb/MMBtu	(7)	2.4E-02	4.8E-03
Formaldehyde	7.89E-05	lb/MMBtu	(7)	2.4E-03	4.8E-04
Naphthalene	1.30E-04	lb/MMBtu	(8)	4.0E-03	8.0E-04
Polycyclic Organic Matter	8.20E-05	lb/MMBtu	(8)	2.5E-03	5.0E-04
Toluene	2.81E-04	lb/MMBtu	(7)	8.6E-03	1.7E-03
Xylenes	1.93E-04	lb/MMBtu	(7)	5.9E-03	1.2E-03
Arsenic	1.1E-05	lb/MMBtu	(9)	3.4E-04	6.7E-05
Beryllium	3.1E-07	lb/MMBtu	(9)	9.5E-06	1.9E-06
Cadmium	4.8E-06	lb/MMBtu	(9)	1.5E-04	2.9E-05
Chromium	1.1E-05	lb/MMBtu	(9)	3.4E-04	6.7E-05
Manganese	7.9E-04	lb/MMBtu	(9)	2.4E-02	4.8E-03
Mercury	1.2E-06	lb/MMBtu	(9)	3.7E-05	7.4E-06
Nickel	4.6E-06	lb/MMBtu	(9)	1.4E-04	2.8E-05
Selenium	2.5E-05	lb/MMBtu	(9)	7.7E-04	1.5E-04
Total HAPs				**0.07**	**1.5E-02**
Maximum Individual HAP					**4.8E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [S (wt%) / 100] x [Fuel Density (lb/gal)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr) / [Fuel Heat Content (Btu/gal)] x [SO_2 Molecular Weight (lb/lb-mol)] / [S Molecular Weight (lb/lb-mol)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] x

[2.20462 (lb/kg)] / [1,000,000 (Btu/MMBtu)]

Maximum Rate (hp) =	4,376	(10)
Fuel Density (lb/gal) =	7.1	(11)
Fuel Heat Content (Btu/gal) =	140,005	(11)
Engine Heat Rate (Btu/hp-hr) =	7,000	(12)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	2	(13)
Hours of Operation (hr/yr) =	200	(13)

Notes:

(1) Emissions performance data provided by manufacturer at rated speed potential site variation (1800 rpm). Maximum value at 50% of load or greater. Conservative to use lower load (highest) emission rates for CO, VOC, and PM.

(2) Engine is required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.

(3) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(4) AP-42, Chapter 3.1, Table 3.1-2a. Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines, April 2000. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 3.4, Table 3.4-3. Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(8) AP-42, Chapter 3.4, Table 3.4-4. PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(9) AP-42, Chapter 3.1, Table 3.1-5. Emission Factors for Metallic Hazardous Air Pollutants from Distillate Oil-Fired Stationary Gas Turbines, April 2000.

(10) Maximum engine rate supplied by KBJ.

(11) Site specific fuel heat content and fuel density provided by KBJ.

(12) AP-42, Chapter 3.3, Table 3.1-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, footnote a, October 1996.

(13) Number of units and hours of operation provided by KBJ.

Table 10. Natural Gas Ground Flare Pilot and Purge Gas Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	0.068	lb/MMBtu	(1)	0.14	0.64
CO	0.31	lb/MMBtu	(2)	0.66	2.90
SO_2	0.01	grains S/scf	(3),(4)	6.7E-03	2.9E-02
VOC	0.66	lb/MMBtu	(2)	1.41	6.16
$PM/PM_{10}/PM_{2.5}$	40	μg/L	(1)	6.5E-02	0.28
H_2SO_4	---		(4)	5.1E-04	2.2E-03
NH_3	---			---	---
Lead	0.0005	lb/MMscf	(5)	1.2E-06	5.4E-06
CO_2e	---		(6)	329	1,439.47
CO_2	53.06	kg/MMBtu	(7)	249.43	1,092.50
CH_4	0.001	kg/MMBtu	(7)	0.80	3.52
N_2O	0.0001	kg/MMBtu	(7)	0.20	0.87
Hazardous Air Pollutants					
Acetaldehyde	4.30E-02	lb/MMscf	(8)	1.1E-04	4.6E-04
Acrolein	1.00E-02	lb/MMscf	(8)	2.5E-05	1.1E-04
Benzene	1.59E-01	lb/MMscf	(8)	3.9E-04	1.7E-03
Ethylbenzene	1.44E+00	lb/MMscf	(8)	3.5E-03	1.6E-02
Formaldehyde	1.17E+00	lb/MMscf	(8)	2.9E-03	1.3E-02
N-Hexane	2.90E-02	lb/MMscf	(8)	7.1E-05	3.1E-04
Toluene	5.80E-02	lb/MMscf	(8)	1.4E-04	6.2E-04
Xylenes	2.90E-02	lb/MMscf	(8)	7.1E-05	3.1E-04
Polycyclic Organic Matter	1.40E-02	lb/MMscf	(8)	3.4E-05	1.5E-04
Arsenic	2.0E-04	lb/MMscf	(5)	4.9E-07	2.2E-06
Beryllium	1.2E-05	lb/MMscf	(5)	2.9E-08	1.3E-07
Cadmium	1.1E-03	lb/MMscf	(5)	2.7E-06	1.2E-05
Chromium	1.4E-03	lb/MMscf	(5)	3.4E-06	1.5E-05
Cobalt	8.4E-05	lb/MMscf	(5)	2.1E-07	9.0E-07
Manganese	3.8E-04	lb/MMscf	(5)	9.3E-07	4.1E-06
Mercury	2.6E-04	lb/MMscf	(5)	6.4E-07	2.8E-06
Nickel	2.1E-03	lb/MMscf	(5)	5.2E-06	2.3E-05
Selenium	2.4E-05	lb/MMscf	(5)	5.9E-08	2.6E-07
Total HAPs				**7.27E-03**	**3.2E-02**
Maximum Individual HAP					**1.6E-02**

Calculations:
(a) Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]
Hourly Emissions (lb/hr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] /

[Molecular Weight S (lb/lb-mole) x [Pilot and Purge Fuel Consumption (scf/hr)] / [7000 (grains/lb)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [Emission Factor (μg/L)] / [1,000,000 (μg/g)] x [0.00220462 (lb/g)] x [28.317 (L/ft^3)] x [10.6 (ft^3 exhaust/ft^3 fuel)] x [Pilot and Purge Fuel Consumption (scf/hr)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Pilot and Purge Fuel Consumption (scf/hr) / [1,000,000 (scf/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [2.20462 (lb/kg)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

No. of Unit =	28	
Total Pilot Fuel Consumption (MMBtu/hr) =	1.82	(9)
Total Purge Gas Consumption (scf/hr) =	360	(9)
Fuel Heat Content (Btu/scf) =	868	(10)
Pilot Fuel Consumption (scf/hr) =	2,098	
Purge Gas Consumption (MMBtu/hr) =	0.31	
Conversion of SO_2 to H_2SO_4 (percent) =	5	(4)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] / [2,000 lb/ton]

Hours of Operation (hr/yr) =	8,760	(11)

Notes:

(1) AP-42, Chapter 13.5, Table 13.5-1. THC and Soot Emissions Factors for Flare Operations, December 2016. PM emission factor is for lightly smoking flare.

(2) AP-42, Chapter 13.5, Table 13.5-2. VOC and CO Emissions Factors for Flare Operations, December 2016.

(3) Sulfur content of 0.01 grains per scf provided by KBJ.

(4) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(5) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(6) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(7) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(8) Ventura County Air Pollution Control District.

(9) Manufacturer specifications provided by KBJ. Ground flare consists of a warm and cold flare (combined multi-point ground flare).

(10) Site specific fuel heat content provided by KBJ.

(11) Hours of operation provided by KBJ.

Table 11. Natural Gas Marine Flare Pilot and Purge Gas Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	0.068	lb/MMBtu	(1)	0.05	0.22
CO	0.31	lb/MMBtu	(2)	0.23	1.01
SO_2	0.01	grains S/scf	(3),(4)	2.3E-03	1.0E-02
VOC	0.66	lb/MMBtu	(2)	0.49	2.14
$PM/PM_{10}/PM_{2.5}$	40	μg/L	(1)	2.3E-02	0.10
H_2SO_4	---		(4)	1.8E-04	7.8E-04
NH_3	---			---	---
Lead	0.0005	lb/MMscf	(5)	4.3E-07	1.9E-06
CO_2e	---		(6)	168	737.66
CO_2	53.06	kg/MMBtu	(7)	86.72	379.83
CH_4	0.001	kg/MMBtu	(7)	0.90	3.96
N_2O	0.0001	kg/MMBtu	(7)	0.20	0.87
Hazardous Air Pollutants					
Acetaldehyde	4.30E-02	lb/MMscf	(8)	3.7E-05	1.6E-04
Acrolein	1.00E-02	lb/MMscf	(8)	8.5E-06	3.7E-05
Benzene	1.59E-01	lb/MMscf	(8)	1.4E-04	6.0E-04
Ethylbenzene	1.44E+00	lb/MMscf	(8)	1.2E-03	5.4E-03
Formaldehyde	1.17E+00	lb/MMscf	(8)	1.0E-03	4.4E-03
N-Hexane	2.90E-02	lb/MMscf	(8)	2.5E-05	1.1E-04
Toluene	5.80E-02	lb/MMscf	(8)	5.0E-05	2.2E-04
Xylenes	2.90E-02	lb/MMscf	(8)	2.5E-05	1.1E-04
Polycyclic Organic Matter	1.40E-02	lb/MMscf	(8)	1.2E-05	5.2E-05
Arsenic	2.0E-04	lb/MMscf	(5)	1.7E-07	7.5E-07
Beryllium	1.2E-05	lb/MMscf	(5)	1.0E-08	4.5E-08
Cadmium	1.1E-03	lb/MMscf	(5)	9.4E-07	4.1E-06
Chromium	1.4E-03	lb/MMscf	(5)	1.2E-06	5.2E-06
Cobalt	8.4E-05	lb/MMscf	(5)	7.2E-08	3.1E-07
Manganese	3.8E-04	lb/MMscf	(5)	3.2E-07	1.4E-06
Mercury	2.6E-04	lb/MMscf	(5)	2.2E-07	9.7E-07
Nickel	2.1E-03	lb/MMscf	(5)	1.8E-06	7.9E-06
Selenium	2.4E-05	lb/MMscf	(5)	2.1E-08	9.0E-08
Total HAPs				**2.53E-03**	**1.1E-02**
Maximum Individual HAP					**5.4E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] / [Molecular Weight S (lb/lb-mole) x [Pilot and Purge Fuel Consumption (scf/hr)] / [7000 (grains/lb)] x

[1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [Emission Factor (μg/L)] / [1,000,000 (μg/g)] x [0.00220462 (lb/g)] x [28.317 (L/ft^3)] x [10.6 (ft^3 exhaust/ft^3 fuel)] x [Pilot and Purge Fuel Consumption (scf/hr)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Pilot and Purge Fuel Consumption (scf/hr) / [1,000,000 (scf/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [2.20462 (lb/kg)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

No. of Unit =	6	
Total Pilot Fuel Consumption (MMBtu/hr) =	0.39	(9)
Total Purge Gas Consumption (scf/hr) =	405	(9)
Fuel Heat Content (Btu/scf) =	868	(10)
Total Pilot Fuel Consumption (scf/hr) =	450	
Total Purge Gas Consumption (MMBtu/hr) =	0.35	
Conversion of SO_2 to H_2SO_4 (percent) =	5	(4)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] / [2,000 lb/ton]

Hours of Operation (hr/yr) =	8,760	(11)

Notes:

(1) AP-42, Chapter 13.5, Table 13.5-1. THC and Soot Emissions Factors for Flare Operations, December 2016. PM emission factor is for lightly smoking flare.

(2) AP-42, Chapter 13.5, Table 13.5-2. VOC and CO Emissions Factors for Flare Operations, December 2016.

(3) Sulfur content of 0.01 grains per scf provided by KBJ.

(4) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(5) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(6) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(7) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(8) Ventura County Air Pollution Control District.

(9) Manufacturer specifications provided by KBJ. Flare is a marine flare (enclosed ground flare).

(10) Site specific fuel heat content provided by KBJ.

(11) Hours of operation provided by KBJ.

Table 12. LNG Ship Gas Up Emissions (from Marine Flare)
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions[a] (lb/hr)	Annual Emissions [b] (tons/yr)
Criteria Pollutants					
NO_X	0.068	lb/MMBtu	(1)	62.31	2.09
CO	0.31	lb/MMBtu	(2)	284.07	9.53
SO_2	0.01	grains S/scf	(3),(4)	4.89	0.16
VOC	0.57	lb/MMBtu	(2)	522.31	17.53
$PM/PM_{10}/PM_{2.5}$	40	µg/L	(1)	33.43	1.12
H_2SO_4	---		(4)	0.37	0.01
NH_3	---			---	
Lead	0.0005	lb/MMscf	(5)	6.3E-04	0.00002
CO_2e	---		(6)	129,644	4,351
CO_2	53.06	kg/MMBtu	(7)	129,510	4,346
CH_4	0.001	kg/MMBtu	(7)	2.4	0.08
N_2O	0.0001	kg/MMBtu	(7)	0.2	0.01
Hazardous Air Pollutants					
Acetaldehyde	4.30E-02	lb/MMscf	(8)	3.6E-02	5.5E-04
Acrolein	1.00E-02	lb/MMscf	(8)	8.4E-03	1.3E-04
Benzene	1.59E-01	lb/MMscf	(8)	1.3E-01	2.0E-03
Ethylbenzene	1.44E+00	lb/MMscf	(8)	1.2E+00	1.8E-02
Formaldehyde	1.17E+00	lb/MMscf	(8)	9.9E-01	1.5E-02
N-Hexane	2.90E-02	lb/MMscf	(8)	2.4E-02	3.7E-04
Toluene	5.80E-02	lb/MMscf	(8)	4.9E-02	7.4E-04
Xylenes	2.90E-02	lb/MMscf	(8)	2.4E-02	3.7E-04
Polycyclic Organic Matter	1.40E-02	lb/MMscf	(8)	1.2E-02	1.8E-04
Arsenic	2.0E-04	lb/MMscf	(5)	1.7E-04	2.5E-06
Beryllium	1.2E-05	lb/MMscf	(5)	1.0E-05	1.5E-07
Cadmium	1.1E-03	lb/MMscf	(5)	9.3E-04	1.4E-05
Chromium	1.4E-03	lb/MMscf	(5)	1.2E-03	1.8E-05
Cobalt	8.4E-05	lb/MMscf	(5)	7.1E-05	1.1E-06
Manganese	3.8E-04	lb/MMscf	(5)	3.2E-04	4.8E-06
Mercury	2.6E-04	lb/MMscf	(5)	2.2E-04	3.3E-06
Nickel	2.1E-03	lb/MMscf	(5)	1.8E-03	2.7E-05
Selenium	2.4E-05	lb/MMscf	(5)	2.0E-05	3.0E-07
Total HAPs					**3.8E-02**
Maximum Individual HAP					**1.8E-02**

Flaring of Excess Boil off gas generated during gas up of the LNG carrier each time it returns to LNG transportation service following a drydock overhaul period (when the entire cargo system needs to be fully warmed up and gas freed) is expected to occur at the JCLNG terminal for up to 4 ships per year. The operational assumption is 50% of the gas up volume would be recovered and 50% flared. A worst-case scenario would be flaring of 100% of the gas. Inert gas and methane are routed to the marine flare for combustion.

Calculations:

(a) Hourly Emissions (lb/hr) = [Annual Emissions (tons/yr)] x [2000 lbs/ton)] / [Number of gas up events/year] / [Duration of flaring for event (hours/event)]

Average tanker size hull gas relief (LNG tonnes/ship) =	355.7	(9)
Average flared gas -Turbulent mixing (MMBtu/ship, LHV) =	22,264	(9)
Duration of turbulent event flaring (hours/event) =	30	(9)
Number of turbulent events per year (ships/year) =	1	(9)
Average flared gas - Laminar mixing (MMBtu/ship, LHV) =	19,619	(9)

Duration of non-turbulent event flaring (hours/event) =	18.52	(9)
Number of non-turbulent events per year (ships/year) =	2	(9)
Average flared gas per year (MMBtu/year) =	61,502	
Average duration of event flaring (hours/event) =	22.37	(9)
Fuel Heat Content (Btu/scf) =	877	(9)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(4)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Flared gas per year (MMBtu/yr)] x [Emission factor (lb/MMBtu)] / [2,000 lb/ton]

Annual Emissions (ton/yr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] / [Molecular Weight S (lb/lb-mole) x [Flared gas (MMBtu/yr)/ Flared Gas HHV (Btu/scf)* 1,000,000 Btu/MMBtu] / [7000 (grains/lb)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Annual Emissions (ton/yr) = [Emission Factor (µg/L)] / [1,000,000 (µg/g)] x [0.00220462 (lb/g)] x [28.317 (L/ft ^{3})] x [10.6 (ft ^{3} exhaust/ft ^{3} fuel)] x [Flared gas (MMBtu/yr) / Flared Gas HHV (Btu/scf) * 1,000,000 Btu/MMBtu]

Annual Emissions (ton/yr) = [SO_2 Annual Emissions (ton/yr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Annual Emissions (tons/yr) = [Emission Factor (lb/MMscf)] x [Flared Gas (MMBtu/yr) / [Flared gas HHV (Btu/scf)] / [2,000 lb/ton]

Annual Emissions (ton/yr) = [Emission Factor (kg/MMBtu)] x [Flared Gas (MMBtu/yr)] x [2.20462 (lb/kg)] / [2,000 (lb/ton)]

Notes:

(1) AP-42, Chapter 13.5, Table 13.5-1. THC and Soot Emissions Factors for Flare Operations, October 1996. PM emission factor is for lightly smoking flare.

(2) AP-42, Chapter 13.5, Table 13.5-2. VOC and CO Emissions Factors for Flare Operations, October 1996.

(3) Sulfur content of 0.01 grains per scf provided by KBJ.

(4) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(5) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(6) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(7) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(8) Ventura County Air Pollution Control District.

(9) Information provided by JCLNG for gas up/cool down procedures. Ship vapor (14% CO_2, 84% N_2, 2% O_2) is displaced with LNG. When hydrocarbon is detected it is sent to the flare. When the gas contains less than 50 ppm CO_2 it is sent to be used as fuel gas. Two scenarios were supplied, with and without turbulence for the gas up procedure. The scenario with the greater emissions (turbulence) is included. During the cool down procedure all gas is sent to the fuel gas system.

Table 13. Fugitive Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Annual Emissions (tons/yr)			
	LNG Tank	Equipment Leaks	Total	
Criteria Pollutants				
NO_X	---	---	---	
CO	---	---	---	
SO_2	---	---	---	
VOC	0.114	7.87	7.98	(1)
$PM/PM_{10}/PM_{2.5}$	---	---	---	
H_2SO_4	---	---	---	
NH_3	---	---	---	
Lead	---	---	---	
CO_2e			13,116	(2)
CO_2	9.21E-04	1.64	1.64	(3)
CH_4	23.06	501.52	524.58	(1)
N_2O	---	---	---	
Hazardous Air Pollutants				
N-Hexane [(a)]	2.5E-02	1.75	1.77	(4)
Total HAPs			**1.77**	
Maximum Individual HAP			**1.77**	

Calculations:
(a) Annual Emissions (tons/yr) = [VOC Hourly Emissions (tons/yr)] x [N-Hexane/CO_2 Content (mass %)] / [VOC Content (mass %)]

N-Hexane Content (mass %) =	0.31	(4)
VOC Content (mass %) =	1.38	(4)

Notes:
(1) The tank size is the same as in the original permit application. Therefore, the tons/yr emissions for the tanks are from original permit application. See Table 17 for the Equipment Leak Emission calculations.
(2) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25
(3) Carbon dioxide emissions are based on a gas composition of 0.36 mol percent VOC and 0.11 mol percent CO_2. See KBJ fuel gas composition provided in Zeeco flare quote.
(4) N-Hexane emissions are based on a fuel gas composition provided by KBJ.

Table 14. Equipment Leaks Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Components	Phase	TOC/VOC Emission Factor (lb/hr/component)		Actual Component Count		Hourly CH_4 Emissions [(a),(b)] (lb/hr)	Annual CH_4 Emissions [(d)] (tons/yr)	Hourly CO_2 Emissions [(a),(b)] (lb/hr)	Annual CO_2 Emissions [(d)] (tons/yr)	Hourly VOC Emissions [(a),(c)] (lb/hr)	Annual VOC Emissions [(d)] (tons/yr)
Valves	Gas/Vapor	9.9E-03	(1)	9277	(3)	89.52	392.12	0.29	1.28	1.40	6.15
Pressure Relief Valves	Gas/Vapor	1.9E-02	(1)	287	(3)	5.42	23.72	1.8E-02	7.7E-02	8.5E-02	0.37
Pump Seals	Gas/Vapor	5.3E-03	(1)	47	(3)	0.24	1.06	7.9E-04	3.5E-03	3.8E-03	1.7E-02
Flanges	Gas/Vapor	8.6E-04	(1)	559	(3)	0.47	2.05	1.5E-03	6.7E-03	7.3E-03	3.2E-02
Connectors	Gas/Vapor	4.4E-04	(1)	8752	(3)	3.75	16.44	1.2E-02	5.4E-02	5.9E-02	0.26
Compressor Seals	Gas/Vapor	1.9E-02	(1)	18	(3)	0.34	1.49	1.1E-03	4.9E-03	5.3E-03	2.3E-02
Sampling Connections	All	3.3E-02	(2)	7	(3)	14.76	64.65	4.8E-02	0.21	0.23	1.01
Total							**501.52**		**1.64**		**7.87**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor (lb TOC/hr/component)] x [Count (component)] x [CH_4/CO_2//VOC Content (Mass %)] / [TOC Content (Mass %)]

(b) Hourly Emissions (lb/hr) = [Emission Factor (lb VOC/hr/component)] x [Count (component)] x [CH_4/CO_2 Content (Mass %)] / [VOC Content (Mass%)]

(c) Hourly Emissions (lb/hr) = [Emission Factor (lb VOC/hr/component)] x [Count (component)]

CH_4 Content (mass %) =	88.3	(4)
CO_2 Content (mass %) =	0.29	(4)
VOC Content (mass %) =	1.38	(4)
TOC Content (mass %) =	90.77	(4)

(d) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] / [2,000 lb/ton]

Hours of Operation (hr/yr) =	8,760	(3)

Notes:

(1) EPA-453/R-95-017 Protocol for Equipment Leak Emission Estimates, EPA, November 1995. Table 2-4. Oil and Gas Production Operations Average Emission Factors (page 2-15), total organic compounds emission factors (TOC).

(2) EPA-453/R-95-017 Protocol for Equipment Leak Emission Estimates, EPA, November 1995. Table 2-2. Refinery Average Emission Factors (page 2-13), non-methane organic compounds emission factor (VOC).

(3) Component counts and hours supplied by KBJ.

(4) Assumed methane and CO_2 content of fuel gas provided in Table 16.

Table 15: GE Natural Gas Turbines Parameters
Black & Veatch Emission Estimates
Jordan Cove, Coos Bay, Oregon

COMBUSTION TURBINE	
CTG Manufacturer	GE
CTG Model	LM6000PF+
CTG Combustor Type	DLN
CTG Fuel Type	Natural Gas
CTG Inlet Air Cooling Type	Chiller
Duct Burner Fuel Type	Natural Gas
CTG Fuel HHV, Btu/lb	21,500
Post Combustion NO_X Emissions Control	SCR
Post Combustion CO Emissions Control	CO Catalyst

	Design Scenario - Steady State Emissions																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Combustion Turbine Parameters																		
Ambient Dry Bulb Temperature, ° F	42	42	59	59	59	59	59	59	59	59	90	90	90	90	90	90	90	90
CTG Load Level, percent of base load	*100*	*100*	*50*	*75*	*100*	*100*	*50*	*75*	*100*	*100*	*50*	*75*	*100*	*100*	*50*	*75*	*100*	*100*
Gross CTG Output, kW	55,607	55,607	25,794	38,692	51,589	51,589	27,581	41,371	55,162	55,162	22,189	33,283	44,378	44,378	24,672	37,008	49,343	49,343
CTG Heat Input, MBtu/h (HHV)	504.4	504.4	327.3	395.7	476.6	476.6	336.9	413.6	500.2	500.2	301.2	359.1	427.3	427.3	319.4	378.1	461.4	461.4
CTG Inlet Air Cooling Status, On/Off	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
HRSG Duct Firing	Unfired	Fired	Unfired	Unfired	Unfired	Fired	Unfired	Unfired	Unfired	Fired	Unfired	Unfired	Unfired	Unfired	Unfired	Unfired	Unfired	Fired
Duct Burner Heat Input, MBtu/h (HHV)	0	19.7	0	0	0	8.7	0	0	0	20.9	0	0	0	0	0	0	0	3.1
Stack Exhaust Analysis (Volume Basis - Wet)																		
Ar, % vol.			0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.93	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92
CO_2, % vol.			3.25	3.25	3.38	3.44	3.2	3.26	3.39	3.53	3.29	3.27	3.36	3.36	3.26	3.19	3.36	3.38
H_2O, % vol.			7.83	7.82	8.07	8.19	7.33	7.44	7.7	7.96	10.41	10.37	10.55	10.55	9.12	9	9.33	9.37
N_2, % vol.			74.47	74.47	74.38	74.33	74.82	74.78	74.68	74.58	72.48	72.5	72.43	72.43	73.46	73.51	73.38	73.37
O_2, % vol.			13.52	13.52	13.24	13.11	13.71	13.58	13.3	13	12.91	12.96	12.75	12.75	13.24	13.38	13.01	12.96
SO_2, (after SO_2 oxidation), % vol.			0.00005	0.00005	0.00005	0.00004	0.00004	0.00005	0.00005	0.00004	0.00005	0.00005	0.00005	0.00005	0.00005	0.00004	0.00005	0.00004
SO_3, (after SO_2 oxidation), % vol.			0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002
Stack Exit Temperature, ° F	242.8	242.8	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
Stack Flow, lb/hr			754,560	912,844	1,057,879	1,058,281	790,163	952,982	1,108,096	1,109,067	680,835	816,908	944,053	944,053	732,348	884,766	1,024,149	1,024,292
Stack Flow, scfm			168,023	203,270	235,566	235,832	175,556	211,890	246,379	246,780	153,082	183,677	212,265	212,265	163,810	197,902	229,250	229,282
Stack Flow, acfm			284,357	344,007	398,840	399,169	297,247	358,656	417,219	417,770	259,184	310,849	359,387	359,387	277,329	335,047	388,001	388,226
Stack Exit Velocity, ft/s	71	71	60	73	85	85	63	76	89	89	55	66	76	76	59	71	82	82
Total Stack Emission Rates (Controlled) [1]																		
NO_X, ppmvd (dry, 15% O_2)	2.0	2.0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO, ppmvd (dry, 15% O2)	4.0	4.0	3.8	3.8	3.8	3.9	3.8	3.8	3.8	4	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.9
SO_2, ppmvd (dry, 15% O_2) [2]			0.46	0.46	0.46	0.42	0.46	0.46	0.46	0.42	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.42
VOC, ppmvd (dry, 15% O_2)	2.1	2.5	2.1	2.1	2.1	2.3	2.1	2.1	2.1	2.5	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2
NO_X, lb/hr as NO_2	3.7	3.8	2.4	2.9	3.5	3.5	2.5	3	3.6	3.8	2.2	2.6	3.1	3.1	2.3	2.8	3.4	3.4
CO, lb/hr	4.4	4.6	2.8	3.4	4.1	4.2	2.9	3.5	4.3	4.6	2.6	3.1	3.6	3.6	2.7	3.2	3.9	4
SO_2, lb/hr [2]	0.9	0.9	0.77	0.93	1.12	1.03	0.79	0.97	1.18	1.1	0.71	0.85	1.01	1.01	0.75	0.89	1.09	0.98
VOC, lb/hr as CH_4	1.3	1.7	0.9	1.1	1.3	1.4	0.9	1.1	1.3	1.7	0.8	1	1.1	1.1	0.9	1	1.2	1.3
CO_2, lb/hr	57,958	60,218	38,037	46,009	55,406	56,412	39,161	48,083	58,155	60,585	35,013	41,735	49,658	49,658	37,137	43,960	53,631	53,991
Particulate, lb/hr	4.9	5.4	4	4.1	4.2	4.7	4	4.1	4.3	5	4	4	4.1	4.1	4	4.1	4.2	4.5
PM_{10}, lb/hr	4.9	5.4	4	4.1	4.2	4.7	4	4.1	4.3	5	4	4	4.1	4.1	4	4.1	4.2	4.5
$PM_{2.5}$, lb/hr	4.9	5.4	4	4.1	4.2	4.7	4	4.1	4.3	5	4	4	4.1	4.1	4	4.1	4.2	4.5
Maximum Stack Sulfur Mist [H_2SO_4] (assuming 100% conversion from SO_3 to H_2SO_4), lb/hr	0.48	0.5	0.37	0.45	0.54	0.73	0.38	0.47	0.57	0.78	0.34	0.41	0.48	0.48	0.36	0.43	0.52	0.69
SCR NH_3 slip, lb/hr	3.4	3.5	2.2	2.66	3.21	3.27	2.27	2.78	3.37	3.51	2.03	2.42	2.88	2.88	2.15	2.55	3.11	3.13
NO_X, lb/MBtu (HHV) as NO_2	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073
CO, lb/MBtu (HHV)	0.0087	0.0087	0.0085	0.0085	0.0085	0.0086	0.0085	0.0085	0.0085	0.0088	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0086
SO_2, lb/MBtu (HHV) (incl. duct burner fuel) [2]	0.0017	0.0018	0.0024	0.0024	0.0024	0.0021	0.0024	0.0024	0.0024	0.0021	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0021
VOC, lb/MBtu (HHV) as CH_4	0.0026	0.0032	0.0027	0.0027	0.0027	0.0029	0.0027	0.0027	0.0027	0.0032	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0028
CO_2, lb/MBtu (HHV)	115	115	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116
Particulate, lb/MBtu (HHV) (incl. duct burner fuel)	0.0097	0.0103	0.0122	0.0104	0.0089	0.0096	0.0119	0.01	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097
PM_{10}, lb/MBtu (HHV) (incl. duct burner fuel)	0.0097	0.0103	0.0122	0.0104	0.0089	0.0096	0.0119	0.01	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097
$PM_{2.5}$, lb/MBtu (HHV) (incl. duct burner fuel)	0.0097	0.0103	0.0122	0.0104	0.0089	0.0096	0.0119	0.01	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097

Notes

[1] Emissions include massflow added to match CTG manufacturer estimate and duct burner emissions.

[2] SO_2 emissions include assumptions of 20 percent by volume oxidation rate in CO catalyst and 3 percent by volume oxidation rate in SCR.

Table 16. Turbine Fuel Specifications
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Component	Component Molecular Weight (lb/lb-mol)	Mole % [1]	Mass % [1]	Mixture Molecular Weight (lb/lb-mol)
Hydrogen (H_2)	2.02	0.20	0.02	0.004
Nitrogen (N_2)	28.01	5.16	8.60	1.446
Carbon Dioxide (CO_2)	44.01	0.11	0.29	0.048
Helium (He)	4.00	0.99	0.24	0.040
Oxygen (O_2)	32.00	0.04	0.08	0.013
Methane (CH_4)	16.04	92.48	88.30	14.837
Ethane (C_2H_6)	30.07	0.61	1.09	0.183
Propane (C_3H_8)	44.10	0.20	0.52	0.088
Butane (C_4H_{10})	58.12	0.11	0.38	0.064
Pentane (C_5H_{12})	72.15	0.04	0.17	0.029
Hexanes (C_6H_{14})	86.18	0.06	0.31	0.052
Molecular Weight (lb/lb-mol)				**16.80**
Volume per Mole (scf/lb-mol) [2]				**379.5**
Density (lb/scf)				**0.044**
Lower Heating Value, LHV (Btu/lb) [1]				**19,536**
Lower Heating Value, LHV (Btu/scf)				**865**
Higher Heating Value, HHV (Btu/scf) [3]				**952**

Notes

[1] Fuel gas specification supplied by KBJ.

[2] Calculated at standard conditions (T = 60^{o}F, P = 1 atm).

[3] Higher heating value is assumed to be 10% higher.

Table 17. Flare Supporting Information
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Warm and Cold Flare (Combined Multi-Point Ground Flare [MPGF]) Specifications

<table>
<tr><th>Parameter</th><th>Warm</th><th>Cold</th><th>Combined</th></tr>
<tr><td>Number of Stages</td><td>7</td><td>7</td><td>14</td></tr>
<tr><td>Pilots per stage</td><td colspan="3">2</td></tr>
<tr><td>Number of pilots</td><td>14</td><td>14</td><td>28</td></tr>
<tr><td>Btu/h per pilot</td><td colspan="3">65,000</td></tr>
<tr><td>MMBtu/h from pilots</td><td>0.91</td><td>0.91</td><td>1.82</td></tr>
<tr><td colspan="4"></td></tr>
<tr><td>Stage 1 burners purged</td><td>4</td><td>4</td><td>8</td></tr>
<tr><td>Purge flow per burner (SCFH)</td><td colspan="3">45</td></tr>
<tr><td>Purge flow (SCFH)</td><td>180</td><td>180</td><td>360</td></tr>
<tr><td>Btu/SCF (LHV)</td><td colspan="3">867.5</td></tr>
<tr><td>MMBtu/h from purge</td><td>0.16</td><td>0.16</td><td>0.31</td></tr>
</table>

Fuel Sulfur Content	1	gr/100 scf
Hours of Operation	8,760	hrs/year
Conversion of SO_2 to SO_3	5	%(v)

Marine Flare (Enclosed Ground Flare [EGF]) Specifications

Parameter	Value
Number of Stages	6
Pilots per stage	1
Number of pilots	6
Btu/h per pilot	65,000
MMBtu/h from pilots	0.39
Stage 1 burners purged	9
Purge flow per burner (SCF	45
Purge flow (SCFH)	405
Btu/SCF (LHV)	867.5
MMBtu/h from purge	0.35

Fuel Sulfur Content	1	gr/100 scf
Hours of Operation	8,760	hrs/year
Conversion of SO_2 to SO_3	5	%(v)

Table 18. Zeeco Natural Gas Thermal Oxidizer Parameters
Black & Veatch Emission Estimates
Jordan Cove, Coos Bay, Oregon

Process Flow Rate and Heat Input

Component	lb/hr	MMBtu/hr	MW (lb/mole)
Acid Gas	124,710	1	43.4
Flash Gas	1,276	22	
Fuel Gas	3,905	79	
Combustion Air	108,251		
Total	**238,142**	**102**	

Exhaust Composition

Component	lb/hr	MW (lb/mole)	lb-mol/hr	mol %
CO_2	137,049	44.01	3,114	44.84
H_2O	12,574	18.02	698	10.05
N_2	82,472	28.01	2,944	42.39
SO_2	4	64.06	0.07	1.0E-03
O_2	6,044	32.00	189	2.72
Total	**238,142.00**	**34.29**	**6,944.94**	**100.00**

Exhaust Parameters

Exhaust Temperature (°F)	1,600
Exhaust Flowrate (acfm) [1]	177,370

Notes

[1] Exhaust flowrate calculated based on exit velocity of 41.7 ft/sec. Using ideal gas law results in a rate of 174,083 acfr

Exhaust Composition

Component	lbmol/h	mole% (Dry)	Number of Carbons	Methane Equivalents (lbmol/hr)
CO_2	2806.157525	97.66	Not a VOC	
H_2S	0	0.0E+00	Not a VOC	
N_2	0.001982717	6.9E-05	Not a VOC	
C1	3.062492551	0.11	Not a VOC	
C2	0.221949318	0.01	Not a VOC	
C3	0	0.0E+00	3	0.00
iC4	0.001436751	5.0E-05	4	5.7E-03
nC4	0.001436751	5.0E-05	4	5.7E-03
C5	0.000660906	2.3E-05	5	3.3E-03
C6	0.00011494	4.0E-06	6	6.9E-04
C7	0.00022988	8.0E-06	7	1.6E-03
C8	0.00011494	4.0E-06	8	9.2E-04
C9	0.00011494	4.0E-06	9	1.0E-03
C10	0	0	10	0
COS	0.001436751	5.0E-05	1	1.4E-03
CH_3SH (Methyl Mercaptan)	0.026551161	9.2E-04	1	2.7E-02
C_2H_5SH (Ethyl Mercaptan)	0.009241183	3.2E-04	2	1.8E-02
C_3H_7SH (Propyl Mercaptan)	0.001034461	3.6E-05	3	3.1E-03
Benzene	0.014051426	4.9E-04	6	8.4E-02
Toluene	0.014051426	4.9E-04	7	0.10
Ethylbenzene	0.001752836	6.1E-05	8	1.4E-02
o-Xylene	0.002413742	8.4E-05	8	1.9E-02
m-Xylene	0.005632065	2.0E-04	8	4.5E-02
p-Xylene	0.005632065	2.0E-04	8	4.5E-02
Total:	**2873.50**			
			Total Input VOCs	0.37
			VOC Destruction Removal Efficiency	99.9
			Total Output VOCs	3.7E-04

APPENDIX C

NSPS SUBPART Db APPLICABILITY SUMMARY

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

Table C-1 40 CFR Part 60 Subpart Db Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units	
	Auxiliary Boiler
Applicability §60.40b(a) and (j)	(a) The affected facility to which this subpart applies is each steam generating unit that commences construction, modification, or reconstruction after June 19, 1984, and that has a heat input capacity from fuels combusted in the steam generating unit of greater than 29 megawatts (MW) (100 million British thermal units per hour (MMBtu/hr)). (j) Any affected facility meeting the applicability requirements under paragraph (a) of this section and commencing construction, modification, or reconstruction after June 19, 1986 is not subject to subpart D (Standards of Performance for Fossil-Fuel-Fired Steam Generators, §60.40).
Sulfur dioxide (SO_2) Standards §60.42b(k)(2)	Units firing only gaseous fuel with a potential SO_2 emission rate of 140 ng/J (0.32 lb/MMBtu) heat input or less are exempt from the SO_2 emissions limit in §60.42b(k)(1).
Particulate Matter (PM) Standards §60.43b	PM standards do not apply to units combusting only natural gas.
Nitrogen Oxides (NO_X) Standards §60.44b (h), (i), and (l)(1)	Do not discharge into the atmosphere any gases that contain NO_X in excess of 0.20 lb/MMBtu heat input determined on a 30-day rolling average basis. This standard applies at all times including periods of startup, shutdown, or malfunction. Based on the calculated heat release rate (design heat capacity divided by furnace volume), the auxiliary boiler has a high heat release rate. (See attachment for calculation).
Monitoring §60.48b(b), (e), (f)	Install, calibrate, maintain, and operate a continuous emission monitoring system (CEMS) for measuring NO_x and O_2 (or CO_2) emissions discharged to the atmosphere, and record the output of the system. When NO_X emission data are not obtained because of CEMS breakdowns, repairs, calibration checks and zero and span adjustments, emission data will be obtained by using standby monitoring systems, Method 7 or 7A, or other approved reference methods to provide emission data for a minimum of 75 percent of the operating hours in each steam generating unit operating day, in at least 22 out of 30 successive steam generating unit operating days.
Recordkeeping §60.45b(k), §60.48b(b), and §60.49b(d)(1), (g), (h), (o), (p), and (r)	1) Record and maintain records of the amounts of natural gas combusted during each day and calculate the annual capacity factor for the reporting period. The annual capacity factor is determined on a 12-month rolling average basis with a new annual capacity factor calculated at the end of each calendar month. [§60.49b(d)] 2) Obtain and maintain fuel receipts (such as a current, valid purchase contract, tariff sheet, or transportation contract) from the fuel supplier that certify that the gaseous fuel meets the definition of natural gas and has a potential SO_2 emission rate of 140 ng/J (0.32 lb/MMBtu) heat input or less. [§60.45b(k) and §60.49b(r)] 3) Record the NO_x and O_2 (or CO_2) output of the CEMS. [§60.48b(b)] 4) For each auxiliary boiler operating day, record: a) Calendar date; b) The average hourly NO_X emission rates (expressed as NO_2) (ng/J or lb/MMBtu heat input) measured or predicted; c) The 30-day average NO_X emission rates (ng/J or lb/MMBtu heat input) calculated at the end of each steam generating unit operating day from the measured or predicted hourly NO_X emission rates for the preceding 30 steam generating unit operating days; d) Identification of the steam generating unit operating days when the calculated

Table C-1 40 CFR Part 60 Subpart Db Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units	
	Auxiliary Boiler
	30-day average NO_X emission rates are in excess of the NO_X emissions standards, with the reasons for such excess emissions as well as a description of corrective actions taken; e) Identification of the steam generating unit operating days for which pollutant data have not been obtained, including reasons for not obtaining sufficient data and a description of corrective actions taken; f) Identification of the times when emission data have been excluded from the calculation of average emission rates and the reasons for excluding data; g) Identification of "F" factor used for calculations, method of determination, and type of fuel combusted; h) Identification of the times when the pollutant concentration exceeded full span of the CEMS; i) Description of any modifications to the CEMS that could affect the ability of the CEMS to comply with Performance Specification 2 or 3; and j) Results of daily CEMS drift tests and quarterly accuracy assessments as required under appendix F, Procedure 1 of 40 CFR Part 60. 5) Submit excess emission reports for any excess emissions that occurred during the reporting period. 6) Calculate a new annual capacity factor at the end of each calendar month (12-month rolling average). 7) Records shall be maintained for a period of two years following the date of the record.
Reporting §60.49b(a), (i), (r), (v), and (w)	1) Submit a notification of the date of initial startup and include the following: k) The design heat input capacity of the auxiliary boiler; l) Identification of the fuel to be combusted (natural gas); and m) Annual capacity factor anticipated for the auxiliary boiler based on all fuels fired. 2) Submit performance test data from the initial performance test and performance evaluation of the CEMS. 3) Submit reports containing the information above in Recordkeeping, paragraph 4. Reports shall be submitted to the Administrator certifying that only natural gas that is known to contain insignificant amounts of sulfur were combusted in the auxiliary boiler during the reporting period. 4) Submit written reports semi-annually (every six months). All reports submitted to the Administrator must be postmarked by the 30^{th} day following the end of the reporting period. 5) Quarterly electronic records of CEMS data or excess emissions reports may be submitted in lieu of semi-annual written reports.
Performance Test §60.46b(c), (e)(1) and (3)	Initial Compliance Test: Use the CEMS to monitor NO_X for 30 successive steam generating unit operating days. The 30-day average emission rate is used to determine compliance with the NO_x emission standards. The 30-day average emission rate is calculated as the average of all hourly emissions data recorded by the monitoring system during the 30-day test period. Following the initial compliance test, determine compliance with the NO_x standards on a continuous basis through the use of a 30-day rolling average emission rate. A new 30-day rolling average emission rate is calculated each steam generating unit operating day as the average of all of the hourly NO_x emission data for the preceding 30 steam generating unit operating days.

Jordan Cove
40 CFR 60 Subpart Db
Appendix C

Annual Capacity Factor

$$\text{Annual Capacity Factor} = \frac{\text{Actual Heat Input from Fuel}}{\text{Potential Heat Input to Boiler at 8,760 hr/yr}}$$

Actual Heat Input from Fuel								
Annual fuel consumption rate =	296.20	MMBtu/hr	x	876	hr/yr	=	259,471.20	**MMBtu/yr**

Potential Heat Input to Boiler at 8,760 hr/yr								
Potential heat input to boiler =	296.2	MMBtu/hr	x	8,760	hr/yr	=	**2,594,712.0**	**MMBtu/yr**

Annual Capacity Factor								
Annual Capacity Factor =	259,471	MMBtu/yr	/	2,594,712	MMBtu/yr	=	0.10	10%

Jordan Cove Energy Project is not taking a federally enforceable limit on the annual capacity factor of 10%.

Heat Release Rate

$$\text{Heat Release Rate} = \frac{\text{Boiler Design Heat Input Capacity}}{\text{Furnace Volume}}$$

Heat Release Rate								
Heat Release Rate =	296.2	MMBtu/hr	/	3,125	ft3	=	**94,784.0**	**Btu/hr-ft^3**

High Heat Release Rate is defined as a heat release rate greater than 70,000 Btu/hr-ft^3

Notes:

Heat input from fuel =	1024.6	Btu/scf
Project operating hours =	876	hr/yr
Boiler heat input capacity =	296.2	MMBtu/hr
Furnace volume (boiler specification sheet) =	3,125	ft^3

APPENDIX D

MODELING PROTOCOL

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

June 1, 2017

Mr. Philip Allen
Department of Environmental Quality
Air Quality Program
700 NE Multnomah Street, Suite 600
Portland, Oregon 97232

Re: Jordan Cove Energy Project L.P.
Jordan Cove LNG Terminal, Coos Bay, Oregon
Type B State New Source Review Dispersion Modeling Protocol

Dear Mr. Allen,

On behalf of Jordan Cove Energy Project, L.P., SLR International Corporation (SLR) is submitting a dispersion modeling protocol for a proposed Type B State New Source Review (NSR) permit modification application for the Jordan Cove LNG terminal located in Coos Bay, Oregon. Jordan Cove was issued the Prevention of Significant Deterioration (PSD) Air Contaminant Discharge Permit (ACDP) 06-0118-ST-01 on June 16, 2015. A technical permit modification application will be submitted to incorporate changes for the final design of the facility. Included in the protocol are:

- Project description and background
- Emissions data
- Regulatory applicability for a Type B State New Source Review project
- Methodology proposed for demonstrating compliance with the NAAQS and PSD increments in Class II areas
- Methodology proposed for addressing PSD Class I area requirements
- Methodology proposed for assessment of the potential for $PM_{2.5}$ and ozone secondary formation

Under separate cover Jordan Cove is submitting a White Paper on PSD applicability for LNG terminals to summarize research and findings on applicability and determinations for permitting of other LNG projects nationally.

The air quality analysis will be performed following approval of this protocol. After submission of the air permit modification application to DEQ, a copy of the complete application will be included in the FERC application Resource Report 9 (RR9) as an appendix. A version of the RR9 is being submitted to FERC this month which includes dispersion modeling results for a preliminary analysis performed to inform the design process. Those results will be replaced in a future RR9 version with the final air quality analysis results, when available.

We look forward to receiving your approval on the proposed methodologies contained within the dispersion modeling protocol. If you have questions, please contact Jason Reed at (970) 999-3970 or Meagan Masten at (541) 280-9099.

Sincerely,
SLR International Corporation

Jessica Stark, P.E.	Jason Reed, CCM
Principal Engineer	Senior Scientist

Enc Attachment – Type B State NSR Dispersion Modeling Protocol

SLR

global environmental solutions

Jordan Cove Energy Project, L.P.

Jordan Cove LNG Terminal

Type B State New Source Review Dispersion Modeling Protocol

June 2017

CONTENTS

TABLES

CONTENTS (CONTINUED)

FIGURES

(Figures appear at the end of the document.)

ACRONYMS

ACDP	Air Contaminant Discharge Permit
AMSL	Above Mean Sea Level
AQRV	Air Quality Related Value
ARM	Ambient Ratio Method
FLM	Federal Land Manager
GEP	Good Engineering Practice Stack Height
H_2SO_4	Hydrogen Sulfate
HRSG	Heat Recovery Steam Generator
JCEP	Jordan Cove Energy Project, L. P.
K	Kelvin
kg	Kilogram
km	Kilometer
LNG	Liquefied Natural Gas
LNGC	LNG Carrier
m	Meter
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NED	National Elevation Dataset
NLCD92	National Land Cover Data 1992
NNSR	Nonattainment New Source Review
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
OAR	Oregon Administrative Rule
O_3	Ozone
OC	Organic Carbon
ODEQ	Oregon Department of Environmental Quality
PM	Particulate Matter
$PM_{2.5}$	Particulate Matter Less Than 2.5 microns
PM_{10}	Particulate Matter Less Than 10 microns
ppb	Parts Per Billion
PSD	Prevention of Significant Deterioration

ACRONYMS (CONTINUED)

SER	Significant Emission Rate
SIA	Source Impact Area
SIL	Significant Impact Level
SLR	SLR International Corporation
SMCs	Significant Monitoring Concentration
SO_2	Sulfur Dioxide
SO_4	Sulfate
tpy	Tons per Year
µg	Micrograms
EPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOC	Volatile Organic Compounds
yr	Year

1. INTRODUCTION

Jordan Cove Energy Project, L.P. (JCEP) plans to construct and operate a natural gas liquefaction and export facility (LNG Terminal or Project) located on the bay side of the North Spit of Coos Bay, Oregon. The LNG Terminal will include five gas-fired turbine-driven compressors, an auxiliary boiler, emergency fire water booster pumps, backup engine generators, a thermal oxidizer, and three flares. Standard Air Contaminant Discharge Permit (ACDP) No. 06- 0118-ST-01 was issued for the Project, but due to facility design changes, a permit modification is sought. This dispersion modeling protocol proposes the analysis methodologies for the Standard ACDP Technical Modification application. An illustration of the area is provided in Figure 1-1 and an illustration of the site layout is provided in Figures 1-2A and 1-2B.

The LNG Terminal is located in Coos County, Oregon, which is in attainment or unclassified for all pollutants. The proposed Jordan Cove LNG Project has the potential to emit nitrogen oxides (NO_X), volatile organic compounds (VOC), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), particulate matter less than 10 micrometers (PM_{10}), particulate matter less than 2.5 micrometers ($PM_{2.5}$), and sulfuric acid mist (H_2SO_4) above Oregon Significant Emission Rates (SERs) but below the Prevention of Significant Deterioration (PSD) threshold of 250 tons per year.[1] Therefore, a Type B State New Source Review (NSR) air quality impact analysis will be conducted for CO, SO_2, PM_{10}, $PM_{2.5}$ and NO_X.

The air quality impact analysis will be conducted to demonstrate that predicted ambient air concentrations from NO_X, CO, SO_2, PM_{10}, and $PM_{2.5}$ emissions comply with the National Ambient Air Quality Standards (NAAQS) and PSD Increments, as they apply to Class I and Class II areas. The purpose of this modeling protocol is to obtain approval from the Oregon Department of Environmental Quality (DEQ) for the proposed modeling inputs and methodologies. NAAQS and PSD Increment modeling methodologies will follow DEQ and United States Environmental Protection Agency (EPA) modeling guidance as further described in this document.[1]

[1] OAR 340-224-0010(1)(a)(A) and 340-224-0010(2)(b)(A)

2. PROJECT DESCRIPTION

Jordan Cove Energy Project, L.P. (JCEP) is proposing to construct and operate a natural gas liquefaction and export facility (LNG Terminal or Project), located on the bay side of the North Spit of Coos Bay, Oregon. The Project would include a facility capable of liquefying natural gas and storing the liquefied natural gas (LNG) for export. Once completed, the Project facilities would be placed in service and natural gas would be delivered to the LNG Terminal via the proposed Pacific Connector Gas Pipeline, which would connect the Project with existing interstate natural gas pipeline systems.

Natural gas received at the LNG Terminal would be cooled into liquid form and stored in two 160,000 cubic meter (m^3) full-containment LNG storage tanks. The Project facilities would have the capability to allow export of 7.8 million metric tons per annum (MMTPA) via LNG carriers.

JCEP is proposing to utilize the following equipment at the LNG terminal:

- Five (5) combined-cycle natural gas turbines with duct burners
- One (1) Auxiliary boiler
- Three (3) liquefaction area fire pumps
- Four (4) emergency generators
- One (1) thermal oxidizer
- Three (3) flares

LNG carrier (LNGC) emissions are not part of the stationary source, but LNGC emissions and downwash will be included in the cumulative source emissions modeling as competing sources.

2.1 SOURCE EMISSION RATES

The potential annual emission rates for each criteria air pollutant from each source are shown in Table 2-1. The EPC contractor, KBJ, has completed the pre-FEED design stage of the project and is currently developing the detailed facility design.

Table 2-1 Stationary Source Criteria Air Pollutant Potential Emissions

Unit	PM/PM_{10}/ $PM_{2.5}$ (tpy)	SO_2 (tpy)	NO_X (tpy)	CO (tpy)	VOC (tpy)	H_2SO_4 (tpy)	Pb (tpy)	CO2e (tpy)
Turbines (with 4000 hours DB)	112.26	35.19	81.99	97.82	32.72	23.61	--	1,292,706
Turbines Startup/Shutdown	0.11	4.4E-03	0.23	0.73	0.10	--	--	188
Thermal Oxidizer	3.59	19.84	63.25	38.50	1.12	--	2.4E-04	624,730
Auxiliary Boiler	2.47	0.36	0.96	1.16	0.67	2.4E-01	6.4E-05	15,193
Fire-Water Pumps	9.0E-02	2.1E-03	1.59	0.80	4.5E-02	1.6E-04	2.1E-05	241
Generators	0.09	1.1E-02	4.81	0.49	0.13	8.7E-04	1.1E-04	1,280
Flares	0.36	3.7E-02	0.80	3.64	7.74	2.8E-03	6.8E-06	2,077
Gas Up	1.12	0.16	2.09	9.50	17.53	1.3E-02	2.1E-05	4,351
Fugitives	--	--	-	--	7.98	--	--	13,116
AIE	1.00	1.00	1.00	1.00	1.00	0.70		
Total Emissions	121.1	56.6	156.7	153.7	69.0	24.6	4.6E-04	1,953,883

Note: The LNGC emissions are not included in this table because they are not subject to federal or state stationary source permitting regulations.

2.2 REGULATORY APPLICABILITY

The LNG terminal was permitted as a PSD source under ACDP No. 06- 0118-ST-01 in 2015. The facility design included six 70 megawatt (MW) combined-cycle gas turbines to be operated at the South Dunes Power Plant. The Project was classified as a 'fossil fuel-fired steam electric plant of more than 250 million BTU/hour heat input.' Electricity was to be generated at the South Dunes Power plant to power the facility.

With the change in design to remove the power plant from the LNG Terminal, the source operations no longer fall within any of the listed 28 source categories, and the applicable PSD threshold is 250 tons per year of any regulated pollutant, excluding GHGs.[2]

The Project will have a fossil fuel-fired boiler capacity in excess of 250 MMBtu per hour heat input. One of the designated source categories for purposes of identifying Federal Major Sources is "fossil fuel fired boilers, or combination thereof, totaling more than 250 million BTU per hour heat input." Therefore, the fossil fuel-fired boiler must be evaluated to determine if it constitutes a Federal Major Source.[3]

Consistent with EPA guidance, the boiler is evaluated independently of the facility as a whole based on the boiler being a "nested source" or "source within a source." EPA guidance recognizes that listed source categories can exist within an unlisted source category. However, the presence of a listed source category does not make the entire facility subject to the 100 tpy threshold. As EPA has explained:

> In other words, a source subject to the 100 TPY applicability test that emits greater than 100 TPY is subject to the PSD requirements even if that source is located within a facility for which the primary activity is subject to a 250 TPY applicability threshold and emits less than 250 TPY. In this situation, only the source that exceeds its applicability threshold is subject to PSD, not the entire facility.[4]

This guidance means that the fossil fuel-fired boiler is subject to the 100 tpy PSD threshold while the parent facility is subject to the 250 tpy threshold. Emissions from the auxiliary boiler will not exceed 100 tpy. The auxiliary boiler is only planned to operate for up to 10 percent of any given year, except during the first year of facility commissioning. The auxiliary boiler emissions are compared to the PSD threshold in Table 2-2.

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2 *See* White Paper on applicability of the Federal Major Source categories to LNG Facilities.
3 The duct burners on the turbines do not meet the definition for 'boiler' in EPA's NSPS rules. Therefore, the auxiliary boiler is the only unit to consider against the 250 MMBtu/hr threshold.
4 March 24, 1995, letter from EPA Region 3 to Henry Nickel on behalf of Consolidation Coal Company.

Table 2-2 Auxiliary Boiler Emissions Comparison to PSD Threshold

Source	NOX (tpy)	CO (tpy)	SO_2 (tpy)	VOC (tpy)	$PM_{10}/PM_{2.5}$ (tpy)
Auxiliary Boiler	0.96	1.16	0.36	0.67	2.47
Federal Major Source Threshold	100	100	100	100	100
PSD?	No	No	No	No	No

Jordan Cove does not need to request that DEQ impose a 99 tpy limit on emissions of any of the criteria pollutants from the fossil fuel-fired boiler at the facility. The auxiliary boiler PTE is below 100 tpy for all criteria pollutants. Because the criteria pollutant potential to emit from the fossil fuel-fired boiler will be limited to less than 100 tpy, the fossil fuel-fired boiler is not a Federal Major Source.

PSD only applies to a Federal Major Source. Because LNG terminals are not within any of the 28 listed source categories in OAR 340-200 0020(55), the Jordan Cove LNG Terminal emissions must be compared to the 250 tpy threshold to determine whether it is a Federal Major Source. As shown in Table 2-1, the potential to emit of the plant as a whole will be limited to less than 250 tpy for each regulated pollutant.

As neither the facility as a whole nor the fossil fuel-fired boiler qualifies as a Federal Major Source, the Jordan Cove LNG terminal is not subject to PSD program requirements. The project is subject to Type B State NSR requirements.

2.3 POLLUTANTS TO BE EVALUATED

JCEP is located in Coos County, which is currently designated as attainment or unclassified for all criteria pollutants. Because the project does not fall under any of the 28 categories of named sources in OAR-340-200-0020(66)(c), the applicable threshold for being considered a Federal Major Source is 250 tons per year of any individual regulated pollutant, excluding GHG. As shown in Table 2-1, the project does not have the potential to emit more than 250 tons of any one of these pollutants. Therefore, the Project is not a Federal Major Source. However, since the potential emissions of PM_{10}, $PM_{2.5}$, NOx, CO, SO_2, H_2SO_4, VOC, and GHG are greater than the Oregon SER, the proposed project is subjected to Type B State NSR and must meet the requirements of OAR 340-224-0270, *Requirement for Sources in Attainment and Unclassified Areas*.

The dispersion modeling analysis will therefore include an evaluation of PM_{10}, $PM_{2.5}$, CO, NO_X, SO_2, and VOC emissions to demonstrate compliance with their respective significance levels, NAAQS and PSD Increments, as applicable. The sulfuric acid mist is included in the $PM_{2.5}$ emission rates and not evaluated individually. VOC, SO_2, and NOx are considered precursors for pollutants ozone and $PM_{2.5}$ and will be evaluated using the latest federal modeling guidance for pollutants with secondary formation as described further in Section 4.

2.4 SOURCE LOCATION

The area surrounding the facility (within 3 kilometers) consists mainly of forested areas, sand dunes, and water bodies to the east, north, and west of the site with some industrial use along the bay to the south. The residential area of North Bend as well as North Bend Municipal Airport (currently known as the Southwest Oregon Regional Airport) is located to the south of the facility. Approximately 90 percent of the land uses within 3 kilometers of the facility consist of water, forest/undeveloped areas and sand dunes.

The graded elevation of the proposed facility site will vary from 30 to 60 feet above mean sea level (MSL). Topography proximate of the facility is relatively flat with elevations ranging from MSL to 160 feet above MSL within 1 kilometer of the site. To the east of the site lies some rolling terrain with hill top elevations ranging up to approximately 600 feet above MSL.

The proposed facility will be located at approximately 43.434024° North Latitude, 124.243219° West Longitude, North American Datum 1983 (NAD83). The approximate Universal Transverse Mercator (UTM) coordinates of the proposed facility are 399,383 meters Easting, 4,809,765 meters Northing, in Zone 10, NAD83.

2.5 STACK PARAMETERS

2.5.1 COMBUSTION TURBINES

JCEP proposes to use five (5) combustion turbines, each equipped with duct burner. The five turbines would be direct compressor-driver turbines located in the Ingram Yard area of the project. Each turbine is rated at 504.4 MMBtu/hr with an additional duct burner heat input of 19.7 MMBtu/hr, for a total input (HHV) of 524.1 MMBtu/hr per turbine. Twelve startups at 10 minutes per startup and twelve shutdowns at 9 minutes per shutdown will be modeled for each unit. Normal, full load operation is assumed for the remainder of the year. Additional information regarding the turbine parameters is shown in Table 2-3 and Table 2-4.

For the annual emissions, the modeled emission rate was determined by developing a weighted emission factor that encompasses the following operating scenarios to be encountered over the year:

- 8,760 hours of operation at full load and 42°F with 4,000 hours of duct burner firing
- 8,760 hours of operation at full load and 42°F without duct burner firing

From the scenarios and operating times discussed above, a weighted emission factor for the entire year of operation can be obtained. This weighted emission factor is then used over the entire year, minus the hours in which the turbine is in startup or shutdown, to determine the total annual emissions.

Table 2-3 Turbine Parameters with Duct Burner Firing

Stack Parameters				Potential Emission Rates			
Temperature (°F)	Velocity (ft/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
243	71	10	119	3.8	5.4	1.64	4.6

Table 2-4 Turbine Parameters without Duct Burner Firing

Stack Parameters				Potential Emission Rates			
Temperature (°F)	Velocity (ft/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
243	71	10	119	3.7	4.9	1.58	4.4

2.5.2 AUXILIARY BOILER

The natural gas-fired auxiliary boiler, with the maximum hourly heat input capacity of 269 MMBtu/hr, will be utilized during turbine startups. Total time of operation is conservatively estimated as 876 hours per year. Potential maximum hourly emissions and stack parameters for the auxiliary boiler are provided in Table 2-5 below.

Table 2-5 Auxiliary Boiler Stack Parameters and Emissions

Stack Parameters				Potential Emission Rates			
Temperature (°F)	Velocity (ft/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
330	49	6	100	2.18	5.63	0.83	2.66

2.5.3 OXIDIZER

The thermal oxidizer will be used to combust acid gas from the hydrogen sulfide removal process. The unit will have a maximum heat rate of 110 MMBtu/hr and operate 8,760 hours per year. Potential emissions and stack parameters for the thermal oxidizer are provided in Table 2-6 below.

Table 2-6 Oxidizer Stack Parameters and Emissions

Stack Parameters				Potential Emission Rates			
Temperature (°F)	Velocity (ft/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
1,600	42	9.5	131	14.44	0.82	4.53	8.79

2.5.4 FLARES

Three (3) separate flares will be used to handle gas relieved during emergency upset conditions. The design has warm and cold flares (a combined multi-point ground flare) and a marine flare (enclosed ground flare). However, emissions are not evaluated for emergency upset conditions because of the unpredictability and rarity of this occurrence. Emissions from the continuous operation of the pilot and purge gas on each flare will be included in the dispersion modeling.

If an LNG tanker arrives which requires cooling of the hull prior to LNG loading, hull gas must be vented. The inert gas and some methane is routed to the marine flare and combusted. Due to the intermittent nature of LNG gas up of warm interted LNGC events, the annualized emissions will be used in the dispersion modeling analysis. The stack parameters and potential hourly emissions for the flares are provided in Table 2-7 below for the marine flare. The gas-up annual emissions will also be included with this source.

Table 2-7 Marine Flare Stack Parameters and Emissions

Stack Parameters				Potential Emission Rates			
Temperature (K)	Velocity (m/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
ambient	negligible	45	100	0.04	0.017	0.0017	0.17

The flare parameters and potential hourly emissions for the multi-point ground flare, modeled as an area source, are provided in Table 2-8 below.

Table 2-8 Ground Flare Parameters and Emissions

Flare Parameters		Potential Emission Rates			
Area of Enclosure	Enclosure Height	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
259 ft x 227 ft	85 ft	0.14	0.065	0.0067	0.66

2.5.5 FIRE WATER PUMPS

Three (3) 700 hp fire water pumps will be placed in the liquefaction area. These pumps are expected to operate less than 1 hour per short-term period for reliability testing and maintenance and no more than 200 hours per year per pump. Stack parameters and potential hourly emissions for each fire water pump are provided in Table 2-9 below. Due to their intermittent nature, the annualized emissions will be used in the dispersion modeling analysis.

Table 2-9 Fire Water Pumps Stack Parameters and Emissions

Stack Parameters				Potential Emission Rates			
Temperature (°F)	Velocity (ft/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
948.3	193	0.67	18	5.31	0.30	0.0071	2.68

2.5.6 GENERATORS

JCEP proposes a total of four generators at the site. There will be two different types of generators at the site. Two of the generators will be black start generators and rated at 4,376 hp each, and the other two generators will be backup generators and rated at 1,214 hp each. Annual operation is not expected to exceed 200 hours per year per generator. Stack parameters and potential hourly emissions for the generators are provided in Tables 2-10 and 2-11 below. Due to their intermittent nature, the annualized emissions will be used in the dispersion modeling analysis.

Table 2-10 1,214 hp Backup Generator Stack Parameters and Emissions

Stack Parameters				Potential Emission Rates			
Temperature (°F)	Velocity (ft/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
952.5	287	0.67	13	16.63	0.19	0.012	1.42

Table 2-3 4,376 hp Black Start Generator Stack Parameters and Emissions

Stack Parameters				Potential Emission Rates			
Temperature (°F)	Velocity (ft/sec)	Stack Diameter (ft)	Stack Height (ft)	NO_X (lb/hr)	$PM_{10}/PM_{2.5}$ (lb/hr)	SO_2 (lb/hr)	CO (lb/hr)
873.6	177	1.67	13	7.43	0.23	0.044	1.04

3. CLASS II AIR QUALITY ANALYSIS

This section discusses the modeling methodology that will be used to demonstrate compliance with the NAAQS and PSD Increments in Class II Areas. The air dispersion modeling analysis will be organized into two tiers: a Significant Impact Analysis and a Full Impact Analysis. The techniques used in the air dispersion modeling analysis will be consistent with the modeling protocol discussion held on March 13, 2017 with Oregon DEQ, current EPA modeling guidelines, OAR 340, and other agency guidance as applicable.[5,6]

3.1 MODEL SELECTION AND INPUTS

SLR will use the latest version of the AERMOD modeling system (currently version 16216r) to perform the Class II analysis. AERMOD is the official guideline model for short-range (i.e., <50 km) analyses recommended in 40 CFR 51 Appendix W. Since the land use in a 3 km radius surrounding the proposed facility is rural in nature, the rural option will be used. All other model settings will be set to their default values.

3.1.1 UTM COORDINATE SYSTEM

The Coos Bay area of western Oregon is located in UTM Zone 10. All emission points, building, and receptor locations will be converted to UTM coordinates in Zone 10, North American Datum of 1983. Table 3-1 summarizes the coordinates and elevation of all emission sources included in the modeling.

[5] Code of Federal Regulations, Title 40-Protection of Environment, Part 51, Appendix W, January 17, 2017.

[6] The contents of a modeling analysis were discussed with Phil Allen (Oregon DEQ) on March 13, 2017 in Portland, Oregon. The methodology and inputs described herein are based on that discussion.

Table 3-1 Stationary Source UTM Coordinates

Source ID	Source Description	UTM Easting (meters)	UTM Northing (meters)	Elevation (meters)
Turb1	Turbine 1	397644.88	4809333.42	14
Turb2	Turbine 2	397642.86	4809401.18	14
Turb3	Turbine 3	397640.84	4809468.96	14
Turb4	Turbine 4	397638.82	4809536.74	14
Turb5	Turbine 5	397636.80	4809604.52	14
ThermOx	Oxidizier	397464.17	4809693.73	14
AuxBoil	Auxiliary Boiler	397385.32	4809623.54	14
FP1	Firewater Pump 1	397822.97	4809674.74	16.5
FP2	Firewater Pump 2	397830.32	4809674.96	16.5
FP3	Firewater Pump 3	397835.46	4809675.11	16.5
Gen1	Generator 1	397296.40	4809619.99	19.2
Gen2	Generator 2	397288.79	4809619.76	19.2
MFlare	Marine Flare	397361.50	4809302.31	14
GFlare	Ground Flare	397296.45	4809827.91	14*

*Fence height

3.1.2 METEOROLOGICAL DATA

The surface data to be used in the analysis will be the five most-recent complete years of data collected at the Southwest Oregon Regional Airport (call sign KOTH), located at 43.419°N, 124.243°W, which is approximately 2 km southeast of the project site. The meteorological sensors at KOTH are Automated Weather Observing System (AWOS III)[7], which does not collect 1- or 5-minute data for use in the analysis. Upper air data from McNary Field in Salem, OR (44.92°N, 123.02°W) will also be used, which is approximately 197 km northeast of the project site. The period of meteorological data to be used is January 1, 2012 to December 31, 2016.

As detailed in the prior modeling assessment as part of the Prevention of Significant Deterioration (PSD) application, the surface meteorological data collected at the Southwest Regional Airport is temporally and spatially representative of the project location and areas of concern.[8] A topographic map with both the project site and the location of the AWOS instruments is provided in Figure 1-1. A windrose of the meteorological data is provided in Figure 3-1.

[7] https://www.faa.gov/air_traffic/weather/asos/?state=OR
[8] Jordan Cove Energy Project, L.P. PSD Air Permit Application, TRC, May 2013.

Since the instrumentation is a standard AWOS system, it does not collect atmospheric turbulence data for input into AERMET/AERMOD. As a result, this dataset meets the criteria for use of the AJD_u* model option[9], which is contained within the latest AERMET/AERMOD models as default, if invoked. SLR will review the processed meteorological datasets and will document and justify the use of this model option if it is invoked.

3.1.3 LAND COVER ANALYSIS

A land cover analysis will also be conducted to define the surface characteristics (surface albedo, Bowen ratio, and roughness length) for input into stage 3 of AERMET. The EPA-provided AERSURFACE program (version 13016) will be run with 1992 National Land Cover Data 1992 (NLCD92)[10] to generate surface characteristics for the area surrounding the meteorological site. The inputs to AERSURFACE are provided in Table 3-2 below. Figure 3-2 shows a plot of the NLCD92 data for the area surrounding the facility.

Table 3-2 Summary of AERSURFACE Inputs

Parameter	Value
Surface roughness study radius	1 km
Bowen ratio and albedo study region	10 km by 10 km
Vary by sector?	Yes, 12 sectors, each 30 degrees in width.
Temporal Resolution	Summer: June, July, August Autumn: September, October, November Winter: December, January, February Spring: March, April, May
Continuous snow-cover most of the winter?	No
Is the site near an airport?	Yes
Is the site an arid region?	No
Surface Moisture	TBD on a monthly basis

3.1.4 DOMAIN AND RECEPTOR GRIDS

Ground-level concentrations will be calculated within a nested, Cartesian receptor grid. The nested grids will cover an area extending up to 30 km from the proposed facility, but truncated over the Pacific Ocean. The grids will be defined as follows:

1) receptors spaced every 25 m along the facility fenceline;
2) receptors spaced every 25 m that extend 100 m from the facility fenceline;
3) receptors spaced every 100 m that extend from 100 m to 3 km;

[9] From the preamble to Title 40-Protection of Environment, Part 51, Appendix W, January 17, 2017 "the model performance and diagnostic evaluations strongly support the finding that the ADJ_U* option provides for an appropriate adjustment to the surface friction velocity parameter when standard National Weather Service (NWS) airport meteorological data".
[10] http://www.mrlc.gov/nlcd92_data.php

4) receptors spaced every 250 m that extend from 3 km to 5 km;
5) receptors spaced every 500 m that extend from 5 km to 20 km; and
6) receptors spaced every 1,000 m that extend from 20 km to 30 km.

The locations of the fenceline receptors and near-field gridded receptors are shown in Figure 3-3. Figure 3-4 illustrates the receptor grid out to 30 km. If the maximum concentration is predicted at any receptor in the coarse grids (greather than 100 m spacing) and is within 75% of an ambient standard, then, a refined grid with 100 m receptor spacing will be centered on the "hot spot".

3.1.5 TERRAIN DATA

Significant grading of the existing site is expected; therefore the graded elevations of the sources, buildings, fenceline and any ambient air receptors will be based on project-supplied information. For those areas outside of the graded area, terrain elevations for the receptors within the modeling domain will be taken from National Elevation Dataset (NED) terrain data using AERMAP (version 11103). All receptors, graded or not, will be run through AERMAP in order to obtain the appropriate scale heights. The NED data will be at a 1/3 arcsecond resolution, which translates into a resolution of approximately 10 meter spacing for the terrain.

3.1.6 DOWNWASH AND GEP STACK HEIGHT ANALYSIS

The effects of plume downwash will be considered for all stationary point sources. The effects of plume downwash will also be considered for the marine carriers when considered for the multisource modeling. Direction-specific building dimensions will be calculated using the current version of the EPA-approved Building Profile Input Program (BPIPPRM Version 04274). The site layout, dimensions and heights will be obtained from facility drawings. In addition to calculating direction-specific building dimensions, the BPIPPRM program also calculates the Good Engineering Practice (GEP) stack height. All facility stack heights will be checked to verify that they are within the GEP stack height limit.

3.2 BASELINE AIR QUALITY AND SIGNIFICANCE ANALYSIS

The first step in the air quality impact analysis will be to model the proposed project emissions and compare the maximum modeled concentrations to the applicable significant impact levels (SILs), provided in Table 3-3 below.[11] Comparison to these thresholds is used to determine the scope of the modeling analysis by pollutant/averaging period. However, use of the SILs in a tiered modeling analysis first requires an assessment of the background concentration relative to the ambient air quality standards i.e., the headroom; as well as recent emission changes in the nearby area. The headroom analysis (ambient standard minus background value with the difference compared to the SIL) is provided in Table 3-3 and demonstrates sufficient headroom to support the use of the SILs as protective of air quality. For this analysis, the NW AIRQUEST database was used as representative background data for the area. The NW AIRQUEST

[11] U.S. EPA, Office of Air Quality Planning and Standards, Guidance for PM2.5 Permit Modeling, May 20, 2014. This guidance describes the vacation of the $PM_{2.5}$ SILs and SMC for use in permitting analyses. However, the SILs in Table 3-1 are provided in OAR 340-200-0020(163) and will be used in this analysis based on an assessment of the headroom.

project used air quality observations and archived CMAQ model data from daily air quality forecast models from Idaho, Oregon, and Washington to compute the design values on a 12-km grid for the period of 2009-2011. The values were obtained from the grid cell representative of the proposed facility location (latitude 43.434, longitude -124.2538). The 2009 – 2011 NW AIRQUEST data are the most recent data available.

With regard to second criteria for using the SILs, SLR has reviewed the past three National Emission Inventory releases for years 2008, 2011, and 2014 for Coos County, Oregon to assess recent changes in local emission changes.[12] The emission summaries for the area are shown in Table 3-4 and reveal generally flat levels of emissions in the area, which indicates the NW AIRQUEST background values for the area should be considered temporally and spatially representative. It is noted that there is an increase in primary PM_{10} emission in 2014 over 2011; review of the data indicates there was a substantial increase (+8,000 tons) in 'miscellaneous' PM_{10} emissions in 2014.

[12] The Tier 1 summaries consolidate the emission inventory sectors into 14 main categories and can be summarized by county. https://www.epa.gov/air-emissions-inventories/national-emissions-inventory-nei

Table 3-3 Applicable Class II Significant Thresholds, Ambient Standards, and Headroom Analysis

Pollutant	Averaging Period	Applicable Thresholds	Applicable Standards[3]		NW AIRQUEST Background Data ($\mu g/m^3$)	Headroom ($\mu g/m^3$) [2] / Is Headroom > SIL?
		Class II SILs[1] ($\mu g/m^3$ or as noted)	NAAQS ($\mu g/m^3$ or as noted)	Class II PSD Increment ($\mu g/m^3$)		
SO_2	1-hour	8.0	196	--	3.1	193 / Yes
	3-hour	25.0	1,300	512	2.9	1,297 / Yes
	24-hour	5.0	262	91	2.9	259 / Yes
	Annual	1.0	52	20	1.1	51 / Yes
NO_2	1-hour	8.0	188	--	16	172 / Yes
	Annual	1.0	100	25	1.9	98 / Yes
CO	1-hour	2,000	40,000	--	755	39,245 / Yes
	8-hour	500	10,000	--	591	9,409 / Yes
Ozone	8-hour	1 ppb	70 ppb	--	46	24 / Yes
PM_{10}	24-Hour	1.0	150	30	35	115 / Yes
	Annual	0.20	--	17	--	--
$PM_{2.5}$	24-hour	1.2	35	9	9.9	25 / Yes
	Annual	0.2 | 0.3	12	4	6.7	5 / Yes

(1) OAR 340-200-0020(163) All SILS are based on the first highest concentration at any one location. For ozone, the SIL is proposed by EPA in Revised August 18, 2016 Guidance on Significant Impact Levels for Ozone and Fine Particulates in the Prevention of Significant Deterioration Permitting Program. For $PM_{2.5}$, the 0.2 $\mu g/m^3$ value is also from the August 18, 2016 guidance.

(2) Headroom values represent NAAQS minus NW AIRQUEST background data; the result is compared to the SILs for an assessment if the headroom is greater the SIL.

(3) The form of the standards are as defined in OAR 340-202

Table 3-4 Summary of Recent National Emission Inventories in Coos County, Oregon

Pollutant (tons/year)	2008	2011	2014
CO	104,684	103,304	94,009
NO_x	3,381	3,048	2,491
Primary PM_{10}	14,097	13,452	21,148
Primary $PM_{2.5}$	7,937	8,074	7,971
SO_2	572	558	513
VOC	41,783	38,850	44,262

3.2.1 OPERATING SCENARIOS

The potential operating scenarios for the turbines include normal operation and SU/SD. The support equipment will be held constant for both turbine scenarios. The scenario will include the following:

- Normal operation - where the turbine operates in normal mode (full load) for the entire period (short-term); and
- SU/SD mode - where the turbine undergoes start-up for a portion of the period (e.g., 10 minutes) and operates in normal mode for the remainder of the period (short-term).

The annual emissions scenario will include the total emissions from the expected number of startups and shutdowns plus normal operation for the remainder of the year. Any other project non-baseload source will also be considered in the development of modeled scenarios.

3.3 TIER I: PROJECT SIGNIFICANCE ANALYSIS

As noted above, the first step in the air quality impact analysis will be to model the proposed project scenarios with the worst-case equipment and compare the maximum modeled concentrations to the applicable Class II SILs. If the maximum modeled concentrations for a pollutant/averaging time are less than the applicable SILs, then no additional modeling is required for that pollutant/averaging period. If the maximum modeled concentrations for a pollutant/averaging time are equal to or above the SIL, then a tier 2 analysis for NAAQS and Class II PSD increment compliance is required for that pollutant/averaging time. This modeling step is also used to determine the Source Impact Area (SIA) of the proposed source, by pollutant/averaging period. The SIA is any location with a predicted concentration equal to or above the SIL, defined for each pollutant and averaging period. In the event that there are no predicted significant impacts, the SIA is zero. Once the SIA is determined, it will be provided to DEQ in order for the offsite source inventory to be updated, if needed.

3.4 TIER 2: REFINED ANALYSIS

For those pollutants/averaging periods shown to have a significant impact, a refined air quality analysis will be conducted to demonstrate compliance with the NAAQS and Class II PSD increments. The same project operating scenario/equipment configuration used in the SIL analysis will be combined with the DEQ-provided competing source inventory as defined following OAR 340-225. In addition, LNGC emissions will be included in the cumulative impact analyses, similar to the prior modeling demonstration. For the NAAQS analysis, background air quality concentrations will be added to the project and competing source inventory modeled impacts; background will not be added for the increment analysis. The background values shown in Table 3-3 will be used for the NAAQS analysis.

3.5 CHEMICAL TRANSFORMATION

3.5.1 NO_2 FORMATION

The modeling analysis will follow the tiered approach described in the latest EPA guidance:

- The first Tier will assume a full, 100% conversion of NO_x to NO_2.
- If needed, the second tier will utilize the ambient ratio method (ARM2) method implemented and documented per EPA guidance.
- If needed, the third tier will utilize the Ozone Limiting Method (OLM) or Plume Volume Molar Ratio Method (PVMRM) implemented and documented per EPA guidance.

3.5.2 $PM_{2.5}$ AND OZONE FORMATION

In consultation with DEQ, the draft EPA guidance on addressing secondary formation of $PM_{2.5}$ and ozone will be used to develop a project-specific evaluation of the potential impacts from these VOC, SO_2, and NOx.[13,14] Project emissions will be compared to the information provided in the EPA guidance for Maximum Emission Rates for Precursors (MERPs). This EPA guidance is based on a suite of photochemical modeling runs across the continental U.S. designed to assess secondary ozone and $PM_{2.5}$ formation from various, hypothetical sources. These runs were used to establish modeled responses to precursor emissions, which can be used to determine:

- emission thresholds below which insignificant secondary formation is expected to occur and
- secondarily-formed downwind concentrations of ammonium sulfate, ammonium nitrate or ozone from emitted precursors.

The first step of the guidance is to compare Project emissions to the emission thresholds. Since the Project emits more than one precursor pollutant, an additional calculation is needed to account for the combined effect of the precursors. This is accomplished by adding ratios (project emissions divided by an emission threshold) for each precursor together. If the

[13] Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program, December 2016.

[14] Distribution of the EPA's modeling data used to develop illustrative examples in the draft Guidance on the Development of Modeled Emission Rates for Precursors (MERPs) as a Tier 1 Demonstration Tool for Ozone and PM2.5 under the PSD Permitting Program, February, 2017.

combined ratios of the precursors are greater than one, then significant secondary formation is possible and needs to be quantified.

The second use of the guidance allows for quantification of the secondary formation. Since the EPA modeling was for a limited number of sources, several inputs were varied by EPA to obtain more robust model responses. The inputs that were varied include stack height and parameters, precursor emission levels, and inherently based on the source's location, regional emissions and geophysical characteristics (i.e., climate, terrain, proximity to other large sources or cities). If the quantification of secondary effects is required, Appendix A of the EPA guidance will be reviewed to find a source-impact relationship that is representative of the Project. Representativeness will be determined by stack parameters, emission levels, local/regional emissions, and geophysical environment.

Table 3-5 compares the lowest (most conservative) ozone emission threshold values for NOx and VOCs in the Western U.S to Project emissions. Since both NOx and VOC are emitted, the combined effect is accounted for as shown in Table 3-5. Following the draft EPA guidance, since the sum of the combined ratios (project emissions/emission threshold value) for each precursor is less than a value of 1, significant ozone concentrations will not be generated from the Project.

Table 3-5 Summary of MERPs Analysis for Ozone

Precursor	Project Emissions (tpy)	8-hr O3 MERP (tpy) [1]	Ratio of Project Emissions to Daily Ozone MERP	Sum of Ratios
NOx	155.0	184	0.84	0.91
VOC	72.5	1,049	0.07	

[1] These are the most conservative (lowest) MERP values for ozone in the Western U.S. as summarized in the February 23, 2017 memorandum.

A similar analysis for daily and annual $PM_{2.5}$ is shown in Tables 3-6 and 3-7, respectively. The approach for secondary $PM_{2.5}$ formation from NOx and SO_2 emissions is the same as ozone, but $PM_{2.5}$ also needs to include direct $PM_{2.5}$ impacts as modeled in AERMOD.[15] As shown in Tables 3-6 and 3-7, insignificant secondary formation is expected to occur for both daily and annual $PM_{2.5}$. However, if Project direct $PM_{2.5}$ impacts (i.e., modeled in AERMOD) are above the significant impact level, then the reported $PM_{2.5}$ will include the expected secondary formation using representative modeled responses in Appendix A of the EPA guidance as discussed further below.

[15] Total $PM_{2.5}$ is the sum of direct $PM_{2.5}$ plus secondary $PM_{2.5}$. Direct $PM_{2.5}$ emissions and downwind impacts are modeled in AERMOD. The secondary formation of Project NOx and SO_2 emissions into $PM_{2.5}$ is crux of the MERPs guidance.

While the lowest (most conservative) emission thresholds are useful for screening project emissions, they are not necessarily representative of potential secondary formation due to Project emissions. For instance, the sources with the lowest SO_2 and NOx emission thresholds are in interior California, which is not representative of the climatology or source environment of the proposed Project. Furthermore, both of these sources were modeled with 'low' source heights (release height of 1 m), which is not representative of Project sources.

The summarized modeling results for 24-hour average concentrations of secondary formation for precursor SO_2 and NOx in Appendix A of the modeling guidance was further reviewed. The data was sorted to only include:

- sources located in Oregon or Washington (considered to be more representative of climate at the Project site);
- Precursor emissions of 500 tpy (similar in magnitude, yet conservative, to Project emissions); and
- And 'high' stack heights (similar to Project sources).

The results of this analysis are summarized in Table 3-8. Taking the two highest modeled responses, 0.15 $\mu g/m^3$ and 0.24 $\mu g/m^3$ for NOx and SO_2, respectively, the combined potential secondary formation from Project emissions is 0.39 $\mu g/m^3$.

Table 3-6 Summary of MERPs Analysis for Daily $PM_{2.5}$

Precursor	Project Emissions (tpy)	Daily $PM_{2.5}$ MERP (tpy) [1]	Ratio of Project Emissions to Daily $PM_{2.5}$ MERP	Sum of Ratios
Direct $PM_{2.5}$	AERMOD			0.34
NOx	155.0	1,075	0.14	
SO_2	40.2	210	0.19	

[1] These are the most conservative (lowest) MERP values for ozone in the Western U.S. as summarized in the February 23, 2017 memorandum.

Table 3-7 Summary of MERPs Analysis for Annual $PM_{2.5}$

Precursor	Project Emissions (tpy)	Annual $PM_{2.5}$ MERP (tpy) [1]	Ratio of Project Emissions to Annual $PM_{2.5}$ MERP	Sum of Ratios
Direct $PM_{2.5}$	AERMOD			0.07
NOx	155.0	2,289	0.05	
SO_2	40.2	3,184	0.02	

[1] These are the most conservative (lowest) MERP values for ozone in the Western U.S. as summarized in the February 23, 2017 memorandum.

Table 3-8 Summary of Modeled Responses for Representative Sources

Precursor	Area	Emissions (tpy)	Height	Source	FIPs	State	County	Modeled Response ($\mu g/m^3$)
NOx	WUS	500	H	18	41049	Oregon	Morrow	0.15
NOx	WUS	500	H	22	53057	Washington	Skagit	0.05
NOx	WUS	500	H	23	53039	Washington	Klickitat	0.03
SO_2	WUS	500	H	23	53039	Washington	Klickitat	0.24
SO_2	WUS	500	H	18	41049	Oregon	Morrow	0.19
SO_2	WUS	500	H	22	53057	Washington	Skagit	0.08

4. CLASS I AIR QUALITY ANALYSIS

Federal Class I areas are afforded the highest level of protection under the Clean Air Act. As such, the Class I area analysis for Type B State NSR projects includes the assessment of ambient impacts in terms of pollutant concentrations. The model inputs and scenarios described in Section 3 will be used for the Class I analyses for all Class I areas located within 200 km from the project location (provided in Table 4-1 below).

Table 4-1 Distance to Class I Areas

Class I Area	State	Distance (km)
Crater Lake National Park	OR	165
Redwood National Park	CA	177
Kalmiopsis Wilderness Area	OR	110
Diamond Peak Wilderness Area	OR	165
Three Sisters Wilderness Area	OR	178

There are no Class I areas within 50 km of the project.

4.1 Q/D SCREENING ANALYSIS

An air quality related values (AQRV) analysis is not required for a Type B State NSR project, but is required as part of other regulatory requirements the Project will be required to meet.[16] Therefore for consistency and informational purposes a Q/D calculation for regional haze and deposition will be used to screen for the air quality related values (AQRVs).[17] The screening analysis is based on distance from the source to the Class I area and the annualized daily emissions of AQRV-impacting pollutants. If the Q/D analysis results are less than or equal to the screening factor of 10, then FLM agencies do not require any further Class I AQRV impact analyses from those sources.

Using the emissions summarized in Table 2-1 for the visibility impairing pollutants of NOx, SO_2, PM, and H_2SO_4 the calculated Q value is 327.6. Using the shortest distance, D, from Table 4-1 above, the Q/D value is calculated to be 2.98, which is below the threshold value of 10.

4.2 CLASS I SIGNIFICANCE ANALYSIS

An assessment of project impacts in comparison to the Class I significant impact level for the Class I PSD increments will be run using AERMOD as a screening tool. Receptors will be

[16] The 2017 FERC analysis requirements specify that visibility impacts at Class I areas must be considered.
[17] U.S. Forest Service – Air Quality Program, National Park Service – Air Resources Division, U.S. Fish and Wildlife Service – Air Quality Branch, *Phase I Report of the Federal Land Managers' Air Quality Related Values Workgroup (FLAG)- Revised*, Section 3.2. October 2010.

placed at a distance of 50 km from the project in arcs that will be located to capture plume impacts in the direction of each Class I area. The elevation of the receptors will be based on the actual elevation of each receptor location as determined by AERMAP and standard NED data. Results from the screening modeling will be compared to the Class I SILs defined in the OAR and proposed by EPA, which are listed in Table 4-2, below. Similar to the Class II analyses, direct $PM_{2.5}$ impacts from AERMOD at 50 km will be added to the representative secondary formation discussed in Section 3.5.2, if applicable.

If Project impacts are above the Class I SILs then a qualitative approach will be developed to demonstrate that Project impacts will be less than the Class I SILs at the actual distance of the Class I areas.

Table 4-2 Class I Significant Impact Levels and PSD Increments

Pollutant	Averaging Period	OAR Class I SILs(1) (μg/m³)	EPA Class I SILs(2) (μg/m³)	Class I Increments(3) (μg/m³)
SO_2	3-hour	1.0	--	2
	24-hour	0.2	--	5
	Annual	0.1	--	25
NO_2	Annual	0.1	--	2.5
PM_{10}	24-Hour	0.3	--	8
	Annual	0.2	--	4
$PM_{2.5}$	24-hour	0.07	0.27	2
	Annual	0.06	0.05	1

(1) OAR 340-200-0020(163). All SILs are based on the first highest concentration at any one location.
(2) Revised August 18, 2016 Guidance on Significant Impact Levels for Ozone and Fine Particulates in the Prevention of Significant Deterioration Permitting Program
(3) OAR 340-202-0210. For any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location.

FIGURES

FIGURE 1-: PROJECT AREA

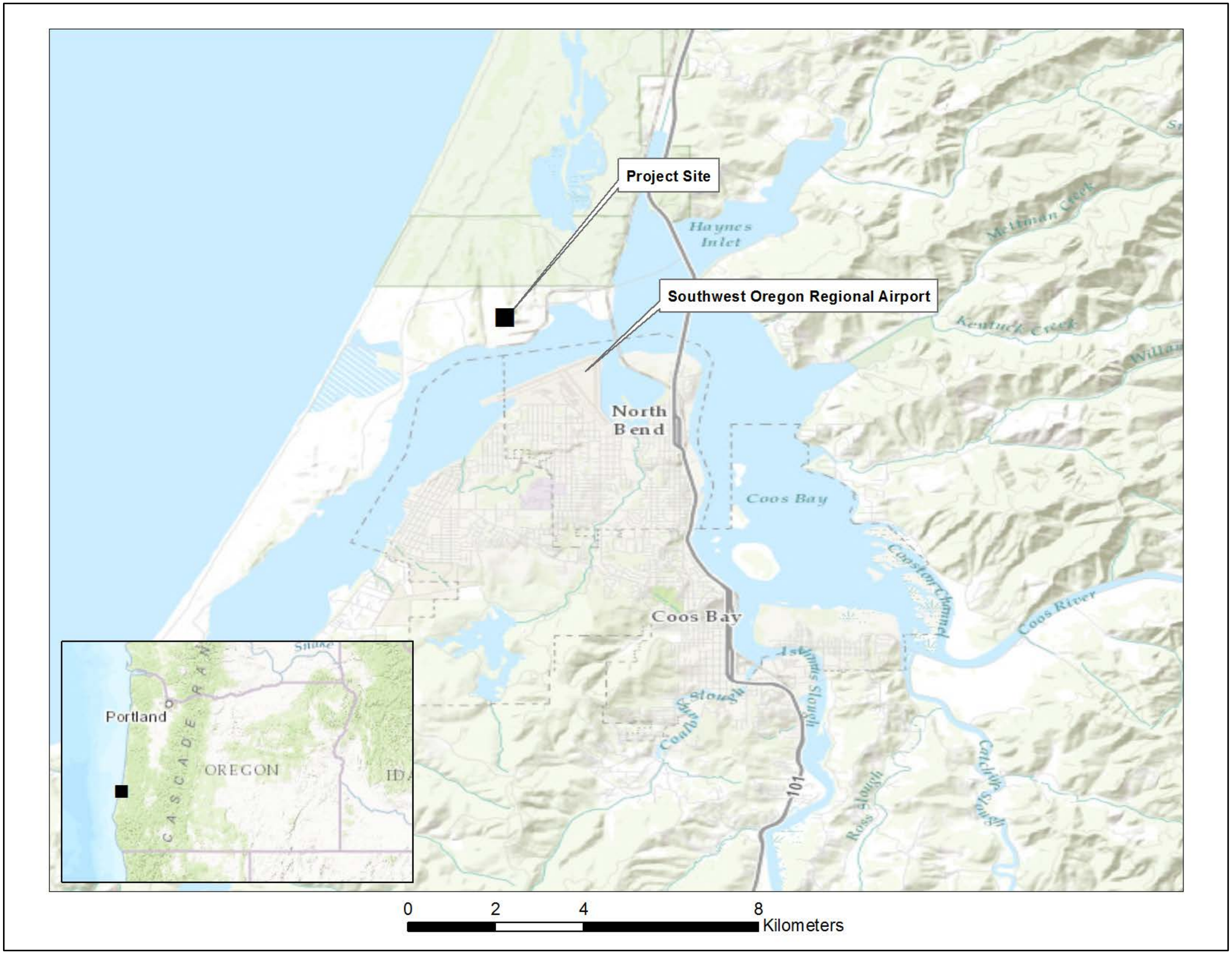


FIGURE 1-2A: SITE LAYOUT – SOUTH DUNES

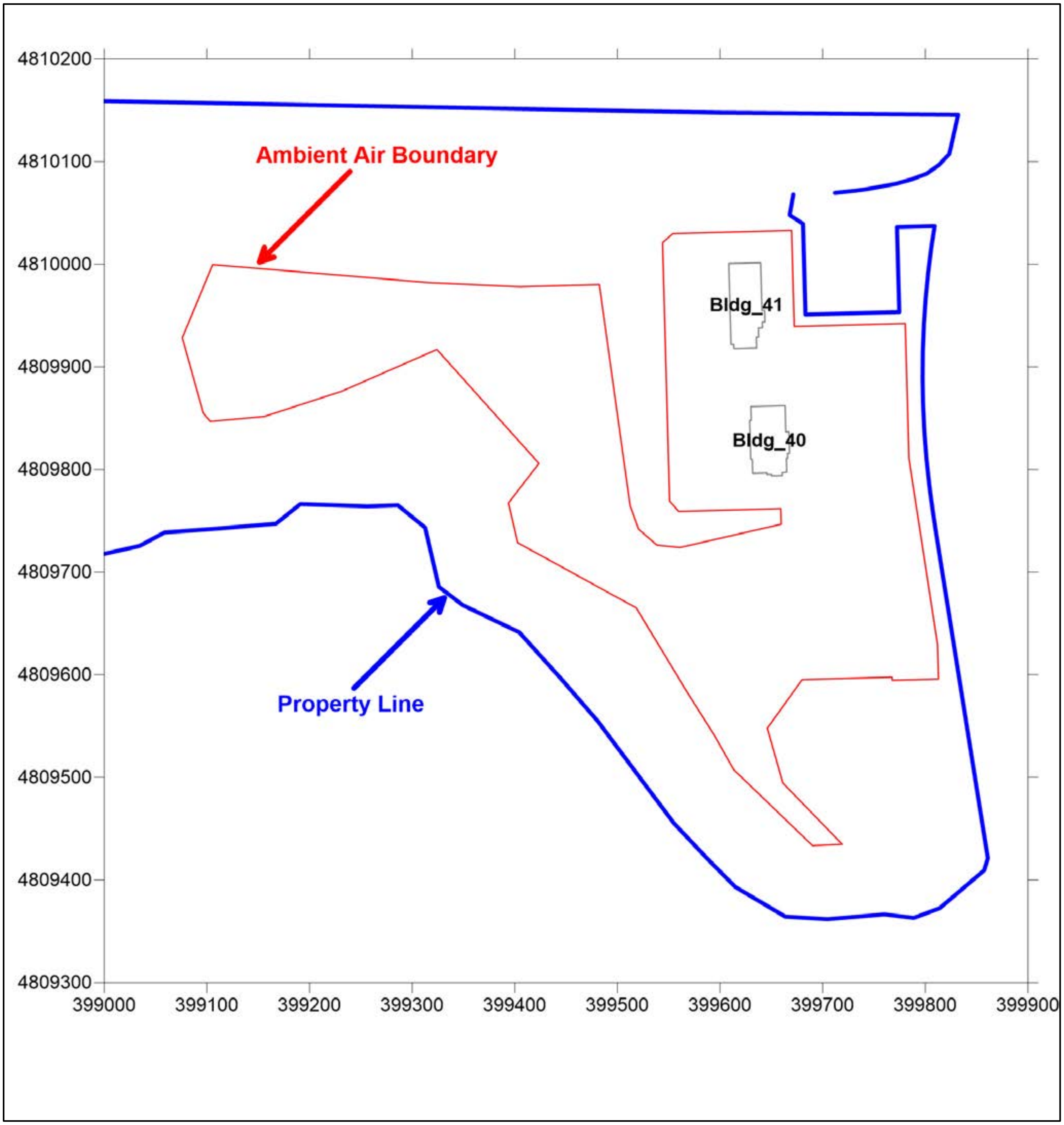


FIGURE 1-2B: SITE LAYOUT – TERMINAL

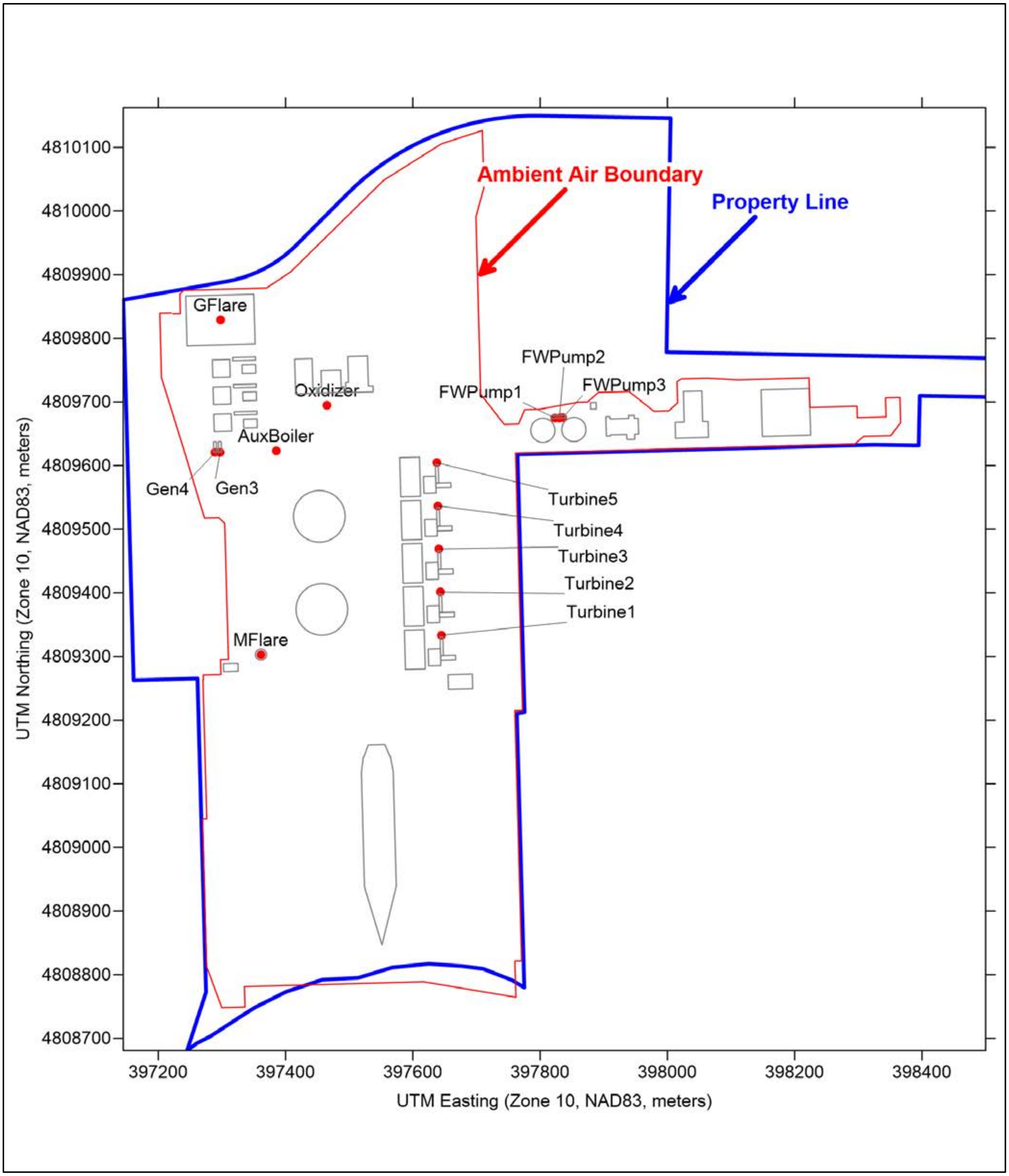


FIGURE 3-1: 2012-2016 WINDROSE FROM SOUTHWEST OREGON REGIONAL AIRPORT (KOTH)

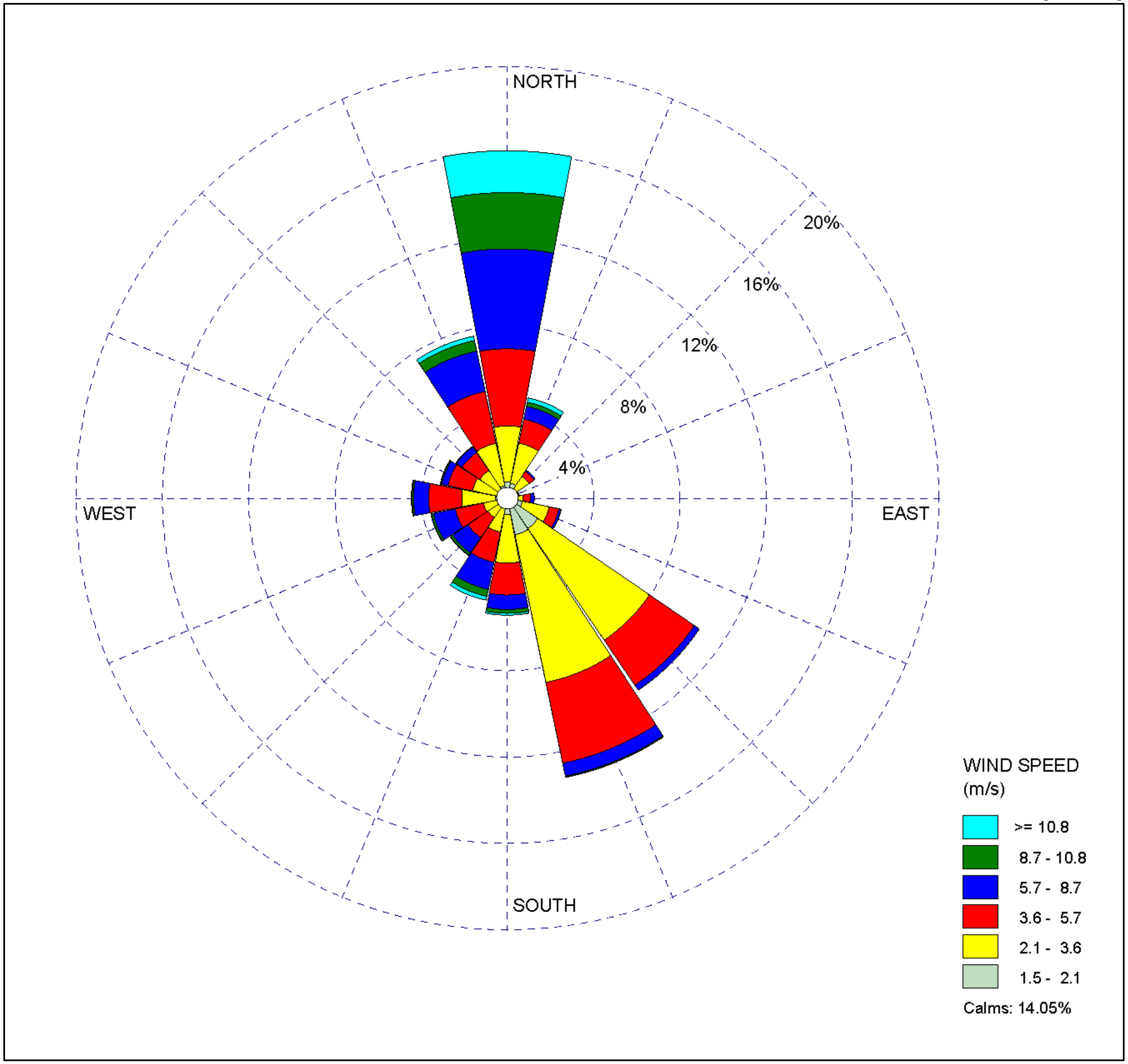


FIGURE 3-2: 1992 NLCD DATA AT PROJECT SITE

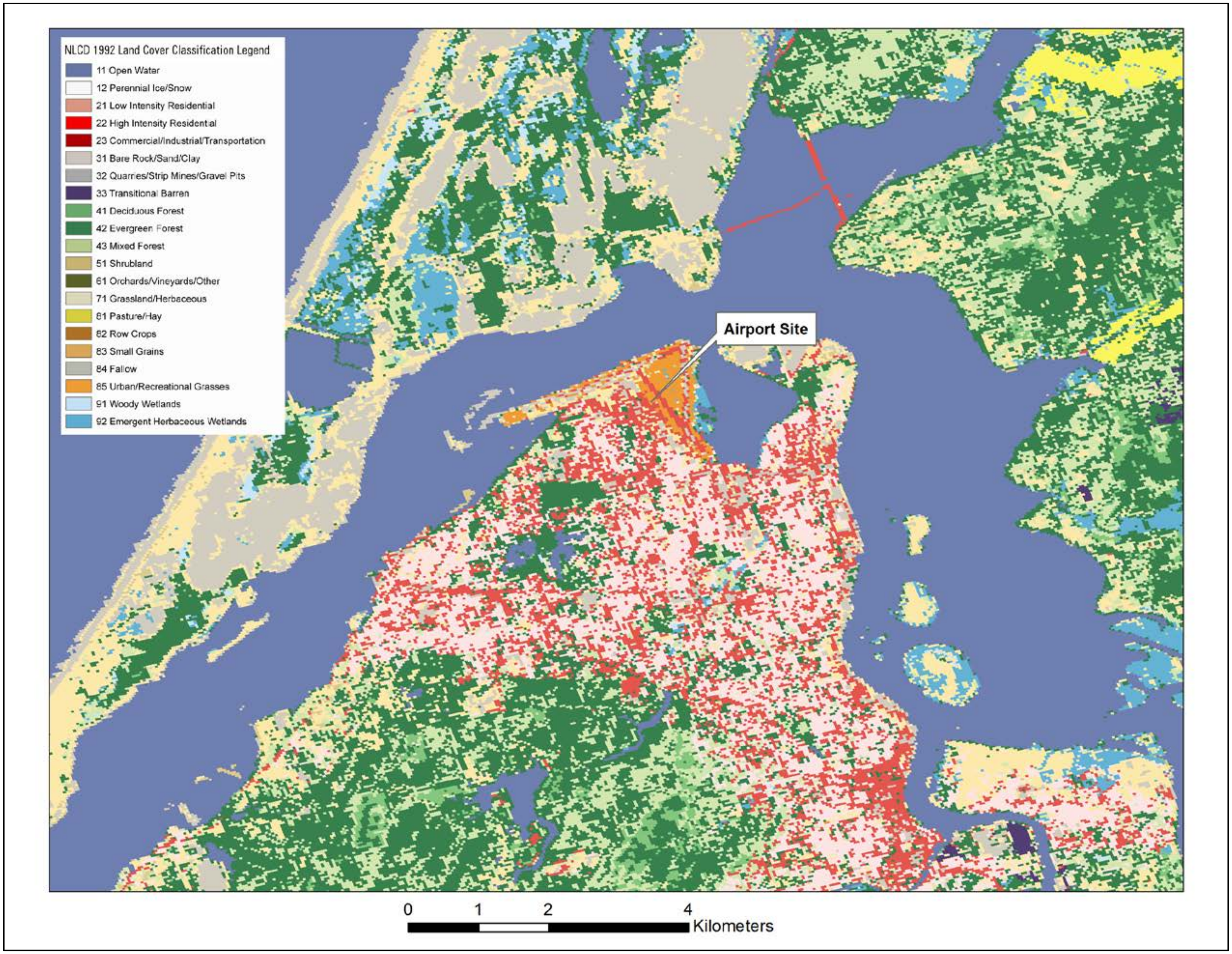


FIGURE 3-3: NEARFIELD RECEPTORS

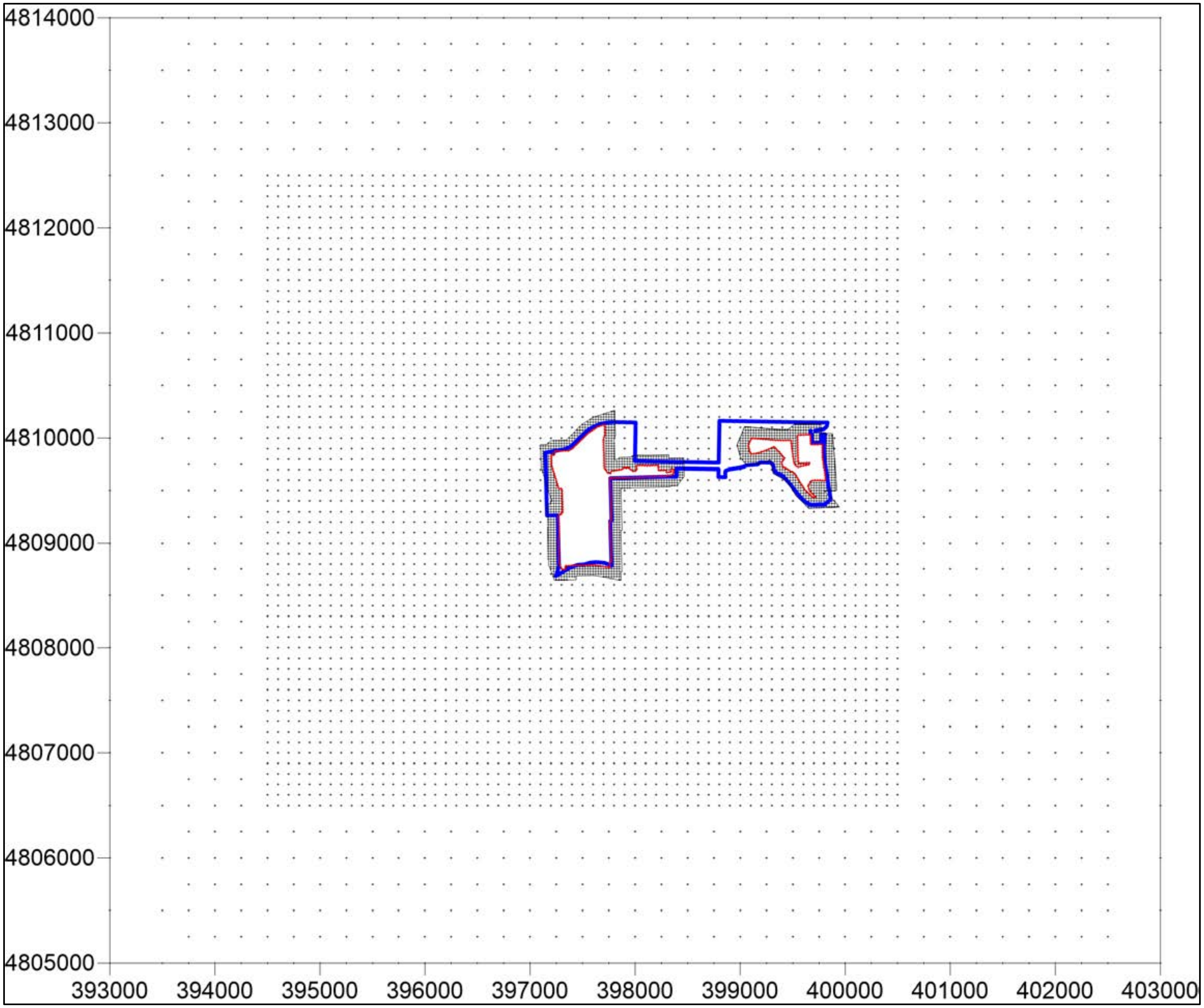


FIGURE 3-4: EXTENT OF RECEPTOR GRIDS

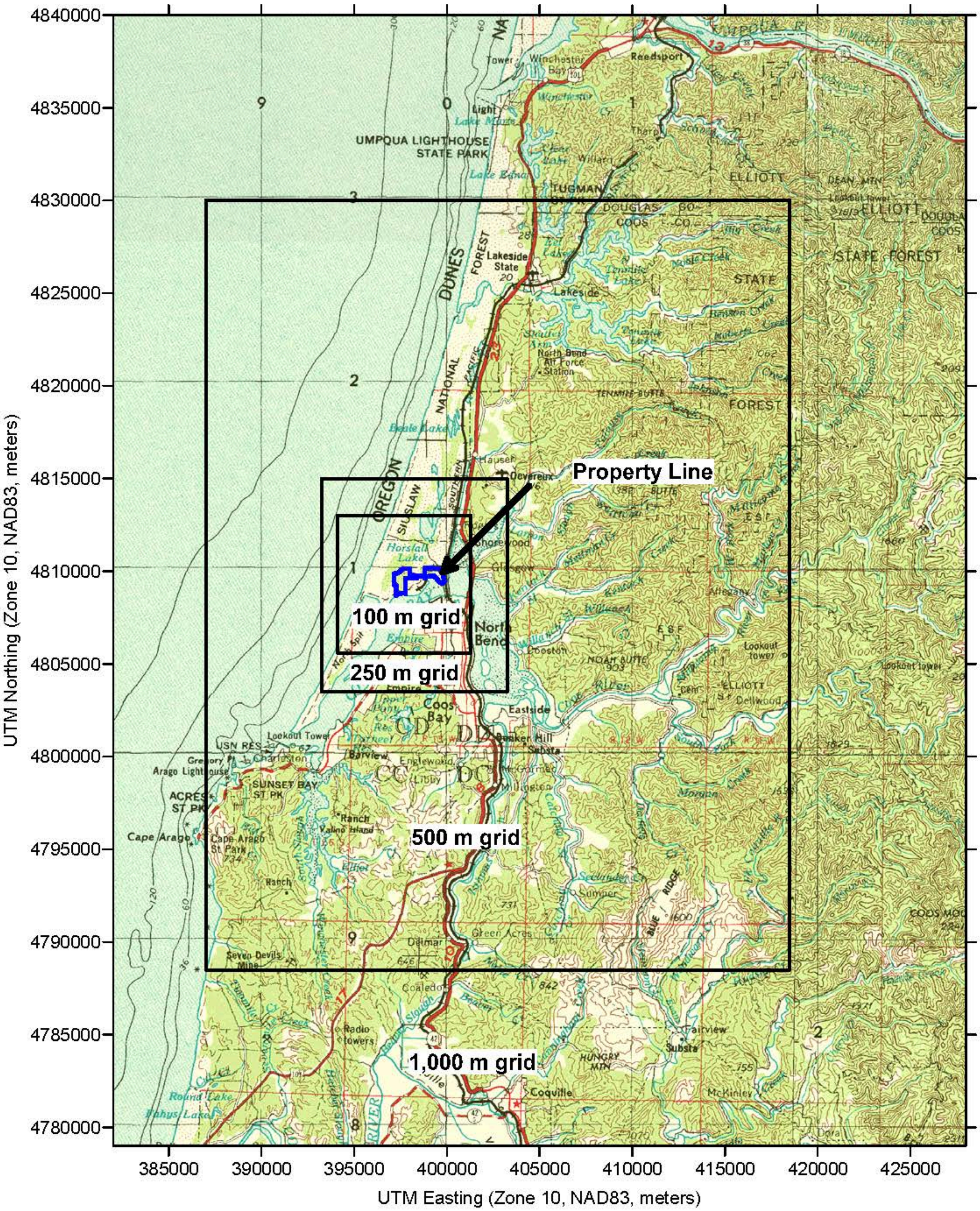
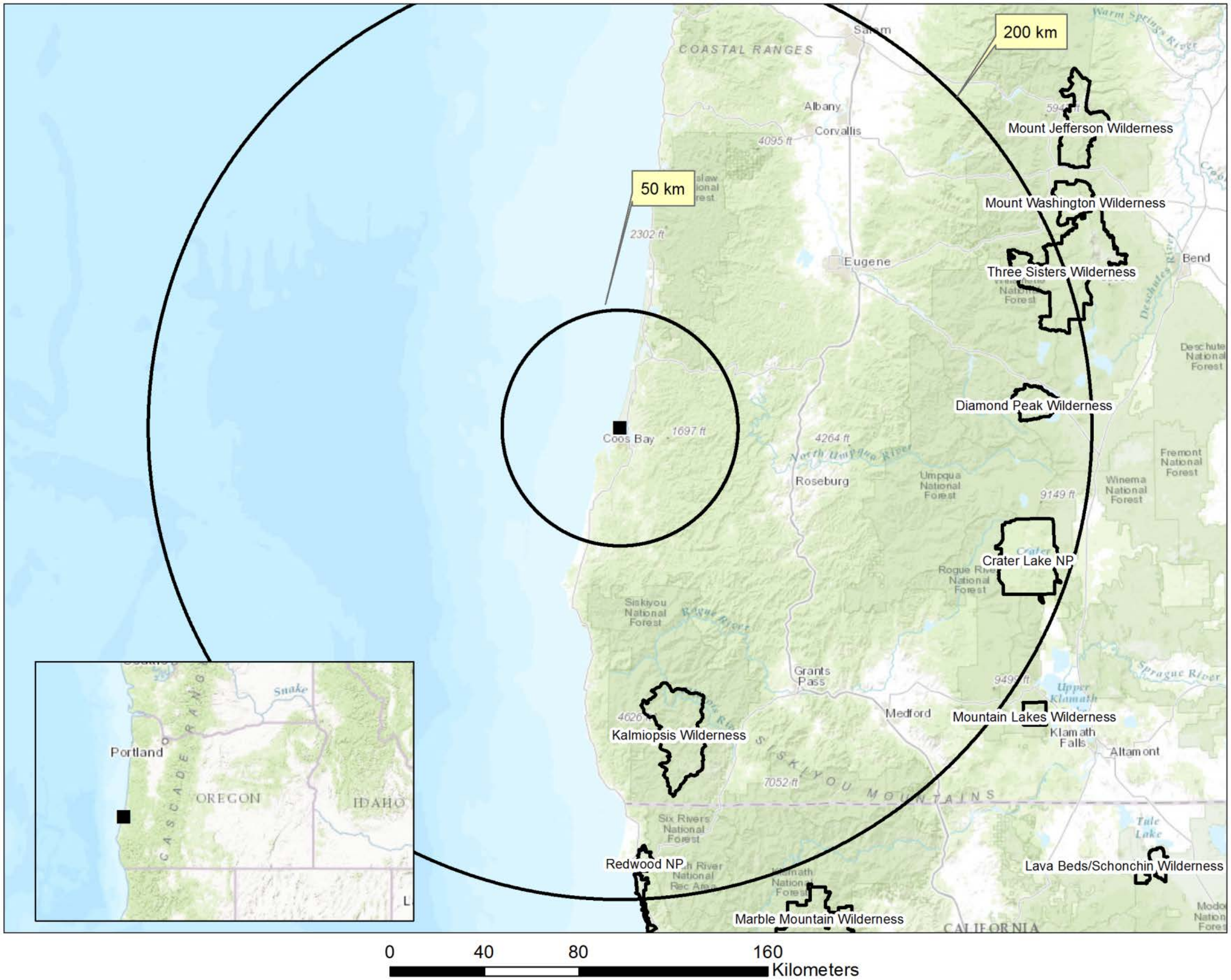


FIGURE 4-1: ILLUSTRATION OF CLASS I AREAS AND DISTANCE FROM PROJECT



Memorandum

To: Michael Eisele, P.E./Oregon Department of Environmental Quality

From: Jessica Stark, P.E.

Date: June 1, 2017

Subject: **Applicability of the Prevention of Significant Deterioration Enumerated Source Categories to Natural Gas Liquefaction Facilities**

This paper addresses whether natural gas liquefaction facilities are, per se, within one of the 28 source categories listed in the Clean Air Act ("CAA" or "the Act") that are subject to the Prevention of Significant Deterioration ("PSD") program if they emit 100 tons per year or more of a regulated pollutant. This paper also summarizes recent permits issued to natural gas liquefaction facilities in the United States, and discusses whether, and on what basis, the relevant state agencies evaluated whether the facility was subject to the PSD program.

A. Summary

As further discussed below, LNG liquefaction facilities are not, per se, within one of the 28 source categories listed in the CAA that are subject to the PSD program if they emit 100 tons per year ("tpy") or more of a regulated pollutant. In its regulations and guidance documents, EPA has not concluded that LNG liquefaction facilities are per se within one of the 28 source categories listed in the Act. A review of recent permitting decisions for other LNG liquefaction facilities has reached the same conclusion.

B. Background

Under the CAA, certain facilities are subject to the PSD program if they emit, or have the potential to emit, one hundred tpy or more of any air pollutant.[1] Other sources not specifically listed in the CAA are subject to the PSD program if they emit, or have the potential to emit, two hundred and fifty tpy or more of any air pollutant.[2] The 28 source categories that are subject to the 100 tpy limit are listed in the Act and its implementing regulations.[3]

The list of 28 source categories included in the Act and its implementing regulations was derived from a list that EPA included in an early PSD rulemaking. In 1974, before Congress amended the Clean Air Act to include the PSD program, EPA issued a final rule that established an early version of the PSD program.[4] In that final rule, EPA included a list of 18 source

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[1] 42 U.S.C. § 7479(1).
[2] *Id*.
[3] *Id*.; 40 C.F.R. § 52.21(b)(1)(i).
[4] 39 Fed. Reg. 42,510 (Dec. 5, 1974).

categories that would be subject to the early PSD program.[5] When Congress amended the Clean Air Act in 1977 to include the PSD program, it relied on the list of 18 sources included in EPA's earlier rule and added ten additional sources to that list.

The 28 source categories listed in the Act and in EPA's PSD regulations are not clearly defined in the statute or regulations. EPA has acknowledged this and has explained that where a facility does not clearly fall into any of the 28 categories, the facility should consult the definitions in EPA's New Source Performance Standards ("NSPS") regulations to determine whether the facility is a listed source.[6] EPA has also clarified the meaning of many of the 28 source categories in guidance documents.

C. Listed Source Categories

As described in more detail below, under the Act, EPA regulations, and EPA guidance documents, LNG liquefaction facilities have not per se been considered to be included under one of the 28 listed source categories for purposes of PSD applicability. An analysis of certain listed source categories is presented below. The remaining source categories would not apply to LNG liquefaction facilities.

1. Fuel Conversion Plants

Nothing in the Act, EPA regulations or EPA Guidance suggest that an LNG liquefaction facility is a "fuel conversion plant" for purposes of PSD applicability. The Act, the PSD regulations, and the NSPS regulations do not define "fuel conversion plant." However, EPA has explained in guidance that a facility is a "fuel conversion plant" if it changes the state (e.g., solid to gas) or form (e.g., coal gasification, oil shale processing, conversion of waste to fuel gas and processes saw dust into pellets) of a fuel.[7] However, even if a facility changes the state of a fuel (e.g., liquid to gas), it is not a fuel conversion plant if the change requires only minimal processing.[8]

EPA has specifically considered whether LNG vaporization facilities are "fuel conversion plants" for purposes of PSD applicability. In a 2003 guidance document, EPA examined whether a facility that converted LNG into natural gas was a "fuel conversion plant" under the PSD program.[9] EPA explained that, while the facility did change the state of the fuel (liquid to gas), it did so with only minimal processing.[10] EPA stated that the facility was not a "fuel conversion plant" because converting LNG into natural gas could be done "without the need for

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[5] *Id*.
[6] U.S. EPA, Prevention of Significant Deterioration, Workshop Manual I-A-9 (Oct. 1980), *available at* https://www.epa.gov/sites/production/files/2015-07/documents/1980wman.pdf.
[7] Memorandum from Edward J. Lillis, Chief, Permits Programs Branch, U.S. EPA Headquarters, to George T. Czerniak, Chief, Air Enforcement Branch, U.S. EPA Region V (May 26, 1992), *available at* https://www.epa.gov/sites/production/files/2015-07/documents/clvlndel.pdf.
[8] Memorandum from Racqueline Shelton, Group Leader, U.S. EPA Integrated Implementation Group, to Guy Donaldson, Acting Chief, U.S. EPA Region 6 Air Permits Section (July 31, 2003), *available at* https://www.epa.gov/sites/production/files/2015-07/documents/pelican.pdf.
[9] *Id*.
[10] *Id*.

chemical or process change that generally occurs at other sources that EPA considers as 'fuel conversion plants' (e.g., coal gasification, oil shale processing, conversion of municipal waste to fuel gas, processing of sawdust into pellets) under the PSD rules."[11]

For the same reasons described by EPA in its 2003 guidance, an LNG liquefaction facility (converting natural gas to liquid) is not a "fuel conversion plant." Like converting LNG to natural gas, converting natural gas to LNG does not require significant chemical or process changes. Both LNG vaporization facilities and LNG liquefaction facilities rely on changing the temperature of the fuel to convert it from one state to another, and neither requires any other chemical or process changes. As a result, like an LNG vaporization facility, an LNG liquefaction facility would not be considered a "fuel conversion plant" for purposes of PSD applicability.

2. Petroleum Storage and Transfer Facility

Nothing in the Act, EPA regulations or EPA Guidance suggest that an LNG liquefaction facility is a "petroleum storage and transfer facility" for purposes of PSD applicability. The Act, the PSD regulations, and the NSPS regulations do not define "petroleum storage and transfer facility." The NSPS regulations do, however, define "petroleum" as "the crude oil removed from the earth and the oils derived from tar sands, shale, and coal."[12] EPA has further stated that a facility that stores or transfers gasoline is not considered a "petroleum storage and transfer facility."[13] In its guidance, EPA explained that "it is our determination that the named category [petroleum storage and transfer facility] was limited to crude oil and not its refined products."[14] Because an LNG liquefaction facility does not store "petroleum," it is not a "petroleum storage and transfer facility" for purposes of PSD applicability.

3. Petroleum Refinery

Nothing in the Act, EPA regulations or EPA Guidance suggest that an LNG liquefaction facility is a "petroleum refinery" for purposes of PSD applicability. Neither the Act nor the PSD regulations define "petroleum refinery." The NSPS regulations define "petroleum refinery" as "any facility engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants, asphalt (bitumen) or other products through distillation of petroleum or through redistillation, cracking or reforming of unfinished petroleum derivatives. A facility that produces only oil shale or tar sands-derived crude oil for further processing at a petroleum refinery using only solvent extraction and/or distillation to recover diluent is not a petroleum refinery."[15] An LNG liquefaction facility does produce petroleum products through distillation, cracking or reforming. Because an LNG liquefaction facility does not meet the definition of "petroleum refinery" under the NSPS regulations, it is not a "petroleum refinery" for purposes of PSD applicability.

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[11] *Id*. at 1-2.
[12] 40 CFR §§ 60.101(b), 60.111(d), 60.111a(d), 60.111b.
[13] Letter from R. Douglas Neely, Chief, U.S. EPA Region 4 Air and Radiation Technology Branch to Chun-chi S. Liu, Mecklenburg County Department of Environmental Protection (Feb. 18, 1998), *available at* https://www3.epa.gov/ttn/naaqs/aqmguide/collection/t5/apl_mek1.pdf.
[14] *Id*.
[15] 40 CFR § 60.101a.

4. Fossil Fuel-Fired Steam Electric Plant

Nothing in the Act, EPA regulations or EPA Guidance suggest that an LNG liquefaction facility is a "fossil fuel-fired steam electric plant" for purposes of PSD applicability. The Act, the PSD regulations, and the NSPS regulations do not define "fossil fuel-fired steam electric plant." However, EPA's initial PSD program and the legislative history of the Act indicate that this source category was intended to cover large electric power plants, not LNG liquefaction facilities even if electricity is produced.

As described above, the list of 28 source categories in the CAA and in the current PSD regulations was derived from a list that EPA established in an earlier version of the PSD program. In the Federal Register notices promulgating that earlier rule, EPA explained that the list of source categories was intended to include the largest emitters in the nation.[16] In the proposed rule, EPA stated that the listed source categories "account for approximately 30 percent of the particulate matter and 75 percent of the sulfur dioxide emitted" each year.[17] Similarly, in a technical support document that was part of the PSD rulemaking, EPA stated that the listed source categories were "the largest present emitters of SO2 and [total suspended particulates] on a nationwide basis."[18] At the time of EPA's initial rulemaking in 1974, there were few (if any) operating LNG liquefaction facilities. There is nothing in EPA's supporting documents which suggests that EPA intended to regulate under this category LNG liquefaction facilities.

Further, rulemaking documents confirm that the source category "fossil fuel-fired steam electric plant" was intended to cover large power plants. In a technical support document prepared as part of the PSD rulemaking, EPA repeatedly refers to "fossil fuel-fired steam electric power plants" when discussing various aspects of the rule.[19] While the regulations remove the term "power" in the list of covered sources, this rulemaking document confirms that EPA understood this category to cover what are commonly thought of as electric power plants.

Similarly, the legislative history of the 1977 amendments to the CAA, which formalized the PSD program, indicate that the source category "fossil fuel-fired steam electric plant" was understood to cover large electric power plants. In Congressional debate over the proposed amendments, the representatives repeatedly discuss the impact of the proposed amendments on the construction of large power plants.[20]

While EPA has issued a few short guidance documents describing the meaning of "fossil fuel-fired steam electric plant," it has not found that LNG liquefaction plants are part of this source category. In a 1987 applicability determination, EPA concluded that certain equipment that was ancillary to a gas turbine should be considered when determining whether the turbine

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[16] 38 Fed. Reg. 18,986, 18,989 (July 16, 1973); U.S. EPA, TECHNICAL SUPPORT DOCUMENT – EPA REGULATIONS FOR PREVENTING THE SIGNIFICANT DETERIORATION OF AIR QUALITY, EPA-450/2-75-001 (Jan. 1975) [hereinafter "Technical Support Document"].
[17] 38 Fed. Reg. at 18,989.
[18] Technical Support Document at 28.
[19] *See* e.g., Technical Support Document at 34 (emphasis added).
[20] *See* e.g., 123 Cong. Rec. 18,154 (June 9, 1977).

satisfied the 250 mmbtu heat input requirement for this source category.[21] EPA did not, however, describe the facility in which the turbine was located or describe whether and why the facility was considered a "fossil fuel-fired steam electric plant." EPA only addressed the narrow issue of what ancillary equipment should be considered when calculating the heat input of a "fossil fuel-fired steam electric plant."[22] Similarly, in a 1993 applicability determination, EPA concluded that gas turbine combined cycle cogeneration plants could be considered "fossil fuel-fired electric plants," but did not discuss whether that determination extended to combined cycle cogeneration plants at LNG liquefaction facilities.[23] In a 1978 applicability determination, EPA concluded that a steam generating unit that produced electricity could be considered a "fossil fuel-fired steam electric plant" even if it was not part of a large power plant.[24] This determination from almost forty years ago, however, does not address whether gas turbines used to drive compressors that do not directly generate electricity would be considered "fossil fuel-fired steam electric plants." The applicability determination was also issued when there were very few, if any, LNG liquefaction facilities in the United States and does not address whether LNG liquefaction facilities are considered part of this source category.

Finally, turbines used at LNG liquefaction facilities are used to drive compressors for refrigeration and do not produce electric output through the shaft work to drive generators. Therefore the turbines do not produce electricity and would not be considered a "fossil fuel-fired steam <u>electric</u> plant" for purposes of PSD applicability. As a result, an LNG liquefaction facility would not be considered a "fossil fuel-fired steam electric plant" for purposes of PSD applicability.

5. <u>Fossil-Fuel Boilers and LNG Gas Turbines with Duct Burners</u>

Nothing in the Act, EPA regulations or EPA Guidance suggest that gas turbines with duct burners at an LNG liquefaction facility qualify as "fossil-fuel boilers" for purposes of PSD applicability. Neither the Act nor the PSD regulations define "fossil fuel boilers of more than [250 mmbtu] per hour heat input." However, the NSPS regulations define "boiler" as "any enclosed device that extracts useful energy in the form of steam."[25] The term boiler does not include "duct burners." In contrast, a duct burner is "a device that combusts fuel and that is placed in the exhaust duct from another source, such as a stationary gas turbine, internal combustion engine, kiln, etc., to allow the firing of additional fuel to heat the exhaust gases before the exhaust gases enter a heat recovery steam generating unit."[26] When a duct burner is connected to and part of a combined cycle gas turbine, it is considered part of the gas turbine

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[21] Letter from David Kee, Director, U.S. EPA Air and Radiation Division to Dell Collins, Impell Power Projects (Sept. 30, 1987), *available at* https://www.epa.gov/sites/production/files/2015-07/documents/equptmnt.pdf.
[22] *Id*.
[23] Letter from Edward J. Lillis, Chief, U.S. EPA Permits Program Branch to Bernard E. Turlinski, Chief, U.S. EPA Region III Air Enforcement Branch and George T. Czerniak, Chief, U.S. EPA Region V Air Enforcement Branch (Feb. 2, 1993), *available at* https://www.epa.gov/sites/production/files/2015-07/documents/turbines.pdf.
[24] Letter from Director, U.S. EPA Division of Stationary Source Enforcement to Thomas W. Devine, Chief, U.S. EPA Region I Air Branch (Feb. 13, 1978, *available at* https://www.epa.gov/sites/production/files/2015-07/documents/m021378.pdf.
[25] 40 C.F.R. §§ 60.561, 60.611, 60.661.
[26] 40 C.F.R. § 60.41Da.

and is regulated as part of the turbine under NSPS Subpart KKKK, and is explicitly exempted from the NSPS requirements for boilers.[27],[28]

To the extent that an LNG liquefaction facility uses a combined cycle gas turbine with an attached duct burner to drive the refrigeration compressor and also has a fossil-fuel fired boiler on site, the heat input capacity of the duct burner is not combined with the boiler to determine whether the 250 mmbtu heat input threshold is met. As described above, a duct burner is not a boiler and should not be considered when determining the heat input of the boiler. Similarly, if the duct burner is not even attached to the boiler, it would be inappropriate to consider the heat input of the duct burner when determining PSD applicability with respect to the boiler. As a result, an LNG liquefaction facility using gas turbines with duct burners to drive refrigeration compressors would not be considered a "fossil-fuel boiler" for purposes of PSD applicability.

6. Sulfur Recovery Plants

Nothing in the Act, EPA regulations or EPA Guidance suggest that gas treatment systems at an LNG liquefaction facility qualify as "sulfur recovery plants" for purposes of PSD applicability. Neither the Act nor the PSD regulations define "sulfur recovery plants." Under EPA's NESHAPs regulations a "*Sulfur recovery unit*" means "a process unit that recovers elemental sulfur from gases that contain reduced sulfur compounds and other pollutants, usually by a vapor-phase catalytic reaction of sulfur dioxide and hydrogen sulfide. This definition does not include a unit where the modified reaction is carried out in a water solution which contains a metal ion capable of oxidizing the sulfide ion to sulfur, e.g., the LO-CAT II process."[29] Similarly, sulfur recovery as defined by AP-42 refers to the conversion of hydrogen sulfide to elemental sulfur.[30] Gas treatment systems at LNG liquefaction facilities treat the natural gas to reduce hydrogen sulfide followed by a carbon dioxide removal process using a primary amine process to remove CO_2 and a dehydration system to remove water and mercury. The remaining acid gas is typically sent to a thermal oxidizer for combustion. Elemental sulfur is not recovered. Because the gas treatment systems at an LNG liquefaction facility do not recover sulfur, an LNG liquefaction facility is not a "sulfur recovery plant" for purposes of PSD applicability.

7. Chemical Process Plants

Nothing in the Act, EPA regulations or EPA Guidance suggest that an LNG liquefaction facility is a "chemical process plant" for purposes of PSD applicability. The Act, the PSD regulations, and the NSPS regulations do not define "chemical process plant." Chemical process plants are described in the SIC manual, and cited in EPA applicability determination, as "establishments producing basic chemicals, and establishments manufacturing products by predominantly chemical processes." The SIC manual notes these facilities manufacture three general classes of products: "(1) basic chemicals, such as acids, alkalines, salts, and organic chemicals; (2) chemical products to be used in further manufacture, such as synthetic fibers, plastics materials, dry colors and pigments; and (3) finished chemical products to be used for

[27] 40 C.F.R. § 60.4305(a).
[28] Note that duct burners installed on turbines not subject to NSPS Subpart KKKK can be subject to other NSPS regulations but have not been considered to be "boilers" as is referenced in the PSD listed source category.
[29] 40 C.F.R. § 63.1579.
[30] AP-42, Section 8.13 (7/93, reformatted 1/95).

ultimate consumption, such as drugs, cosmetics, and explosives."[31] The purpose of a LNG liquefaction facility is to liquefy natural gas by refrigeration, not manufacture the types of chemicals described above. Liquefying natural gas is not a process included in the list described in the SIC manual. For these reasons, an LNG liquefaction facility would not be considered a "chemical process plant" for purposes of PSD applicability.

D. LNG Facility Permit Review

As described above, an LNG liquefaction facility does not, per se, fall within one of the 28 source categories listed in the Act. Several permitting authorities have recently reached the same conclusion and found that LNG liquefaction facilities are not listed sources subject to the 100 tpy threshold for purposes of the PSD program. The discussion below examines PSD permits that were recently issued to LNG liquefaction facilities and confirms that the permitting authorities did not treat the LNG liquefaction facilities as being within one of the 28 listed source categories. No permitting decisions have been located that reached a different conclusion.

1. <u>Port Arthur LNG, LLC, TX, Permit Numbers 131769, PSDTX1456, and GHGPSDTX134</u>

Port Arthur LNG, LLC received a PSD permit on February 17, 2016 for the proposed construction and operation of a natural gas liquefaction and export terminal near Port Arthur, Jefferson County and the Sabine Pass in Southeast Texas. The proposed liquefaction plant will consist of two liquefaction trains, each capable of producing 5.0 MMTPA of LNG. Each LNG train will consist of one propane and one mixed refrigeration compression turbine and an Acid Gas Removal Unit.

The facility will be located in Jefferson County, which is classified as an attainment or unclassified area for all criteria pollutants. The major source threshold of 250 tpy was used for the PSD applicability of this project.

2. <u>Golden Pass Products LLC, TX, Permit Numbers 116055 and PSDTX1386</u>

Golden Pass Products, LLC received a PSD permit on January 16, 2015 for the proposed construction and operation of a natural gas liquefaction and export plant near the Sabine Pass in Southeast Texas. The proposed liquefaction plant will consist of three liquefaction trains. Each train will consist of two gas-fired refrigeration compressor turbines equipped with heat recovery steam generating units.

The facility will be located in Jefferson County, which is classified as an attainment or unclassified area for all criteria pollutants. The major source threshold of 250 tpy was used for the PSD applicability of this project.

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[31] Letter dated August 8, 1997 from Carla E. Pierce, Chief, Operating Source Section, U.S. EPA Air & Radiation Technology Branch, to Chun-chi S. Liu, Mecklenburg County Department of Environmental Protection

3. Corpus Christi Liquefaction Stage III, LLC, TX, Permit Numbers 139479, PSDTX1496, and GHGPSDTX157

Corpus Christi Liquefaction Stage III, LLC received a PSD permit on February 14, 2017 for the proposed construction and operation of two new LNG trains, including 12 natural gas compressor turbines, at a preexisting facility in San Patricio County, TX. The original construction at the facility (Permits 70741 and PSDTX1038) was for an LNG import terminal, while the proposed new trains are for natural gas compression. Since the construction is to occur at a pre-existing facility, the permit application was considered under the "major modification" rules and is not relevant for determining whether a new LNG liquefaction facility is one of the 28 listed source categories.

4. Freeport LNG Pretreatment Facility, TX, Permit Numbers 100114, N150, and PSDTX1282

Freeport LNG Development, L.P. received a PSD permit on March 24, 2015 to construct and operate a natural gas liquefaction plant at the site of an existing LNG import terminal near Freeport, Texas. Since the liquefaction plant is proposed at a pre-existing facility, the permit application was considered under "major modification" rules and is not relevant for determining whether a new LNG liquefaction facility is one of the 28 listed source categories.

5. Elba Island LNG Terminal, GA, Permit 4922-051-0003-V-05-0

Kinder Morgan, Inc. proposed to construct the Elba Liquefaction Terminal, an LNG export terminal, at the site of a pre-existing LNG import terminal in Chatham County, Georgia near the city of Savannah. Because the liquefaction terminal was proposed at a pre-existing facility, the permit application was considered a "major modification" and is not relevant for determining whether a new LNG liquefaction facility is one of the 28 listed source categories.

However, the facility's most recent Title V Renewal Application Review (dated April 21, 2014) explains that the facility is not within one of the 28 listed source categories and that the 250 tpy standard is the appropriate standard to use in determining whether the facility is a Federal Major Source for PSD purposes. According to the renewal application, the facility had been subject to the 100 tpy standard at one time because its combined boiler capacity was greater than 250 MMBtu/hr. However, because the combined boiler capacity at the time of the Title V renewal had dropped below 250 MMBtu/hr, the 100 tpy standard no longer applied. This is significant because it confirms that there was nothing other than the boiler capacity that caused the facility to be designated as one of the 28 listed sources.

6. Sabine Pass LNG Terminal, LA, Permit PSD-LA-703(M3, M4, M5)

Sabine Pass LNG has been granted several modifications to its existing PSD permit to allow the construction of natural gas liquefaction facilities at a pre-existing LNG vaporization facility in Johnsons Bayou, Louisiana. The M3 modification of the permit (December 6, 2011) permitted construction of four natural gas liquefaction trains, consisting of 24 compressor turbines, two generator turbines, two generator engines, flares, acid gas vents, and fugitives. The M4 modification of the permit (March 22, 2013) allowed several changes to the proposed four liquefaction trains. The M5 modification of the permit (June 3, 2015) allowed construction of two additional liquefaction trains, to be similar to the initial four trains.

Since the liquefaction trains were constructed at a pre-existing facility, the application was considered a "major modification" and is not relevant for determining whether a new LNG liquefaction facility is one of the 28 listed source categories.

APPENDIX E

MODEL INPUT SUMMARY

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

Table E- 1. Project Sources

						Emission Rates (g/s)												Stack parameters			
Scenario	Source ID	Description	UTM-x (m)	UTM-Y (m)	Elevation (m)	NO_x 1-hr	NO_x Annual	SO_2 1-hr	SO_2 3-hr	SO_2 24-hr	SO_2 Annual	CO 1-hr	CO 8-hr	$PM_{2.5}$ 24-hr	$PM_{2.5}$ Ann	PM_{10} 24-hr	PM_{10} Ann	Height (m)	Diameter(m)	Exit Temp. (K)	Exit Velocity (m/s)
Normal Operation	Turb1	Turbine 1	397644.9	4809333.4	14.0	4.788E-01	4.719E-01	2.066E-01	2.066E-01	2.066E-01	2.025E-01	5.733E-01	5.733E-01	6.804E-01	6.462E-01	6.804E-01	6.462E-01	36.3	3.0	390.3	21.6
	Turb2	Turbine 2	397643.0	4809401.2	14.0	4.788E-01	4.719E-01	2.066E-01	2.066E-01	2.066E-01	2.025E-01	5.733E-01	5.733E-01	6.804E-01	6.462E-01	6.804E-01	6.462E-01	36.3	3.0	390.3	21.6
	Turb3	Turbine 3	397641.2	4809469.0	14.0	4.788E-01	4.719E-01	2.066E-01	2.066E-01	2.066E-01	2.025E-01	5.733E-01	5.733E-01	6.804E-01	6.462E-01	6.804E-01	6.462E-01	36.3	3.0	390.3	21.6
	Turb4	Turbine 4	397639.3	4809536.8	14.0	4.788E-01	4.719E-01	2.066E-01	2.066E-01	2.066E-01	2.025E-01	5.733E-01	5.733E-01	6.804E-01	6.462E-01	6.804E-01	6.462E-01	36.3	3.0	390.3	21.6
	Turb5	Turbine 5	397637.5	4809604.6	14.0	4.788E-01	4.719E-01	2.066E-01	2.066E-01	2.066E-01	2.025E-01	5.733E-01	5.733E-01	6.804E-01	6.462E-01	6.804E-01	6.462E-01	36.3	3.0	390.3	21.6
Startup/Shutdown	Turb1SU	Turbine 1 Startup/Shutdown	397644.9	4809333.4	14.0	8.778E-01	4.730E-01	1.843E-01	1.992E-01	2.057E-01	2.025E-01	2.100E+00	7.642E-01	6.935E-01	6.465E-01	6.935E-01	6.465E-01	36.3	3.0	390.3	21.6
	Turb2SU	Turbine 2 Startup/Shutdown	397643.0	4809401.2	14.0	8.778E-01	4.730E-01	1.843E-01	1.992E-01	2.057E-01	2.025E-01	2.100E+00	7.642E-01	6.935E-01	6.465E-01	6.935E-01	6.465E-01	36.3	3.0	390.3	21.6
	Turb3SU	Turbine 3 Startup/Shutdown	397641.2	4809469.0	14.0	8.778E-01	4.730E-01	1.843E-01	1.992E-01	2.057E-01	2.025E-01	2.100E+00	7.642E-01	6.935E-01	6.465E-01	6.935E-01	6.465E-01	36.3	3.0	390.3	21.6
	Turb4SU	Turbine 4 Startup/Shutdown	397639.3	4809536.8	14.0	8.778E-01	4.730E-01	1.843E-01	1.992E-01	2.057E-01	2.025E-01	2.100E+00	7.642E-01	6.935E-01	6.465E-01	6.935E-01	6.465E-01	36.3	3.0	390.3	21.6
	Turb5SU	Turbine 5 Startup/Shutdown	397637.5	4809604.6	14.0	8.778E-01	4.730E-01	1.843E-01	1.992E-01	2.057E-01	2.025E-01	2.100E+00	7.642E-01	6.935E-01	6.465E-01	6.935E-01	6.465E-01	36.3	3.0	390.3	21.6
Other Project Sources (All Included with both Normal and Startup/Shutdown Scenatios)	ThermOx	Thermal Oxidizer	397465.0	4809694.7	14.0	1.819E+00	1.819E+00	5.708E-01	5.708E-01	5.708E-01	5.708E-01	1.108E+00	1.108E+00	1.107E-01	1.107E-01	1.107E-01	1.107E-01	40.0	2.9	1144.3	12.7
	AuxBoil	Auxiliary Boiler	397385.3	4809623.5	14.0	2.750E-01	2.750E-02	1.044E-01	1.044E-01	1.044E-01	1.044E-02	3.348E-01	3.348E-01	2.769E-01	2.769E-02	2.769E-01	2.769E-02	30.5	1.8	438.7	14.8
	FP1	Fire Pump 1	397823.0	4809674.7	15.8	1.528E-02	1.528E-02	2.035E-05	2.035E-05	2.035E-05	2.035E-05	7.709E-03	7.709E-03	8.630E-04	8.630E-04	8.630E-04	8.630E-04	5.5	0.2	782.2	58.8
	FP2	Fire Pump 2	397830.3	4809674.9	15.8	1.528E-02	1.528E-02	2.035E-05	2.035E-05	2.035E-05	2.035E-05	7.709E-03	7.709E-03	8.630E-04	8.630E-04	8.630E-04	8.630E-04	5.5	0.2	782.2	58.8
	FP3	Fire Pump 3	397835.5	4809675.1	15.8	1.528E-02	1.528E-02	2.035E-05	2.035E-05	2.035E-05	2.035E-05	7.709E-03	7.709E-03	8.630E-04	8.630E-04	8.630E-04	8.630E-04	5.5	0.2	782.2	58.8
	Gen1	Backup Generator 1	399631.0	4809864.4	19.8	4.784E-02	4.784E-02	3.530E-05	3.530E-05	3.530E-05	3.530E-05	4.085E-03	4.085E-03	5.466E-04	5.466E-04	5.466E-04	5.466E-04	4.0	0.2	784.5	87.5
	Gen2	Backup Generator 2	399627.0	4809864.2	19.8	4.784E-02	4.784E-02	3.530E-05	3.530E-05	3.530E-05	3.530E-05	4.085E-03	4.085E-03	5.466E-04	5.466E-04	5.466E-04	5.466E-04	4.0	0.2	784.5	87.5
	BSGen1	Black Start Generator 1	397297.1	4809620.9	14.0	2.137E-02	2.137E-02	1.272E-04	1.272E-04	1.272E-04	1.272E-04	2.992E-03	2.992E-03	6.616E-04	6.616E-04	6.616E-04	6.616E-04	5.5	0.5	740.7	53.9
	BSGen2	Black Start Generator 2	397289.4	4809620.7	14.0	2.137E-02	2.137E-02	1.272E-04	1.272E-04	1.272E-04	1.272E-04	2.992E-03	2.992E-03	6.616E-04	6.616E-04	6.616E-04	6.616E-04	5.5	0.5	740.7	53.9
	MFlare	Marine Flare	397361.3	4809303.0	14.0	6.650E-02	6.650E-02	5.010E-03	5.010E-03	5.010E-03	5.010E-03	3.032E-01	3.032E-01	3.512E-02	3.512E-02	3.512E-02	3.512E-02	30.5	13.7	1273.0	9.1
	GFlare	Ground Flare	397253.6	4809794.1	14.0	3.345E-06	3.345E-06	1.538E-07	1.538E-07	1.538E-07	1.538E-07	1.525E-05	1.525E-05	1.501E-06	1.501E-06	1.501E-06	1.501E-06	N/A	N/A	N/A	N/A

Notes:
"Normal" Scenario includes the five turbines in normal operation mode, and all the other project sources.
"Startup/Shutdown" Scenario includes the five turbines in startup/shutdown mode, and all the other project sources.

Table E- 2. Competing Sources Provided by ODEQ											
Source ID	Owner	Source latitude (deg)	Source longitude (deg)	Allowable Emissions (tpy)				Stack parameters			
				NO_x	PM_{10}	$PM_{2.5}$	SO_2	Height (ft)	Diameter(ft)	Exit Temp. (F)	Exit Velocity (ft/s)
106-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	1	1	---	20	50	72	7
206-0010	Roseburg Forest Products Co.	43.1802	-124.2172	73	13	12	17	50	7	521	30
306-0010	Roseburg Forest Products Co.	43.1802	-124.2172	2	10	10	---	40	5	72	40
406-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	---	---	1	40	5	72	40
506-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	---	---	---	20	50	72	7
606-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	---	---	---	20	50	72	7
706-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	6	3	---	40	5	72	40
806-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	4	2	---	20	50	72	7
906-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	17	8	---	40	5	72	40
1006-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	0	0	---	20	50	72	7
1106-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	2	0	---	20	50	72	7
1206-0010	Roseburg Forest Products Co.	43.1802	-124.2172	---	---	---	---	40	5	72	40
1306-0013	Westrum Funeral Services, Inc. dba Myrtle Crest Memorial Gardens, Inc.	43.1637	-124.1557	---	14	9	---	25	2	1500	7
1406-0013	Westrum Funeral Services, Inc. dba Myrtle Crest Memorial Gardens, Inc.	43.1637	-124.1557	39	---	---	39	25	2	1500	7
1506-0014	Bandon Concrete & Development, Inc.	43.1045	-124.4087	---	14	9		20	50	72	7
1606-0027	Southport Forest Products, LLC	43.4380	-124.2393	39	1	1	39	40	3	350	25
1706-0027	Southport Forest Products, LLC	43.4380	-124.2393	---	3	1	---	40	5	72	40
1806-0027	Southport Forest Products, LLC	43.4380	-124.2393	---	4	3	---	40	5	72	40
1906-0027	Southport Forest Products, LLC	43.4380	-124.2393	---	1	0	---	40	5	72	40
2006-0027	Southport Forest Products, LLC	43.4380	-124.2393	---	5	4	---	40	5	72	40
2106-0027	Southport Forest Products, LLC	43.4380	-124.2393	---	---	---	---	20	50	72	7
2206-0028	Allweather Wood, LLC	43.5098	-124.2120	---	---	---	---	20	50	72	7
2306-0084	LTM, Incorporated	43.3350	-124.1952	---	14	9	---	20	50	72	7
2406-0104	Coastal Cremation and Funeral Service, LLC	43.3888	-124.2594	39	---	---	39	25	2	1500	7
2506-0104	Coastal Cremation and Funeral Service, LLC	43.3888	-124.2594	---	14	9	---	25	2	1500	7
2606-0116	Georgia-Pacific Wood Products LLC	43.3557	-124.1952	---	2	1	---	40	5	72	40
2706-0116	Georgia-Pacific Wood Products LLC	43.3557	-124.1952	---	8	4	---	40	5	72	40
2806-0116	Georgia-Pacific Wood Products LLC	43.3557	-124.1952	---	---	---	---	20	50	72	7
2906-0116	Georgia-Pacific Wood Products LLC	43.3557	-124.1952	---	4	4	---	40	5	72	40

Notes:
All ODEQ competing sources are included in the full impact model runs.

Table E-3. Ship Emissions Scenarios for Annual Averaging Periods					
Scenario	Source	Description	Emission Factors for Modeling (g/s)		
			PM_{10}	PM_{25}	NO_2
Steam Turbine Ships Operating on Oil	STHTL1	Berthed, Not Carrying Out Cargo Transfer	7.979E-03	7.979E-03	6.781E-02
	STHTL4	Berthed, Carrying Out Cargo Transfer	5.985E-02	5.985E-02	5.086E-01
	LNG01	Arrival to Berth	1.099E-02	1.099E-02	9.342E-02
	LNG02	Berthing Vessel	1.330E-03	1.330E-03	1.130E-02
	LNG08	Vessel Warm Up and Unberthing	3.990E-03	3.990E-03	3.390E-02
	LNG09	Departure from Berth to Pilot Station	1.099E-02	1.099E-02	9.342E-02
	TUGS01-TUGS04	Tugboats(1)	1.900E-05	1.900E-05	2.378E-01
	VES01-VES68	Vessel Transit through Channel(1)	3.234E-04	3.234E-04	5.015E-02
Steam Turbine Ships Operating on Gas	GSTHTL1	Berthed, Not Carrying Out Cargo Transfer	1.442E-03	1.442E-03	4.375E-01
	GSTHTL4	Berthed, Carrying Out Cargo Transfer	1.081E-02	1.081E-02	1.313E+00
	GLNG01	Arrival to Berth	1.986E-03	1.986E-03	1.808E+00
	GLNG02	Berthing Vessel	2.403E-04	2.403E-04	4.375E-01
	GLNG08	Vessel Warm Up and Unberthing	7.209E-04	7.209E-04	8.750E-01
	GLNG09	Departure from Berth to Pilot Station	1.986E-03	1.986E-03	1.808E+00
	TUGS01-TUGS04	Tugboats(1)	1.900E-05	1.900E-05	2.378E-01
	GVES01-GVES68	Vessel Transit through Channel(1)	5.843E-05	5.843E-05	1.457E-03
DFDE Ships	DFDHTL1	Berthed, Not Carrying Out Cargo Transfer	3.555E-03	3.555E-03	1.757E-01
	DFDHTL4	Berthed, Carrying Out Cargo Transfer	4.854E-02	4.854E-02	8.733E-01
	DFDLNG01	Arrival to Berth	1.185E-03	1.185E-03	5.856E-02
	DFDLNG02	Berthing Vessel	5.925E-04	5.925E-04	2.928E-02
	DFDLNG08	Vessel Warm Up and Unberthing	4.147E-03	4.147E-03	2.050E-01
	DFDLNG09	Departure from Berth to Pilot Station	1.185E-03	1.185E-03	5.856E-02
	TUGS01-TUGS04	Tugboats(1)	1.900E-05	1.900E-05	2.378E-01
	DFDVES01-DFDVES68	Vessel Transit through Channel(1)	3.485E-05	3.485E-05	1.722E-03

(1) Four surrogate tugboat sources and 68 surrogate vessel sources are used to represent the motion of these vessels.
Each surrogate tug is assigned 1/4 of the total tug emissions, and each surrogate vessel 1/68 of the total vessel emissions

Each of the three ship scenarios above (steam turbine ships on oil, steam turbine ships on gas, and DFDE ships) is combined with the ODEQ competing sources and project source scenarios (either normal operation or shartup/shutdown), to come up with the annual scenarios for full impact runs.

Table E-4. Ship Emissions Scenarios for 24-Hour Averaging Periods				
Scenario	Source	Description	Emission Factors for Modeling (g/s)	
			PM_{10}	PM_{25}
Steam Turbine Ships Operating on Oil	STHTL1	Berthed, Not Carrying Out Cargo Transfer	2.427E-02	2.427E-02
	STHTL4	Berthed, Carrying Out Cargo Transfer	1.820E-01	1.820E-01
	LNG01	Arrival to Berth	3.344E-02	3.344E-02
	LNG02	Berthing Vessel	4.045E-03	4.045E-03
	LNG08	Vessel Warm Up and Unberthing	1.214E-02	1.214E-02
	LNG09	Departure from Berth to Pilot Station	3.344E-02	3.344E-02
	TUGS01-TUGS04	Tugboats[(1)]	7.925E-03	7.925E-03
	VES01-VES68	Vessel Transit through Channel[(1)]	9.835E-04	9.835E-04
Steam Turbine Ships Operating on Gas	GSTHTL1	Berthed, Not Carrying Out Cargo Transfer	4.385E-03	4.385E-03
	GSTHTL4	Berthed, Carrying Out Cargo Transfer	3.289E-02	3.289E-02
	GLNG01	Arrival to Berth	6.042E-03	6.042E-03
	GLNG02	Berthing Vessel	7.309E-04	7.309E-04
	GLNG08	Vessel Warm Up and Unberthing	2.193E-03	2.193E-03
	GLNG09	Departure from Berth to Pilot Station	6.042E-03	6.042E-03
	TUGS01-TUGS04	Tugboats[(1)]	7.925E-03	7.925E-03
	GVES01-GVES68	Vessel Transit through Channel[(1)]	1.777E-04	1.777E-04
DFDE Ships	DFDHTL1	Berthed, Not Carrying Out Cargo Transfer	1.081E-02	1.081E-02
	DFDHTL4	Berthed, Carrying Out Cargo Transfer	1.477E-01	1.477E-01
	DFDLNG01	Arrival to Berth	3.604E-03	3.604E-03
	DFDLNG02	Berthing Vessel	1.802E-03	1.802E-03
	DFDLNG08	Vessel Warm Up and Unberthing	1.261E-02	1.261E-02
	DFDLNG09	Departure from Berth to Pilot Station	3.604E-03	3.604E-03
	TUGS01-TUGS04	Tugboats[(1)]	7.925E-03	7.925E-03
	DFDVES01-DFDVES68	Vessel Transit through Channel[(1)]	1.060E-04	1.060E-04

[(1)] Four surrogate tugboat sources and 68 surrogate vessel sources are used to represent the motion of these vessels.
Each surrogate tug is assigned 1/4 of the total tug emissions, and each surrogate vessel 1/68 of the total vessel emissions.
Each of the three ship scenarios above (steam turbine ships on oil, steam turbine ships on gas, and DFDE ships) is combined with the ODEQ competing sources and project source scenarios (either normal operation or shartup/shutdown), to come up with the 24-hour scenarios for full impact runs.

Table E-5. Emissions Scenarios for 1-Hour Averaging Periods				
Scenario	Source	Description	Emission Factors for Modeling (g/s)	
			NO_2	SO_2
All 1-Hour Scenarios[(1)]	TUGS01-TUGS04	Tugboats[(2)]	2.378E-01	6.500E-02
Steam Turbine Ships Operating on Oil in Transit	VES01-VES68	Vessel Transit through Channel[(2)]	5.015E-02	1.694E-02
Steam Turbine Ships Operating on Gas in Transit	GVES01-GVES68	Vessel Transit through Channel[(2)]	2.659E-02	7.851E-05
DFDE Ships in Transit	DFDVES01-DFDVES68	Vessel Transit through Channel[(2)]	3.143E-02	1.029E-03
Steam Turbine Ships Operating on Oil Arriving at Berth	LNG01	Arrival to Berth	3.410E+00	1.152E+00
Steam Turbine Ships Operating on Gas Arriving at Berth	GLNG01	Arrival to Berth	1.808E+00	5.339E-03
DFDE Ships Arriving at Berth	DFDLNG01	Arrival to Berth	2.138E+00	7.000E-02
Steam Turbine Ships Operating on Oil Berthing	LNG02	Berthing Vessel	8.250E-01	2.788E-01
Steam Turbine Ships Operating on Gas Berthing	GLNG02	Berthing Vessel	4.375E-01	1.292E-03
DFDE Ships Berthing	DFDLNG02	Berthing Vessel	2.138E+00	7.000E-02
Steam Turbine Ships Operating on Oil Hoteling	STHTL1	Berthed, Not Carrying Out Cargo Transfer	8.250E-01	2.788E-01
Steam Turbine Ships Operating on Gas Hoteling	GSTHTL1	Berthed, Not Carrying Out Cargo Transfer	4.375E-01	1.292E-03
DFDE Ships Hoteling	DFDHTL1	Berthed, Not Carrying Out Cargo Transfer	2.138E+00	7.000E-02
Steam Turbine Ships Operating on Oil Loading	STHTL4	Berthed, Carrying Out Cargo Transfer	2.475E+00	8.363E-01
Steam Turbine Ships Operating on Gas Loading	GSTHTL4	Berthed, Carrying Out Cargo Transfer	1.313E+00	1.288E-02
DFDE Ships Loading	DFDHTL4	Berthed, Carrying Out Cargo Transfer	4.250E+00	4.163E-01
Steam Turbine Ships Operating on Oil Warmup/Unberth	LNG08	Vessel Warm Up and Unberthing	1.650E+00	5.575E-01
Steam Turbine Ships Operating on Gas Warmup/Unberth	GLNG08	Vessel Warm Up and Unberthing	8.750E-01	2.583E-03
DFDE Ships Warmup/Unberth	DFDLNG08	Vessel Warm Up and Unberthing	6.413E+00	2.100E-01
Steam Turbine Ships Operating on Oil Departing	LNG09	Departure from Berth to Pilot Station	3.410E+00	1.152E+00
Steam Turbine Ships Operating on Gas Departing	GLNG09	Departure from Berth to Pilot Station	1.808E+00	5.339E-03
DFDE Ships Departing	DFDLNG09	Departure from Berth to Pilot Station	2.138E+00	7.000E-02

(1) The tug emissions are included in all 1-hour scenarios, along with one of the individual activities below.
These are combined with the ODEQ competing sources, and the project sources (either the normal scenario or SUSD scenario), to come up with the 1-hour scenarios for full impact runs.

(2) Four surrogate tugboat sources and 68 surrogate vessel sources are used to represent the motion of these vessels.
Each surrogate tug is assigned 1/4 of the total tug emissions, and each surrogate vessel 1/68 of the total vessel emissions.

APPENDIX F

DETAILED MODELING RESULTS AND CD OF MODELING INPUT AND OUTPUT FILES

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

Placeholder Sheet

A CD is provided with the final hardcopies containing Input and Output files

APPENDIX G

LNG CARRIER CALCULATIONS

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

Jordan Cove Energy Project, L.P.

Appendix G – LNG Carriers

The fleet of LNG vessels expected to call at the JCEP terminal consists of both vessels that have boiler/steam turbine driven (ST) propulsion systems, as well as vessels powered by duel-fuel diesel-electric (DFDE) propulsion. Further, each type of vessel may be operated on either natural gas or fuel oil. For the DFDE ships, however, operation on oil versus operation on natural gas was confined to different activities during the ship's call. Therefore, three vessel emissions scenarios were created in order to determine worst-case air emissions calculations and associated air quality impacts:

- ST vessels operating on oil
- ST vessels operating on natural gas
- DFDE ships

JCEP expects up to 120 LNG vessel calls per year. For the purposes of the modeling, in each of the three scenarios, it is assumed that all of the 120 vessel calls will be of ships of the same propulsion and fuel type.

The LNG vessel call activities can be divided into the following activities and operating periods per visit. These activity times are not dependent on the ship or fuel type. As can be seen in table F-1 the activities in total will last 29 hours per vessel call.

Emission rates for different activities during the ship's call are developed from the emission factors shown in Table F-2, and the amount of power expected to be consumed during that particular activity. As the emission factors are in a g/kWh basis, and the power will vary depending on activity, the emission rates (on a mass per unit time basis) will vary depending on the activity in which the ship is engaged.

If a ship is engaged in a particular activity for the full averaging period, than the full mass per unit time rate is used for modeling of that activity. If a ship is engaged for the activity for a portion of the averaging period, then the mass per unit time emission factor is weighted by the proportion of the activity time to the time of the averaging period. For example, for an activity that takes four hours, the full mass per unit time emission rate calculated will be used for 1-hour averaging periods (as the activity time is longer than that averaging period), but one-sixth of the full mass per unit time emission rate will be used for 24-hour averaging periods (as the four hours of activity time is one-sixth of the averaging period).

The emission factors are shown in Table F-2. The mass per unit time emission calculations for each of the three types of ships are shown in Tables F-3 through F-5, respectively. The emission rates by pollutant and averaging period for model input are shown in Tables F-6 through F-8, respectively. Vessel source locations and stack parameters are shown in Tables F-9 through F-11, respectively.

In addition to the activities at and in the immediate vicinity of the terminal, the emissions of the ship's transit of the channel and near-shore open water are considered by setting up 68 sources along the geographic track of arriving and departing ships. The transit emission rates are used for these surrogate sources, with the emissions divided equally over the 68 surrogate sources.

In addition to the LNG vessels, tugboats will also be deployed in operation at the JCEP LNG terminal. The worst-case scenario involves use of one tugboat. Since the tugboat will be maneuvering around the ship during the worst case, the tugboat is represented as a series of four surrogate sources in the channel adjacent to the ship dock, with one-quarter of the total tugboat emissions assigned to each surrogate source. The tugboat emissions are shown in Table F-12, and stack parameters and location information of the tugboat are detailed in Table F-13.

Marine vessel emissions scenario summaries for the annual, 24-hour, and 1-hour averaging periods are shown in Tables F-14 through F-16.

Table G-1. LNG Vessel Activities and Operating Periods per Visit		
Category	Activity	Time (hours)
Transit	Arrival to Berth	2
	Transit Berth to Pilot Station	2
Hoteling	Berthing Vessel	1
	Berthed, Not Carrying Out Cargo Transfer	6
	Vessel warm up of main engine and departure preparation	2
	Unberthing time	1
Loading	Berthed carrying out cargo transfer	15

Table G-2. Emission Factors for LNG Vessels (g/kWh)				
Pollutant	DFDE Ships		Steam Turbine Ships	
	Gas	Oil	Gas	Oil
NO_x (1)	1.71E+00	3.40E+00	1.05E+00	1.98E+00
CO (2)	1.09E+00	2.80E+00	4.71E-01	2.10E-01
PM (2)	3.46E-02	1.89E-01	4.21E-02	2.33E-01
VOC (2)	6.59E-01	2.70E-01	3.10E-02	1.18E-02
SO_2 (2,3)	5.60E-02	3.33E-01	3.10E-03	6.69E-01
CO_2 (4)	3.62E+02	5.43E+02	7.28E+02	1.03E+03
CH_4 (5)	4.28E-02	1.45E-02	1.40E-02	4.13E-02
N_2O (5)	7.26E-04	4.84E-03	1.34E-02	4.54E-03

(1) Based on IMO Marine Tier III standards.

(2) Based on Afton, Y. and Ervin, D., "An Assessment of Air Emissions from Liquefied Natural Gas Ships Using Different Power Systems and Different Fuels, " J. Air Waste Management Assoc., vol. 58 (2008), pp. 404-411. DFDE ships are assumed to have a 47% efficiency factor and ST ships a 25% efficiency factor.

(3) Fuel Oil sulfur content was assumed 0.1%.

(4) Based on AP-42 Table 3.4.-1 for Diesel Engines and Tables 1.3-12 and 1.4-2 for ST ships.

(5) ST emission factors based upon AP-42 Tables 1.3-3, 1.3-8, and 1.4-2. DFDE ship emission factors based on California Climate Action Registry General Reporting Protvol, Version 3.0, April 2008, Table C.7.

Table G-3. Emission Calculations Steam Turbine Vessels Powered by Fuel Oil

Period		Transit Time (hr)	Marine Grade Oil - MGO (tonnes)	Marine Grade Oil - MGO (gallons)	NOX			CO			PM		
					lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy
Transit													
	Arrival to Berth at 4-5 knots	2.00	1.2	367	27.06	0.0271	3.25	2.87	0.003	0.34	3.18	0.003	0.38
	Transit Berth to Pilot Station	2.00	1.2	367	27.06	0.0271	3.25	2.87	0.003	0.34	3.18	0.003	0.38
Hotelling													
	Berthing Vessel	1.00	0.6	184	6.55	0.0033	0.39	0.69	0.000	0.04	0.77	0.000	0.05
	Berthed Not Carrying Out Cargo Transfer	6.00	7.2	2,205	6.55	0.0196	2.36	0.69	0.002	0.25	0.77	0.002	0.28
	Vessel warm up of main engine and prep to depart berth	2.00	1.2	367	6.55	0.0065	0.79	0.69	0.001	0.08	0.77	0.001	0.09
	Unberthing time	1.00	0.6	184	6.55	0.0033	0.39	0.69	0.000	0.04	0.77	0.000	0.05
LNG Loading													
	Berthed carrying out cargo transfer	15.00	9.0	2,756	19.64	0.1473	17.68	2.08	0.016	1.88	2.31	0.017	2.08
Total		29.00			99.96	0.23	28.10	10.60	0.02	2.98	11.76	0.03	3.31

Period		VOC			SO2			CO2			CH4			N2O		
		lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy
Transit																
	Arrival to Berth at 4-5 knots	0.16	0.0002	0.02	9.14	0.01	1.10	14078.72	14.08	1689.45	0.56	0.00	0.07	0.06	0.00	0.01
	Transit Berth to Pilot Station	0.16	0.0002	0.02	9.14	0.01	1.10	14078.72	14.08	1689.45	0.56	0.00	0.07	0.06	0.00	0.01
Hotelling																
	Berthing Vessel	0.04	0.0000	0.00	2.21	0.00	0.13	3406.14	1.70	204.37	0.14	0.00	0.01	0.02	0.00	0.00
	Berthed Not Carrying Out Cargo Transfer	0.04	0.0001	0.01	2.21	0.01	0.80	3406.14	10.22	1226.21	0.14	0.00	0.05	0.02	0.00	0.01
	Vessel warm up of main engine and prep to depart berth	0.04	0.0000	0.00	2.21	0.00	0.27	3406.14	3.41	408.74	0.14	0.00	0.02	0.02	0.00	0.00
	Unberthing time	0.04	0.0000	0.00	2.21	0.00	0.13	3406.14	1.70	204.37	0.14	0.00	0.01	0.02	0.00	0.00
LNG Loading																
	Berthed carrying out cargo transfer	0.12	0.0009	0.11	6.64	0.05	5.97	10218.43	76.64	9196.58	0.41	0.00	0.37	0.05	0.00	0.04
Total		0.596	0.001	0.17	33.78	0.08	9.50	52,000.43	121.83	14,619.16	2.09	0.00	0.59	0.23	0.00	0.06

Notes:

1.	LNG Capacity (m3)	142,950
	Number of Ship Calls per Year	120
	Total Electric Power Engine Rating (kW)	10,350
	Fuel Consumption Rate (at NCR)	182.2 metric tonnes per day
	Fuel Type	RMH 55
	HHV (kcal/kg)	10,280
	Density (lb/gal)	7.2

Table G-4. Emission Factors Steam Turbine Calculations Powered by Natural Gas

Period		Transit Time (hr)	Total Required Power (kW)	BOG - (tonnes)	BOG (MMscf)	NOX			CO			PM			VOC			SO2			CO2			CH4			N2O		
						lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy
Transit	Arrival to Berth at 4-5 knots	2.00	6,200	4.6	0.230	14.35	0.0144	1.72	6.44	0.006	0.77	0.58	0.001	0.07	0.42	0.0004	0.05	0.04	0.00	0.01	9950.78	9.95							
	Transit Berth to Pilot Station	2.00	6,200	4.6	0.230	14.35	0.0144	1.72	6.44	0.006	0.77	0.58	0.001	0.07	0.42	0.0004	0.05	0.04	0.00	0.01	9950.78	9.95	1194.09	0.19	0.00	0.02	0.18	0.00	0.02
																							1194.09	0.19	0.00	0.02	0.18	0.00	0.02
Hotelling																													
	Berthing Vessel	1.00	1,500	2.3	0.115	3.47	0.0017	0.21	1.56	0.001	0.09	0.14	0.000	0.01	0.10	0.0001	0.01	0.01	0.00	0.00	2407.45	1.20	144.45	0.05	0.00	0.00	0.04	0.00	0.00
	Berthed Not Carrying Out Cargo Transfer	6.00	1,500	0.0	0.000	3.47	0.0104	1.25	1.56	0.005	0.56	0.14	0.000	0.05	0.10	0.0003	0.04	0.01	0.00	0.00	2407.45	7.22	866.68	0.05	0.00	0.02	0.04	0.00	0.02
	Vessel warm up of main engine and prep to depart berth	2.00	1,500	4.8	0.241	3.47	0.0035	0.42	1.56	0.002	0.19	0.14	0.000	0.02	0.10	0.0001	0.01	0.01	0.00	0.00	2407.45	2.41	288.89	0.05	0.00	0.01	0.04	0.00	0.01
	Unberthing time	1.00	1,500	2.4	0.120	3.47	0.0017	0.21	1.56	0.001	0.09	0.14	0.000	0.01	0.10	0.0001	0.01	0.01	0.00	0.00	2407.45	1.20	144.45	0.05	0.00	0.00	0.04	0.00	0.00
LNG Loading																													
	Berthed carrying out cargo transfer	15.00	4,500	51.0	2.555	10.42	0.0781	9.38	4.67	0.035	4.21	0.42	0.003	0.38	0.31	0.0023	0.28	0.10	0.00	0.09	7222.34	54.17	6500.11	0.14	0.00	0.13	0.13	0.00	0.12
Total		29.00	22,900	70	3	53.01	0.12	14.90	23.78	0.06	6.69	2.13	0.00	0.60	1.57	0.004	0.44	0.23	0.00	0.11	36,753.70	86.11	10,332.77	0.71	0.00	0.20	0.68	0.00	0.19

Notes:

1.	LNG Capacity (m3)	142,950
	Number of Ship Calls per Year	120
	Total Electric Power Engine Rating (kW)	10,350
	Fuel Consumption Rate (at NCR)	182.2 metric tonnes per day
	Fuel Type	BOG
	HHV (Btu/scf)	946
	Density (lb/scf)	0.044

Table G-5. Emission Calculations DFDE Vessels

Period		Transit Time (hr)	Required Power per Hour (kW)	Total Required Power (kWhr)	Fuel Burned	NOX			CO			PM			VOC			SO2			CO2			CH4			N2O		
						lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy
Transit																													
	Arrival to Berth at 4-5 knots	2.00	4,500	9,000	Gas	16.96	0.0170	2.04	10.81	0.011	1.30	0.34	0.000	0.04	6.54	0.0065	0.78	0.56	0.00	0.07	3591.35	3.59	430.96	0.42	0.00	0.05	0.01	0.00	0.00
	Transit Berth to Pilot Station	2.00	4,500	9,000	Gas	16.96	0.0170	2.04	10.81	0.011	1.30	0.34	0.000	0.04	6.54	0.0065	0.78	0.56	0.00	0.07	3591.35	3.59	430.96	0.42	0.00	0.05	0.01	0.00	0.00
Hotelling																													
	Berthing Vessel	1.00	4,500	4,500	Gas	16.96	0.0085	1.02	10.81	0.005	0.65	0.34	0.000	0.02	6.54	0.0033	0.39	0.56	0.00	0.03	3591.35	1.80	215.48	0.42	0.00	0.03	0.01	0.00	0.00
	Berthed Not Carrying Out Cargo Transfer	6.00	4,500	27,000	Gas	16.96	0.0509	6.11	10.81	0.032	3.89	0.34	0.001	0.12	6.54	0.0196	2.35	0.56	0.00	0.20	3591.35	10.77	1292.89	0.42	0.00	0.15	0.01	0.00	0.00
	Vessel warm up of main engine and prep to depart berth	2.00	13,500	27,000	Gas	50.89	0.0509	6.11	32.44	0.032	3.89	1.03	0.001	0.12	19.61	0.0196	2.35	1.67	0.00	0.20	10774.05	10.77	1292.89	1.27	0.00	0.15	0.02	0.00	0.00
	Unberthing time	1.00	4,500	4,500	Gas	16.96	0.0085	1.02	10.81	0.005	0.65	0.34	0.000	0.02	6.54	0.0033	0.39	0.56	0.00	0.03	3591.35	1.80	215.48	0.42	0.00	0.03	0.01	0.00	0.00
LNG Loading																													
	Berthed carrying out cargo transfer	15.00	0	0	Fuel Oil	33.73	0.2530	30.36	27.78	0.208	25.00	1.88	0.014	1.69	2.68	0.0201	2.41	3.30	0.02	2.97	5387.02	40.40	4848.32	0.14	0.00	0.13	0.05	0.00	0.04
Total		29.00	36,000	81,000		169.45	0.41	48.68	114.29	0.31	36.68	4.62	0.02	2.06	54.98	0.079	9.47	7.75	0.03	3.57	34,117.82	72.72	8,726.98	3.54	0.00	0.59	0.11	0.00	0.05

Notes:

1.	LNG Capacity (m3)	168,162
	Number of Ship Calls per Year	120
	Total Propulsion Engine Rating (kW)	25,400
	Total Electric Power Engine Rating (kW)	39,900

Table G-6. Emission Rates for Model Input - Steam Turbine Vessels Operating on Fuel Oil

Activity		NOx (g/s)		SO2 (g/s)				CO (g/s)		PM (g/s)	
		1 hour	Annual	1 hour	3 hour	24 hour	Annual	1 hour	8 hour	24 hour	Annual
Transit											
	Arrival to Berth at 4-5 knots	3.41E+00	9.34E-02	1.15E+00	7.68E-01	9.60E-02	1.58E-05	3.62E-01	9.04E-02	3.34E-02	1.10E-02
	Transit Berth to Pilot Station	3.41E+00	9.34E-02	1.15E+00	7.68E-01	9.60E-02	1.58E-05	3.62E-01	9.04E-02	3.34E-02	1.10E-02
Hotelling											
	Berthing Vessel	8.25E-01	1.13E-02	2.79E-01	9.29E-02	1.16E-02	1.91E-06	8.75E-02	1.09E-02	4.05E-03	1.33E-03
	Berthed Not Carrying Out Cargo Transfer	8.25E-01	6.78E-02	2.79E-01	2.79E-01	6.97E-02	1.15E-05	8.75E-02	6.56E-02	2.43E-02	7.98E-03
	Vessel warm up of main engine and prep to depart berth	8.25E-01	2.26E-02	2.79E-01	1.86E-01	2.32E-02	3.82E-06	8.75E-02	2.19E-02	8.09E-03	2.66E-03
	Unberthing time	8.25E-01	1.13E-02	2.79E-01	9.29E-02	1.16E-02	1.91E-06	8.75E-02	1.09E-02	4.05E-03	1.33E-03
LNG Loading											
	Berthed carrying out cargo transfer	2.48E+00	5.09E-01	8.36E-01	8.36E-01	5.23E-01	8.59E-05	2.63E-01	2.63E-01	1.82E-01	5.98E-02

Table G-7. Emission Rates for Model Input - Steam Turbine Vessels Operating on Natural Gas

Activity		NOx (g/s)		SO2 (g/s)				CO (g/s)		PM (g/s)	
		1 hour	Annual	1 hour	3 hour	24 hour	Annual	1 hour	8 hour	24 hour	Annual
Transit											
	Arrival to Berth at 4-5 knots	1.81E+00	4.95E-02	5.34E-03	3.56E-03	4.45E-04	7.31E-08	8.11E-01	2.03E-01	6.04E-03	1.99E-03
	Transit Berth to Pilot Station	1.81E+00	4.95E-02	5.34E-03	3.56E-03	4.45E-04	7.31E-08	8.11E-01	2.03E-01	6.04E-03	1.99E-03
Hotelling											
	Berthing Vessel	4.38E-01	5.99E-03	1.29E-03	4.31E-04	5.38E-05	8.85E-09	1.96E-01	2.45E-02	7.31E-04	2.40E-04
	Berthed Not Carrying Out Cargo Transfer	4.38E-01	3.60E-02	1.29E-03	1.29E-03	3.23E-04	5.31E-08	1.96E-01	1.47E-01	4.39E-03	1.44E-03
	Vessel warm up of main engine and prep to depart berth	4.38E-01	1.20E-02	1.29E-03	8.61E-04	1.08E-04	1.77E-08	1.96E-01	4.91E-02	1.46E-03	4.81E-04
	Unberthing time	4.38E-01	5.99E-03	1.29E-03	4.31E-04	5.38E-05	8.85E-09	1.96E-01	2.45E-02	7.31E-04	2.40E-04
LNG Loading											
	Berthed carrying out cargo transfer	1.31E+00	2.70E-01	1.29E-02	1.29E-02	8.05E-03	1.32E-06	5.89E-01	5.89E-01	3.29E-02	1.08E-02

Table G-8. Emission Rates for Model Input - DFDE Vessels

Activity		NOx (g/s)		SO2 (g/s)				CO (g/s)		PM (g/s)	
		1 hour	Annual	1 hour	3 hour	24 hour	Annual	1 hour	8 hour	24 hour	Annual
Transit											
	Arrival to Berth at 4-5 knots	2.14E+00	5.86E-02	7.00E-02	4.67E-02	5.83E-03	1.92E-03	1.36E+00	3.41E-01	3.60E-03	1.18E-03
	Transit Berth to Pilot Station	2.14E+00	5.86E-02	7.00E-02	4.67E-02	5.83E-03	1.92E-03	1.36E+00	3.41E-01	3.60E-03	1.18E-03
Hotelling											
	Berthing Vessel	2.14E+00	2.93E-02	7.00E-02	2.33E-02	2.92E-03	9.59E-04	1.36E+00	1.70E-01	1.80E-03	5.92E-04
	Berthed Not Carrying Out Cargo Transfer	2.14E+00	1.76E-01	7.00E-02	7.00E-02	1.75E-02	5.75E-03	1.36E+00	1.02E+00	1.08E-02	3.55E-03
	Vessel warm up of main engine and prep to depart berth	6.41E+00	1.76E-01	2.10E-01	1.40E-01	1.75E-02	5.75E-03	4.09E+00	1.02E+00	1.08E-02	3.55E-03
	Unberthing time	2.14E+00	2.93E-02	7.00E-02	2.33E-02	2.92E-03	9.59E-04	1.36E+00	1.70E-01	1.80E-03	5.92E-04
LNG Loading											
	Berthed carrying out cargo transfer	4.25E+00	8.73E-01	4.16E-01	4.16E-01	2.60E-01	8.55E-02	3.50E+00	3.50E+00	1.48E-01	4.85E-02

Table G-9. Locations and Stack Parameters for Steam Turbine Ships Operating on Oil

Activity	AERMOD Source ID	Stack Location			Stack Parameters			
		UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
Berthed Not Carrying Out Cargo Transfer	STHTL1	397540.7	4809097.7	0.0	40.0	408.2	6.9	1.5
Berthed carrying out cargo transfer	STHTL4	397540.7	4809097.7	0.0	40.0	408.2	5.9	1.5
Tugboat	TUGS01	397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
	TUGS02	397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
	TUGS03	397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
	TUGS04	397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3
Arrival to Berth at 4-5 knots	LNG01	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Berthing Vessel	LNG02	397540.7	4809097.7	0.0	40.0	408.2	8.4	1.5
Vessel warm up and unberthing	LNG08	397540.7	4809097.7	0.0	40.0	408.2	8.4	1.5
Transit Berth to Pilot Station	LNG09	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Transit in Channel/Near Shore	VES1	389899.8	4801854.5	0.0	40.0	408.2	34.5	1.5
	VES2	390078.0	4801763.5	0.0	40.0	408.2	34.5	1.5
	VES3	390256.2	4801672.5	0.0	40.0	408.2	34.5	1.5
	VES4	390434.4	4801581.5	0.0	40.0	408.2	34.5	1.5
	VES5	390612.5	4801490.5	0.0	40.0	408.2	34.5	1.5
	VES6	390790.7	4801399.5	0.0	40.0	408.2	34.5	1.5
	VES7	390968.9	4801308.5	0.0	40.0	408.2	34.5	1.5
	VES8	391147.1	4801217.5	0.0	40.0	408.2	34.5	1.5
	VES9	391325.3	4801126.5	0.0	40.0	408.2	34.5	1.5
	VES10	391503.5	4801035.5	0.0	40.0	408.2	34.5	1.5
	VES11	391681.7	4800944.5	0.0	40.0	408.2	34.5	1.5
	VES12	391859.9	4800853.5	0.0	40.0	408.2	34.5	1.5
	VES13	392038.2	4800765.0	0.0	40.0	408.2	34.5	1.5
	VES14	392206.6	4800822.0	0.0	40.0	408.2	34.5	1.5
	VES15	392375.1	4800879.0	0.0	40.0	408.2	34.5	1.5
	VES16	392543.4	4800936.0	0.0	40.0	408.2	34.5	1.5
	VES17	392711.8	4800993.0	0.0	40.0	408.2	34.5	1.5
	VES18	392839.0	4801112.0	0.0	40.0	408.2	34.5	1.5
	VES19	392924.7	4801293.0	0.0	40.0	408.2	34.5	1.5
	VES20	393010.5	4801474.0	0.0	40.0	408.2	34.5	1.5
	VES21	393096.2	4801655.0	0.0	40.0	408.2	34.5	1.5
	VES22	393182.0	4801836.0	0.0	40.0	408.2	34.5	1.5
	VES23	393267.7	4802017.0	0.0	40.0	408.2	34.5	1.5
	VES24	393381.2	4802176.5	0.0	40.0	408.2	34.5	1.5
	VES25	393522.3	4802318.5	0.0	40.0	408.2	34.5	1.5
	VES26	393663.4	4802460.5	0.0	40.0	408.2	34.5	1.5
	VES27	393804.4	4802602.5	0.0	40.0	408.2	34.5	1.5
	VES28	393945.5	4802744.5	0.0	40.0	408.2	34.5	1.5
	VES29	394086.6	4802886.5	0.0	40.0	408.2	34.5	1.5
	VES30	394227.6	4803028.5	0.0	40.0	408.2	34.5	1.5
	VES31	394368.7	4803170.5	0.0	40.0	408.2	34.5	1.5
	VES32	394509.7	4803312.5	0.0	40.0	408.2	34.5	1.5
	VES33	394650.8	4803454.5	0.0	40.0	408.2	34.5	1.5
	VES34	394791.9	4803596.5	0.0	40.0	408.2	34.5	1.5
	VES35	394932.9	4803738.5	0.0	40.0	408.2	34.5	1.5
	VES36	395074.0	4803880.5	0.0	40.0	408.2	34.5	1.5
	VES37	395215.1	4804022.5	0.0	40.0	408.2	34.5	1.5
	VES38	395356.0	4804161.0	0.0	40.0	408.2	34.5	1.5
	VES39	395438.1	4804335.0	0.0	40.0	408.2	34.5	1.5
	VES40	395520.2	4804509.1	0.0	40.0	408.2	34.5	1.5
	VES41	395602.4	4804683.1	0.0	40.0	408.2	34.5	1.5
	VES42	395684.5	4804857.1	0.0	40.0	408.2	34.5	1.5
	VES43	395766.6	4805031.1	0.0	40.0	408.2	34.5	1.5
	VES44	395848.7	4805205.1	0.0	40.0	408.2	34.5	1.5
	VES45	395930.9	4805379.1	0.0	40.0	408.2	34.5	1.5
	VES46	396013.0	4805553.1	0.0	40.0	408.2	34.5	1.5
	VES47	396095.1	4805727.1	0.0	40.0	408.2	34.5	1.5
	VES48	396177.2	4805901.1	0.0	40.0	408.2	34.5	1.5
	VES49	396259.4	4806075.1	0.0	40.0	408.2	34.5	1.5
	VES50	396341.5	4806249.1	0.0	40.0	408.2	34.5	1.5
	VES51	396423.9	4806421.6	0.0	40.0	408.2	34.5	1.5
	VES52	396453.3	4806604.6	0.0	40.0	408.2	34.5	1.5
	VES53	396482.6	4806787.6	0.0	40.0	408.2	34.5	1.5
	VES54	396512.0	4806970.6	0.0	40.0	408.2	34.5	1.5
	VES55	396541.4	4807153.6	0.0	40.0	408.2	34.5	1.5
	VES56	396570.8	4807336.6	0.0	40.0	408.2	34.5	1.5
	VES57	396600.1	4807519.6	0.0	40.0	408.2	34.5	1.5
	VES58	396629.7	4807705.6	0.0	40.0	408.2	34.5	1.5
	VES59	396732.8	4807876.6	0.0	40.0	408.2	34.5	1.5
	VES60	396848.9	4808023.6	0.0	40.0	408.2	34.5	1.5
	VES61	396978.0	4808145.6	0.0	40.0	408.2	34.5	1.5
	VES62	397107.1	4808267.6	0.0	40.0	408.2	34.5	1.5
	VES63	397236.2	4808389.6	0.0	40.0	408.2	34.5	1.5
	VES64	397365.3	4808512.6	0.0	40.0	408.2	34.5	1.5
	VES65	397560.9	4808554.1	0.0	40.0	408.2	34.5	1.5
	VES66	397561.4	4808721.1	0.0	40.0	408.2	34.5	1.5
	VES67	397561.9	4808888.1	0.0	40.0	408.2	34.5	1.5
	VES68	397562.5	4809054.1	0.0	40.0	408.2	34.5	1.5

Table G-10. Locations and Stack Parameters for Steam Turbine Ships Operating on Gas

Activity	AERMOD Source ID	Stack Location			Stack Parameters			
		UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
Berthed Not Carrying Out Cargo Transfer	GSTHTL1	397540.7	4809097.7	0.0	40.0	408.2	7.1	1.5
Berthed carrying out cargo transfer	GSTHTL4	397540.7	4809097.7	0.0	40.0	408.2	6.1	1.5
Tugboat	TUGS01	397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
	TUGS02	397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
	TUGS03	397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
	TUGS04	397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3
Arrival to Berth at 4-5 knots	GLNG01	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Berthing Vessel	GLNG02	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Vessel warm up and unberthing	GLNG08	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Transit Berth to Pilot Station	GLNG09	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Transit in Channel/Near Shore	GVES1	389899.8	4801854.5	0.0	40.0	408.2	34.5	1.5
	GVES2	390078.0	4801763.5	0.0	40.0	408.2	34.5	1.5
	GVES3	390256.2	4801672.5	0.0	40.0	408.2	34.5	1.5
	GVES4	390434.4	4801581.5	0.0	40.0	408.2	34.5	1.5
	GVES5	390612.5	4801490.5	0.0	40.0	408.2	34.5	1.5
	GVES6	390790.7	4801399.5	0.0	40.0	408.2	34.5	1.5
	GVES7	390968.9	4801308.5	0.0	40.0	408.2	34.5	1.5
	GVES8	391147.1	4801217.5	0.0	40.0	408.2	34.5	1.5
	GVES9	391325.3	4801126.5	0.0	40.0	408.2	34.5	1.5
	GVES10	391503.5	4801035.5	0.0	40.0	408.2	34.5	1.5
	GVES11	391681.7	4800944.5	0.0	40.0	408.2	34.5	1.5
	GVES12	391859.9	4800853.5	0.0	40.0	408.2	34.5	1.5
	GVES13	392038.2	4800765.0	0.0	40.0	408.2	34.5	1.5
	GVES14	392206.6	4800822.0	0.0	40.0	408.2	34.5	1.5
	GVES15	392375.1	4800879.0	0.0	40.0	408.2	34.5	1.5
	GVES16	392543.4	4800936.0	0.0	40.0	408.2	34.5	1.5
	GVES17	392711.8	4800993.0	0.0	40.0	408.2	34.5	1.5
	GVES18	392839.0	4801112.0	0.0	40.0	408.2	34.5	1.5
	GVES19	392924.7	4801293.0	0.0	40.0	408.2	34.5	1.5
	GVES20	393010.5	4801474.0	0.0	40.0	408.2	34.5	1.5
	GVES21	393096.2	4801655.0	0.0	40.0	408.2	34.5	1.5
	GVES22	393182.0	4801836.0	0.0	40.0	408.2	34.5	1.5
	GVES23	393267.7	4802017.0	0.0	40.0	408.2	34.5	1.5
	GVES24	393381.2	4802176.5	0.0	40.0	408.2	34.5	1.5
	GVES25	393522.3	4802318.5	0.0	40.0	408.2	34.5	1.5
	GVES26	393663.4	4802460.5	0.0	40.0	408.2	34.5	1.5
	GVES27	393804.4	4802602.5	0.0	40.0	408.2	34.5	1.5
	GVES28	393945.5	4802744.5	0.0	40.0	408.2	34.5	1.5
	GVES29	394086.6	4802886.5	0.0	40.0	408.2	34.5	1.5
	GVES30	394227.6	4803028.5	0.0	40.0	408.2	34.5	1.5
	GVES31	394368.7	4803170.5	0.0	40.0	408.2	34.5	1.5
	GVES32	394509.7	4803312.5	0.0	40.0	408.2	34.5	1.5
	GVES33	394650.8	4803454.5	0.0	40.0	408.2	34.5	1.5
	GVES34	394791.9	4803596.5	0.0	40.0	408.2	34.5	1.5
	GVES35	394932.9	4803738.5	0.0	40.0	408.2	34.5	1.5
	GVES36	395074.0	4803880.5	0.0	40.0	408.2	34.5	1.5
	GVES37	395215.1	4804022.5	0.0	40.0	408.2	34.5	1.5
	GVES38	395356.0	4804161.0	0.0	40.0	408.2	34.5	1.5
	GVES39	395438.1	4804335.0	0.0	40.0	408.2	34.5	1.5
	GVES40	395520.2	4804509.1	0.0	40.0	408.2	34.5	1.5
	GVES41	395602.4	4804683.1	0.0	40.0	408.2	34.5	1.5
	GVES42	395684.5	4804857.1	0.0	40.0	408.2	34.5	1.5
	GVES43	395766.6	4805031.1	0.0	40.0	408.2	34.5	1.5
	GVES44	395848.7	4805205.1	0.0	40.0	408.2	34.5	1.5
	GVES45	395930.9	4805379.1	0.0	40.0	408.2	34.5	1.5
	GVES46	396013.0	4805553.1	0.0	40.0	408.2	34.5	1.5
	GVES47	396095.1	4805727.1	0.0	40.0	408.2	34.5	1.5
	GVES48	396177.2	4805901.1	0.0	40.0	408.2	34.5	1.5
	GVES49	396259.4	4806075.1	0.0	40.0	408.2	34.5	1.5
	GVES50	396341.5	4806249.1	0.0	40.0	408.2	34.5	1.5
	GVES51	396423.9	4806421.6	0.0	40.0	408.2	34.5	1.5
	GVES52	396453.3	4806604.6	0.0	40.0	408.2	34.5	1.5
	GVES53	396482.6	4806787.6	0.0	40.0	408.2	34.5	1.5
	GVES54	396512.0	4806970.6	0.0	40.0	408.2	34.5	1.5
	GVES55	396541.4	4807153.6	0.0	40.0	408.2	34.5	1.5
	GVES56	396570.8	4807336.6	0.0	40.0	408.2	34.5	1.5
	GVES57	396600.1	4807519.6	0.0	40.0	408.2	34.5	1.5
	GVES58	396629.7	4807705.6	0.0	40.0	408.2	34.5	1.5
	GVES59	396732.8	4807876.6	0.0	40.0	408.2	34.5	1.5
	GVES60	396848.9	4808023.6	0.0	40.0	408.2	34.5	1.5
	GVES61	396978.0	4808145.6	0.0	40.0	408.2	34.5	1.5
	GVES62	397107.1	4808267.6	0.0	40.0	408.2	34.5	1.5
	GVES63	397236.2	4808389.6	0.0	40.0	408.2	34.5	1.5
	GVES64	397365.3	4808512.6	0.0	40.0	408.2	34.5	1.5
	GVES65	397560.9	4808554.1	0.0	40.0	408.2	34.5	1.5
	GVES66	397561.4	4808721.1	0.0	40.0	408.2	34.5	1.5
	GVES67	397561.9	4808888.1	0.0	40.0	408.2	34.5	1.5
	GVES68	397562.5	4809054.1	0.0	40.0	408.2	34.5	1.5

Table G-11. Locations and Stack Parameters for DFDE Ships

Activity	AERMOD Source ID	Stack Location			Stack Parameters			
		UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
Berthed Not Carrying Out Cargo Transfer	DFDEHTL1	397540.7	4809097.7	0.0	40.0	623.2	5.6	1.5
Berthed carrying out cargo transfer	DFDEHTL4	397540.7	4809097.7	0.0	40.0	623.2	4.8	1.5
Tugboat	TUGS01	397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
	TUGS02	397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
	TUGS03	397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
	TUGS04	397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3
Arrival to Berth at 4-5 knots	DFDLNG01	397540.7	4809097.7	0.0	40.0	623.2	35.5	1.5
Berthing Vessel	DFDLNG02	397540.7	4809097.7	0.0	40.0	623.2	8.7	1.5
Vessel warm up and unberthing	DFDLNG08	397540.7	4809097.7	0.0	40.0	623.2	8.7	1.5
Transit Berth to Pilot Station	DFDLNG09	397540.7	4809097.7	0.0	40.0	623.2	35.5	1.5
Transit in Channel/Near Shore	DFDVES1	389899.8	4801854.5	0.0	40.0	623.2	35.5	1.5
	DFDVES2	390078.0	4801763.5	0.0	40.0	623.2	35.5	1.5
	DFDVES3	390256.2	4801672.5	0.0	40.0	623.2	35.5	1.5
	DFDVES4	390434.4	4801581.5	0.0	40.0	623.2	35.5	1.5
	DFDVES5	390612.5	4801490.5	0.0	40.0	623.2	35.5	1.5
	DFDVES6	390790.7	4801399.5	0.0	40.0	623.2	35.5	1.5
	DFDVES7	390968.9	4801308.5	0.0	40.0	623.2	35.5	1.5
	DFDVES8	391147.1	4801217.5	0.0	40.0	623.2	35.5	1.5
	DFDVES9	391325.3	4801126.5	0.0	40.0	623.2	35.5	1.5
	DFDVES10	391503.5	4801035.5	0.0	40.0	623.2	35.5	1.5
	DFDVES11	391681.7	4800944.5	0.0	40.0	623.2	35.5	1.5
	DFDVES12	391859.9	4800853.5	0.0	40.0	623.2	35.5	1.5
	DFDVES13	392038.2	4800765.0	0.0	40.0	623.2	35.5	1.5
	DFDVES14	392206.6	4800822.0	0.0	40.0	623.2	35.5	1.5
	DFDVES15	392375.1	4800879.0	0.0	40.0	623.2	35.5	1.5
	DFDVES16	392543.4	4800936.0	0.0	40.0	623.2	35.5	1.5
	DFDVES17	392711.8	4800993.0	0.0	40.0	623.2	35.5	1.5
	DFDVES18	392839.0	4801112.0	0.0	40.0	623.2	35.5	1.5
	DFDVES19	392924.7	4801293.0	0.0	40.0	623.2	35.5	1.5
	DFDVES20	393010.5	4801474.0	0.0	40.0	623.2	35.5	1.5
	DFDVES21	393096.2	4801655.0	0.0	40.0	623.2	35.5	1.5
	DFDVES22	393182.0	4801836.0	0.0	40.0	623.2	35.5	1.5
	DFDVES23	393267.7	4802017.0	0.0	40.0	623.2	35.5	1.5
	DFDVES24	393381.2	4802176.5	0.0	40.0	623.2	35.5	1.5
	DFDVES25	393522.3	4802318.5	0.0	40.0	623.2	35.5	1.5
	DFDVES26	393663.4	4802460.5	0.0	40.0	623.2	35.5	1.5
	DFDVES27	393804.4	4802602.5	0.0	40.0	623.2	35.5	1.5
	DFDVES28	393945.5	4802744.5	0.0	40.0	623.2	35.5	1.5
	DFDVES29	394086.6	4802886.5	0.0	40.0	623.2	35.5	1.5
	DFDVES30	394227.6	4803028.5	0.0	40.0	623.2	35.5	1.5
	DFDVES31	394368.7	4803170.5	0.0	40.0	623.2	35.5	1.5
	DFDVES32	394509.7	4803312.5	0.0	40.0	623.2	35.5	1.5
	DFDVES33	394650.8	4803454.5	0.0	40.0	623.2	35.5	1.5
	DFDVES34	394791.9	4803596.5	0.0	40.0	623.2	35.5	1.5
	DFDVES35	394932.9	4803738.5	0.0	40.0	623.2	35.5	1.5
	DFDVES36	395074.0	4803880.5	0.0	40.0	623.2	35.5	1.5
	DFDVES37	395215.1	4804022.5	0.0	40.0	623.2	35.5	1.5
	DFDVES38	395356.0	4804161.0	0.0	40.0	623.2	35.5	1.5
	DFDVES39	395438.1	4804335.0	0.0	40.0	623.2	35.5	1.5
	DFDVES40	395520.2	4804509.1	0.0	40.0	623.2	35.5	1.5
	DFDVES41	395602.4	4804683.1	0.0	40.0	623.2	35.5	1.5
	DFDVES42	395684.5	4804857.1	0.0	40.0	623.2	35.5	1.5
	DFDVES43	395766.6	4805031.1	0.0	40.0	623.2	35.5	1.5
	DFDVES44	395848.7	4805205.1	0.0	40.0	623.2	35.5	1.5
	DFDVES45	395930.9	4805379.1	0.0	40.0	623.2	35.5	1.5
	DFDVES46	396013.0	4805553.1	0.0	40.0	623.2	35.5	1.5
	DFDVES47	396095.1	4805727.1	0.0	40.0	623.2	35.5	1.5
	DFDVES48	396177.2	4805901.1	0.0	40.0	623.2	35.5	1.5
	DFDVES49	396259.4	4806075.1	0.0	40.0	623.2	35.5	1.5
	DFDVES50	396341.5	4806249.1	0.0	40.0	623.2	35.5	1.5
	DFDVES51	396423.9	4806421.6	0.0	40.0	623.2	35.5	1.5
	DFDVES52	396453.3	4806604.6	0.0	40.0	623.2	35.5	1.5
	DFDVES53	396482.6	4806787.6	0.0	40.0	623.2	35.5	1.5
	DFDVES54	396512.0	4806970.6	0.0	40.0	623.2	35.5	1.5
	DFDVES55	396541.4	4807153.6	0.0	40.0	623.2	35.5	1.5
	DFDVES56	396570.8	4807336.6	0.0	40.0	623.2	35.5	1.5
	DFDVES57	396600.1	4807519.6	0.0	40.0	623.2	35.5	1.5
	DFDVES58	396629.7	4807705.6	0.0	40.0	623.2	35.5	1.5
	DFDVES59	396732.8	4807876.6	0.0	40.0	623.2	35.5	1.5
	DFDVES60	396848.9	4808023.6	0.0	40.0	623.2	35.5	1.5
	DFDVES61	396978.0	4808145.6	0.0	40.0	623.2	35.5	1.5
	DFDVES62	397107.1	4808267.6	0.0	40.0	623.2	35.5	1.5
	DFDVES63	397236.2	4808389.6	0.0	40.0	623.2	35.5	1.5
	DFDVES64	397365.3	4808512.6	0.0	40.0	623.2	35.5	1.5
	DFDVES65	397560.9	4808554.1	0.0	40.0	623.2	35.5	1.5
	DFDVES66	397561.4	4808721.1	0.0	40.0	623.2	35.5	1.5
	DFDVES67	397561.9	4808888.1	0.0	40.0	623.2	35.5	1.5
	DFDVES68	397562.5	4809054.1	0.0	40.0	623.2	35.5	1.5

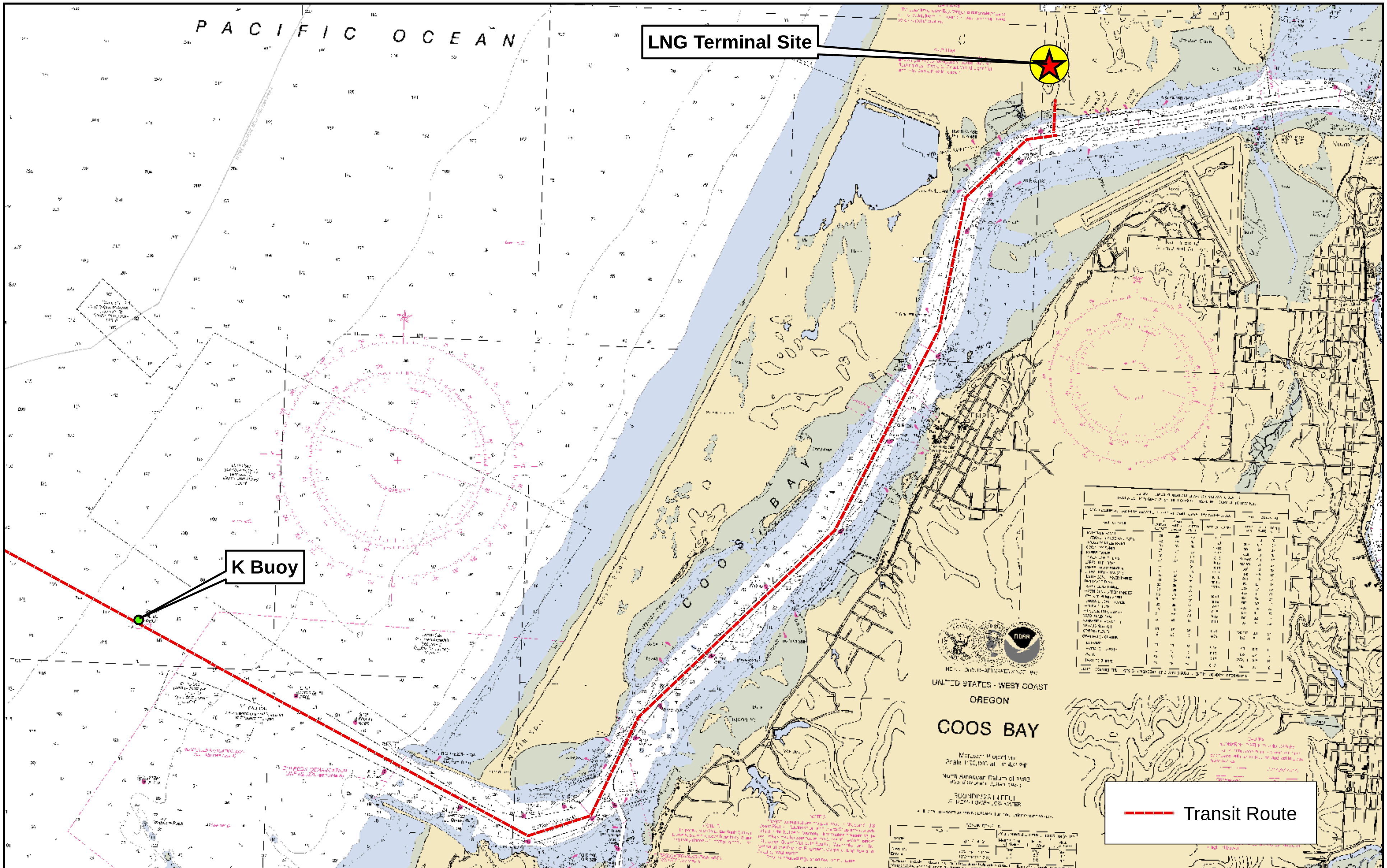
Table G-12. Tugboat Emissions Information[1]							
Pollutant	Emission Factor (g/kWh)	Tug Emissions per Port Call (kg)	Emission Factors for Modeling (per surrogate source, g/s)[1]				
			1-hour	3-hour	8-hour	24-hour	Annual
NO_x[2]	1.80E+00	72	2.38E-01	N/A	N/A	N/A	5.70E-04
CO[3]	3.35E+00	134	4.42E-01	N/A	4.42E-01	N/A	N/A
PM[2]	6.00E-02	2	N/A	N/A	N/A	7.93E-03	1.90E-05
SO_2[3]	4.92E-01	20	6.50E-02	6.50E-02	N/A	6.50E-02	1.56E-04
VOC[2]	1.90E-01	8	N/A	N/A	N/A	N/A	N/A
CO_2[3]	7.06E+02	28183	N/A	N/A	N/A	N/A	N/A

Notes:
(1) Tug is represented as four surrogate sources to account for manuevering about the berthed ship.
(2) NOx, PM, and VOC emissions are EPA Marine Tier 4 standards (40 CFR Section 1042.1, Table 3)
(3) CO, SO2, and CO2 emission factors from AP42 Table 3.4-1. Sulfur content of fuel assumed 0.1%.
(4) Emissions per call calculated by multiplying emisison factor by 39942 kWh, the total energy expended per ship call. Rates determined by dividing total emissions by 1260 minutes operation per ship call. Emission rate for each surrogate source is one-quarter of the overall emission rate. Annual emissions based on 120 ship calls per year.

Tug Activities and Operating Times per Ship Call

Activity	Time (min)	Kw	Kw-Hour
Maneuvering Around Ship	1200	1902	38040
Maneuvering Around Ship/Easy Push	60	1902	1902
Total Tug Activity per LNG Ship Call	1260	1902	39942

Table F-13. Tugboat Stack and Location Information[1]						
Location			Stack Parameters			
UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3

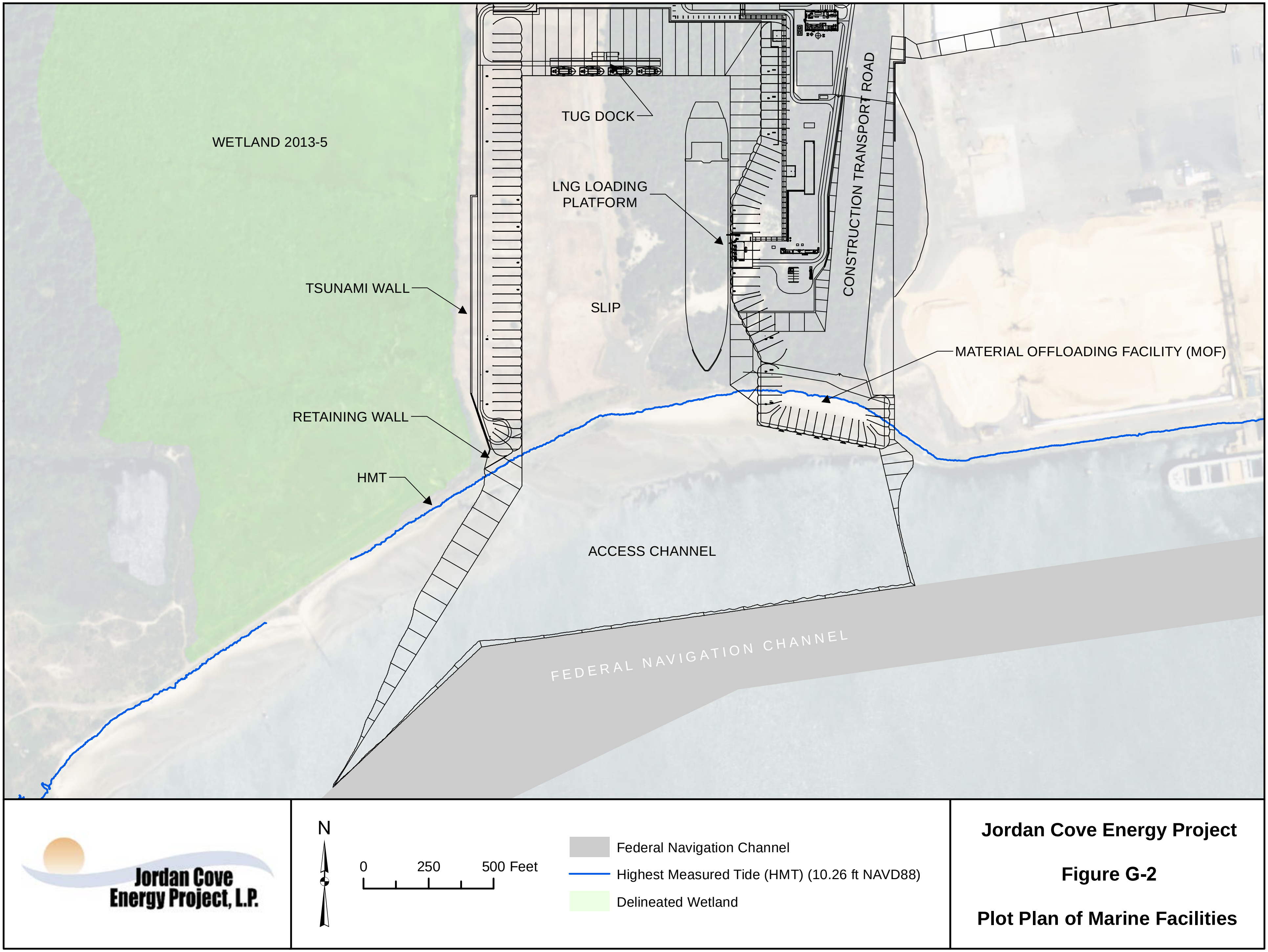


Data Sources: NOAA/NOS/Office of Coast Survey, Oregon GEO, USACE

Jordan Cove Energy Project

Figure G-1

LNG Ship Transit Route



Jordan Cove Energy Project, L.P.

Jordan Cove Energy Project

Figure G-2

Plot Plan of Marine Facilities

GAS FORM C

DESCRIPTION OF THE VESSEL

METHANE JULIA LOUISE
SHI – HULL 1745

1	**GENERAL**	
	Hull Number	1745
	Builder and Yard	Samsung Heavy Industries Co. Ltd. Korea
	Year Built	2010
	Flag	Bermuda
	Classification Society	American Bureau of Shipping
	Classification Notations	HA1 E, Liquefied gas carrier, Ship type 2G (Membrane tank, Maximum pressure 25 kPaG and Minimum Temperature -163ºC, Specific Gravity 500 kg/m^3), SH, FL(40), SH-DLA, SHCM, SFA(40), HM2+R, HAMS, NIBS, HACCU, UWILD, PMS including CMS, R2 without dual centralized fresh water cooling systems.
	Call Sign	ZCEB2
2	**PERFORMANCE STANDARDS**	
	Guaranteed Deadweight	80,700 metric tonnes at design draft of 11.5 meters
	Guaranteed Speed	19.75 knots at a draft of 11.5 meters and at propulsion shaft power of 20, 840 kW
	Guaranteed LNG Cargo Carrying Capacity	168,162.306 cubic meters at maximum allowable cargo tank fill ratio of 98.5% and reference temperature according to IGC Code 15.1.2-4
	Guaranteed Fuel Consumption	Maximum Continuous Rating (MCR): Approx 25,400kW X 86 RPM. Gas Operation: Specific energy consumption at MCR with main generation driven pumps of 7,410 kJ/kWh, with 1.0 g/kWh for pilot fuel Back Up Fuel Operation: Specific energy consumption at MCR with main generation driven pumps of 189 g/kWh Daily Fuel Oil Consumption of 124.9 metric tons per day of DO at MCR Daily fuel consumption of reliq plant 11.4 metric tons of DO per day Fuel Consumption shall be measured according to ISO 3046/1-1995, with lower calorific value of 42,700 kJ/kg of diesel oil.
	Guaranteed Boil-off Rate	0.15 per cent by volume per laden day.
	Cargo containment system type	Gaztransport & Technigaz (MARK III) Membrane

3	**DIMENSIONS**	
	Length Overall	291.066 meters
	Length between perpendiculars	279.000 meters
	Breadth (moulded)	45.000 meters
	Depth to upper deck (moulded)	26.000 meters
	Design Draft, moulded (in seawater of specific gravity of 1.025) :	11.500 meters
	Scantling Draft, moulded (in seawater of specific gravity of 1.025)	12.500 meters
	Air Draft	54.338 meters Ballast draught 9.72m
4	**TONNAGE**	
	Dead-weight tonnage on LNG loaded draught: (11.73m)	84,000 metric tonnes (at full cargo with density 470 kg/m3 plus 5050 m/t bunker, FW, lubs, etc).
	Light ship displacement	32,968.9 metric tonnes
	Displacement	119,094.1 metric tonnes (summer)
	Gross Tonnage	109,004 tons
	Net Tonnage	32,701 tons
	Suez Canal Gross Tonnage	113,005.56
	Suez Canal New Tonnage	101,642.68
5	**MACHINERY**	
	Main Propulsion Plant:	Dual Fuel Diesel Electric, Twin Shaft
	Electric Propulsion Motor Make and Type	Converteam, N3HXC 1000. Squirrel Cage Induction Motor x 2 Sets
	Horsepower (at MCR)	25,400 kW (12,700 kW x 2 sets)
	Normal Service Rating	20,840 kW
	Main Electrical Generating Plant:	
	Dual Fuel Generator Engines Make and Type	Wartsila 12V50DF x 3 sets Wartsila 6L50DF x 1 set
	Generators Make and Type	Converteam M4HXD 253-71 x 3 Sets Converteam M4HXD 253-58 x 1 Set
	Maximum Output	11,400 kW x 3 Sets 5,700 kW x 1 Set
	Auxiliary Boilers:	
	Make	Aalborg
	Type	Mission OS 5000
	Maximum Evaporation	5000 kg/h
	Number	2 Sets

6	**CARGO TANKS**	
	Number of Cargo Tanks	4
	Total Capacity 100% full	170,723.372 m^3
	Type of construction	GTT Mark III system (Membrane)
	Type of insulation	Rigid polyurethane foam with reinforcing glass fibre.
	Minimum Temperature	Minus 163 degrees Celsius
	Loading/filling restrictions	98.5% maximum filling limit
	100%Capacity at 25 ℃ of: • No. 1 tank • No. 2 tank • No. 3 tank • No. 4 tank	 26,995.4 m^3 47,904.6 m^3 47,906.1 m^3 47,917.3 m^3
	The Vessel's cargo tanks can be cooled down from ambient temperature to the loading condition (minus 130 degree Celsius mean temperature of cargo tanks) within ten hours.	
	Relief valve settings	25kPa gauge
	Loaded boil-off design rate	0.15 per cent by volume per laden day
7	**FRESH WATER**	
	Capacity of F.W. generators	30 Tonnes per Day x 2sets
	Capacity of Tanks:	
	Boiler Feed (Distilled Water) Fresh Water Drinking Water	63.6 m^3 495.5 m^3 Not applicable
8	**BUNKER CAPACITY**	
	Diesel Oil (100%)	824.0 m^3 (Storage and Service Tanks in Machinery Space)
	Fuel Oil (100%)	5,259.5 m^3 (Storage, Settling and Low Sulphur Tanks)
9	**WATER BALLAST**	
	Tank Capacity (100%)	62,933.4 m^3 (including peak tanks)
	Number and Capacity of water ballast pumps	3000 m^3/hr each X 3 sets
	The vessel is capable of loading/discharging ballast concurrent with cargo operations	Yes
10	**CARGO PUMPS**	
	Number	8 sets
	Type and Make	Single stage centrifugal submerged, Ebara International Corporation
	Rated Capacity of each Pump	1750 m^3/hr 160 MLC (specific gravity 0.5)
11	**SPRAY PUMPS**	
	Number	4 sets
	Type and Make	Single stage centrifugal submerged, Ebara International Corporation
	Rated capacity of each Pump	50 m^3/hr 145 MLC (specific gravity 0.5)

12	**FUEL GAS PUMPS**	
	Number	2 sets
	Type and Make	Single stage centrifugal submerged, Ebara International Corporation
	Rated capacity of each Pump	15 m^3/hr 215 MLC (specific gravity 0.5)
13	**CARGO INSTRUMENTATION**	
	Liquid Level Gauge Primary: Maker and Type Number per Tank Accuracy Measuring Range Secondary: Type and Maker Number per Tank Accuracy Measuring Range	 SAAB Marine Electronics AB, Radar Ullage Measurement 1 set ± 7.5 mm 0.026m to 26.52m Whessoe Total Automation, Float Type Ullage Measurement 1 set ± 7.5mm 0 to 54 m.
	Temperature Sensor Type Number per Tank Accuracy Measuring range	 Resistance temperature detectors 5 pairs ± 0.2 ℃ (between - 165℃ and - 145℃) Rising to + 1.5 ℃ at +50 ℃ From - 165 ℃ to + 50 ℃
	Pressure Sensor System Number per Tank Accuracy Measuring range	 1 set ± 1 % of span with deck temperature ranging between – 30^{0}C and +60^{0}C 800 - 1,400 mbar
14	**RE-LIQUEFACTION PLANT**	
	System Maker and Type	Hamworthy Gas Systems, Moss RS™ Mark I re-liquefaction system
	System Capacity	2500 kg/hr (including 500kg/hr flash gas)
	BOG Compressors	
	Type and Make Number and Capacity Discharge Pressure Suction Press. and Temperature	Cryostar, CM2-200 Horizontal, two stage centrifugal. Two sets, 6,699 m^3/h each 6.5 barA 1.03 barA / -120 ℃
	Compander Make and Type	 Atlas Copco, Model GT026N3D0+ET1135MS Three stage integral gear compressor with a single stage radial turbine.
	Cold Box	
	Make and Type	Fives Cryogenic, Counter-Flow Heat Exchanger
	Capacity	2,500 kg/hr

15	**INERT GAS GENERATION**	
	Make and Type	Smit Gas Systems BV, Oil burning type with cooling and drying unit,
	Capacity	14000 Nm^3/hour
	Quality of Gas	O_2 - max 1% by volume CO_2 - max approx 14% by volume CO- max 100 ppm SO_x - max 1 ppm N_2 - balance Soot - complete absence (0 on Bacharach scale) Dew Point not more than -45 °C
16	**NITROGEN GENERATION**	
	Make and Type	Air Products AS, NC1.1-1816-WXP-130970 Ext.cab Membrane Separation Type.
	Capacity	130 Nm^3/h @ 97% N_2 x 2 sets
	Pressure Tank	32 m^3 x 10 bar g x 1 set
17	**GAS COMPRESSORS**	
	High Duty:	
	Make and Type	Cryostar, CM 400/55 Horizontal, single stage, centrifugal.
	Number and Capacity	Two sets 28,000 m^3/h each
	Discharge Pressure	2.0 barA,
	Suction Press. and Temp.	1.03 barA -140 °C
18	**CARGO VAPOURISERS**	
	Forcing Vapouriser Make, Type and Capacity	Cryostar, 34-UT-25/21-3.6, 5,500 kg/hr
	LNG Vapouriser Make, Type and Capacity	Cryostar, 65-UT-3838/34-5.6, 25,000 kg/hr
19	**DECK MACHINERY**	
	Winches: Number, Position, Type	Upper deck forward Combine Anchor Windlass and Mooring winch 2 sets x 30 Metric Tonnes x 15 m/min (winch) or x 57 Metric Tonnes x 9 m/min (windlass) for 110 meters chain in the water Total drums: 9 Mooring Winches 2 sets x 30 Metric Tonnes x 15 m/min Upper deck Aft Mooring Winches 5 sets x 30 Metric Tonnes x 15 m/min Total drums: 11
	Holding Power of Brakes	99.7 Metric Tonnes Type: Split Compact Electro Hydraulic Winch.
	Mooring Ropes Make and Type	Samson, Amsteel Blue

	Size and min. B.S. of Wires	40 mmΦ x 200 m, ISO/BS EN 919 MBS 128mt
	Whether Fitted with Tails, State Length, Material, Min. B.S.	Samson P-7 Grommet Mooring Line Pendant 56mmΦ x 11 m, 100% Polyester ISO/BS EN919 MBS 164mt
	Derrick, Cranes, etc.: Type and Capacity	Midships Hose Handling cranes : MacGregor x 2 Sets, Slewing single jib type, 5.0 metric tonnes SWL, minimum outreach 5.2 m, maximum outreach 26m Cargo Machinery crane: DMC x 1 set, slewing single jib type, SW L 6.0 tonnes, out reach min. 3,4 m max. 12 m. Provision cranes Stbd side – MacGregor,1 set, slewing single jib type, 10.0 metric tonnes SWL, minimum outreach 3.7m, maximum outreach 18.3m, hook travel 54m Port Side-MacGregor,1 set, slewing single jib type, 5.0 metric tonnes SWL, minimum outreach 3.7m, maximum outreach 18.3m, hook travel 54m
20	**NAVIGATION AND RADIO**	
	Navigation Aids	Make: Furuno Electric Co Ltd. Two sets X-band radar with Arpa One set S-band radar with Arpa Two sets Differential Global Positioning System navigator equipment One set Electronic Chart Display and Information System.
	Radio Equipment	Make: Furuno Electric Co Ltd One set GMDSS (area 3) Radio Equipment, One set radio station comprising 1 set MF/HF transmitter/receiver with radio telephone and DSC control unit , 1 set MH/HF DSC watch receiver, and I set remote distress message controller. One set Inmarsat C MES equipment One set Inmarsat F MES equipment
21	**OTHERS**	
	Bilge Oily Water Monitor	Make: Smart Cell– Bilge Type; Detection of light scatter across oily water sample. .
	Incinerator	Make Hyundai -Atlas Type: Forced draught package type, 500,000 kcal per hour
	Sewage Treatment Plant	Make: DVZ-Services GmBH. Type: DVZ-SKA-30 “BIOMASTER” Bio reaction and aeration system Capacity 3,450 ltr per day.

PROFORMA FORM C

DESCRIPTION OF THE VESSEL

SHI – HULL 1553-54-55-85-86-87-88

1.	**GENERAL**			
	1.1	Vessel Name and Hull Number	:	*To be named* Hull Number 1553-54-55-85-86-87-88
	1.2	Builder and Yard	:	Samsung Heavy Industries Geoje Island, Korea
	1.3	Year Built / delivered	:	2006-2008
	1.4	Containment System	:	Membrane Type GTT Mark 3
	1.5	Country of Registry	:	Bermuda
	1.6	Port of registration	:	Hamilton
	1.7	Classification Society		American Bureau of Shipping A1Ⓔ, Liquefied gas carrier, ship type 2G (Membrane tank, Maximum pressure 25 kPaG and Minimum Temperature - 163ºC, Specific Gravity 500 kg/m^3), SH, FL(40), SH-DLA, SHCM, SFA(40), HM2+R, AMS, NIBS, ACCU, UWILD, PMS including CMS.
			:	
2.	**DIMENSIONS, TONNAGE**			
	2.1	Length Overall	:	approx. 283 metres
	2.2	Length between Perpendiculars	:	270.0 metres
	2.3	Beam (moulded)	:	43.4 metres
	2.4	Depth to upper deck, moulded	:	26.0 metres
	2.5	Scantling Draft, moulded (in seawater of specific gravity of 1.025)	:	12.4 metres
	2.6	Design Draft, moulded (in seawater of specific gravity of 1.025)	:	11.4 metres
	2.7	Summer Draft (moulded)	:	Apprx. 12.0 metres
	2.8	Air Draft	:	max. 50.00 A/B with radar mast in lowered position and about 56.00m A/B with radar mast in raised position.
3.	**TONNAGE**			
	3.1	Deadweight at Design Draft, extreme	:	Apprx. 71,450 metric tonnes
		at Summer Draft, extreme	:	Apprx. 77,450 metric tonnes
	3.2	Lightweight	:	-
	3.3	Displacement at Summer Draft	:	-
	3.4	Gross Tonnage (International)	:	Apprx. 97,100 metric tonnes
	3.5	Net Register Tonnage	:	-
	3.6	Suez Canal Gross Tonnage	:	-
	3.7	Suez Canal Net Tonnage	:	-
4.	**MACHINERY**			
	4.1	Propelling Machinery,		

	Type and Make	:	Steam Turbine, Reversible Geared, Cross Compound, Steam Driven / Kawasaki Heavy Industries Limited
	Maximum Continuous Rating	:	39,500 PS @ 90 RPM
	Normal Service Rating	:	33,550 PS @ 86.9 RPM
4.2	Main Boilers		
	Type, Make and Number	:	Two Water tube, forced draft, marine boiler, Kawasaki Heavy Industries Limited
	Maximum Evaporation	:	Total 65 Te/h, each (incl. 4 Te/h desuperheated steam)
4.3	Electrical Generating Plan		
	Type, Maximum Output per	:	Two (2) sets of turbo generator, 4,312.5 kVA (3,450 kW), 6,600 VAC, 60 Hz, 3 Phase / Mitsubishi Heavy Industries Limited One (1) sets of diesel generator, 4,312.5 kVA (3,450 kW), 6,600 VAC, 60 Hz, 3 Phase / Wärtsilä One (1) set of emergency diesel generator, 1,062 kVA (850 kW), 450V AC, 60Hz, 3 Phase / STX--Cummins
4.4	Bow Thruster	:	Controllable Pitch Propeller (C.P.P.)
	Electric motor	:	2,500 kW, 6,600V
	No of blades	:	Four (4) (Ni-Al-Bronze)

5. OWNER GUARANTEE SPEEDS

The guarantee speed at the designed draft of 11.4m on even keel shall be not less than 20.2 knots with the main propulsion machinery running at an output of 30,910 PS under weather conditions not exceeding Beaufort 4.

6. FUEL CONSUMPTION RATE

At NCR	:	182.2 metric tonnes per day

Consumption rate based upon using fuel classified as RMH55 in accordance with ISO8217 (1996) and having a higher calorific value of 43 MJ/kg (10,280 kcal/kg).

7. CARGO TANKS

7.1	Total Capacity 98.5% full	:	142,950 cubic metres at maximum allowable cargo tank fill ratio of 98.5% and reference temperature according to IGC Code 15.1.2-4
7.2	Number of Cargo Tanks	:	4
7.3	Maximum S.G.	:	470 kg/m^3
7.4	Minimum Temperature	:	-163ºC
7.5	Normal Tank Operating Pressure	:	106 kPa absolute
7.6	Relief Valve Settings	:	25 kPa gauge
7.7	Capacity at -163°C 100% full	:	Apprx.145,130 m^3

No. 1 tank	:	22,040 m^3	No. 2 tank	:	42,760 m^3
No. 3 tank	:	42,,760 m^3	No. 4 tank	:	37,570 m^3

7.8 The Vessel's cargo tanks can be cooled down from ambient temperature to the loading condition in less than 10 hours (-130°C , mean temp. of cargo tanks).

8 CARGO LOADING AND DISCHARGE PERFORMANCE

(a) The ship shall be able to load the bulk of the cargo (exluding slow starting and topping off) through two (2) liquid manifolds in ***approximately 12 hours at pressure of 240 kPa(G)*** inboard of the manifold strainer.

(b) The ship shall be able to discharge the bulk cargo through three (3) liquid manifolds in approximately 12 hours (excluding slow starting and topping off) against a backpressure of 100 MLC measured inboard of the manifold strainer with cargo tanks at mid-level.

9. BOIL-OFF RATE

9.1	Guarantee Boil-off Rate	:	Not to exceed 0.15% per day

10. FRESH WATER

10.1	Capacity of F.W. generators	:	Two 60 T/d / Alfa-Laval
10.2	Capacity of Tanks		
	Boiler Feed	:	Apprx. 400 m^3
	Fresh Water	:	Apprx. 350 m^3

11. BUNKER CAPACITY

11.1	Fuel Oil (100%)	:	Apprx. 7,400 m^3
11.2	Gas Oil (100%)	:	Apprx. 100 m^3
11.3	Diesel Oil (100%)	:	Apprx. 300 m^3
		:	

12. WATER BALLAST

12.1	Tank Capacity (100%)	:	Apprx. 55,500 m^3
12.2	Number and Capacity of water ballast pumps	:	3 X 3,000 m^3/h at 30 mwc
12.3	The vessel is capable of loading/discharging ballast concurrent with cargo operations	:	Yes

13. CARGO PUMP

13.1	Number	:	8
13.2	Type and Make	:	Centrifugal, single stage, submerged / Ebara
13.3	Rated Capacity of each Pump	:	1,700 m^3/h at 155 mlc (S.G. 0.5)

14. SPRAY PUMP

14.1	Number	:	4
14.2	Type and Make	:	Centrifugal, submerged / Ebara
14.3	Rated Capacity of each Pump	:	50 m^3/h at 145 mlc (S.G. 0.5)

15. EMERGENCY CARGO PUMP

15.1	Number	:	1
15.2	Type and Make	:	Centrifugal, single stage, removable type / Ebara
15.3	Rated Capacity	:	550 m^3/h at 155 mlc (S.G. 0.5)

16. CARGO INSTRUMENTATION

16.1	Liquid Level Gauge		
	<u>Primary</u>		
	Type	:	Radar / Saab
	Number per Tank	:	1
	Accuracy	:	7.5 mm
	Measuring range	:	26.52 m

	Secondary		
	Type	:	Float / Whessoe
	Number per Tank	:	1
	Accuracy	:	7.5 mm
	Measuring range	:	26.52 m
16.2	Temperature Sensor		
	Type	:	High Accuracy
	Number per Tank	:	5 pair
	Accuracy	:	+0.2°C between -165°C and -145°C, rising to +1.5°C at +50°C
	Measuring range	:	-165°C to +50°C
16.3	Pressure Sensor System		
	Number per Tank	:	1
	Accuracy	:	+ 1% of span with deck temperature ranging between -30°C and +60°C
	Measuring range	:	800 - 1,400 mbar
16.4	Ship shore communication system	:	Fibre optic, intrinsically safe and pneumatic types

17. NITROGEN GENERATION

17.1	Type and Make	:	Membrane permeation type / Air Product AS
17.2	Capacity	:	2 off 100 Nm^3/h
17.3	Pressure Tank	:	6.5 bar g

18. INERT GAS GENERATION

18.1	Type and Make	:	Stoichiometric combustion of fuel oil / Smit Gas System
18.2	Capacity	:	14,000 Nm3/h inert gas or dry air
18.3	Quality of Gas	:	Dew point -45°C at 760 mmHg

O_2	: max. 1.0% by vol.
CO	: max. 100 ppm
SOx	: max. 10 ppm
NOx	: max. 100 ppm
Soot	: Bacharach 0
HC	: 0%
CO_2	: max. 14% by volume
Remainder	: N_2 , H_2 , Ar

19. GAS COMPRESSORS

19.1	High Duty		
	Type and Make	:	Horizontal, single stage centrifugal / Cyrostar
	Number and Capacity		2 off 26,000 m^3/h
	Discharge Pressure		200 kPa A
	Suction Press and Temp		-140°C, 103 kPa A
19.2	Low Duty		
	Type and Make	:	Horizontal, single stage centrifugal / Cyrostar
	Number and Capacity	:	2 off 8,000 m^3/h
	Discharge Pressure	:	200 kPa A
	Suction Press and Temp	:	-40°C, 106 kPa A

20. FORCING VAPORIZER

20.1	Capacity	:	7,000 kg/h from -163°C to -40°C / Cyrostar

21. DECK MACHINERY

21.1	Winches Number, Position, Type (incl. windlass)	:	4 for'd (2 combined with windlass) 5 aft, Electro-hydraulic self contained power pack, non auto-tension type mooring winches & windlasses / Kochs
21.2	Holding Power of Brake	:	80% of mooring line MBL (design) set at 60%
21.4	Size of Wires and whether fitted with Tails State Length, Material	:	Twenty-two (22) sets including two (2) spares, each 200 m long and 44 mm diameter of spectra rope or equivalent with each 11 m long nylon tail and a Tonsberg mooring link.
21.5	Derrick, cranes, etc. Type and Capacity	:	Electro-hydraulic driven single jib crane One (1) x 5.0 Te SWL at port aft and one (1) x 10.0 Te SWL at starboard aft. One (1) x 6.0 Te SWL for cargo machinery room Two (2) x 5.0 Te SWL at P&S manifold

22. NAVIGATION AND RADIO

22.1	Navigation Aids and Radio Equipment	:	VHF radio telephones GMDSS distress message controller Display units for radars (X and S-bands), ECDIS and conning display Auto pilot operating unit CCTV control station for mooring area camera and night vision camera UHF base station DGPS navigator Echo sounder recorder Master electric clock DGPS navigator Speed log main unit Navtex receiver Signal light control panel Loran-C receiver VHF radio telephone Inmarsat-B Inmarsat-C

23. OTHER

23.1	Bilge Oily Water Monitor	:	1 X 5 m^3/h (15 ppm)
23.2	Incinerator	:	1 X 500,000 kcal/h for solid garbage waste and sludge oil having flash point above 60°C
23.3	Sewage Treatment Plant	:	One (1) biological type for 45 persons

23.4 CCTV system with 11 cameras and monitors in wheelhouse, engine control room and cargo control room;
23.5 Loading computer including damage stability calculations;
23.6 Shipboard management system
23.7 Public address system
23.8 Master clock system
23.9 UHF onboard radio communication with 2 base stations, 1 base repeater station and twelve portable sets

APPENDIX H

CLASS I SCREENING AND Q/D ANALYSIS

Type B State New Source Review Application

Jordan Cove LNG Terminal
Jordan Cove Energy Project, LP
125 Central Avenue, Suite 380
Coos Bay, Oregon 97240

September 2017

Table H-1: Crater Lake Results and Significant Impact Levels (μg/m^3)

Pollutant	Averaging Period	Maximum Concentration at 50 km	Maximum Concentration at Class I Area	Class I SILs[1]
SO_2	3-hr	0.129	N/A	1
	24-hr	0.029	N/A	0.2
	Annual	0.002	N/A	0.1
NO_2	Annual	0.004	N/A	0.1
PM_{10}	24-hr	0.072	N/A	0.3
	Annual	0.003	N/A	0.2
$PM_{2.5}$	24-hr	0.072	5.93E-06	0.07
	Annual	0.003	N/A	0.06

(1) OAR 340-200-0020(163). All SILs are based on the first highest concentration at any one location.

Table H-2: Diamond Peak Results and Significant Impact Levels ($\mu g/m^3$)

Pollutant	Averaging Period	Maximum Concentration at 50 km	Maximum Concentration at Class I Area	Class I SILs[(1)]
SO_2	3-hr	0.118	N/A	1
	24-hr	0.025	N/A	0.2
	Annual	0.001	N/A	0.1
NO_2	Annual	0.004	N/A	0.1
PM_{10}	24-hr	0.059	N/A	0.3
	Annual	0.003	N/A	0.2
$PM_{2.5}$	24-hr	0.059	N/A	0.07
	Annual	0.003	N/A	0.06

(1) OAR 340-200-0020(163). All SILs are based on the first highest concentration at any one location.

Table H-3: Kalmiopsis Results and Significant Impact Levels (µg/m^3)

Pollutant	Averaging Period	Maximum Concentration at 50 km	Maximum Concentration at Class I Area	Class I SILs[(1)]
SO_2	3-hr	1.331	0.24	1
	24-hr	0.354	0.023	0.2
	Annual	0.012	N/A	0.1
NO_2	Annual	0.032	N/A	0.1
PM_{10}	24-hr	0.854	0.061	0.3
	Annual	0.026	N/A	0.2
$PM_{2.5}$	24-hr	0.854	0.061	0.07
	Annual	0.026	N/A	0.06

(1) OAR 340-200-0020(163). All SILs are based on the first highest concentration at any one location.

Table H-4: Redwood Results and Significant Impact Levels (μg/m^3)

Pollutant	Averaging Period	Maximum Concentration at 50 km	Maximum Concentration at Class I Area	Class I SILs[(1)]
SO_2	3-hr	1.331	0.049	1
	24-hr	0.354	0.002	0.2
	Annual	0.012	N/A	0.1
NO_2	Annual	0.032	N/A	0.1
PM_{10}	24-hr	0.854	0.004	0.3
	Annual	0.026	N/A	0.2
$PM_{2.5}$	24-hr	0.854	0.004	0.07
	Annual	0.026	N/A	0.06

(1) OAR 340-200-0020(163). All SILs are based on the first highest concentration at any one location.

Table H-5: Three Sisters Results and Significant Impact Levels (μg/m^3)

Pollutant	Averaging Period	Maximum Concentration at 50 km	Maximum Concentration at Class I Area	Class I SILs[(1)]
SO_2	3-hr	0.691	N/A	1
	24-hr	0.117	N/A	0.2
	Annual	0.003	N/A	0.1
NO_2	Annual	0.007	N/A	0.1
PM_{10}	24-hr	0.28	N/A	0.3
	Annual	0.006	N/A	0.2
$PM_{2.5}$	24-hr	0.28	0.003	0.07
	Annual	0.006	N/A	0.06

(1) OAR 340-200-0020(163). All SILs are based on the first highest concentration at any one location.

Table 1: Refined Q Calculations for Jordan Cove Energy Project

	Pound per Hour				Duration	Pounds per Day				Tons per Year			
Source	PM	SO_2	NO_x	H_2SO_4	(hours/day)	PM	SO_2	NO_x	H_2SO_4	PM	SO_2	NO_x	H_2SO_4
Turbine 1													
Normal Operation	5.40	1.64	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 2													
Normal Operation	5.40	1.64	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 3													
Normal Operation	5.40	1.640	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 4													
Normal Operation	5.40	1.64	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 5													
Normal Operation	5.40	1.640	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Oxidizer	0.82	4.53	14.44	0.00	24.00	19.67	108.72	346.56	0.00	3.6	19.8	63.2	0.0
Auxiliary Boiler	5.63	0.83	2.18	0.56	24.00	135.08	19.90	52.38	13.40	24.7	3.6	9.6	2.4
Fire Water Pump 1	0.30	0.01	5.31	0.00	1.00	0.30	0.01	5.31	0.00	0.1	0.0	1.0	0.0
Fire Water Pump 2	0.30	0.01	5.31	0.00	1.00	0.30	0.01	5.31	0.00	0.1	0.0	1.0	0.0
Fire Water Pump 3	0.30	0.01	5.31	0.00	1.00	0.30	0.01	5.31	0.00	0.1	0.0	1.0	0.0
Backup Generator 1	0.19	0.01	16.63	0.00	1.00	0.19	0.01	16.63	0.00	0.0	0.0	3.0	0.0
Backup Generator 2	0.19	0.01	16.63	0.00	1.00	0.19	0.01	16.63	0.00	0.0	0.0	3.0	0.0
Black Start Generator 1	0.23	0.04	7.43	0.00	1.00	0.23	0.04	7.43	0.00	0.0	0.0	1.4	0.0
Black Start Generator 2	0.23	0.04	7.43	0.00	1.00	0.23	0.04	7.43	0.00	0.0	0.0	1.4	0.0
Ground Flare	0.07	0.01	0.14	0.00	24.00	1.56	0.16	3.48	0.01	0.3	0.0	0.6	0.0
Marine Flare	0.02	0.00	0.04	0.00	24.00	0.40	0.04	0.89	0.00	0.1	0.0	0.2	0.0
Gas Up (From Marine Flare)	33.43	4.89	62.31	0.37	24.00	802.34	117.29	1495.47	8.98	146.4	21.4	272.9	1.6

Total (tpy)	295.9	80.7	444.3	28.0
Q	849			

Table 2: Refined Q/D Calculations for Jordan Cove Energy Project

Class I Area	State	Q (tpy)	Distance (km)	Q/D
Crater Lake NP	OR	849	165	5.1
Diamond Peak Wilderness	OR	849	177	4.8
Kalmiopsis Wildnerness	OR	849	110	7.7
Redwood NP	CA	849	165	5.1
Three Sisters Wilderness	OR	849	178	4.8

Jason Reed

From: ALLEN Philip <philip.allen@state.or.us>
Sent: August 07, 2017 9:52 AM
To: Jason Reed; Jessica Stark; EISELE Michael
Cc: 'Miller, James - FS'; Graw, Rick -FS
Subject: NPS Class I Area Determination

All,

Here is the determination by Don Shepherd of the NPS that Jordan Cove will not have a significant impact on AQRVs for the NPS Class I areas. The USFS has not yet made their determination.

Phil

From: Shepherd, Don [mailto:don_shepherd@nps.gov]
Sent: Monday, August 07, 2017 8:32 AM
To: ALLEN Philip
Cc: Tonnie Cummings
Subject: Re: FW: Additional information request

Hi Phil,

Based upon the new information provided by the applicant, we conclude that it is unlikely that the Jordan Cove Energy Project would have a significant impact upon Air Quality Related Values in any of our Class I areas.

We would appreciate it if OR DEQ would provide electronic copies of the complete/final permit application, staff analysis, draft permit, and public notice.

thanks,

On Sun, Aug 6, 2017 at 6:21 PM, ALLEN Philip <philip.allen@state.or.us> wrote:

Don,

Here is the response from SLR regarding their revised Q/d calculation for Crater Lake NP and Redwood NP. If you have additional concerns, please let me know. Thanks.

Phil

Philip Allen

Air Quality Program

Oregon DEQ

Portland

503.229.6904

allen.philip@deq.state.or.us

From: Jason Reed [mailto:jreed@slrconsulting.com]
Sent: Saturday, August 05, 2017 1:10 PM
To: ALLEN Philip
Cc: DAVIS Claudia; CAMARATA Mary; 'meagan.masten@vereseninc.com'; EISELE Michael; Andrew Jackson; Jessica Stark
Subject: RE: Additional information request

Hi Phil, please see below for our response to Don Shepherd's request. Please let me know if there are any additional questions.

SLR has recalculated the Q value for the Jordan Cove Energy Project based on a worst-case 24 hour emission scenario for project emissions of PM, SO_2, NOx, and H_2SO_4 (see attached). Following FLAG 2010 guidance, the worst-case 24 hour emissions were assumed to persist for the entire year and then summed in order to calculate the ton per year emissions (Q). The worst-case daily emissions scenario includes the following assumptions:

- Each turbine undergoing a startup/shutdown with normal operation (with duct burners) thereafter;
- Continuous operation of the thermal oxidizer;
- Continuous operation of the auxiliary boiler;
- One hour of operation of each of the three fire water pumps;
- One hour of operation of each of the two backup generators;
- One hour of operation of each of the two black start generators;
- Continuous operation of the ground flare and the marine flare pilot and purge gas; and
- Continuous emissions from gas up (flaring of gas vented from incoming LNG tankers).

Based on this worst-case daily emissions scenario, the calculated Q value is 849 tons per year. Both Crater Lake National Park (NP) and Redwood NP are approximately 165 km from the facility, **resulting in a Q/D value of 5.1**. In the development of the worst-case scenario, it is noted that several of the sources are intermittent (e.g., startup/shutdowns, auxiliary boiler, firewater pumps, backup generators, black start generators, and gas up emissions), thus concurrent operation of these sources in the same day is extremely unlikely.

It should also be noted that the Q value quoted in the Jordan Cove Energy Project modeling protocol was provided for informational purposes only for the Type B state New Source Review application, since AQRV analyses are not required.

Jason Reed, CCM
Senior Scientist

d 970-999-3970
o 970-494-0805
e jreed@slrconsulting.com

SLR International Corporation
1612 Specht Point Road, Suite 119, Fort Collins, CO, 80525

From: ALLEN Philip [mailto:philip.allen@state.or.us]
Sent: August 02, 2017 1:44 PM
To: Jessica Stark; Jason Reed
Cc: DAVIS Claudia; CAMARATA Mary; 'meagan.masten@vereseninc.com'; EISELE Michael
Subject: Additional information request

Hi Jason,

See below for email from Don Shepherd of the NPS requesting additional information for the Q/d calculation for Class I Area impacts. Please respond to me, and I will forward the revised information to both the NPS and USFS.

On a separate note, the inventory of competing sources will be sent later today by separate email.

Please contact me if you have questions. Thanks.

Phil

Philip Allen

Air Quality Program

Oregon DEQ

Portland

503.229.6904

allen.philip@deq.state.or.us

From: Shepherd, Don [mailto:don_shepherd@nps.gov]
Sent: Wednesday, August 02, 2017 8:05 AM
To: philip.allen@state.or.us
Cc: Tonnie Cummings; d King
Subject: Jordan Cove Modeling Protocol and Q/d

Hello Phil,

Tonnie Cummings has asked me to respond to your request for comments on the modeling protocol for the Jordan Cove Energy Project.

Before i can give you a decision, i need clarification of how the "Q" value in the Q/d calculation was derived. Here is what the applicant says on page 21 of the application:

Using the emissions summarized in Table 2-1 for the visibility impairing pollutants of NOx, SO2, PM, and H2SO4 the calculated Q value is 327.6. Using the shortest distance, D, from Table 4-1 above, the Q/D value is calculated to be 2.98, which is below the threshold value of 10.

My concern regards Table 2.1 on page 3. According to the applicant:

The potential annual emission rates for each criteria air pollutant from each source are shown in Table 2-1. The EPC contractor, KBJ, has completed the pre-FEED design stage of the project and is currently developing the detailed facility design.

Instead of using annual average emissions, Q should be calculated based upon the maximum 24-emission rates of NOx, SO2, PM, and H2SO4, including start-ups and shut-downs. The maximum 24-hour emission rate should then annualized to yield a tpy value for Q. It is also important that the applicant provide its calculations and assumptions in deriving these emission rates.

Please feel free to contact me with any questions.

thanks,

Don Shepherd

National Park Service

Air Resources Division

12795 W. Alameda Pkwy.

Lakewood, CO 80228

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Don Shepherd
National Park Service
Air Resources Division
12795 W. Alameda Pkwy.
Lakewood, CO 80228
Phone: 303-969-2075
Fax: 303-969-2822
E-Mail: don_shepherd@nps.gov
"the man who really counts in the world is the doer, not the mere critic" TR 1891

Jason Reed

From: ALLEN Philip <philip.allen@state.or.us>
Sent: August 07, 2017 11:08 AM
To: Jason Reed; Jessica Stark; EISELE Michael
Subject: USFS Class I Area Determination

Hi All,

The USFS agrees with the NPS that Jordan Cove will not have a significant AQRV impact on USFS Class I areas. See below.

Thanks.

Phil

From: Miller, James - FS [mailto:jamesmiller2@fs.fed.us]
Sent: Monday, August 07, 2017 9:41 AM
To: ALLEN Philip
Subject: RE: NPS Class I Area Determination

Hi Phil,

Given that the revised Q/D for Kalmiopsis – the closest Class I unit – is still < 10, Rick and I do not think Jordan Cove will have a significant impact for USFS Class I areas. Thank you for providing the feedback from Tonnie, Don, and others.

Best,

Jim

APPENDIX B.9

Stationary Source Emission Unit Inventory and Emission Calculations

Table 1. Annual Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Source	NO_X (tpy)	CO (tpy)	SO_2 (tpy)	VOC (tpy)	$PM/PM_{10}/PM_{2.5}$ (tpy)	H_2SO_4 (tpy)	NH_3 (tpy)	Lead (tpy)	CO_2e (tpy)	HAPs (tpy)
Turbines	81.99	97.82	35.19	32.72	112.26	23.61	75.43	---	1,292,706	5.06
Turbines Startup/Shutdown	0.23	0.73	4.4E-03	0.10	0.11	--	--	---	188	6.2E-04
Oxidizer	63.25	38.50	19.84	1.08	3.85	--	--	2.5E-04	622,154	0.96
Auxiliary Boiler	0.96	1.16	0.36	0.67	1.30	2.4E-01	0.87	6.3E-05	15,193	0.24
Fire-Water Pumps	1.59	0.80	2.1E-03	4.5E-02	9.0E-02	1.6E-04	--	2.1E-05	241	3.6E-03
Backup Generators	3.33	0.28	2.5E-03	0.04	0.04	1.9E-04	--	2.4E-05	278	4.1E-03
Black Start Generators	1.49	0.21	8.8E-03	0.09	0.05	6.8E-04	--	8.6E-05	1,002	1.5E-02
Flares	0.86	3.90	3.9E-02	8.31	0.38	3.0E-03	--	7.3E-06	2,177	4.3E-02
Gas Up	2.09	9.5	0.16	17.53	1.12	1.3E-02	--	2.1E-05	4,351	3.8E-02
Fugitives	--	--	--	7.98	--	--	--	--	13,116	1.77
AIE	1.00	1.00	1.00	1.00	1.00	0.70	--	--	--	--
Potential Emissions	**156.8**	**153.9**	**56.6**	**69.5**	**120.2**	**24.6**	**76.3**	**4.8E-04**	**1,951,406**	**8.1**
PSD ACDP PSELs	**221.0**	**156.1**	**63.5**	**209.3**	**181.9**	**55.8**	**196.9**	**7.8E-03**	**2,165,917**	**8.9**
Percent Change (%)	**-29**	**-1**	**-11**	**-67**	**-34**	**-56**	**-61**	**-94**	**-10**	**-9**
Federal Major Source Threshold	**250**	**250**	**250**	**250**	**250**					
SER	**40**	**100**	**40**	**40**	**25/15/10**	**7**		**0.6**	**75,000**	
New Source Review/PSD?	Type B State NSR	Type B State NSR	Type B State NSR	Type B State NSR	Type B State NSR	Type B State NSR			No GHG State NSR	

Table 2. Combustion Unit Rates and Operational Characteristics
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Parameter		Turbines	Thermal Oxidizer	Auxiliary Boiler	Marine Enclosed Flare	Multipoint Ground Flare	Firewater Pumps	Black Start Generator Engines	Backup Generators
Fuel	(1)	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Diesel	Diesel	Diesel
Fuel Type	(2)	Pipeline	Pipeline	Pipeline	Pipeline	Pipeline	ULSD	ULSD	ULSD
Sulfur Content	(3)	0.01 grains/dscf	0.01 grains/dscf	0.01 grains/dscf	0.01 grains/dscf	0.01 grains/dscf	15 ppmvd	15 ppmvd	15 ppmvd
Heating Value of Fuel, HHV	(3)	952 Btu/scf	952 Btu/scf	1024.6 Btu/scf	868 Btu/scf	868 Btu/scf	140,005 Btu/gal	140,005 Btu/gal	140,005 Btu/gal
Number of Units	(1)	5	1	1	6	28	3	2	2
Hours of Operation	(1)	8,760	8,760	876	8,760	8,760	200	200	200
Rating	(1)	524.1 MMBtu/hr	110 MMBtu/hr	296.2 MMBtu/hr	0.74 MMBtu/hr	2.13 MMBtu/hr	700 hp	4,376 hp	800 kW
Stack Inside Diameter (ft)	(1)	10	9.5	6	45	Wall Heights = 85' on E+S and 60' on N+W	0.67	1.67	0.67
Stack Height (ft)	(1)	119	131	100	100	Field Dimensions = 259' E-W x 227' N-S	18	18	13
Exhaust Flowrate (acfm)	(1)								
Exit Velocity (ft/sec)	(1)	71	42	49	30		193	177	287
Exit Temperature (˚F)	(1)	243	1,600	330	1832	ambient	948.3	873.6	952.5

Notes:
(1) Provided by KBJ.
(2) Engines are required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.
(3) Site-specific data provided by KBJ.

Table 3. Natural Gas Turbines Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon
Scenario: 4000 hours 100% load DB, 4760 hours 100% load no DB

Pollutant		Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants						
NO_X	100% Load - DB fired	3.8	lb/hr	(1)	3.75	81.99
	100% Load - DB unfired	3.7	lb/hr			
CO	100% Load - DB fired	4.6	lb/hr	(1)	4.47	97.82
	100% Load - DB unfired	4.4	lb/hr			
SO_2	100% Load - DB fired	1.64	lb/hr	(1), (2)	1.61	35.19
	100% Load - DB unfired	1.58	lb/hr			
VOC	100% Load - DB fired	1.7	lb/hr	(1)	1.49	32.72
	100% Load - DB unfired	1.3	lb/hr			
$PM/PM_{10}/PM_{2.5}$	100% Load - DB fired	5.4	lb/hr		5.13	112.26
	100% Load - DB unfired	4.9	lb/hr	(1)		
H_2SO_4	100% Load - DB fired	1.10	lb/hr	(1)	1.08	23.61
	100% Load - DB unfired	1.06	lb/hr			
NH_3	100% Load - DB fired	3.5	lb/hr	(1)	3.45	75.43
	100% Load - DB unfired	3.4	lb/hr			
Lead		---		(3)	---	---
CO_2e		---		(4)	59,053	1,292,706
CO_2	100% Load - DB fired	60,218	lb/hr	(1)	58,990	1,291,320
	100% Load - DB unfired	57,958	lb/hr			
CH_4		0.001	kg/MMBtu	(5)	1.155	25.293
N_2O		0.0001	kg/MMBtu	(5)	0.116	2.529
Hazardous Air Pollutants						
Acetaldehyde - Turbine		4.0E-05	lb/MMBtu	(6)	2.0E-02	4.4E-01
Acrolein - Turbine		6.4E-06	lb/MMBtu	(6)	3.2E-03	7.1E-02
Benzene - Turbine		1.2E-05	lb/MMBtu	(6)	6.1E-03	1.3E-01
Benzene - Duct Burner		2.1E-03	lb/MMscf	(7)	4.3E-05	4.3E-04
1,3-Butadiene - Turbine		4.3E-07	lb/MMBtu	(6)	2.2E-04	4.7E-03
Dichlorobenzene - Duct Burner		1.2E-03	lb/MMscf	(7)	2.5E-05	2.5E-04
Ethylbenzene - Turbine		3.2E-05	lb/MMBtu	(6)	1.6E-02	3.5E-01
Formaldehyde - Turbine		1.0E-04	lb/MMBtu	(8)	5.0E-02	1.1E+00
Formaldehyde - Duct Burner		7.5E-02	lb/MMscf	(7)	1.6E-03	1.6E-02
Hexane - Duct Burner		1.8E+00	lb/MMscf	(7)	3.7E-02	3.7E-01
Naphthalene - Turbine		1.3E-06	lb/MMBtu	(6)	6.6E-04	1.4E-02
Naphthalene - Duct Burner		6.1E-04	lb/MMscf	(7)	1.3E-05	1.3E-04
PAH - Turbine		2.2E-06	lb/MMBtu	(6)	1.1E-03	2.4E-02
PAH - Duct Burner		8.9E-05	lb/MMscf	(7)	1.8E-06	1.8E-05
Propylene Oxide - Turbine		2.9E-05	lb/MMBtu	(6)	1.5E-02	3.2E-01
Toluene - Turbine		1.3E-04	lb/MMBtu	(6)	6.6E-02	1.4E+00
Toluene - Duct Burner		3.4E-03	lb/MMscf	(7)	7.0E-05	7.0E-04
Xylenes - Turbine		6.4E-05	lb/MMBtu	(6)	3.2E-02	7.1E-01
Arsenic		2.0E-04	lb/MMscf	(3)	1.1E-04	2.4E-03
Beryllium		1.2E-05	lb/MMscf	(3)	6.6E-06	1.4E-04
Cadmium		1.1E-03	lb/MMscf	(3)	6.1E-04	1.3E-02
Chromium		1.4E-03	lb/MMscf	(3)	7.7E-04	1.7E-02
Cobalt		8.4E-05	lb/MMscf	(3)	4.6E-05	1.0E-03

Pollutant	Emission Factor	Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Manganese	3.8E-04 lb/MMscf (3)	2.1E-04	4.6E-03
Mercury	2.6E-04 lb/MMscf (3)	1.4E-04	3.1E-03
Nickel	2.1E-03 lb/MMscf (3)	1.2E-03	2.5E-02
Selenium	2.4E-05 lb/MMscf (3)	1.3E-05	2.9E-04
Total HAPs		**0.25**	**5.06**
Maximum Individual HAP			**1.44**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor for 100% load (lb/hr)] x [Time at 100% load (%) / 100] + [Emission Factor for 75% load (lb/hr)] x [Time at 75% load (%) / 100]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (MMBtu/hr)] x [2.20462 (lb/kg)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Heat Rate (MMBtu/hr)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Heat Rate (MMBtu/hr)] / [Fuel Heat Content (MMBtu/MMscf)]

Hours at 100% load DB fired (%) =	4000	(9)
Hours at 100% load DB unfired (%) =	4760	(9)
Turbine Maximum Heat Rate (MMBtu/hr) =	504.4	(10)
Duct Burner Maximum Heat Rate (MMBtu/hr) =	19.7	(10)
Maximum Heat Rate (MMBtu/hr) =	524.1	(10)
Fuel Heat Content (Btu/scf) =	952	(11)

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Turbine Hours of Operation (hr/yr) - Startup/Shutdown Hours (hr/yr)] x [Number of Units] / [2,000 (lb/ton)]

Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Duct Burner Hours of Operation (hr/yr)] x [Number of Units] / [2,000 (lb/ton)]

Number of Units =	5	(9)
Duct Burner Hours of Operation (hr/yr) =	4,000	(12)
Turbine Hours of Operation (hr/yr) =	8,760	(9)
Startup/Shutdown Hours (hr/yr) =	3.8	(13)

Notes:

(1) Emission estimates provided by manufacturer.
(2) SO_2 emissions include assumptions of 20 percent by volume oxidation rate in CO catalyst and 3 percent by volume oxidation rate in SCR.
(3) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998. Note emission factor for lead is ND as indicated in AP-42, Chapter 3.1-2a, Table 3.1, Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines.
(4) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.
(5) Emission Factors from Table C-2 to Subpart C of 40 CFR Part 98 - Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(6) AP-42, Chapter 3.1, Table 3.1-3. Emission Factors for Hazardous Air Pollutants from Natural Gas-Fired Stationary Gas Turbines, April 2000.
(7) AP-42, Chapter 1.4, Table 1.4-3. Emission Factors for Speciated Organic Compounds from Natural Gas Combustion, July 1998. HAP emission factors used for Duct Burners.
(8) California Air Resource Board (CARB) emission inventory for NG turbine.
(9) Percentage of time at specific loads, number of units, and hours of operation provided by KBJ.
(10) Maximum heat rate at 100% load with duct burners provided by manufacturer (see Table 13).
(11) Provided by KBJ.
(12) Provided by KBJ.
(13) KBJ estimates 12 startup per year at 10 minutes per startup and 12 shutdowns per year at 9 minutes per shutdown. See Table 4 for additional startup and shutdown calculations.

Table 4. Natural Gas Turbines Startup/Shutdown Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Startup Emission Factor per Event		Shutdown Emission Factor per Event		Emissions per Startup Event [(a)] (lb)	Emissions per Shutdown Event [(a)] (lb)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants							
NO_X	3.8 lb	(1)	3.7 lb	(1)	3.80	3.70	0.23
CO	11.5 lb	(1)	12.8 lb	(1)	11.50	12.80	0.73
SO_2	7.7E-02 lb	(2)	6.9E-02 lb	(2)	7.7E-02	6.9E-02	4.4E-03
VOC	1.6 lb	(1)	1.8 lb	(1)	1.60	1.80	0.10
$PM/PM_{10}/PM_{2.5}$	0.40 lb	(1)	3.3 lb	(1)	0.40	3.30	0.11
H_2SO_4	---		---		---	---	---
NH_3	---		---		---	---	---
Lead	---	(3)	---	(3)	---	---	---
CO_2e	---	(4)	---	(4)	3,319	2,948	188.02
CO_2	3,316 lb	(1)	2,945 lb	(1)	3,316	2,945	187.83
CH_4	0.001 kg/MMBtu	(5)	0.001 kg/MMBtu	(5)	5.7E-02	5.7E-02	3.4E-03
N_2O	0.0001 kg/MMBtu	(5)	0.0001 kg/MMBtu	(5)	5.7E-03	5.7E-03	3.4E-04
Hazardous Air Pollutants							
Acetaldehyde	4.0E-05 lb/MMBtu	(6)	4.0E-05 lb/MMBtu	(6)	1.0E-03	9.2E-04	5.8E-05
Acrolein	6.4E-06 lb/MMBtu	(6)	6.4E-06 lb/MMBtu	(6)	1.7E-04	1.5E-04	9.4E-06
Benzene	1.2E-05 lb/MMBtu	(6)	1.2E-05 lb/MMBtu	(6)	3.1E-04	2.8E-04	1.8E-05
1,3-Butadiene	4.3E-07 lb/MMBtu	(6)	4.3E-07 lb/MMBtu	(6)	1.1E-05	9.9E-06	6.3E-07
Ethylbenzene	3.2E-05 lb/MMBtu	(6)	3.2E-05 lb/MMBtu	(6)	8.3E-04	7.3E-04	4.7E-05
Formaldehyde	1.0E-04 lb/MMBtu	(8)	1.0E-04 lb/MMBtu	(8)	2.6E-03	2.3E-03	1.5E-04
Naphthalene	1.3E-06 lb/MMBtu	(6)	1.3E-06 lb/MMBtu	(6)	3.4E-05	3.0E-05	1.9E-06
PAH	2.2E-06 lb/MMBtu	(6)	2.2E-06 lb/MMBtu	(6)	5.7E-05	5.0E-05	3.2E-06
Propylene Oxide	2.9E-05 lb/MMBtu	(6)	2.9E-05 lb/MMBtu	(6)	7.5E-04	6.6E-04	4.2E-05
Toluene	1.3E-04 lb/MMBtu	(6)	1.3E-04 lb/MMBtu	(6)	3.4E-03	3.0E-03	1.9E-04
Xylenes	6.4E-05 lb/MMBtu	(6)	6.4E-05 lb/MMBtu	(6)	1.7E-03	1.5E-03	9.4E-05
Arsenic	2.0E-04 lb/MMscf	(3)	2.0E-04 lb/MMscf	(3)	5.4E-06	4.8E-06	3.1E-07
Beryllium	1.2E-05 lb/MMscf	(3)	1.2E-05 lb/MMscf	(3)	3.3E-07	2.9E-07	1.8E-08
Cadmium	1.1E-03 lb/MMscf	(3)	1.1E-03 lb/MMscf	(3)	3.0E-05	2.7E-05	1.7E-06
Chromium	1.4E-03 lb/MMscf	(3)	1.4E-03 lb/MMscf	(3)	3.8E-05	3.4E-05	2.2E-06
Cobalt	8.4E-05 lb/MMscf	(3)	8.4E-05 lb/MMscf	(3)	2.3E-06	2.0E-06	1.3E-07
Manganese	3.8E-04 lb/MMscf	(3)	3.8E-04 lb/MMscf	(3)	1.0E-05	9.2E-06	5.8E-07
Mercury	2.6E-04 lb/MMscf	(3)	2.6E-04 lb/MMscf	(3)	7.0E-06	6.3E-06	4.0E-07
Nickel	2.1E-03 lb/MMscf	(3)	2.1E-03 lb/MMscf	(3)	5.7E-05	5.1E-05	3.2E-06
Selenium	2.4E-05 lb/MMscf	(3)	2.4E-05 lb/MMscf	(3)	6.5E-07	5.8E-07	3.7E-08
Total HAPs					**0.01**	**0.01**	**6.2E-04**
Maximum Individual HAP							**1.9E-04**

Calculations:

(a) Emission Factor (lb/Event) = [Sulfur Content (grains/scf)] / [7,000 (grains/lb)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] \ [Molecular Weight S (lb/lb-mole)]

Emission Factor (lb/Event) = [Emission Factor (kg/MMBtu)] x [2.20462 (lb/kg)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

Emission Factor (lb/Event) = [Emission Factor (lb/MMscf)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] / [1,000,000 (scf/MMscf)]

Emission Factor (lb/Event) = [Emission Factor (lb/MMBtu)] x [Fuel Consumption (lb)] / [Fuel Density (lb/scf)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

Fuel Sulfur Content (grains/scf) =	0.01	(2)
Startup Fuel Consumption (lb) =	1,200	(1)
Shutdown Fuel Consumption (lb) =	1,067	(1)
Fuel Heat Content (Btu/scf) =	952	(8)
Fuel Density (lb/scf) =	0.044	(9)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	

(b) Annual Emissions (tons/yr) = {[Emissions per Startup Event (lb/Event)] x [Count of Startup Events (Event)] + [Emissions per Shutdown Event (lb/Event)] x [Count of Shutdown Events (Event)]} x [Number of Units] / [2,000 (lb/ton)]

Count of Startup Events = 12 (10)

Pollutant	Startup Emission Factor per Event	Shutdown Emission Factor per Event	Emissions per Startup Event [a] (lb)	Emissions per Shutdown Event [a] (lb)	Annual Emissions [b] (tons/yr)

Count of Shutdown Events = 12 (10)
Number of Units = 5 (11)

Notes:
(1) Emission estimates and fuel use provided by manufacturer.
(2) Sulfur content provided by KBJ as site data.
(3) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998. Note emission factor for lead is ND as indicated in AP-42, Chapter 3.1, Table 3.1-2a, Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines.
(4) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.
(5) Emission Factors from Table C-2 to Subpart C of 40 CFR Part 98 - Default CH_4 and N_2O Emission Factors for Various Types of Fuel.
(6) AP-42, Chapter 3.1, Table 3.1-3. Emission Factors for Hazardous Air Pollutants from Natural Gas-Fired Stationary Gas Turbines, April 2000.
(7) California Air Resource Board (CARB) emission inventory.
(8) Provided by KBJ
(9) Provided by KBJ
(10) KBJ estimates 12 startup per year at 10 minutes per startup and 12 shutdowns per year at 9 minutes per shutdown.
(11) Number of units provided by KBJ.

Table 5. Zeeco Natural Gas Thermal Oxidizer Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	14.44	lb/hr	(1)	14.44	63.25
CO	8.79	lb/hr	(1)	8.79	38.50
SO_2	4.53	lb/hr	(1)	4.53	19.84
VOC	0.01	lb/hr	(1)	0.01	0.03
VOC (venting)	6.00	lb/hr	(1)	6.00	1.05
$PM/PM_{10}/PM_{2.5}$	7.6	lb/MMscf	(2)	0.88	3.85
H_2SO_4	---			---	---
NH_3	---			---	---
Lead	5.0.E-04	lb/MMscf	(2)	5.78E-05	2.5E-04
CO_2e	---		(3)	261,758	622,154
CO_2	137,049	lb/hr	(1)	137,049	600,274
CO_2 (venting)	123,471	lb/hr		123,471	21,607
CH_4	0.001	kg/MMBtu	(4)	0.24	1.06
CH_4 (venting)	49.00	lb/hr		49.00	8.57
N_2O	0.0001	kg/MMBtu	(4)	2.4E-02	1.1E-01
Hazardous Air Pollutants					
Benzene	2.1E-03	lb/MMscf	(5)	2.4E-04	1.1E-03
Dichlorobenzene	1.2E-03	lb/MMscf	(5)	1.4E-04	6.1E-04
Formaldehyde	7.5E-02	lb/MMscf	(5)	8.7E-03	3.8E-02
Hexane	1.8E+00	lb/MMscf	(5)	0.21	0.91
Naphthalene	6.1E-04	lb/MMscf	(5)	7.1E-05	3.1E-04
Polycyclic Organic Matter	8.8E-05	lb/MMscf	(5)	1.0E-05	4.5E-05
Toluene	3.4E-03	lb/MMscf	(5)	3.9E-04	1.7E-03
Arsenic	2.0E-04	lb/MMscf	(6)	2.3E-05	1.0E-04
Beryllium	1.2E-05	lb/MMscf	(6)	1.4E-06	6.1E-06
Cadmium	1.1E-03	lb/MMscf	(6)	1.3E-04	5.6E-04
Chromium	1.4E-03	lb/MMscf	(6)	1.6E-04	7.1E-04
Cobalt	8.4E-05	lb/MMscf	(6)	9.7E-06	4.3E-05
Manganese	3.8E-04	lb/MMscf	(6)	4.4E-05	1.9E-04
Mercury	2.6E-04	lb/MMscf	(6)	3.0E-05	1.3E-04
Nickel	2.1E-03	lb/MMscf	(6)	2.4E-04	1.1E-03
Selenium	2.4E-05	lb/MMscf	(6)	2.8E-06	1.2E-05
Total HAPs				**0.22**	**0.96**
Maximum Individual HAP					**0.91**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Heat Rate (MMBtu/hr)] / [Fuel Heat Content (MMBtu/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (MMBtu/hr)] x [2.20462 (lb/kg)]

Maximum Heat Rate (MMBtu/hr) =	110	(7)
Fuel Heat Content (Btu/scf) =	952	(8)

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	1	(9)
Hours of Operation (hr/yr) =	8,760	(9)

Notes:

(1) Emission estimates provided by KBJ. VOC emissions include 350 hours of venting.

(2) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998.

(3) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(4) Emission Factors from Table C-2 to Subpart C of 40 CFR Part 98 - Default CH_4 and N_2O Emission Factors for Various Types of Fuel.

(5) AP-42, Chapter 1.4, Table 1.4-3. Emission Factors for Speciated Organic Compounds from Natural Gas Combustion, July 1998.

(6) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998.

(7) Manufacturer specification sheet.

(8) Fuel gas system heat content.

(9) Number of units and hours of operation provided by KBJ.

Table 6. Natural Gas Auxiliary Boiler Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	2	ppmvd @ 15% O_2	(1)	2.18	0.96
CO	4	ppmvd @ 15% O_2	(1)	2.66	1.16
SO_2	0.01	grains S/scf	(2),(3)	0.83	0.36
VOC	4	ppmvd @ 15% O_2	(1)	1.52	0.67
$PM/PM_{10}/PM_{2.5}$	0.01	lb/MMBtu	(2)	2.96	1.30
H_2SO_4	---		(3)	0.56	0.24
NH_3	0.0067	lb/MMBtu	(1)	1.98	0.87
Lead	0.0005	lb/MMscf	(4)	1.45E-04	6.3E-05
CO_2e	---		(5)	34,688	15,193
CO_2	53.06	kg/MMBtu	(6)	34,652	15,178
CH_4	0.001	kg/MMBtu	(6)	0.65	0.29
N_2O	0.0001	kg/MMBtu	(6)	0.07	2.9E-02
Hazardous Air Pollutants					
Benzene	2.1E-03	lb/MMscf	(7)	6.1E-04	2.7E-04
Dichlorobenzene	1.2E-03	lb/MMscf	(7)	3.5E-04	1.5E-04
Formaldehyde	7.5E-02	lb/MMscf	(7)	2.2E-02	9.5E-03
Hexane	1.8E+00	lb/MMscf	(7)	0.52	0.23
Naphthalene	6.1E-04	lb/MMscf	(7)	1.8E-04	7.7E-05
Polycyclic Organic Matter	8.8E-05	lb/MMscf	(7)	2.6E-05	1.1E-05
Toluene	3.4E-03	lb/MMscf	(7)	9.8E-04	4.3E-04
Arsenic	2.0E-04	lb/MMscf	(8)	5.8E-05	2.5E-05
Beryllium	1.2E-05	lb/MMscf	(8)	3.5E-06	1.5E-06
Cadmium	1.1E-03	lb/MMscf	(8)	3.2E-04	1.4E-04
Chromium	1.4E-03	lb/MMscf	(8)	4.0E-04	1.8E-04
Cobalt	8.4E-05	lb/MMscf	(8)	2.4E-05	1.1E-05
Manganese	3.8E-04	lb/MMscf	(8)	1.1E-04	4.8E-05
Mercury	2.6E-04	lb/MMscf	(8)	7.5E-05	3.3E-05
Nickel	2.1E-03	lb/MMscf	(8)	6.1E-04	2.7E-04
Selenium	2.4E-05	lb/MMscf	(8)	6.9E-06	3.0E-06
Total HAPs				**0.55**	**0.24**
Maximum Individual HAP					**0.23**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Concentration (ppmvd @ 15% O_2)] x [Conversion Factor (lb/scf-ppm)] x [F_d (dscf/MMBtu)] x [20.9 / (20.9 - 15) (%)] x [Maximum Heat Rate (MMBtu/hr)]

Hourly Emissions (lb/hr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] / [Molecular Weight S (lb/lb-mole) x [Pilot and Purge Fuel Consumption (scf/hr)] / [7000 (grains/lb)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Heat Rate (MMBtu/hr)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Heat Rate (MMBtu/hr)] / [Fuel Heat Content (MMBtu/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (MMBtu/hr)] x [2.20462 (lb/kg)]

Maximum Heat Rate, LHV (MMBtu/hr) =	269.3	(9)
Maximum Heat Rate, HHV (MMBtu/hr) =	296.2	(9)
Fuel Heat Content (Btu/scf) =	1,024.6	(10)
F_d (dscf/MMBtu) =	8,710	(11)
NO_X Conversion Factor (lb/scf-ppm) =	1.194E-07	(11)
CO Conversion Factor (lb/scf-ppm) =	7.268E-08	(11)
VOC Conversion Factor (lb/scf-ppm) =	4.153E-08	(11)
Conversion of SO_2 to H_2SO_4 (percent) =	44	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	1	(12)
Hours of Operation (hr/yr) =	876	(12)

Notes:

(1) Emission estimates provided by manufacturer.

(2) Provided by KBJ.

(3) Assume conversion of SO_2 to SO_3 of 44 percent by volume as provided by KBJ.

(4) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 1.4, Table 1.4-3. Emission Factors for Speciated Organic Compounds from Natural Gas Combustion, July 1998.

(8) AP-42, Chapter 1.4, Table 1.4-4. Emission Factors for Metals from Natural Gas Combustion, July 1998.

(9) Maximum heat rate in LHV is supplied by KBJ. HHV is assumed to be 10% higher.

(10) Pipeline feed gas fuel heat content provided by JCLNG.

(11) See EPA Method 19 Tables 19-1 - Conversion Factors for Concentration, and 19-2 - F Factors for Various Fuels. Conversion factor for CO and VOC calculated used identical basis.

(12) Number of units and hours of operation provided by KBJ.

Table 7. Diesel Firewater Pump Engine Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [a] (lb/hr)	Annual Emissions [b] (tons/yr)
Criteria Pollutants					
NO_X	5.31	lb/hr	(1)	5.31	1.59
CO	2.68	lb/hr	(1)	2.68	0.80
SO_2	0.0015	weight percent S	(2)	7.1E-03	2.1E-03
VOC	0.15	lb/hr	(1)	0.15	0.05
$PM/PM_{10}/PM_{2.5}$	0.30	lb/hr	(1)	0.30	9.0E-02
H_2SO_4	---		(3)	5.4E-04	1.6E-04
NH_3	---			---	---
Lead	1.40E-05	lb/MMBtu	(4)	6.9E-05	2.1E-05
CO_2e	---		(5)	802	241
CO_2	73.96	kg/MMBtu	(6)	799	240
CH_4	0.003	kg/MMBtu	(6)	3.2E-02	9.7E-03
N_2O	0.0006	kg/MMBtu	(6)	6.5E-03	1.9E-03
Hazardous Air Pollutants					
Acetaldehyde	2.52E-05	lb/MMBtu	(7)	1.2E-04	3.7E-05
Acrolein	7.88E-06	lb/MMBtu	(7)	3.9E-05	1.2E-05
Benzene	7.76E-04	lb/MMBtu	(7)	3.8E-03	1.1E-03
Formaldehyde	7.89E-05	lb/MMBtu	(7)	3.9E-04	1.2E-04
Naphthalene	1.30E-04	lb/MMBtu	(8)	6.4E-04	1.9E-04
Polycyclic Organic Matter	8.20E-05	lb/MMBtu	(8)	4.0E-04	1.2E-04
Toluene	2.81E-04	lb/MMBtu	(7)	1.4E-03	4.1E-04
Xylenes	1.93E-04	lb/MMBtu	(7)	9.5E-04	2.8E-04
Arsenic	1.1E-05	lb/MMBtu	(9)	5.4E-05	1.6E-05
Beryllium	3.1E-07	lb/MMBtu	(9)	1.5E-06	4.6E-07
Cadmium	4.8E-06	lb/MMBtu	(9)	2.4E-05	7.1E-06
Chromium	1.1E-05	lb/MMBtu	(9)	5.4E-05	1.6E-05
Manganese	7.9E-04	lb/MMBtu	(9)	3.9E-03	1.2E-03
Mercury	1.2E-06	lb/MMBtu	(9)	5.9E-06	1.8E-06
Nickel	4.6E-06	lb/MMBtu	(9)	2.3E-05	6.8E-06
Selenium	2.5E-05	lb/MMBtu	(9)	1.2E-04	3.7E-05
Total HAPs				**0.01**	**3.6E-03**
Maximum Individual HAP					**1.2E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [S (wt%) / 100] x [Fuel Density (lb/gal)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr) / [Fuel Heat Content (Btu/gal)] x [SO_2 Molecular Weight (lb/lb-mol)] / [S Molecular Weight (lb/lb-mol)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] x

[2.20462 (lb/kg)] / [1,000,000 (Btu/MMBtu)]

Maximum Rate (hp) =	700	(10)
Fuel Density (lb/gal) =	7.1	(11)
Fuel Heat Content (Btu/gal) =	140,005	(11)
Engine Heat Rate (Btu/hp-hr) =	7,000	(12)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	3	(13)
Hours of Operation (hr/yr) =	200	(13)

Notes:

(1) Emissions performance data provided by manufacturer at rated speed potential site variation (1750 rpm). Maximum value at 50% of load or greater. Conservative to use lower load (highest) emission rates for CO, VOC, and PM.

(2) Engine is required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.

(3) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(4) AP-42, Chapter 3.1, Table 3.1-2a. Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines, April 2000. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 3.4, Table 3.4-3. Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(8) AP-42, Chapter 3.4, Table 3.4-4. PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(9) AP-42, Chapter 3.1, Table 3.1-5. Emission Factors for Metallic Hazardous Air Pollutants from Distillate Oil-Fired Stationary Gas Turbines, April 2000.

(10) Maximum engine rate supplied by KBJ.

(11) Site specific fuel heat content and fuel density provided by KBJ.

(12) AP-42, Chapter 3.3, Table 3.1-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, footnote a, October 1996.

(13) Number of units and hours of operation provided by KBJ.

Table 8. Backup Diesel Generator Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	16.63	lb/hr	(1)	16.63	3.33
CO	1.42	lb/hr	(1)	1.42	0.28
SO_2	0.0015	weight percent S	(2)	1.2E-02	2.5E-03
VOC	0.20	lb/hr	(1)	0.20	0.04
$PM/PM_{10}/PM_{2.5}$	0.19	lb/hr	(1)	0.19	0.04
H_2SO_4	---		(3)	9.4E-04	1.9E-04
NH_3	---			---	---
Lead	1.40E-05	lb/MMBtu	(4)	1.2E-04	2.4E-05
CO_2e	---		(5)	1,390	278
CO_2	73.96	kg/MMBtu	(6)	1,386	277
CH_4	0.003	kg/MMBtu	(6)	0.06	1.1E-02
N_2O	0.0006	kg/MMBtu	(6)	1.1E-02	2.2E-03
Hazardous Air Pollutants					
Acetaldehyde	2.52E-05	lb/MMBtu	(7)	2.1E-04	4.3E-05
Acrolein	7.88E-06	lb/MMBtu	(7)	6.7E-05	1.3E-05
Benzene	7.76E-04	lb/MMBtu	(7)	6.6E-03	1.3E-03
Formaldehyde	7.89E-05	lb/MMBtu	(7)	6.7E-04	1.3E-04
Naphthalene	1.30E-04	lb/MMBtu	(8)	1.1E-03	2.2E-04
Polycyclic Organic Matter	8.20E-05	lb/MMBtu	(8)	7.0E-04	1.4E-04
Toluene	2.81E-04	lb/MMBtu	(7)	2.4E-03	4.8E-04
Xylenes	1.93E-04	lb/MMBtu	(7)	1.6E-03	3.3E-04
Arsenic	1.1E-05	lb/MMBtu	(9)	9.3E-05	1.9E-05
Beryllium	3.1E-07	lb/MMBtu	(9)	2.6E-06	5.3E-07
Cadmium	4.8E-06	lb/MMBtu	(9)	4.1E-05	8.2E-06
Chromium	1.1E-05	lb/MMBtu	(9)	9.3E-05	1.9E-05
Manganese	7.9E-04	lb/MMBtu	(9)	6.7E-03	1.3E-03
Mercury	1.2E-06	lb/MMBtu	(9)	1.0E-05	2.0E-06
Nickel	4.6E-06	lb/MMBtu	(9)	3.9E-05	7.8E-06
Selenium	2.5E-05	lb/MMBtu	(9)	2.1E-04	4.2E-05
Total HAPs				**0.02**	**4.1E-03**
Maximum Individual HAP					**1.3E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [S (wt%) / 100] x [Fuel Density (lb/gal)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr) / [Fuel Heat Content (Btu/gal)] x [SO_2 Molecular Weight (lb/lb-mol)] / [S Molecular Weight (lb/lb-mol)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] x

[2.20462 (lb/kg)] / [1,000,000 (Btu/MMBtu)]

Maximum Rate (kW) =	800	(10)
Maximum Rate (hp) =	1,214	(10)
Fuel Density (lb/gal) =	7.1	(11)
Fuel Heat Content (Btu/gal) =	140,005	(11)
Engine Heat Rate (Btu/hp-hr) =	7,000	(12)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	2	(13)
Hours of Operation (hr/yr) =	200	(13)

Notes:

(1) Emissions performance data provided by manufacturer at rated speed potential site variation (1800 rpm). Maximum value at 50% of load or greater. Conservative to use lower load (highest) emission rates for CO, VOC, and PM.

(2) Engine is required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.

(3) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(4) AP-42, Chapter 3.1, Table 3.1-2a. Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines, April 2000. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 3.4, Table 3.4-3. Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(8) AP-42, Chapter 3.4, Table 3.4-4. PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(9) AP-42, Chapter 3.1, Table 3.1-5. Emission Factors for Metallic Hazardous Air Pollutants from Distillate Oil-Fired Stationary Gas Turbines, April 2000.

(10) Maximum engine rate supplied by KBJ.

(11) Site specific fuel heat content and fuel density provided by KBJ.

(12) AP-42, Chapter 3.3, Table 3.1-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, footnote a, October 1996.

(13) Number of units and hours of operation provided by KBJ.

Table 9. Black Start Diesel Generator Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	7.43	lb/hr	(1)	7.43	1.49
CO	1.04	lb/hr	(1)	1.04	0.21
SO_2	0.0015	weight percent S	(2)	4.4E-02	8.8E-03
VOC	0.45	lb/hr	(1)	0.45	0.09
$PM/PM_{10}/PM_{2.5}$	0.23	lb/hr	(1)	0.23	0.05
H_2SO_4	---		(3)	3.4E-03	6.8E-04
NH_3	---			---	---
Lead	1.40E-05	lb/MMBtu	(4)	4.3E-04	8.6E-05
CO_2e	---		(5)	5,012	1,002
CO_2	73.96	kg/MMBtu	(6)	4,995	999
CH_4	0.003	kg/MMBtu	(6)	0.20	4.1E-02
N_2O	0.0006	kg/MMBtu	(6)	4.1E-02	8.1E-03
Hazardous Air Pollutants					
Acetaldehyde	2.52E-05	lb/MMBtu	(7)	7.7E-04	1.5E-04
Acrolein	7.88E-06	lb/MMBtu	(7)	2.4E-04	4.8E-05
Benzene	7.76E-04	lb/MMBtu	(7)	2.4E-02	4.8E-03
Formaldehyde	7.89E-05	lb/MMBtu	(7)	2.4E-03	4.8E-04
Naphthalene	1.30E-04	lb/MMBtu	(8)	4.0E-03	8.0E-04
Polycyclic Organic Matter	8.20E-05	lb/MMBtu	(8)	2.5E-03	5.0E-04
Toluene	2.81E-04	lb/MMBtu	(7)	8.6E-03	1.7E-03
Xylenes	1.93E-04	lb/MMBtu	(7)	5.9E-03	1.2E-03
Arsenic	1.1E-05	lb/MMBtu	(9)	3.4E-04	6.7E-05
Beryllium	3.1E-07	lb/MMBtu	(9)	9.5E-06	1.9E-06
Cadmium	4.8E-06	lb/MMBtu	(9)	1.5E-04	2.9E-05
Chromium	1.1E-05	lb/MMBtu	(9)	3.4E-04	6.7E-05
Manganese	7.9E-04	lb/MMBtu	(9)	2.4E-02	4.8E-03
Mercury	1.2E-06	lb/MMBtu	(9)	3.7E-05	7.4E-06
Nickel	4.6E-06	lb/MMBtu	(9)	1.4E-04	2.8E-05
Selenium	2.5E-05	lb/MMBtu	(9)	7.7E-04	1.5E-04
Total HAPs				**0.07**	**1.5E-02**
Maximum Individual HAP					**4.8E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [S (wt%) / 100] x [Fuel Density (lb/gal)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr) / [Fuel Heat Content (Btu/gal)] x [SO_2 Molecular Weight (lb/lb-mol)] / [S Molecular Weight (lb/lb-mol)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Maximum Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Heat Rate (hp)] x [Engine Heat Rate (Btu/hp-hr)] x

[2.20462 (lb/kg)] / [1,000,000 (Btu/MMBtu)]

Maximum Rate (hp) =	4,376	(10)
Fuel Density (lb/gal) =	7.1	(11)
Fuel Heat Content (Btu/gal) =	140,005	(11)
Engine Heat Rate (Btu/hp-hr) =	7,000	(12)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(3)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] x [Number of Units] / [2,000 lb/ton]

Number of Units =	2	(13)
Hours of Operation (hr/yr) =	200	(13)

Notes:

(1) Emissions performance data provided by manufacturer at rated speed potential site variation (1800 rpm). Maximum value at 50% of load or greater. Conservative to use lower load (highest) emission rates for CO, VOC, and PM.

(2) Engine is required to combust fuel with 15 ppm sulfur or less per 40 CFR 60 Subpart IIII.

(3) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(4) AP-42, Chapter 3.1, Table 3.1-2a. Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas Turbines, April 2000. Note lead is a HAP and is included in the HAP total.

(5) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(6) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(7) AP-42, Chapter 3.4, Table 3.4-3. Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(8) AP-42, Chapter 3.4, Table 3.4-4. PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

(9) AP-42, Chapter 3.1, Table 3.1-5. Emission Factors for Metallic Hazardous Air Pollutants from Distillate Oil-Fired Stationary Gas Turbines, April 2000.

(10) Maximum engine rate supplied by KBJ.

(11) Site specific fuel heat content and fuel density provided by KBJ.

(12) AP-42, Chapter 3.3, Table 3.1-1, Emission Factors for Uncontrolled Gasoline and Diesel Industrial Engines, footnote a, October 1996.

(13) Number of units and hours of operation provided by KBJ.

Table 10. Natural Gas Ground Flare Pilot and Purge Gas Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [a] (lb/hr)	Annual Emissions [b] (tons/yr)
Criteria Pollutants					
NO_X	0.068	lb/MMBtu	(1)	0.14	0.64
CO	0.31	lb/MMBtu	(2)	0.66	2.90
SO_2	0.01	grains S/scf	(3),(4)	6.7E-03	2.9E-02
VOC	0.66	lb/MMBtu	(2)	1.41	6.16
$PM/PM_{10}/PM_{2.5}$	40	µg/L	(1)	6.5E-02	0.28
H_2SO_4	---		(4)	5.1E-04	2.2E-03
NH_3	---			---	---
Lead	0.0005	lb/MMscf	(5)	1.2E-06	5.4E-06
CO_2e	---		(6)	329	1,439.47
CO_2	53.06	kg/MMBtu	(7)	249.43	1,092.50
CH_4	0.001	kg/MMBtu	(7)	0.80	3.52
N_2O	0.0001	kg/MMBtu	(7)	0.20	0.87
Hazardous Air Pollutants					
Acetaldehyde	4.30E-02	lb/MMscf	(8)	1.1E-04	4.6E-04
Acrolein	1.00E-02	lb/MMscf	(8)	2.5E-05	1.1E-04
Benzene	1.59E-01	lb/MMscf	(8)	3.9E-04	1.7E-03
Ethylbenzene	1.44E+00	lb/MMscf	(8)	3.5E-03	1.6E-02
Formaldehyde	1.17E+00	lb/MMscf	(8)	2.9E-03	1.3E-02
N-Hexane	2.90E-02	lb/MMscf	(8)	7.1E-05	3.1E-04
Toluene	5.80E-02	lb/MMscf	(8)	1.4E-04	6.2E-04
Xylenes	2.90E-02	lb/MMscf	(8)	7.1E-05	3.1E-04
Polycyclic Organic Matter	1.40E-02	lb/MMscf	(8)	3.4E-05	1.5E-04
Arsenic	2.0E-04	lb/MMscf	(5)	4.9E-07	2.2E-06
Beryllium	1.2E-05	lb/MMscf	(5)	2.9E-08	1.3E-07
Cadmium	1.1E-03	lb/MMscf	(5)	2.7E-06	1.2E-05
Chromium	1.4E-03	lb/MMscf	(5)	3.4E-06	1.5E-05
Cobalt	8.4E-05	lb/MMscf	(5)	2.1E-07	9.0E-07
Manganese	3.8E-04	lb/MMscf	(5)	9.3E-07	4.1E-06
Mercury	2.6E-04	lb/MMscf	(5)	6.4E-07	2.8E-06
Nickel	2.1E-03	lb/MMscf	(5)	5.2E-06	2.3E-05
Selenium	2.4E-05	lb/MMscf	(5)	5.9E-08	2.6E-07
Total HAPs				**7.27E-03**	**3.2E-02**
Maximum Individual HAP					**1.6E-02**

Calculations:
(a) Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]
Hourly Emissions (lb/hr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] /

[Molecular Weight S (lb/lb-mole) x [Pilot and Purge Fuel Consumption (scf/hr)] / [7000 (grains/lb)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [Emission Factor (μg/L)] / [1,000,000 (μg/g)] x [0.00220462 (lb/g)] x [28.317 (L/ft^3)] x [10.6 (ft^3 exhaust/ft^3 fuel)] x [Pilot and Purge Fuel Consumption (scf/hr)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Pilot and Purge Fuel Consumption (scf/hr) / [1,000,000 (scf/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [2.20462 (lb/kg)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

No. of Unit =	28	
Total Pilot Fuel Consumption (MMBtu/hr) =	1.82	(9)
Total Purge Gas Consumption (scf/hr) =	360	(9)
Fuel Heat Content (Btu/scf) =	868	(10)
Pilot Fuel Consumption (scf/hr) =	2,098	
Purge Gas Consumption (MMBtu/hr) =	0.31	
Conversion of SO_2 to H_2SO_4 (percent) =	5	(4)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] / [2,000 lb/ton]

Hours of Operation (hr/yr) =	8,760	(11)

Notes:

(1) AP-42, Chapter 13.5, Table 13.5-1. THC and Soot Emissions Factors for Flare Operations, December 2016. PM emission factor is for lightly smoking flare.

(2) AP-42, Chapter 13.5, Table 13.5-2. VOC and CO Emissions Factors for Flare Operations, December 2016.

(3) Sulfur content of 0.01 grains per scf provided by KBJ.

(4) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(5) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(6) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(7) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(8) Ventura County Air Pollution Control District.

(9) Manufacturer specifications provided by KBJ. Ground flare consists of a warm and cold flare (combined multi-point ground flare).

(10) Site specific fuel heat content provided by KBJ.

(11) Hours of operation provided by KBJ.

Table 11. Natural Gas Marine Flare Pilot and Purge Gas Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions per Unit [(a)] (lb/hr)	Annual Emissions [(b)] (tons/yr)
Criteria Pollutants					
NO_X	0.068	lb/MMBtu	(1)	0.05	0.22
CO	0.31	lb/MMBtu	(2)	0.23	1.01
SO_2	0.01	grains S/scf	(3),(4)	2.3E-03	1.0E-02
VOC	0.66	lb/MMBtu	(2)	0.49	2.14
$PM/PM_{10}/PM_{2.5}$	40	µg/L	(1)	2.3E-02	0.10
H_2SO_4	---		(4)	1.8E-04	7.8E-04
NH_3	---			---	---
Lead	0.0005	lb/MMscf	(5)	4.3E-07	1.9E-06
CO_2e	---		(6)	168	737.66
CO_2	53.06	kg/MMBtu	(7)	86.72	379.83
CH_4	0.001	kg/MMBtu	(7)	0.90	3.96
N_2O	0.0001	kg/MMBtu	(7)	0.20	0.87
Hazardous Air Pollutants					
Acetaldehyde	4.30E-02	lb/MMscf	(8)	3.7E-05	1.6E-04
Acrolein	1.00E-02	lb/MMscf	(8)	8.5E-06	3.7E-05
Benzene	1.59E-01	lb/MMscf	(8)	1.4E-04	6.0E-04
Ethylbenzene	1.44E+00	lb/MMscf	(8)	1.2E-03	5.4E-03
Formaldehyde	1.17E+00	lb/MMscf	(8)	1.0E-03	4.4E-03
N-Hexane	2.90E-02	lb/MMscf	(8)	2.5E-05	1.1E-04
Toluene	5.80E-02	lb/MMscf	(8)	5.0E-05	2.2E-04
Xylenes	2.90E-02	lb/MMscf	(8)	2.5E-05	1.1E-04
Polycyclic Organic Matter	1.40E-02	lb/MMscf	(8)	1.2E-05	5.2E-05
Arsenic	2.0E-04	lb/MMscf	(5)	1.7E-07	7.5E-07
Beryllium	1.2E-05	lb/MMscf	(5)	1.0E-08	4.5E-08
Cadmium	1.1E-03	lb/MMscf	(5)	9.4E-07	4.1E-06
Chromium	1.4E-03	lb/MMscf	(5)	1.2E-06	5.2E-06
Cobalt	8.4E-05	lb/MMscf	(5)	7.2E-08	3.1E-07
Manganese	3.8E-04	lb/MMscf	(5)	3.2E-07	1.4E-06
Mercury	2.6E-04	lb/MMscf	(5)	2.2E-07	9.7E-07
Nickel	2.1E-03	lb/MMscf	(5)	1.8E-06	7.9E-06
Selenium	2.4E-05	lb/MMscf	(5)	2.1E-08	9.0E-08
Total HAPs				**2.53E-03**	**1.1E-02**
Maximum Individual HAP					**5.4E-03**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor (lb/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

Hourly Emissions (lb/hr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] / [Molecular Weight S (lb/lb-mole) x [Pilot and Purge Fuel Consumption (scf/hr)] / [7000 (grains/lb)] x

[1 - Conversion of SO_2 to H_2SO_4 (percent)]

Hourly Emissions (lb/hr) = [Emission Factor (µg/L)] / [1,000,000 (µg/g)] x [0.00220462 (lb/g)] x [28.317 (L/ft^3)] x [10.6 (ft^3 exhaust/ft^3 fuel)] x [Pilot and Purge Fuel Consumption (scf/hr)]

Hourly Emissions (lb/hr) = [SO_2 Hourly Emissions (lb/hr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Hourly Emissions (lb/hr) = [Emission Factor (lb/MMscf)] x [Pilot and Purge Fuel Consumption (scf/hr) / [1,000,000 (scf/MMscf)]

Hourly Emissions (lb/hr) = [Emission Factor (kg/MMBtu)] x [Pilot and Purge Fuel Consumption (scf/hr)] x [2.20462 (lb/kg)] x [Fuel Heat Content (Btu/scf)] / [1,000,000 (Btu/MMBtu)]

No. of Unit =	6	
Total Pilot Fuel Consumption (MMBtu/hr) =	0.39	(9)
Total Purge Gas Consumption (scf/hr) =	405	(9)
Fuel Heat Content (Btu/scf) =	868	(10)
Total Pilot Fuel Consumption (scf/hr) =	450	
Total Purge Gas Consumption (MMBtu/hr) =	0.35	
Conversion of SO_2 to H_2SO_4 (percent) =	5	(4)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] / [2,000 lb/ton]

Hours of Operation (hr/yr) =	8,760	(11)

Notes:

(1) AP-42, Chapter 13.5, Table 13.5-1. THC and Soot Emissions Factors for Flare Operations, December 2016. PM emission factor is for lightly smoking flare.

(2) AP-42, Chapter 13.5, Table 13.5-2. VOC and CO Emissions Factors for Flare Operations, December 2016.

(3) Sulfur content of 0.01 grains per scf provided by KBJ.

(4) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(5) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(6) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(7) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(8) Ventura County Air Pollution Control District.

(9) Manufacturer specifications provided by KBJ. Flare is a marine flare (enclosed ground flare).

(10) Site specific fuel heat content provided by KBJ.

(11) Hours of operation provided by KBJ.

Table 12. LNG Ship Gas Up Emissions (from Marine Flare)
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Emission Factor			Hourly Emissions[a] (lb/hr)	Annual Emissions [b] (tons/yr)
Criteria Pollutants					
NO_X	0.068	lb/MMBtu	(1)	62.31	2.09
CO	0.31	lb/MMBtu	(2)	284.07	9.53
SO_2	0.01	grains S/scf	(3),(4)	4.89	0.16
VOC	0.57	lb/MMBtu	(2)	522.31	17.53
$PM/PM_{10}/PM_{2.5}$	40	µg/L	(1)	33.43	1.12
H_2SO_4	---		(4)	0.37	0.01
NH_3	---			---	
Lead	0.0005	lb/MMscf	(5)	6.3E-04	0.00002
CO_2e	---		(6)	129,644	4,351
CO_2	53.06	kg/MMBtu	(7)	129,510	4,346
CH_4	0.001	kg/MMBtu	(7)	2.4	0.08
N_2O	0.0001	kg/MMBtu	(7)	0.2	0.01
Hazardous Air Pollutants					
Acetaldehyde	4.30E-02	lb/MMscf	(8)	3.6E-02	5.5E-04
Acrolein	1.00E-02	lb/MMscf	(8)	8.4E-03	1.3E-04
Benzene	1.59E-01	lb/MMscf	(8)	1.3E-01	2.0E-03
Ethylbenzene	1.44E+00	lb/MMscf	(8)	1.2E+00	1.8E-02
Formaldehyde	1.17E+00	lb/MMscf	(8)	9.9E-01	1.5E-02
N-Hexane	2.90E-02	lb/MMscf	(8)	2.4E-02	3.7E-04
Toluene	5.80E-02	lb/MMscf	(8)	4.9E-02	7.4E-04
Xylenes	2.90E-02	lb/MMscf	(8)	2.4E-02	3.7E-04
Polycyclic Organic Matter	1.40E-02	lb/MMscf	(8)	1.2E-02	1.8E-04
Arsenic	2.0E-04	lb/MMscf	(5)	1.7E-04	2.5E-06
Beryllium	1.2E-05	lb/MMscf	(5)	1.0E-05	1.5E-07
Cadmium	1.1E-03	lb/MMscf	(5)	9.3E-04	1.4E-05
Chromium	1.4E-03	lb/MMscf	(5)	1.2E-03	1.8E-05
Cobalt	8.4E-05	lb/MMscf	(5)	7.1E-05	1.1E-06
Manganese	3.8E-04	lb/MMscf	(5)	3.2E-04	4.8E-06
Mercury	2.6E-04	lb/MMscf	(5)	2.2E-04	3.3E-06
Nickel	2.1E-03	lb/MMscf	(5)	1.8E-03	2.7E-05
Selenium	2.4E-05	lb/MMscf	(5)	2.0E-05	3.0E-07
Total HAPs					**3.8E-02**
Maximum Individual HAP					**1.8E-02**

Flaring of Excess Boil off gas generated during gas up of the LNG carrier each time it returns to LNG transportation service following a drydock overhaul period (when the entire cargo system needs to be fully warmed up and gas freed) is expected to occur at the JCLNG terminal for up to 4 ships per year. The operational assumption is 50% of the gas up volume would be recovered and 50% flared. A worst-case scenario would be flaring of 100% of the gas. Inert gas and methane are routed to the marine flare for combustion.

Calculations:

(a) Hourly Emissions (lb/hr) = [Annual Emissions (tons/yr)] x [2000 lbs/ton)] / [Number of gas up events/year] / [Duration of flaring for event (hours/event)]

Average tanker size hull gas relief (LNG tonnes/ship) =	355.7	(9)
Average flared gas -Turbulent mixing (MMBtu/ship, LHV) =	22,264	(9)
Duration of turbulent event flaring (hours/event) =	30	(9)
Number of turbulent events per year (ships/year) =	1	(9)
Average flared gas - Laminar mixing (MMBtu/ship, LHV) =	19,619	(9)

Duration of non-turbulent event flaring (hours/event) =	18.52	(9)
Number of non-turbulent events per year (ships/year) =	2	(9)
Average flared gas per year (MMBtu/year) =	61,502	
Average duration of event flaring (hours/event) =	22.37	(9)
Fuel Heat Content (Btu/scf) =	877	(9)
Conversion of SO_2 to H_2SO_4 (percent) =	5	(4)
Molecular Weight S (lb/lb-mole) =	32	
Molecular Weight SO_2 (lb/lb-mole) =	64	
Molecular Weight H_2SO_4 (lb/lb-mole) =	98	

(b) Annual Emissions (tons/yr) = [Flared gas per year (MMBtu/yr)] x [Emission factor (lb/MMBtu)] / [2,000 lb/ton]

Annual Emissions (ton/yr) = [S Content (grains/scf)] x [Molecular Weight SO_2 (lb/lb-mole)] / [Molecular Weight S (lb/lb-mole) x [Flared gas (MMBtu/yr)/ Flared Gas HHV (Btu/scf)* 1,000,000 Btu/MMBtu] / [7000 (grains/lb)] x [1 - Conversion of SO_2 to H_2SO_4 (percent)]

Annual Emissions (ton/yr) = [Emission Factor (µg/L)] / [1,000,000 (µg/g)] x [0.00220462 (lb/g)] x [28.317 (L/ft^3)] x [10.6 (ft^3 exhaust/ft^3 fuel)] x [Flared gas (MMBtu/yr) / Flared Gas HHV (Btu/scf) * 1,000,000 Btu/MMBtu]

Annual Emissions (ton/yr) = [SO_2 Annual Emissions (ton/yr)] x [Conversion of SO_2 to H_2SO_4 (percent)] x [Molecular Weight H_2SO_4 (lb/lb-mole)] / [Molecular Weight SO_2 (lb/lb-mole)]

Annual Emissions (tons/yr) = [Emission Factor (lb/MMscf)] x [Flared Gas (MMBtu/yr) / [Flared gas HHV (Btu/scf)] / [2,000 lb/ton]

Annual Emissions (ton/yr) = [Emission Factor (kg/MMBtu)] x [Flared Gas (MMBtu/yr)] x [2.20462 (lb/kg)] / [2,000 (lb/ton)]

Notes:

(1) AP-42, Chapter 13.5, Table 13.5-1. THC and Soot Emissions Factors for Flare Operations, October 1996. PM emission factor is for lightly smoking flare.

(2) AP-42, Chapter 13.5, Table 13.5-2. VOC and CO Emissions Factors for Flare Operations, October 1996.

(3) Sulfur content of 0.01 grains per scf provided by KBJ.

(4) Assume conversion of SO_2 to SO_3 of 5 percent by volume as provided by KBJ.

(5) AP-42, Chapter 1.4, Table 1.4-2. Emission Factors for Criteria Pollutants and Greenhouse Gases from Natural Gas Combustion, July 1998. Note lead is a HAP and is included in the HAP total.

(6) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25, N_2O = 298.

(7) Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

(8) Ventura County Air Pollution Control District.

(9) Information provided by JCLNG for gas up/cool down procedures. Ship vapor (14% CO_2, 84% N_2, 2% O_2) is displaced with LNG. When hydrocarbon is detected it is sent to the flare. When the gas contains less than 50 ppm CO_2 it is sent to be used as fuel gas. Two scenarios were supplied, with and without turbulence for the gas up procedure. The scenario with the greater emissions (turbulence) is included. During the cool down procedure all gas is sent to the fuel gas system.

Table 13. Fugitive Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Pollutant	Annual Emissions (tons/yr)			
	LNG Tank	Equipment Leaks	Total	
Criteria Pollutants				
NO_X	---	---	---	
CO	---	---	---	
SO_2	---	---	---	
VOC	0.114	7.87	7.98	(1)
$PM/PM_{10}/PM_{2.5}$	---	---	---	
H_2SO_4	---	---	---	
NH_3	---	---	---	
Lead	---	---	---	
CO_2e			13,116	(2)
CO_2	9.21E-04	1.64	1.64	(3)
CH_4	23.06	501.52	524.58	(1)
N_2O	---	---	---	
Hazardous Air Pollutants				
N-Hexane [(a)]	2.5E-02	1.75	1.77	(4)
Total HAPs			**1.77**	
Maximum Individual HAP			**1.77**	

Calculations:

(a) Annual Emissions (tons/yr) = [VOC Hourly Emissions (tons/yr)] x [N-Hexane/CO_2 Content (mass %)] / [VOC Content (mass %)]

N-Hexane Content (mass %) =	0.31	(4)
VOC Content (mass %) =	1.38	(4)

Notes:

(1) The tank size is the same as in the original permit application. Therefore, the tons/yr emissions for the tanks are from original permit application. See Table 17 for the Equipment Leak Emission calculations.

(2) Carbon dioxide equivalent, global warming potentials; CO_2 = 1, CH_4 = 25

(3) Carbon dioxide emissions are based on a gas composition of 0.36 mol percent VOC and 0.11 mol percent CO_2. See KBJ fuel gas composition provided in Zeeco flare quote.

(4) N-Hexane emissions are based on a fuel gas composition provided by KBJ.

Table 14. Equipment Leaks Potential Emissions
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Components	Phase	TOC/VOC Emission Factor (lb/hr/component)	Actual Component Count	Hourly CH_4 Emissions [(a),(b)] (lb/hr)	Annual CH_4 Emissions [(d)] (tons/yr)	Hourly CO_2 Emissions [(a),(b)] (lb/hr)	Annual CO_2 Emissions [(d)] (tons/yr)	Hourly VOC Emissions [(a),(c)] (lb/hr)	Annual VOC Emissions [(d)] (tons/yr)
Valves	Gas/Vapor	9.9E-03 (1)	9277 (3)	89.52	392.12	0.29	1.28	1.40	6.15
Pressure Relief Valves	Gas/Vapor	1.9E-02 (1)	287 (3)	5.42	23.72	1.8E-02	7.7E-02	8.5E-02	0.37
Pump Seals	Gas/Vapor	5.3E-03 (1)	47 (3)	0.24	1.06	7.9E-04	3.5E-03	3.8E-03	1.7E-02
Flanges	Gas/Vapor	8.6E-04 (1)	559 (3)	0.47	2.05	1.5E-03	6.7E-03	7.3E-03	3.2E-02
Connectors	Gas/Vapor	4.4E-04 (1)	8752 (3)	3.75	16.44	1.2E-02	5.4E-02	5.9E-02	0.26
Compressor Seals	Gas/Vapor	1.9E-02 (1)	18 (3)	0.34	1.49	1.1E-03	4.9E-03	5.3E-03	2.3E-02
Sampling Connections	All	3.3E-02 (2)	7 (3)	14.76	64.65	4.8E-02	0.21	0.23	1.01
Total					**501.52**		**1.64**		**7.87**

Calculations:

(a) Hourly Emissions (lb/hr) = [Emission Factor (lb TOC/hr/component)] x [Count (component)] x [CH_4/CO_2//VOC Content (Mass %)] / [TOC Content (Mass %)]

(b) Hourly Emissions (lb/hr) = [Emission Factor (lb VOC/hr/component)] x [Count (component)] x [CH_4/CO_2 Content (Mass %)] / [VOC Content (Mass%)]

(c) Hourly Emissions (lb/hr) = [Emission Factor (lb VOC/hr/component)] x [Count (component)]

CH_4 Content (mass %) =	88.3	(4)
CO_2 Content (mass %) =	0.29	(4)
VOC Content (mass %) =	1.38	(4)
TOC Content (mass %) =	90.77	(4)

(d) Annual Emissions (tons/yr) = [Hourly Emissions (lb/hr)] x [Hours of Operation (hr/yr)] / [2,000 lb/ton]

Hours of Operation (hr/yr) =	8,760	(3)

Notes:

(1) EPA-453/R-95-017 Protocol for Equipment Leak Emission Estimates, EPA, November 1995. Table 2-4. Oil and Gas Production Operations Average Emission Factors (page 2-15), total organic compounds emission factors (TOC).

(2) EPA-453/R-95-017 Protocol for Equipment Leak Emission Estimates, EPA, November 1995. Table 2-2. Refinery Average Emission Factors (page 2-13), non-methane organic compounds emission factor (VOC).

(3) Component counts and hours supplied by KBJ.

(4) Assumed methane and CO_2 content of fuel gas provided in Table 16.

Table 15: GE Natural Gas Turbines Parameters
Black & Veatch Emission Estimates
Jordan Cove, Coos Bay, Oregon

COMBUSTION TURBINE	
CTG Manufacturer	GE
CTG Model	LM6000PF+
CTG Combustor Type	DLN
CTG Fuel Type	Natural Gas
CTG Inlet Air Cooling Type	Chiller
Duct Burner Fuel Type	Natural Gas
CTG Fuel HHV, Btu/lb	21,500
Post Combustion NO_X Emissions Control	SCR
Post Combustion CO Emissions Control	CO Catalyst

	Design Scenario - Steady State Emissions																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Combustion Turbine Parameters																		
Ambient Dry Bulb Temperature, ° F	42	42	59	59	59	59	59	59	59	59	90	90	90	90	90	90	90	90
CTG Load Level, percent of base load	*100*	*100*	*50*	*75*	*100*	*100*	*50*	*75*	*100*	*100*	*50*	*75*	*100*	*100*	*50*	*75*	*100*	*100*
Gross CTG Output, kW	55,607	55,607	25,794	38,692	51,589	51,589	27,581	41,371	55,162	55,162	22,189	33,283	44,378	44,378	24,672	37,008	49,343	49,343
CTG Heat Input, MBtu/h (HHV)	504.4	504.4	327.3	395.7	476.6	476.6	336.9	413.6	500.2	500.2	301.2	359.1	427.3	427.3	319.4	378.1	461.4	461.4
CTG Inlet Air Cooling Status, On/Off	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON	OFF	OFF	OFF	OFF	ON	ON	ON	ON
HRSG Duct Firing	Unfired	Fired	Unfired	Unfired	Unfired	Fired	Unfired	Unfired	Unfired	Fired	Unfired	Unfired	Unfired	Unfired	Unfired	Unfired	Unfired	Fired
Duct Burner Heat Input, MBtu/h (HHV)	0	19.7	0	0	0	8.7	0	0	0	20.9	0	0	0	0	0	0	0	3.1
Stack Exhaust Analysis (Volume Basis - Wet)																		
Ar, % vol.			0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.93	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92
CO_2, % vol.			3.25	3.25	3.38	3.44	3.2	3.26	3.39	3.53	3.29	3.27	3.36	3.36	3.26	3.19	3.36	3.38
H_2O, % vol.			7.83	7.82	8.07	8.19	7.33	7.44	7.7	7.96	10.41	10.37	10.55	10.55	9.12	9	9.33	9.37
N_2, % vol.			74.47	74.47	74.38	74.33	74.82	74.78	74.68	74.58	72.48	72.5	72.43	72.43	73.46	73.51	73.38	73.37
O_2, % vol.			13.52	13.52	13.24	13.11	13.71	13.58	13.3	13	12.91	12.96	12.75	12.75	13.24	13.38	13.01	12.96
SO_2, (after SO_2 oxidation), % vol.			0.00005	0.00005	0.00005	0.00004	0.00004	0.00005	0.00005	0.00004	0.00005	0.00005	0.00005	0.00005	0.00005	0.00004	0.00005	0.00004
SO_3, (after SO_2 oxidation), % vol.			0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00002	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00001	0.00002
Stack Exit Temperature, ° F	242.8	242.8	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420	420
Stack Flow, lb/hr			754,560	912,844	1,057,879	1,058,281	790,163	952,982	1,108,096	1,109,067	680,835	816,908	944,053	944,053	732,348	884,766	1,024,149	1,024,292
Stack Flow, scfm			168,023	203,270	235,566	235,832	175,556	211,890	246,379	246,780	153,082	183,677	212,265	212,265	163,810	197,902	229,250	229,282
Stack Flow, acfm			284,357	344,007	398,840	399,169	297,247	358,656	417,219	417,770	259,184	310,849	359,387	359,387	277,329	335,047	388,001	388,226
Stack Exit Velocity, ft/s	71	71	60	73	85	85	63	76	89	89	55	66	76	76	59	71	82	82
Total Stack Emission Rates (Controlled) [1]																		
NO_X, ppmvd (dry, 15% O_2)	2.0	2.0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
CO, ppmvd (dry, 15% O2)	4.0	4.0	3.8	3.8	3.8	3.9	3.8	3.8	3.8	4	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.9
SO_2, ppmvd (dry, 15% O_2) [2]			0.46	0.46	0.46	0.42	0.46	0.46	0.46	0.42	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.42
VOC, ppmvd (dry, 15% O_2)	2.1	2.5	2.1	2.1	2.1	2.3	2.1	2.1	2.1	2.5	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.2
NO_X, lb/hr as NO_2	3.7	3.8	2.4	2.9	3.5	3.5	2.5	3	3.6	3.8	2.2	2.6	3.1	3.1	2.3	2.8	3.4	3.4
CO, lb/hr	4.4	4.6	2.8	3.4	4.1	4.2	2.9	3.5	4.3	4.6	2.6	3.1	3.6	3.6	2.7	3.2	3.9	4
SO_2, lb/hr [2]	0.9	0.9	0.77	0.93	1.12	1.03	0.79	0.97	1.18	1.1	0.71	0.85	1.01	1.01	0.75	0.89	1.09	0.98
VOC, lb/hr as CH_4	1.3	1.7	0.9	1.1	1.3	1.4	0.9	1.1	1.3	1.7	0.8	1	1.1	1.1	0.9	1	1.2	1.3
CO_2, lb/hr	57,958	60,218	38,037	46,009	55,406	56,412	39,161	48,083	58,155	60,585	35,013	41,735	49,658	49,658	37,137	43,960	53,631	53,991
Particulate, lb/hr	4.9	5.4	4	4.1	4.2	4.7	4	4.1	4.3	5	4	4	4.1	4.1	4	4.1	4.2	4.5
PM_{10}, lb/hr	4.9	5.4	4	4.1	4.2	4.7	4	4.1	4.3	5	4	4	4.1	4.1	4	4.1	4.2	4.5
$PM_{2.5}$, lb/hr	4.9	5.4	4	4.1	4.2	4.7	4	4.1	4.3	5	4	4	4.1	4.1	4	4.1	4.2	4.5
Maximum Stack Sulfur Mist [H_2SO_4] (assuming 100% conversion from SO_3 to H_2SO_4), lb/hr	0.48	0.5	0.37	0.45	0.54	0.73	0.38	0.47	0.57	0.78	0.34	0.41	0.48	0.48	0.36	0.43	0.52	0.69
SCR NH_3 slip, lb/hr	3.4	3.5	2.2	2.66	3.21	3.27	2.27	2.78	3.37	3.51	2.03	2.42	2.88	2.88	2.15	2.55	3.11	3.13
NO_X, lb/MBtu (HHV) as NO_2	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073	0.0073
CO, lb/MBtu (HHV)	0.0087	0.0087	0.0085	0.0085	0.0085	0.0086	0.0085	0.0085	0.0085	0.0088	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0085	0.0086
SO_2, lb/MBtu (HHV) (incl. duct burner fuel)[2]	0.0017	0.0018	0.0024	0.0024	0.0024	0.0021	0.0024	0.0024	0.0024	0.0021	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024	0.0021
VOC, lb/MBtu (HHV) as CH_4	0.0026	0.0032	0.0027	0.0027	0.0027	0.0029	0.0027	0.0027	0.0027	0.0032	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0027	0.0028
CO_2, lb/MBtu (HHV)	115	115	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116	116
Particulate, lb/MBtu (HHV) (incl. duct burner fuel)	0.0097	0.0103	0.0122	0.0104	0.0089	0.0096	0.0119	0.01	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097
PM_{10}, lb/MBtu (HHV) (incl. duct burner fuel)	0.0097	0.0103	0.0122	0.0104	0.0089	0.0096	0.0119	0.01	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097
$PM_{2.5}$, lb/MBtu (HHV) (incl. duct burner fuel)	0.0097	0.0103	0.0122	0.0104	0.0089	0.0096	0.0119	0.01	0.0085	0.0097	0.0131	0.0113	0.0097	0.0097	0.0125	0.0108	0.0091	0.0097

Notes

[1] Emissions include massflow added to match CTG manufacturer estimate and duct burner emissions.

[2] SO_2 emissions include assumptions of 20 percent by volume oxidation rate in CO catalyst and 3 percent by volume oxidation rate in SCR.

Table 16. Turbine Fuel Specifications
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Component	Component Molecular Weight (lb/lb-mol)	Mole % [1]	Mass % [1]	Mixture Molecular Weight (lb/lb-mol)
Hydrogen (H_2)	2.02	0.20	0.02	0.004
Nitrogen (N_2)	28.01	5.16	8.60	1.446
Carbon Dioxide (CO_2)	44.01	0.11	0.29	0.048
Helium (He)	4.00	0.99	0.24	0.040
Oxygen (O_2)	32.00	0.04	0.08	0.013
Methane (CH_4)	16.04	92.48	88.30	14.837
Ethane (C_2H_6)	30.07	0.61	1.09	0.183
Propane (C_3H_8)	44.10	0.20	0.52	0.088
Butane (C_4H_{10})	58.12	0.11	0.38	0.064
Pentane (C_5H_{12})	72.15	0.04	0.17	0.029
Hexanes (C_6H_{14})	86.18	0.06	0.31	0.052
Molecular Weight (lb/lb-mol)				**16.80**
Volume per Mole (scf/lb-mol) [2]				**379.5**
Density (lb/scf)				**0.044**
Lower Heating Value, LHV (Btu/lb) [1]				**19,536**
Lower Heating Value, LHV (Btu/scf)				**865**
Higher Heating Value, HHV (Btu/scf) [3]				**952**

Notes

[1] Fuel gas specification supplied by KBJ.

[2] Calculated at standard conditions (T = 60^{o}F, P = 1 atm).

[3] Higher heating value is assumed to be 10% higher.

Table 17. Flare Supporting Information
Jordan Cove Energy Project L.P. - Emission Inventory
Coos Bay, Oregon

Warm and Cold Flare (Combined Multi-Point Ground Flare [MPGF]) Specifications

Parameter	Warm	Cold	Combined
Number of Stages	7	7	14
Pilots per stage	2		
Number of pilots	14	14	28
Btu/h per pilot	65,000		
MMBtu/h from pilots	0.91	0.91	1.82
Stage 1 burners purged	4	4	8
Purge flow per burner (SCFH)	45		
Purge flow (SCFH)	180	180	360
Btu/SCF (LHV)	867.5		
MMBtu/h from purge	0.16	0.16	0.31

Fuel Sulfur Content	1	gr/100 scf
Hours of Operation	8,760	hrs/year
Conversion of SO_2 to SO_3	5	%(v)

Marine Flare (Enclosed Ground Flare [EGF]) Specifications

Parameter	Value
Number of Stages	6
Pilots per stage	1
Number of pilots	6
Btu/h per pilot	65,000
MMBtu/h from pilots	0.39
Stage 1 burners purged	9
Purge flow per burner (SCF	45
Purge flow (SCFH)	405
Btu/SCF (LHV)	867.5
MMBtu/h from purge	0.35

Fuel Sulfur Content	1	gr/100 scf
Hours of Operation	8,760	hrs/year
Conversion of SO_2 to SO_3	5	%(v)

Table 18. Zeeco Natural Gas Thermal Oxidizer Parameters
Black & Veatch Emission Estimates
Jordan Cove, Coos Bay, Oregon

Process Flow Rate and Heat Input

Component	lb/hr	MMBtu/hr	MW (lb/mole)
Acid Gas	124,710	1	43.4
Flash Gas	1,276	22	
Fuel Gas	3,905	79	
Combustion Air	108,251		
Total	**238,142**	**102**	

Exhaust Composition

Component	lb/hr	MW (lb/mole)	lb-mol/hr	mol %
CO_2	137,049	44.01	3,114	44.84
H_2O	12,574	18.02	698	10.05
N_2	82,472	28.01	2,944	42.39
SO_2	4	64.06	0.07	1.0E-03
O_2	6,044	32.00	189	2.72
Total	**238,142.00**	**34.29**	**6,944.94**	**100.00**

Exhaust Parameters

Exhaust Temperature (°F)	1,600
Exhaust Flowrate (acfm) [1]	177,370

Notes

[1] Exhaust flowrate calculated based on exit velocity of 41.7 ft/sec. Using ideal gas law results in a rate of 174,083 acfr

Exhaust Composition

Component	lbmol/h	mole% (Dry)	Number of Carbons	Methane Equivalents (lbmol/hr)
CO_2	2806.157525	97.66	Not a VOC	
H_2S	0	0.0E+00	Not a VOC	
N_2	0.001982717	6.9E-05	Not a VOC	
C1	3.062492551	0.11	Not a VOC	
C2	0.221949318	0.01	Not a VOC	
C3	0	0.0E+00	3	0.00
iC4	0.001436751	5.0E-05	4	5.7E-03
nC4	0.001436751	5.0E-05	4	5.7E-03
C5	0.000660906	2.3E-05	5	3.3E-03
C6	0.00011494	4.0E-06	6	6.9E-04
C7	0.00022988	8.0E-06	7	1.6E-03
C8	0.00011494	4.0E-06	8	9.2E-04
C9	0.00011494	4.0E-06	9	1.0E-03
C10	0	0	10	0
COS	0.001436751	5.0E-05	1	1.4E-03
CH_3SH (Methyl Mercaptan)	0.026551161	9.2E-04	1	2.7E-02
C_2H_5SH (Ethyl Mercaptan)	0.009241183	3.2E-04	2	1.8E-02
C_3H_7SH (Propyl Mercaptan)	0.001034461	3.6E-05	3	3.1E-03
Benzene	0.014051426	4.9E-04	6	8.4E-02
Toluene	0.014051426	4.9E-04	7	0.10
Ethylbenzene	0.001752836	6.1E-05	8	1.4E-02
o-Xylene	0.002413742	8.4E-05	8	1.9E-02
m-Xylene	0.005632065	2.0E-04	8	4.5E-02
p-Xylene	0.005632065	2.0E-04	8	4.5E-02
Total:	**2873.50**			
			Total Input VOCs	0.37
			VOC Destruction Removal Efficiency	99.9
			Total Output VOCs	3.7E-04

APPENDIX C.9

Q/D Emission Calculations

Table 1: Refined Q Calculations for Jordan Cove Energy Project

	Pound per Hour				Duration	Pounds per Day				Tons per Year			
Source	PM	SO_2	NO_x	H_2SO_4	(hours/day)	PM	SO_2	NO_x	H_2SO_4	PM	SO_2	NO_x	H_2SO_4
Turbine 1													
Normal Operation	5.40	1.64	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 2													
Normal Operation	5.40	1.64	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 3													
Normal Operation	5.40	1.640	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 4													
Normal Operation	5.40	1.64	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Turbine 5													
Normal Operation	5.40	1.640	3.80	1.10	23.85	128.79	39.11	90.63	26.24	24.1	7.2	17.2	4.8
Worst-Case Startup or Shutdown	22.00	0.46	24.67	0.00	0.15	3.30	0.07	3.70	0.00				
Oxidizer	0.82	4.53	14.44	0.00	24.00	19.67	108.72	346.56	0.00	3.6	19.8	63.2	0.0
Auxiliary Boiler	5.63	0.83	2.18	0.56	24.00	135.08	19.90	52.38	13.40	24.7	3.6	9.6	2.4
Fire Water Pump 1	0.30	0.01	5.31	0.00	1.00	0.30	0.01	5.31	0.00	0.1	0.0	1.0	0.0
Fire Water Pump 2	0.30	0.01	5.31	0.00	1.00	0.30	0.01	5.31	0.00	0.1	0.0	1.0	0.0
Fire Water Pump 3	0.30	0.01	5.31	0.00	1.00	0.30	0.01	5.31	0.00	0.1	0.0	1.0	0.0
Backup Generator 1	0.19	0.01	16.63	0.00	1.00	0.19	0.01	16.63	0.00	0.0	0.0	3.0	0.0
Backup Generator 2	0.19	0.01	16.63	0.00	1.00	0.19	0.01	16.63	0.00	0.0	0.0	3.0	0.0
Black Start Generator 1	0.23	0.04	7.43	0.00	1.00	0.23	0.04	7.43	0.00	0.0	0.0	1.4	0.0
Black Start Generator 2	0.23	0.04	7.43	0.00	1.00	0.23	0.04	7.43	0.00	0.0	0.0	1.4	0.0
Ground Flare	0.07	0.01	0.14	0.00	24.00	1.56	0.16	3.48	0.01	0.3	0.0	0.6	0.0
Marine Flare	0.02	0.00	0.04	0.00	24.00	0.40	0.04	0.89	0.00	0.1	0.0	0.2	0.0
Gas Up (From Marine Flare)	33.43	4.89	62.31	0.37	24.00	802.34	117.29	1495.47	8.98	146.4	21.4	272.9	1.6

Total (tpy)	295.9	80.7	444.3	28.0
Q	849			

Table 2: Refined Q/D Calculations for Jordan Cove Energy Project

Class I Area	State	Q (tpy)	Distance (km)	Q/D
Crater Lake NP	OR	849	165	5.1
Diamond Peak Wilderness	OR	849	177	4.8
Kalmiopsis Wildnerness	OR	849	110	7.7
Redwood NP	CA	849	165	5.1
Three Sisters Wilderness	OR	849	178	4.8

Jason Reed

From: ALLEN Philip <philip.allen@state.or.us>
Sent: August 07, 2017 9:52 AM
To: Jason Reed; Jessica Stark; EISELE Michael
Cc: 'Miller, James - FS'; Graw, Rick -FS
Subject: NPS Class I Area Determination

All,

Here is the determination by Don Shepherd of the NPS that Jordan Cove will not have a significant impact on AQRVs for the NPS Class I areas. The USFS has not yet made their determination.

Phil

From: Shepherd, Don [mailto:don_shepherd@nps.gov]
Sent: Monday, August 07, 2017 8:32 AM
To: ALLEN Philip
Cc: Tonnie Cummings
Subject: Re: FW: Additional information request

Hi Phil,

Based upon the new information provided by the applicant, we conclude that it is unlikely that the Jordan Cove Energy Project would have a significant impact upon Air Quality Related Values in any of our Class I areas.

We would appreciate it if OR DEQ would provide electronic copies of the complete/final permit application, staff analysis, draft permit, and public notice.

thanks,

On Sun, Aug 6, 2017 at 6:21 PM, ALLEN Philip <philip.allen@state.or.us> wrote:

Don,

Here is the response from SLR regarding their revised Q/d calculation for Crater Lake NP and Redwood NP. If you have additional concerns, please let me know. Thanks.

Phil

Philip Allen

Air Quality Program

Oregon DEQ

Portland

503.229.6904

allen.philip@deq.state.or.us

From: Jason Reed [mailto:jreed@slrconsulting.com]
Sent: Saturday, August 05, 2017 1:10 PM
To: ALLEN Philip
Cc: DAVIS Claudia; CAMARATA Mary; 'meagan.masten@vereseninc.com'; EISELE Michael; Andrew Jackson; Jessica Stark
Subject: RE: Additional information request

Hi Phil, please see below for our response to Don Shepherd's request. Please let me know if there are any additional questions.

SLR has recalculated the Q value for the Jordan Cove Energy Project based on a worst-case 24 hour emission scenario for project emissions of PM, SO_2, NOx, and H_2SO_4 (see attached). Following FLAG 2010 guidance, the worst-case 24 hour emissions were assumed to persist for the entire year and then summed in order to calculate the ton per year emissions (Q). The worst-case daily emissions scenario includes the following assumptions:

- Each turbine undergoing a startup/shutdown with normal operation (with duct burners) thereafter;
- Continuous operation of the thermal oxidizer;
- Continuous operation of the auxiliary boiler;
- One hour of operation of each of the three fire water pumps;
- One hour of operation of each of the two backup generators;
- One hour of operation of each of the two black start generators;
- Continuous operation of the ground flare and the marine flare pilot and purge gas; and
- Continuous emissions from gas up (flaring of gas vented from incoming LNG tankers).

Based on this worst-case daily emissions scenario, the calculated Q value is 849 tons per year. Both Crater Lake National Park (NP) and Redwood NP are approximately 165 km from the facility, **resulting in a Q/D value of 5.1**. In the development of the worst-case scenario, it is noted that several of the sources are intermittent (e.g., startup/shutdowns, auxiliary boiler, firewater pumps, backup generators, black start generators, and gas up emissions), thus concurrent operation of these sources in the same day is extremely unlikely.

It should also be noted that the Q value quoted in the Jordan Cove Energy Project modeling protocol was provided for informational purposes only for the Type B state New Source Review application, since AQRV analyses are not required.

SLR

Jason Reed, CCM
Senior Scientist

d 970-999-3970
o 970-494-0805
e jreed@slrconsulting.com

SLR International Corporation
1612 Specht Point Road, Suite 119, Fort Collins, CO, 80525

From: ALLEN Philip [mailto:philip.allen@state.or.us]
Sent: August 02, 2017 1:44 PM
To: Jessica Stark; Jason Reed
Cc: DAVIS Claudia; CAMARATA Mary; 'meagan.masten@vereseninc.com'; EISELE Michael
Subject: Additional information request

Hi Jason,

See below for email from Don Shepherd of the NPS requesting additional information for the Q/d calculation for Class I Area impacts. Please respond to me, and I will forward the revised information to both the NPS and USFS.

On a separate note, the inventory of competing sources will be sent later today by separate email.

Please contact me if you have questions. Thanks.

Phil

Philip Allen

Air Quality Program

Oregon DEQ

Portland

503.229.6904

allen.philip@deq.state.or.us

From: Shepherd, Don [mailto:don_shepherd@nps.gov]
Sent: Wednesday, August 02, 2017 8:05 AM
To: philip.allen@state.or.us
Cc: Tonnie Cummings; d King
Subject: Jordan Cove Modeling Protocol and Q/d

Hello Phil,

Tonnie Cummings has asked me to respond to your request for comments on the modeling protocol for the Jordan Cove Energy Project.

Before i can give you a decision, i need clarification of how the "Q" value in the Q/d calculation was derived. Here is what the applicant says on page 21 of the application:

Using the emissions summarized in Table 2-1 for the visibility impairing pollutants of NOx, SO2, PM, and H2SO4 the calculated Q value is 327.6. Using the shortest distance, D, from Table 4-1 above, the Q/D value is calculated to be 2.98, which is below the threshold value of 10.

My concern regards Table 2.1 on page 3. According to the applicant:

The potential annual emission rates for each criteria air pollutant from each source are shown in Table 2-1. The EPC contractor, KBJ, has completed the pre-FEED design stage of the project and is currently developing the detailed facility design.

Instead of using annual average emissions, Q should be calculated based upon the maximum 24-emission rates of NOx, SO2, PM, and H2SO4, including start-ups and shut-downs. The maximum 24-hour emission rate should then annualized to yield a tpy value for Q. It is also important that the applicant provide its calculations and assumptions in deriving these emission rates.

Please feel free to contact me with any questions.

thanks,

Don Shepherd

National Park Service

Air Resources Division

12795 W. Alameda Pkwy.

Lakewood, CO 80228

--
Don Shepherd
National Park Service
Air Resources Division
12795 W. Alameda Pkwy.
Lakewood, CO 80228
Phone: 303-969-2075
Fax: 303-969-2822
E-Mail: don_shepherd@nps.gov
"the man who really counts in the world is the doer, not the mere critic" TR 1891

Jason Reed

From: ALLEN Philip <philip.allen@state.or.us>
Sent: August 07, 2017 11:08 AM
To: Jason Reed; Jessica Stark; EISELE Michael
Subject: USFS Class I Area Determination

Hi All,

The USFS agrees with the NPS that Jordan Cove will not have a significant AQRV impact on USFS Class I areas. See below.

Thanks.

Phil

From: Miller, James - FS [mailto:jamesmiller2@fs.fed.us]
Sent: Monday, August 07, 2017 9:41 AM
To: ALLEN Philip
Subject: RE: NPS Class I Area Determination

Hi Phil,

Given that the revised Q/D for Kalmiopsis – the closest Class I unit – is still < 10, Rick and I do not think Jordan Cove will have a significant impact for USFS Class I areas. Thank you for providing the feedback from Tonnie, Don, and others.

Best,

Jim

APPENDIX D.9

Baseline Ambient Sound Level Survey Report

global environmental solutions

Jordan Cove Energy Project, L.P.

JCEP LNG Terminal

Baseline Environmental Noise Survey

SLR Ref: 108.01593.00004

September 18, 2017

Draft Rev. 2

JCEP LNG Terminal

Baseline Environmental Noise Survey

Prepared for:

Jordan Cove LNG LLC
5615 Kirby Drive, Suite 500
Houston, Texas 77005

This document has been prepared by SLR International Corporation. The material and data in this report were prepared under the supervision and direction of the undersigned.

Jessica Stark, P.E.
Principal Engineer

Laurie Morrill
Associate Scientist

CONTENTS

CONTENTS (CONTINUED)

TABLES

ATTACHMENTS

APPENDICES

ACRONYMS AND ABBREVIATIONS

dB	Decibel
dB(A)	A-weighted Decibel
L_{eq}	Equivalent Continuous Sound Level
L_{dn}	Day-Night Average Sound Level
m/s	meters-per-second
mph	miles-per-hour
NSA	Noise Sensitive Area

REFERENCE STANARDS

ANSI S12.9, “Quantities and Procedures for Description and Measurement of Environmental Sound.”

ANSI S12,18, “Procedures for Outdoor Measurement of Sound Pressure Level.”

ANSI S12.100, “Methods to Define and Measure the Residual Sound in Protected Natural and Quiet Residential Areas.”

ISO 1996-1, “Acoustics – Description, measurement and assessment of environmental noise, Part 1: Basic quantities and assessment procedures.”

ISO 1996-2, “Acoustics – Description, measurement and assessment of environmental noise, Part 2: Determination of environmental noise levels.”

SUMMARY

At the request of Jordan Cove Energy Project, L.P. (JCEP), SLR International Corporation (SLR) has conducted baseline ambient sound level monitoring for the proposed natural gas liquefaction and liquefied natural gas (LNG) export facility (LNG Terminal).

This report presents the results of the sound level measurements for the JCEP Project area. The measurement results are summarized in the table below.

Summary of Long-Term Baseline Sound Level Measurement Data

Receptor	Distance to Receptor, Miles	Direction	Measurement Duration(1) HH:MM	Daytime(2) L_{eq}, dBA	Nighttime(3) L_{eq}, dBA	Ambient L_{dn}, dBA
NSA 1	1.3	South	29:48	51.7	43.9	**52.7**
NSA 2	2.2	East	32:39	62.7	57.5	**65.2**
NSA 3	1.3	Northeast	32:03	57.9	40.3	**56.3**
REC 1	0.7	West	31:50	51.1	48.3	**55.2**

(1) The Measurement Duration represents the total duration of valid data, when the wind speed was less than 6.6 m/s.

(2) Daytime is 7:00 a.m. until 10:00 p.m.

(3) Nighttime is 10:00 p.m. until 7:00 a.m. the next day.

1. INTRODUCTION

At the request of Jordan Cove Energy Project, L.P. (JCEP), SLR International Corporation (SLR) has conducted baseline ambient sound level monitoring for the proposed natural gas liquefaction and liquefied natural gas (LNG) export facility (LNG Terminal). The facility site is located on the bay side of the North Spit of Coos Bay, Oregon. This report presents the results of the sound level measurements for the JCEP Project area.

2. ENVIRONMENTAL SOUND LEVEL CRITERIA

2.1 FEDERAL

The environmental sound level contributions from the proposed equipment at this facility are subject to the FERC noise regulation governing interstate gas transmission compressor stations and LNG facilities. The FERC noise regulation is receptor based, and limits LNG facility noise contributions to no more than 55 dB(A) day-night average (L_{dn}) or, equivalently, no more than a continuous 48.6 dB(A) at the surrounding noise sensitive areas (NSAs) such as schools, hospitals, or residences.

2.2 STATE AND LOCAL

The ODEQ noise standards are contained in OAR, Chapter 340, Division 35 – Noise Control Regulations. The OAR noise regulations are not directly applicable to the operational noise from the LNG Terminal site.

The City of North Bend has a noise ordinance that prohibits the “making of unnecessary noise,” but the ordinance has no specific numerical limits (North Bend City Code, Section 9.04.030). Daytime construction noise between the hours of 7 a.m. to 6 p.m. is exempt under the North Bend ordinance. The project is located in Coos County, but Coos County does not have a noise ordinance.

3. SOUND LEVEL SURVEY AND SITE ASSESSMENT

3.1 METHODOLOGY

A baseline ambient environmental sound level survey was conducted near the JCEP project area by Jessica Stark and Kellye Larsen of SLR on May 23 – 26, 2017. Sound level monitors were positioned near each receptor, as shown on the attached Figure 1 in order to measure environmental sound levels during daytime and nighttime hours. Over 72 hours’ worth of continuous sound measurement data were collected at each location. An averaging period with 1-hour samples was used. Sound levels were also simultaneously collected in terms of 60-second averages to capture shorter-term variations in sound levels. The sound meters were time synchronized with each other. Microphones were located approximately 5 feet above the ground and a windscreen was used.

3.2 NOISE SENSITIVE AREAS

A drawing showing the approximate distance and direction from the facility to the receptors is shown in the attached Figure 1 and summarized in Table 1. Distances are referenced from the center of the proposed liquefaction area. There were three NSAs identified. NSAs 1 and 2 represent residential communities consisting primarily of single family houses. NSA 3 was a campground and recreation area. A fourth recreational area was monitored and is referred to as REC 1.

Table 1: Summary of Pre-existing Noise Sensitive Areas

Receptor	Description	Direction to Receptor	Distance, miles
NSA 1	Residential	South	1.3
NSA 2	Residential	East	2.2
NSA 3	Campground	Northeast	1.2
REC 1	Recreational	West	0.7

3.3 MEASUREMENT EQUIPMENT

Sound level equipment used during the site survey included the following instruments:

- Larson Davis Model 831 SLM; Type 1; s/n 0001736, 0001737, and 0002443
- Brüel & Kjær Model 4231 Pure Tone Calibrator; Class 1; s/n 2240964

Equipment was field calibrated before and after measurement intervals. All instrumentation has current laboratory certification. Calibration certificates are attached.

3.4 WEATHER CONDITIONS

Weather station data (wunderground.com) for the North Bend Municipal Airport, North Bend, Oregon (KOTH) were used to determine ranges of environmental parameters during the monitoring period, as summarized in Table 2.

Table 2: Weather Data During the Monitoring Period

Date	May 23 – 26, 2017
Temperature	48 – 61° F
Relative Humidity	59 – 100%
Wind Direction	North & NNE
Wind Speed	0 – 33 mph
Sky Condition	Clear
Ground Condition	Damp

The wind was generally from the north (59% of the time) and north-northeast (12%) during the survey. The wind speed was 10 mph or less 36% of the time. There was no precipitation during the survey period.

3.5 DATA REDUCTION

ANSI S12.18 does not allow for sound level measurements during wind speeds greater than 5 m/s (11.2 mph). To account for the fact that data were collected at a height of 5 feet (1.5 m) above ground, and a typical weather station anemometer is located at a height of 10 m above ground, the wind speed threshold was adjusted for height using wind profile power law. Based on this equation, which corrects between wind speeds at different heights, a speed of 6.6 m/s (14.8 mph) at a height of 10 m was found to correspond to a speed of 5 m/s at a height of 1.5. Therefore, measurement data that were collected during periods with wind speed exceeding 6.6 m/s were excluded from analysis.

The wind speed exceeded this for 44 percent of the measurement duration. The monitored sound level data were processed to eliminate data from periods when wind speeds exceeded 6.6 m/s. The following tables show, for the respective receptors measuring locations, the data reduction including the total cumulative amount of measurement time used to determine the L_{dn} for each location.

Table 3: Data Reduction to Exclude High Wind Speeds at NSA 1.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minute s	%
Day	Used	37	156	341	163	**697**	11	37	25.6
	Total	761	900	900	163	**2724**	45	24	
Night	Used	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	Used	261	560	841	163	**1825**	30	25	42.0
	Total	1301	1440	1440	163	**4344**	72	24	

Table 4: Data Reduction to Exclude High Wind Speeds at NSA 2.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minutes	%
Day	Used	0	156	341	334	**831**	13	51	30.4
	Total	601	900	900	334	**2735**	45	35	
Night	Used	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	Used	224	560	841	334	**1959**	32	39	45.0
	Total	1141	1440	1440	334	**4355**	72	35	

Table 5: Data Reduction to Exclude High Wind Speeds at NSA 3.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minutes	%
Day	**Used**	0	156	341	285	**782**	13	2	28.8
	Total	627	900	900	285	**2712**	45	12	
Night	**Used**	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	**Used**	224	560	841	285	**1910**	31	50	44.1
	Total	1167	1440	1440	285	**4332**	72	12	

Table 6: Data Reduction to Exclude High Wind Speeds at REC 1.

	Minutes	23-May	24-May	25-May	26-May	Total Minutes	Hours	Minutes	%
Day	**Used**	0	156	341	298	**795**	13	15	29.3
	Total	617	900	900	298	**2715**	45	15	
Night	**Used**	224	404	500	0	**1128**	18	48	69.6
	Total	540	540	540	0	**1620**	27	0	
Day + Night	**Used**	224	560	841	298	**1923**	32	3	44.4
	Total	1157	1440	1440	298	**4335**	72	15	

3.6 MEASUREMENT RESULTS AND AMBIENT SOUND ENVIRONMENT

The 24-hour day-night average (L_{dn}) sound levels have been determined based on the data-reduced daytime and nighttime sound levels measured at the four monitoring positions. The results are shown in Table 7. Level versus time graphs are included in Appendix A.

Table 7: Summary of Long-Term Baseline Sound Level Measurement Data

Receptor	Distance to Receptor, Miles	Direction	Duration[(1)] HH:MM	Daytime[(2)] L_{eq}, dBA	Nighttime[(3)] L_{eq}, dBA	Ambient L_{dn}, dBA
NSA 1	1.3	South	29:48	51.7	43.9	**52.7**
NSA 2	2.2	East	32:39	62.7	57.5	**65.2**
NSA 3	1.3	Northeast	32:03	57.9	40.3	**56.3**
REC 1	0.7	West	31:50	51.1	48.3	**55.2**

(1) The Measurement Duration represents the total duration of valid data, when the wind speed was less than 6.6 m/s.

(2) Daytime is 7:00 a.m. until 10:00 p.m.

(3) Nighttime is 10:00 p.m. until 7:00 a.m. the next day.

Existing environmental noise sources present at NSA 1 included industrial noise from the nearby water treatment plant, airplane traffic at the nearby airport, and intermittent traffic noise on the neighborhood streets. Wind noise and frog vocalizations were also audible.

Environmental noise sources present at NSA 2 included vehicular traffic on the Highway 101 bridge and on nearby local roads. A helicopter in flight was also observed. Wind noise was also audible.

Environmental noise sources present at NSA 3 included a recreational vehicle power generator, all-terrain vehicles, and human activities including speech and shouts. Wind noise and frog vocalizations were also audible.

Environmental noise sources present at REC 1 included general traffic noise, an all-terrain vehicle, forest sounds, and high wind noise. Waves and frog noise were generally the dominant sound sources.

In addition to the reduced data, Table 8 show what the sound level was at each receptor without the wind speed data reduction. These data are just slightly higher than the wind speed corrected data. The wind speed corrected data will be used for any further analysis to be conservative.

Table 8: Summary of Baseline Sound Level Measurement Data Without Data Reduction

Receptor	Distance to Receptor, Miles	Direction	Duration HH:MM	Daytime[1] L_{eq}, dBA	Nighttime[2] L_{eq}, dBA	Ambient L_{dn}, dBA
NSA 1	1.3	South	72:24	52.8	46.0	**54.3**
NSA 2	2.2	East	72:35	63.3	57.3	**65.3**
NSA 3	1.3	Northeast	72:15	57.1	44.5	**56.3**
REC 1	0.7	West	72:12	52.3	49.4	**56.4**

(1) Daytime is 7:00 a.m. until 10:00 p.m.

(2) Nighttime is 10:00 p.m. until 7:00 a.m. the next day.

4. SUMMARY AND CONCLUSION

Sound level measurements were taken at the receptors around the proposed LNG Facility. The measurements show that the current ambient sound levels range from 53 to 65 dB(A) L_{dn}. High wind speeds were present during the survey and are typical for the coastal area. However, the data were processed so that only sound level data taken during periods when the wind speed was below 6.6 m/s were used to determine the day night average sound level at each site.

ATTACHMENTS

SLR

6001 Savoy Drive, Suite 215
Houston, Texas 77036-3322
713-789-9400 Tel 713-789-5493 Fax

Project Number:	108.01593.00004	**Scale:**	AS SHOWN	**Date:**	06/16/2017
Description:	NSA DISTANCES AND DIRECTIONS			**By:**	TGS / JWS
Project Name:	JORDAN COVER ENERGY PROJECT			**Figure:**	FIGURE 1

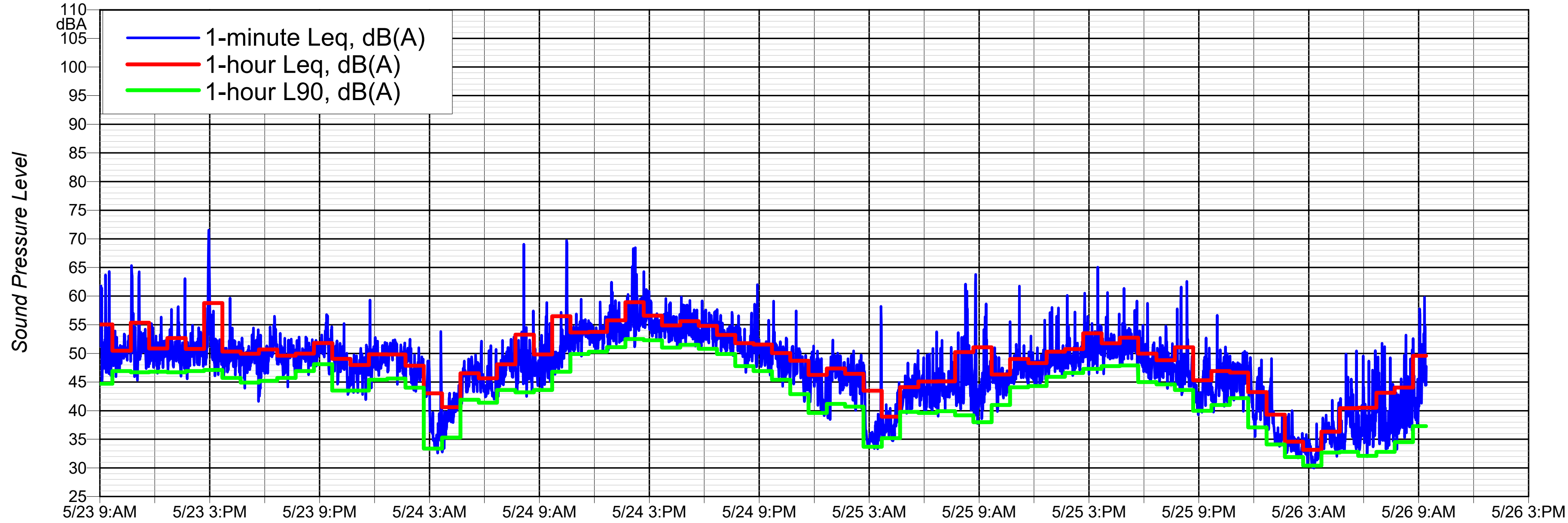
APPENDIX A

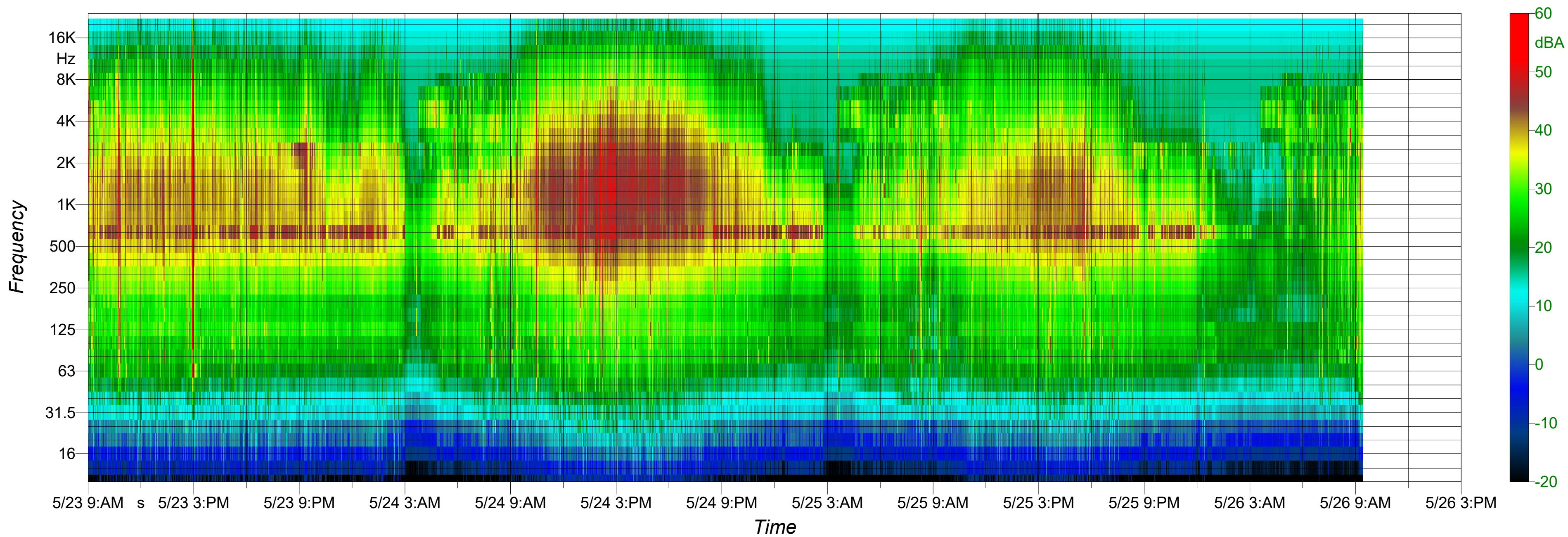
LEVEL VERSUS TIME GRAPHS FOR OVERNIGHT MONITORING

A graphical presentation of all of the monitoring data is included in this appendix. Each measurement position has four pages of graphs, the first is the full data set from May 23 to May 26, 2017 followed by individual daily graphs. The top section of each graph shows the 1-minute L_{eq}, represented by a solid blue line; the 1-hour L_{eq}, a stepped red line; and the 1-hour L_{90}, a stepped green line.

The bottom section of the graphs shows the frequency-based data. Sound frequency is plotted on the vertical axis and time on the horizontal axis. The color indicates the A-weighted sound pressure level at each frequency. The frequency data are useful for determining the presence of any tonal frequencies and helps to characterize the presence of specific noise emissions.

Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 26, 2017
NSA 1 - South of Site

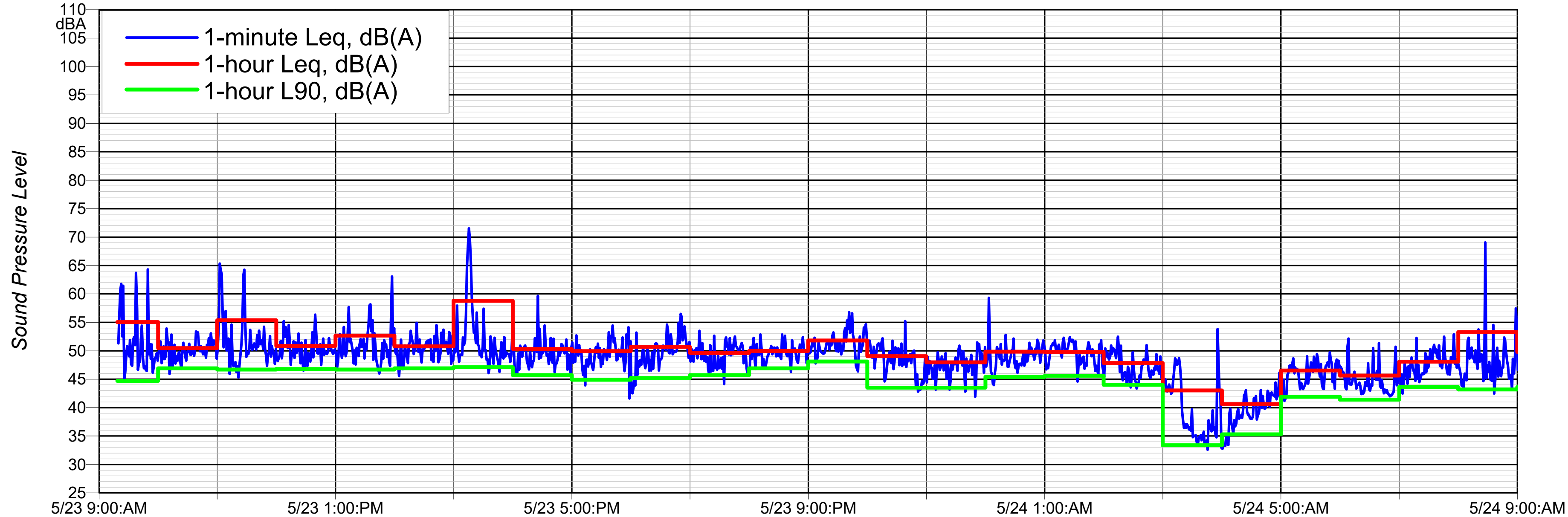


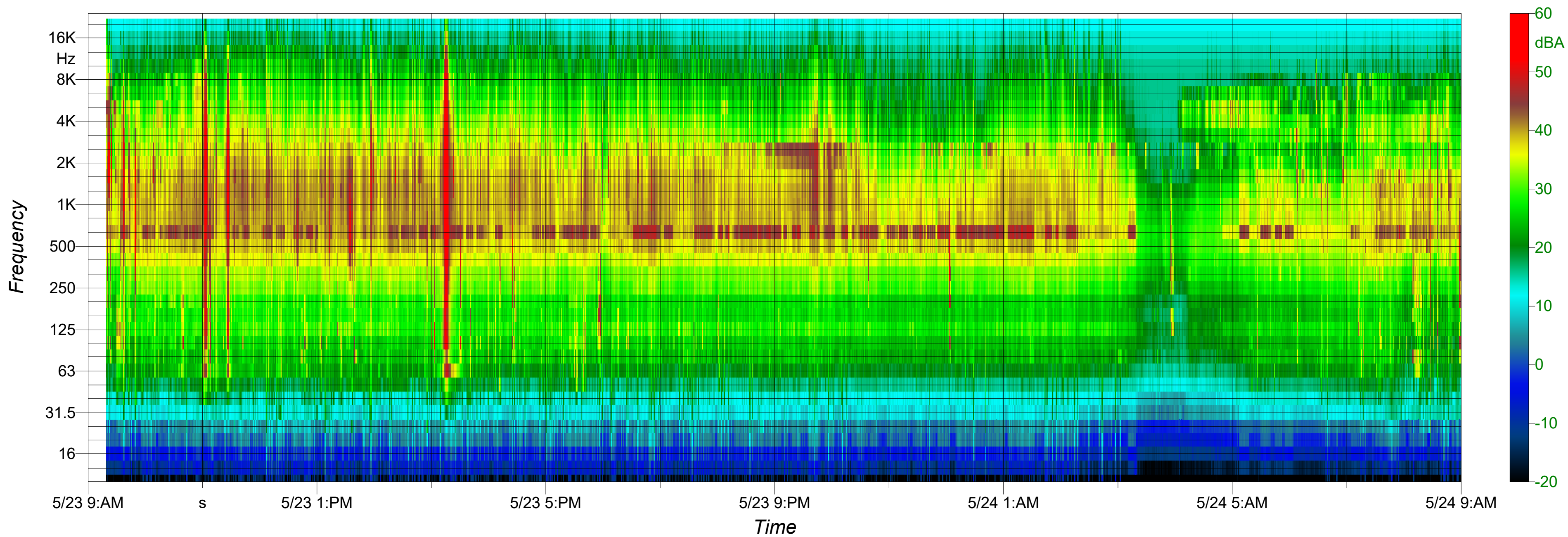


Prepared for Veresen - Jordan Cove LNG

SLR

Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 24, 2017
NSA 1 - South of Site

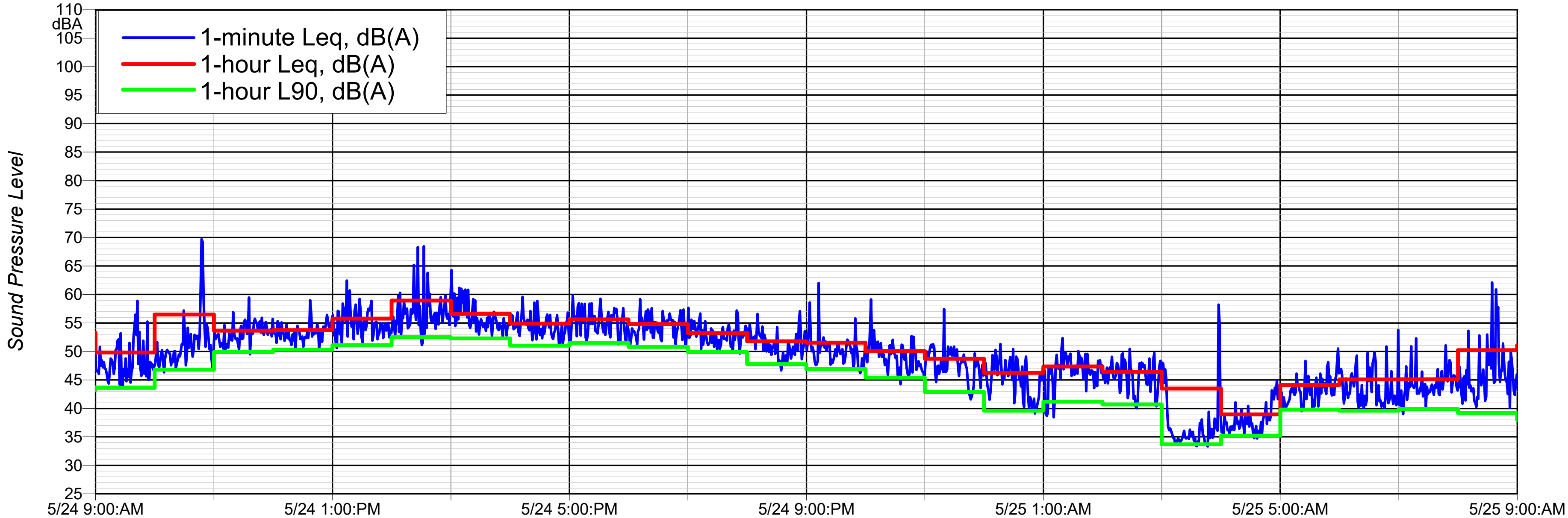


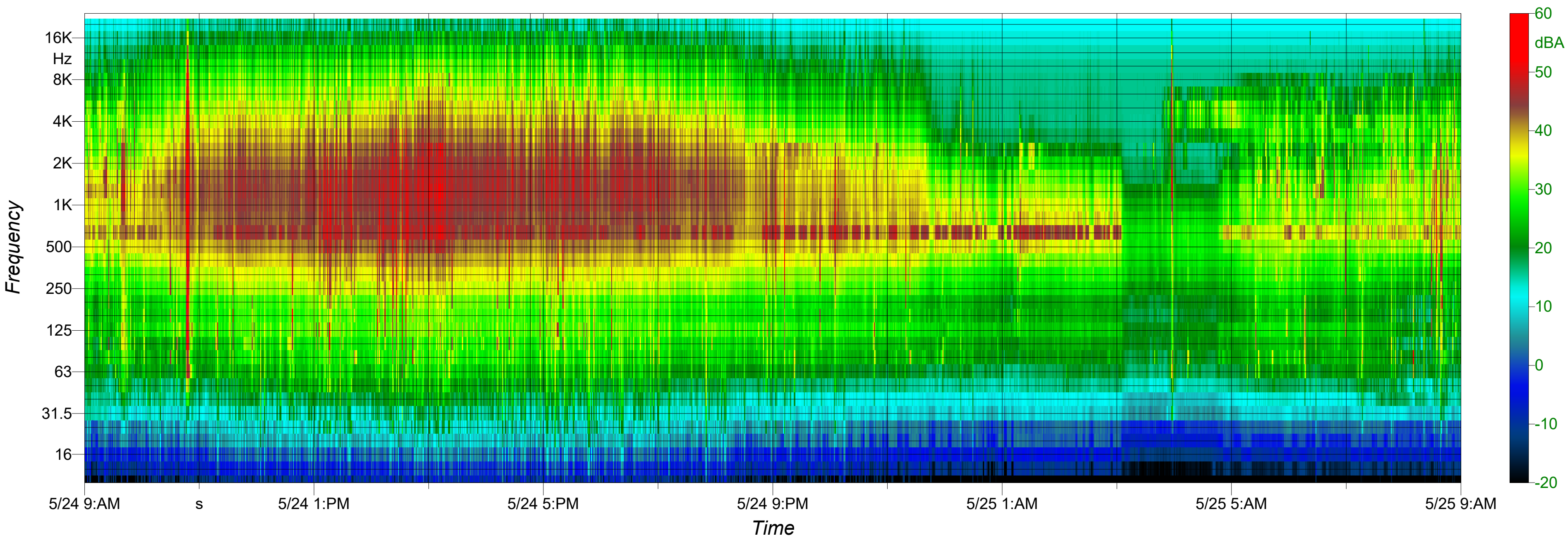


Prepared for Veresen - Jordan Cove LNG

SLR **Exhibit 34**

Sound Level Measurements Near Jordan Cove LNG Site, May 24 - 25, 2017
NSA 1 - South of Site

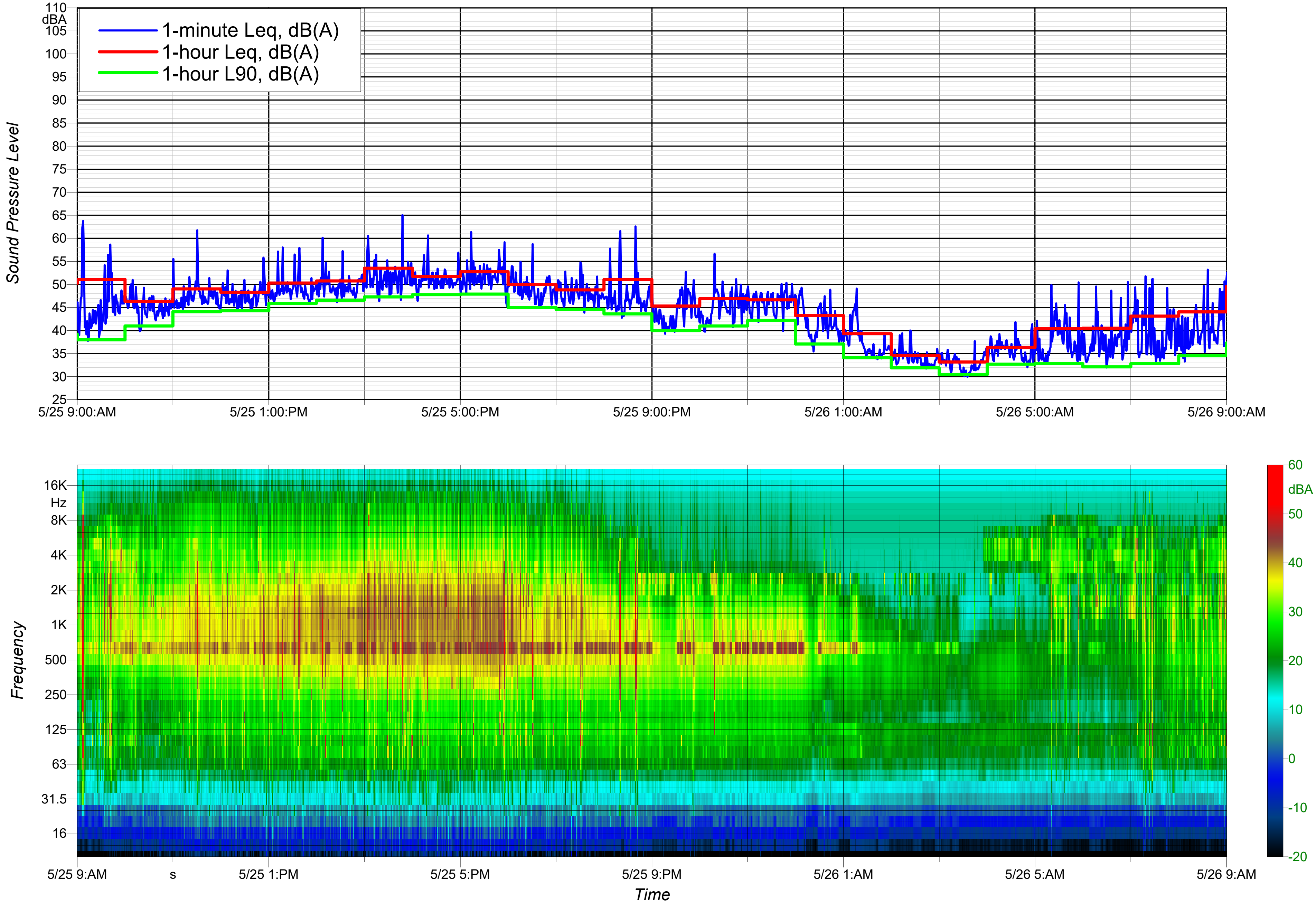




Prepared for Veresen - Jordan Cove LNG

SLR

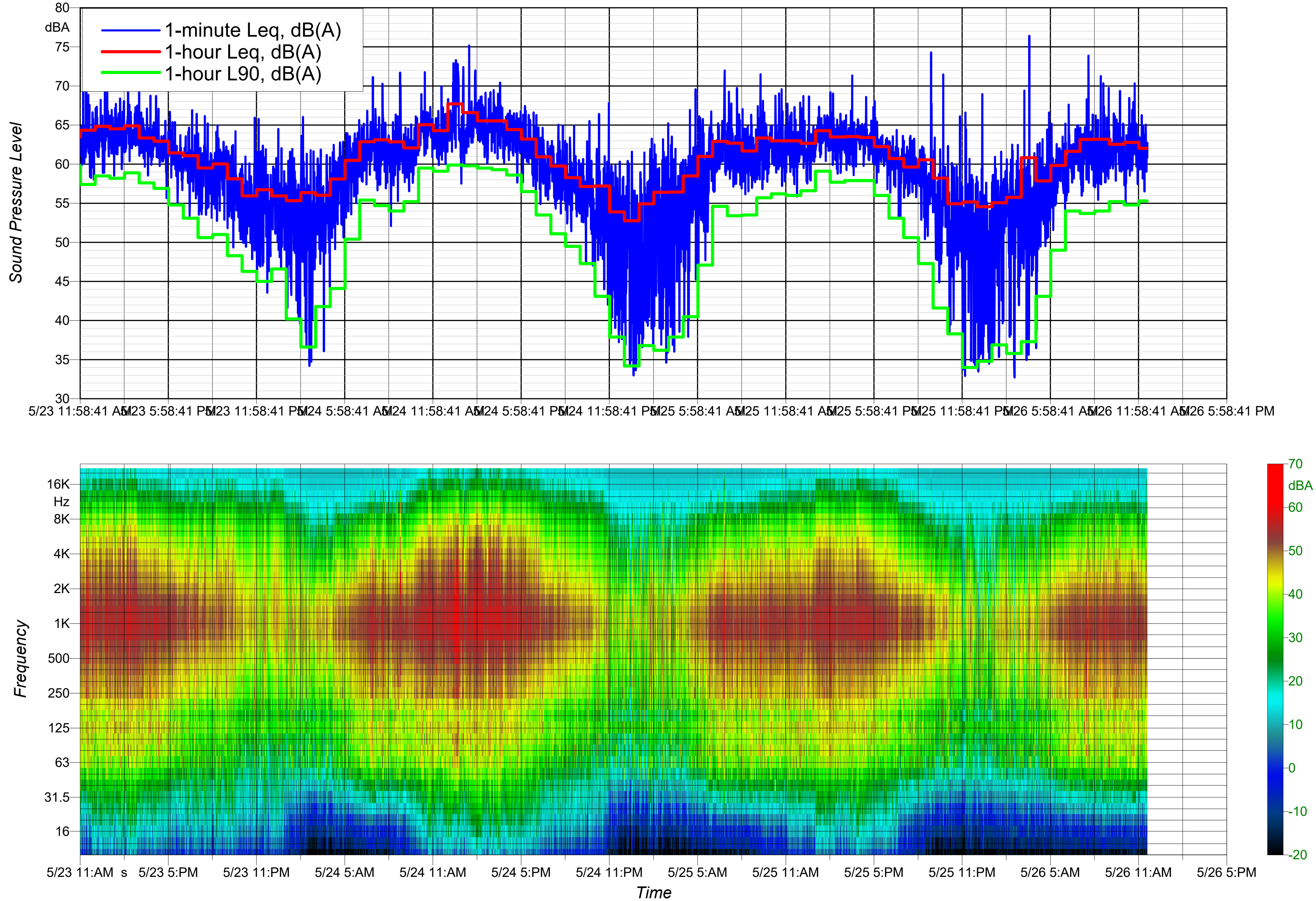
Sound Level Measurements Near Jordan Cove LNG Site, May 25 - 26, 2017
NSA 1 - South of Site



Prepared for Veresen - Jordan Cove LNG

SLR

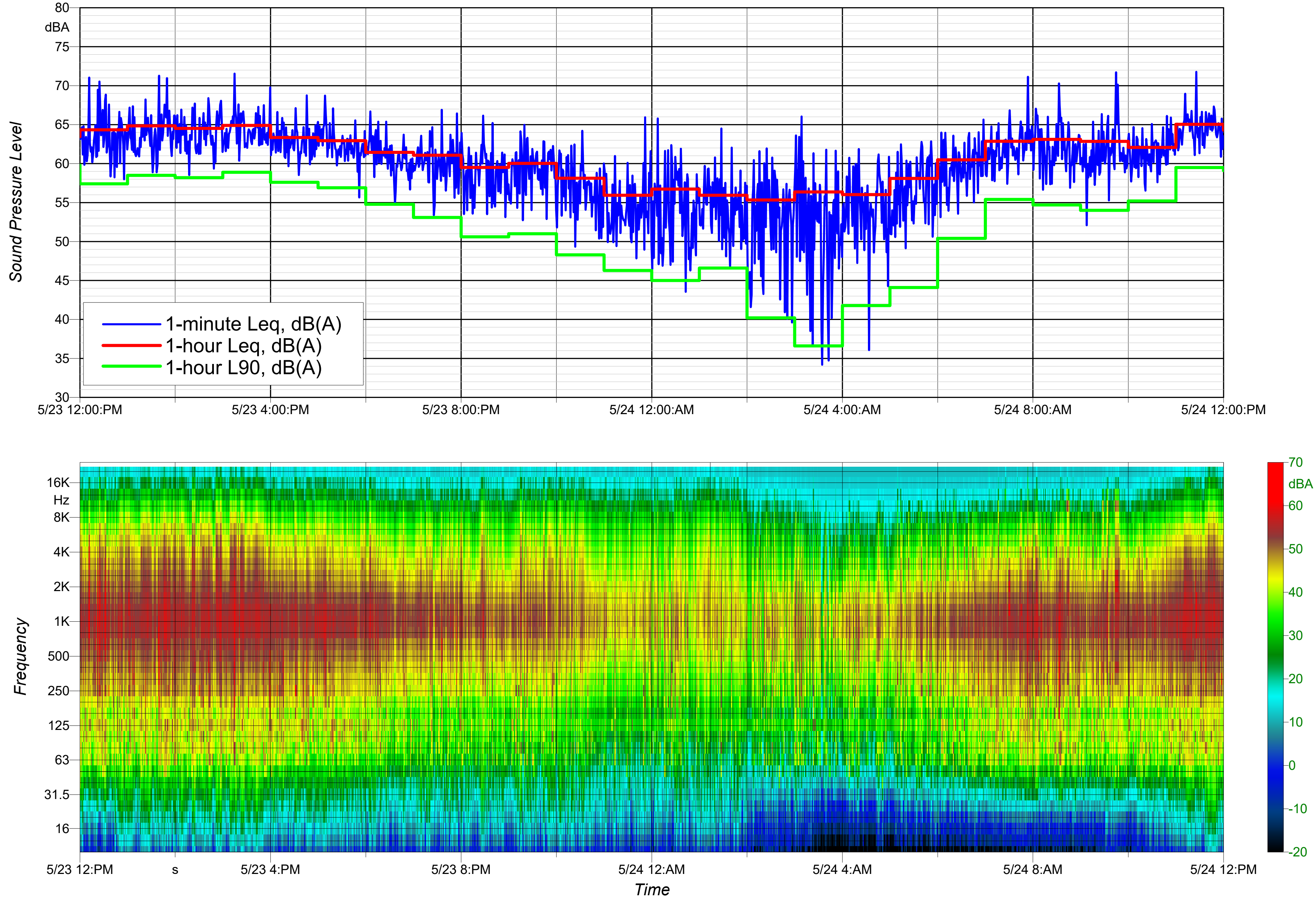
Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 26, 2017
NSA 2 - East of Site



Prepared for Veresen - Jordan Cove LNG

SLR

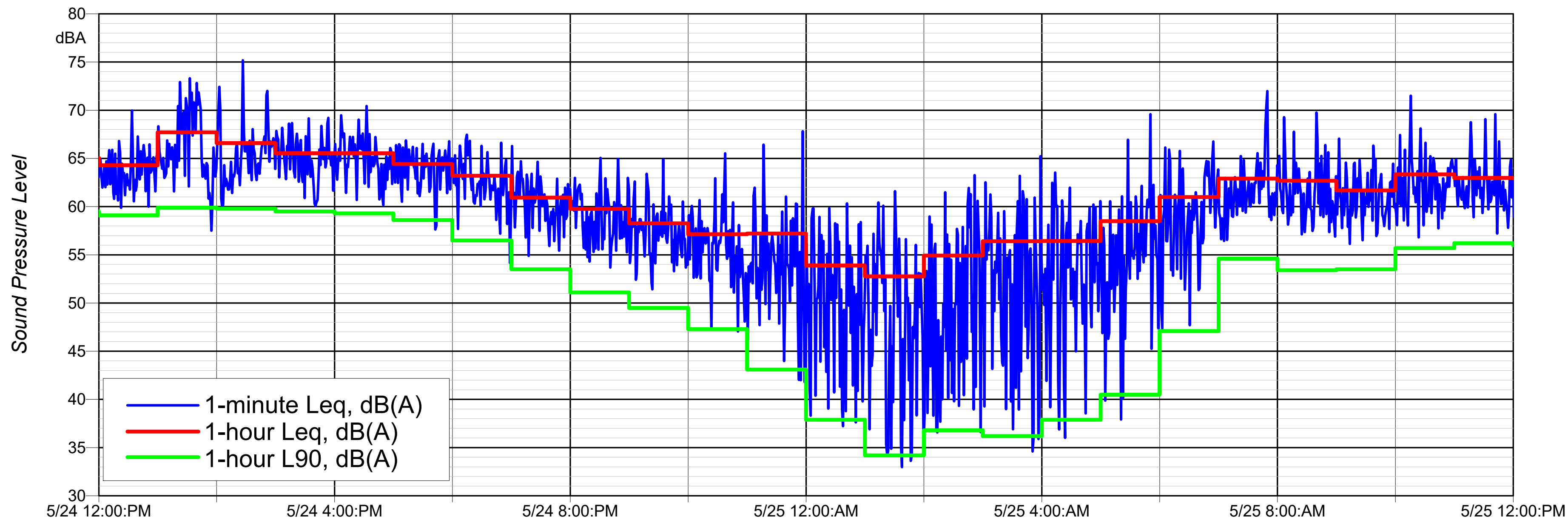
Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 24, 2017
NSA 2 - East of Site

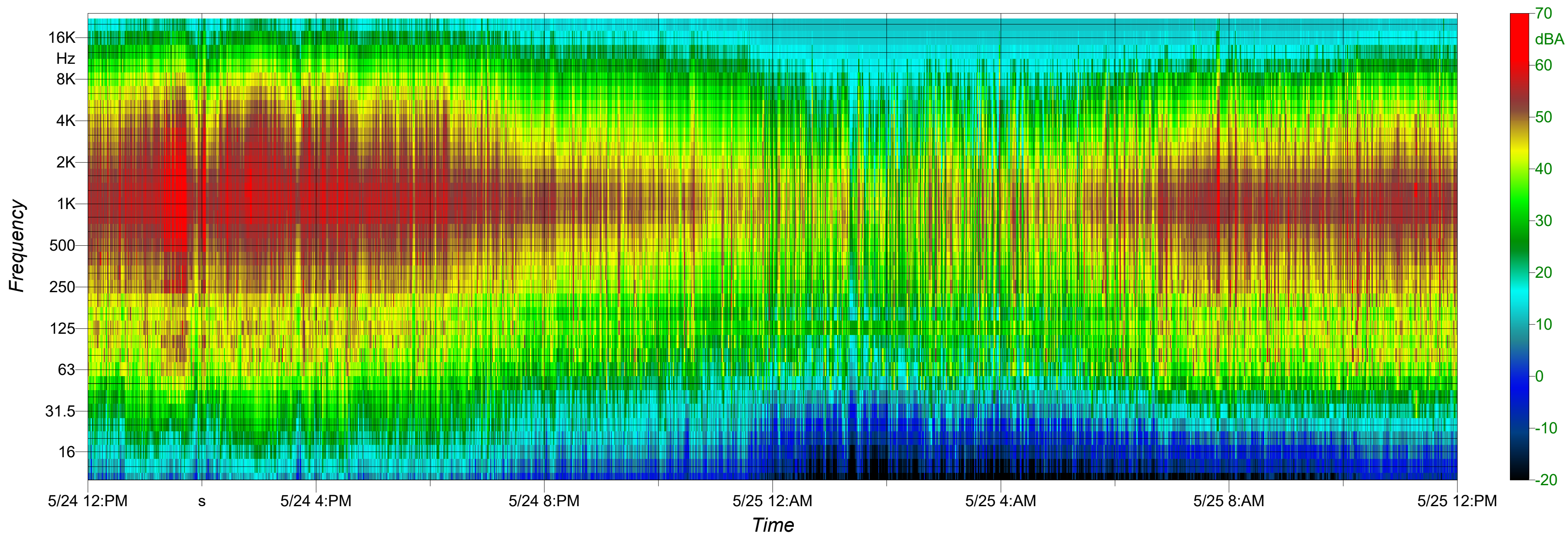


Prepared for Veresen - Jordan Cove LNG

SLR

Sound Level Measurements Near Jordan Cove LNG Site, May 24 - 25, 2017
NSA 2 - East of Site

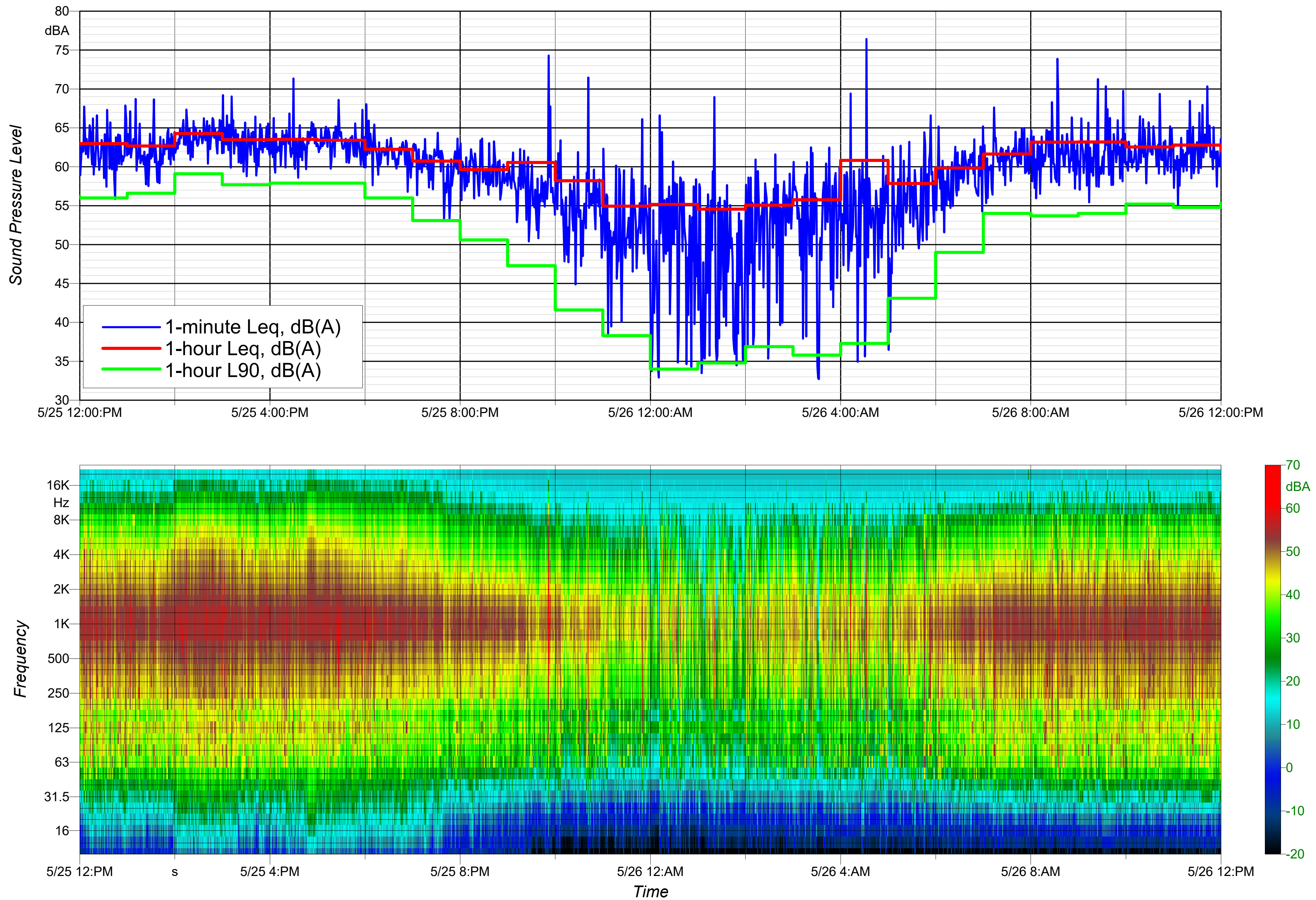




Prepared for Veresen - Jordan Cove LNG

SLR

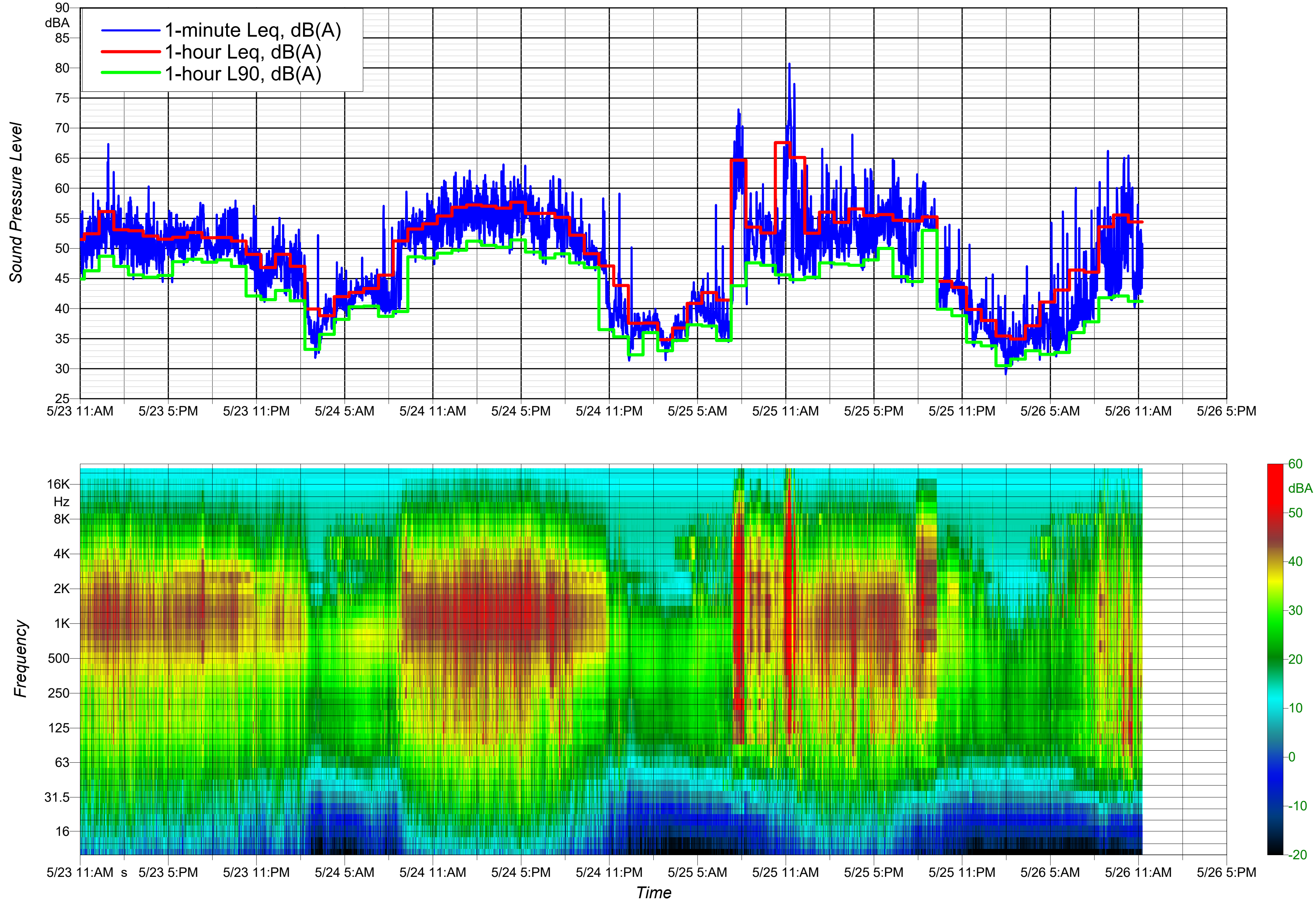
Sound Level Measurements Near Jordan Cove LNG Site, May 25 - 26, 2017
NSA 2 - East of Site



Prepared for Veresen - Jordan Cove LNG

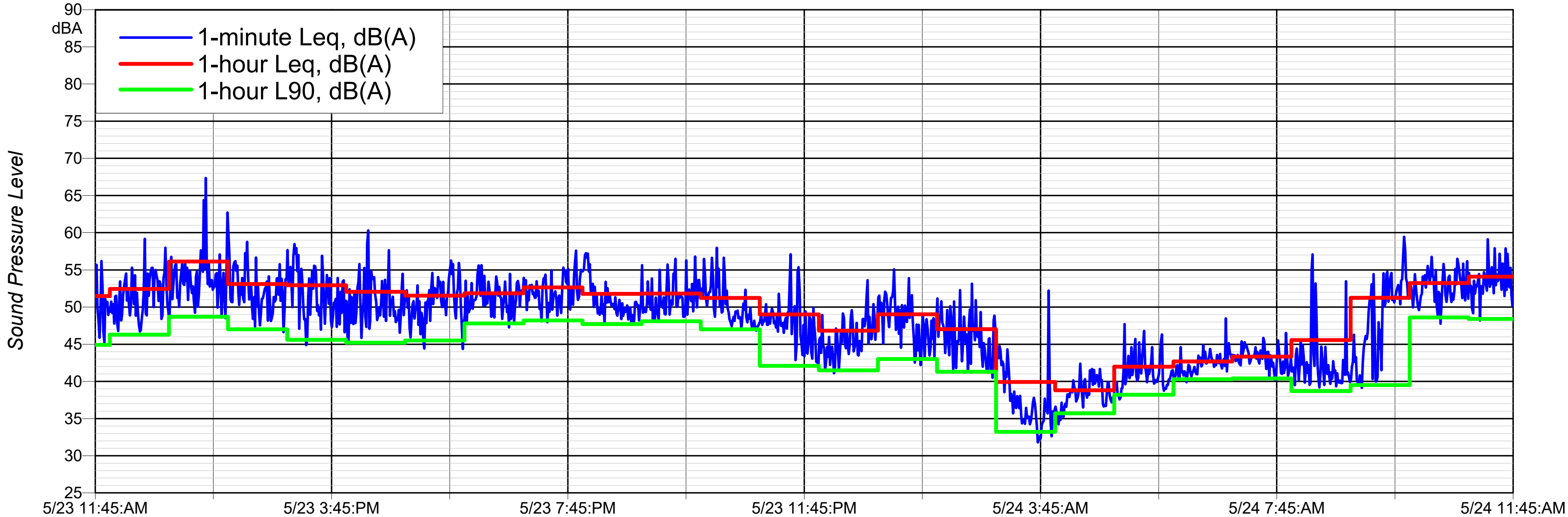
SLR

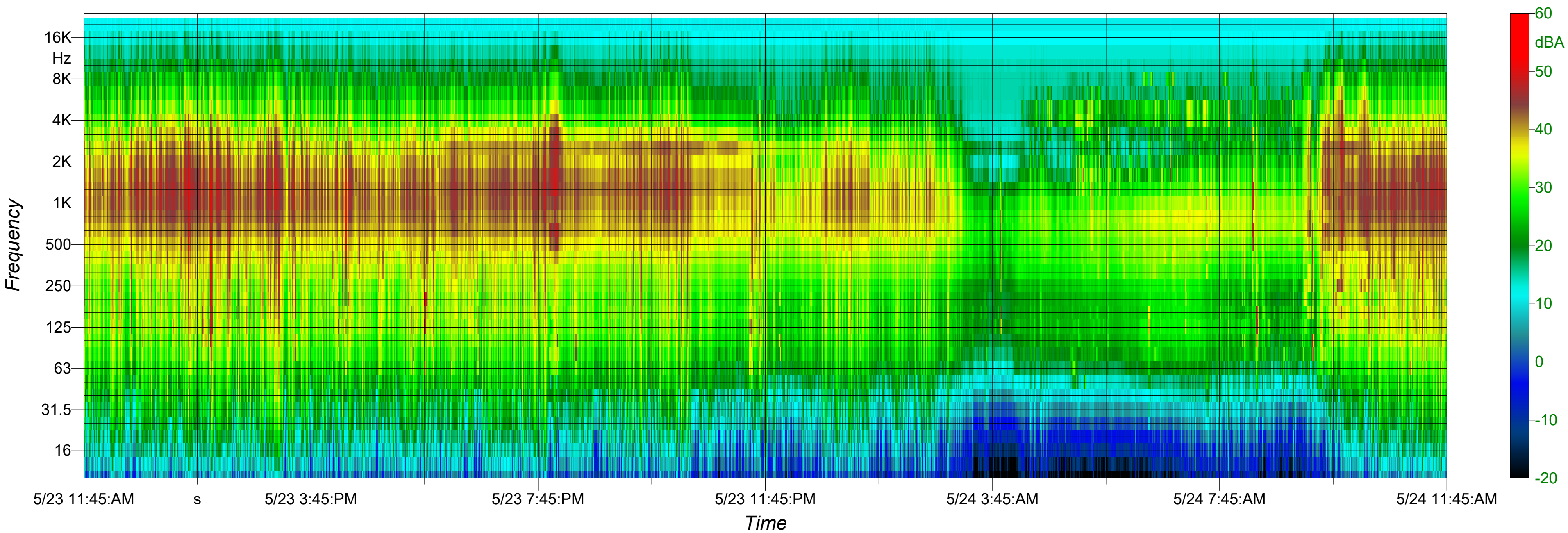
Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 26, 2017
NSA 3 - North of Site



Prepared for Veresen - Jordan Cove LNG

Sound Level Measurements Near Jordan Cove LNG Site, May 23 - 24, 2017
NSA 3 - North of Site

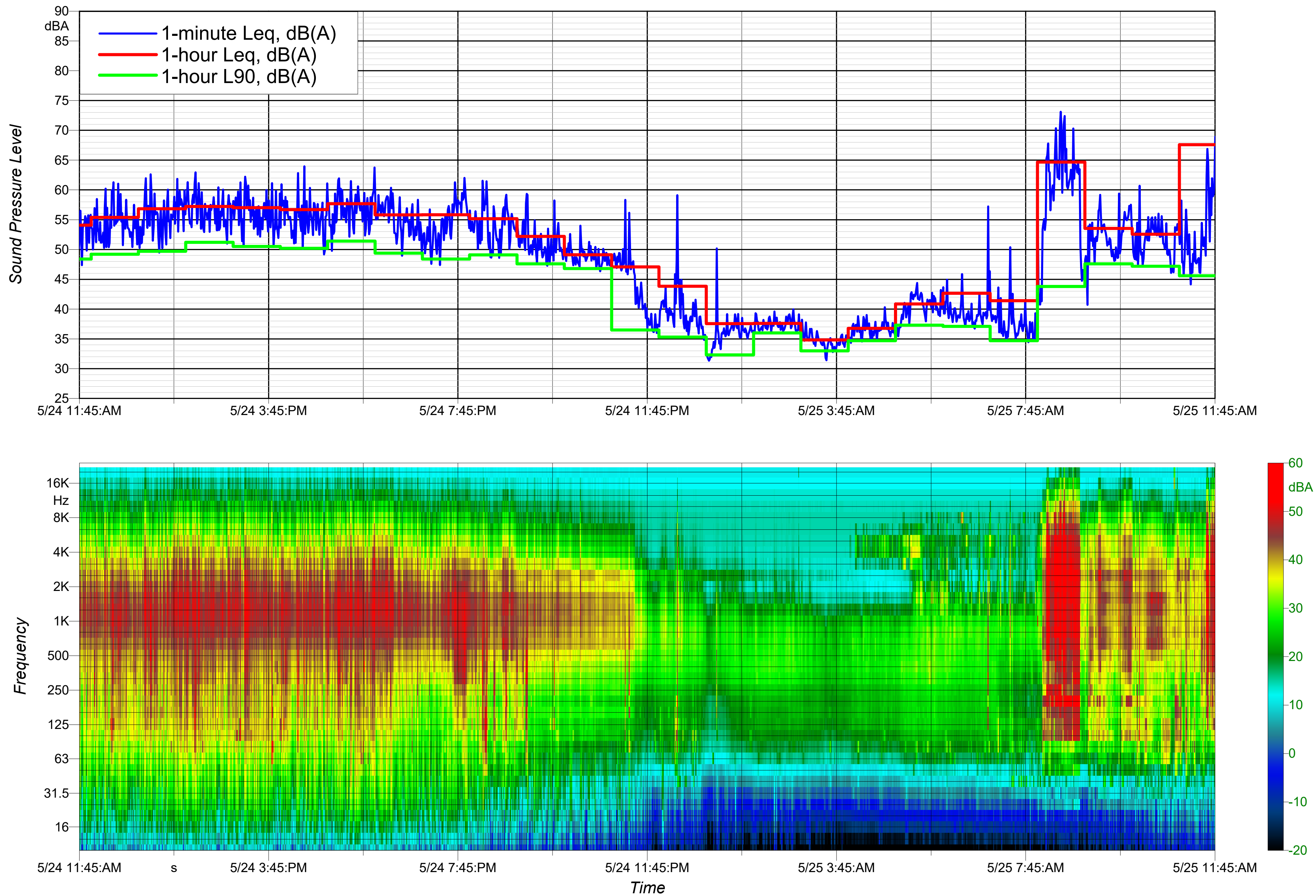




Prepared for Veresen - Jordan Cove LNG

SLR

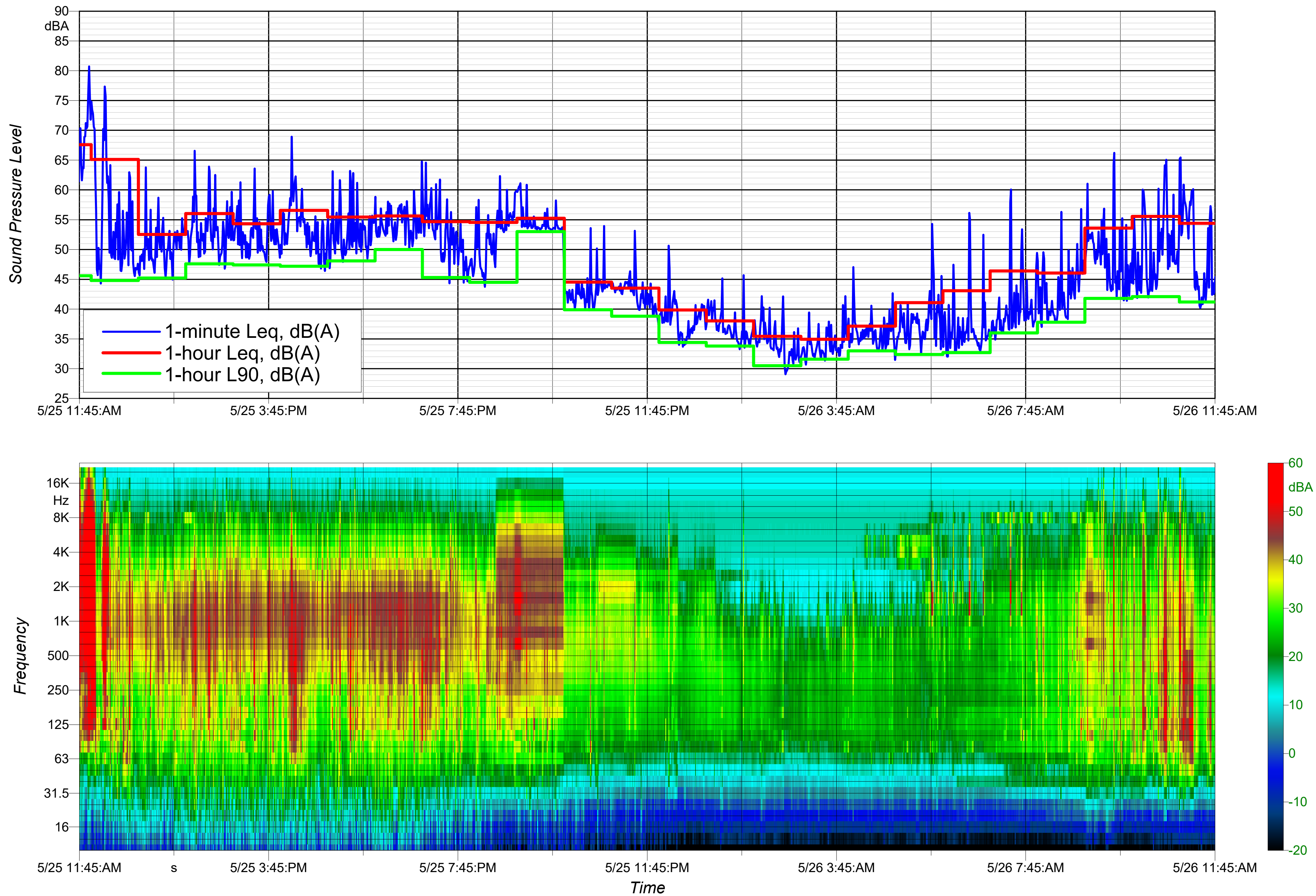
Sound Level Measurements Near Jordan Cove LNG Site, May 24 - 25, 2017
NSA 3 - North of Site



Prepared for Veresen - Jordan Cove LNG

SLR

Sound Level Measurements Near Jordan Cove LNG Site, May 25 - 26, 2017
NSA 3 - North of Site



Prepared for Veresen - Jordan Cove LNG

SLR

APPENDIX B

SOUND LEVEL EQUIPMENT CALIBRATION CERTIFICATIONS

(D)

Calibration Certificate

Certificate Number 2015007196

Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831
Serial Number	0001736
Test Results	**Pass**
Initial Condition	AS RECEIVED same as shipped
Description	Larson Davis Model 831

Procedure Number	D0001.8378		
Technician	Ron Harris		
Calibration Date	30 Jul 2015		
Calibration Due	30 Jul 2016		
Temperature	23.27	°C	± 0.01 °C
Humidity	49.1	%RH	± 0.5 %RH
Static Pressure	86.98	kPa	± 0.03 kPa

Evaluation Method Tested electrically using PRM831 S/N 029412 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005. **Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.**

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Hart Scientific 2626-H Temperature Probe	06/17/2015	06/17/2016	006798
SRS DS360 Ultra Low Distortion Generator	03/26/2015	03/26/2016	007174

Larson Davis, a division of PCB Piezotronics, Inc
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

ilac-MRA ACCREDITED Cert. #3622.01

LARSON DAVIS
A PCB PIEZOTRONICS DIV.

Calibration Certificate

Certificate Number 2015009141

Customer:
The Modal Shop
3149 East Kemper Road
Cincinnati, OH 45241, United States

Model Number	831
Serial Number	0002443
Test Results	**Pass**
Initial Condition	Inoperable
Description	Larson Davis Model 831

Procedure Number	D0001.8378		
Technician	Ron Harris		
Calibration Date	21 Sep 2015		
Calibration Due	21 Sep 2017		
Temperature	22.75	°C	± 0.01 °C
Humidity	51.7	%RH	± 0.5 %RH
Static Pressure	86.36	kPa	± 0.03 kPa

Evaluation Method Tested electrically using PRM831 S/N 029411 and a 12.0 pF capacitor to simulate microphone capacitance. Data reported in dB re 20 μPa assuming a microphone sensitivity of 50.0 mV/Pa.

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8384:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61252:2002	ANSI S1.11 (R2009) Class 1
IEC 61260:2001 Class 1	ANSI S1.25 (R2007)

Larson Davis, a division of PCB Piezotronics, Inc. certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the SI through the National Institute of Standards and Technology (NIST), or other national measurement institutes.

The quality system is registered to ISO 9001:2008.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances will be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
SRS DS360 Ultra Low Distortion Generator	02/06/2015	02/06/2016	006239
Hart Scientific 2626-H Temperature Probe	06/17/2015	06/17/2016	006798

West Caldwell Calibration Laboratories Inc.

Certificate of Calibration

for

PRECISION INTEGRATING SLM

Manufactured by:	LARSON DAVIS
Model No:	831
Serial No:	0001737
Calibration Recall No:	26438

Submitted By:

Customer:	Eve MacPherson
Company:	SLR INTERNATIONAL CORPORATION
Address:	6001 SAVOY DRIVE
	HOUSTON TX 77036-332

The subject instrument was calibrated to the indicated specification using standards traceable to the National Institute of Standards and Technology or to accepted values of natural physical constants. This document certifies that the instrument met the following specification upon its return to the submitter.

West Caldwell Calibration Laboratories Procedure No. 831 LARS

Upon receipt for Calibration, the instrument was found to be:

Within (X)

tolerance of the indicated specification. See attached Report of Calibration.

West Caldwell Calibration Laboratories' calibration control system meets the requirements, ISO 10012-1 MIL-STD-45662A, ANSI/NCSL Z540-1, IEC Guide 25, ISO 9001:2008 and ISO 17025.

Note: With this Certificate, Report of Calibration is included.

Approved by:

Calibration Date: 29-Apr-16

FC

Certificate No: 26438 - 1

Felix Christopher (QA Mgr.)

QA Doc. #1051 Rev. 2.0 10/1/01

Certificate Page 1 of 1

ISO/IEC 17025:2005

West Caldwell Calibration Laboratories, Inc.
uncompromised calibration
1575 State Route 96, Victor, NY 14564, U.S.A.

A2LA ACCREDITED

Calibration Lab. Cert. # 1533.01

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®

NVLAP Lab Code: 200625-0

Calibration Certificate No.36571

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **7/7/2016**	*Cal Due:* **7/7/2017**
Model:	**4231**	*Status:*	**Received** / **Sent**
Manufacturer:	**Brüel and Kjær**	*In tolerance:*	**X** / **X**
Serial number:	**2240964**	*Out of tolerance:*	
Class (IEC 60942):	**1**	*See comments:*	
Barometer type:		*Contains non-accredited tests:*	__ **Yes** _X_ **No**
Barometer s/n:			
Customer:	**SLR International Corporation**	*Address:*	**1800 Blankenship Road, Suite 440, West Linn, OR 97068**
Tel/Fax:	**503-723-4423 / 503-723-4436**		

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 1/16/2015

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 23, 2015	Scantek, Inc./ NVLAP	Oct 23, 2016
DS-360-SRS	Function Generator	33584	Oct 20, 2015	ACR Env./ A2LA	Oct 20, 2017
34401A-Agilent Technologies	Digital Voltmeter	US36120731	Oct 6, 2015	ACR Env. / A2LA	Oct 6, 2016
HM30-Thommen	Meteo Station	1040170/39633	Oct 23, 2015	ACR Env./ A2LA	Oct 23, 2016
140-Norsonic	Real Time Analyzer	1406424	Oct 26, 2015	Scantek / NVLAP	Oct 26, 2016
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Nov 10, 2015	Scantek, Inc. / NVLAP	Nov 10, 2016
1203-Norsonic	Preamplifier	14052	Aug 24, 2015	Scantek, Inc./ NVLAP	Aug 24, 2016

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	Valentin Buzduga
Signature	Lydon Dawkins	Signature	[signature]
Date	7/7/2016	Date	7/07/2016

Document stored as: Z:\Calibration Lab\Cal 2016\BNK4231_2240964_M1.doc

APPENDIX E.9

Construction Emission Inventory and Emission Calculations

Jordan Cove - Construction Emissions Summary

Construction Activity Source	Year 1 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Onroad Construction Equipment	3.50	0.01	2.76	0.21	0.19	0.51	1,048.87	0.09
Nonroad Construction Equipment	119.80	0.21	52.88	6.10	5.92	15.25	39,786.69	6.85
Boats/Tugs	223.02	0.11	51.11	3.73	3.62	5.96	10,642.63	0.16
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	257.32	29.38	0	0.00	0
Material Delivery and Worker Commuting	4.61	0.01	13.11	0.20	0.18	1.06	1,918.59	0.27

Construction Activity Source	Year 2 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Onroad Construction Equipment	4.03	0.01	3.03	0.24	0.22	0.58	1,209.10	0.10
Nonroad Construction Equipment	176.16	0.27	95.89	9.75	9.46	22.90	50,673.63	10.09
Boats/Tugs	212.40	0.11	48.68	3.55	3.44	5.68	10,135.84	0.15
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	296.10	86.56	0	0.00	0
Material Delivery and Worker Commuting	11.14	0.03	36.05	0.43	0.39	2.70	4,689.67	0.69

Construction Activity Source	Year 3 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Onroad Construction Equipment	3.77	0.01	2.89	0.22	0.20	0.55	1,132.05	0.10
Nonroad Construction Equipment	153.94	0.22	121.07	10.19	9.88	23.58	40,644.24	10.11
Boats/Tugs	95.58	0.05	21.90	1.60	1.55	2.55	4,561.13	0.07
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	179.26	75.21	0	0.00	0
Material Delivery and Worker Commuting	15.68	0.05	53.05	0.54	0.49	3.82	6,430.47	0.99

Construction Activity Source	Year 4 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Onroad Construction Equipment	1.21	0.00	0.79	0.07	0.06	0.17	362.97	0.03
Nonroad Construction Equipment	33.42	0.05	48.49	2.81	2.72	7.53	9,618.98	3.05
Boats/Tugs	0	0	0	0	0	0	0.00	0
Stationary Emission Units	0	0	0	0	0	0	0.00	0
Fugitive Sources	0	0	0	14.35	14.35	0	0.00	0
Material Delivery and Worker Commuting	8.51	0.03	31.70	0.28	0.26	2.21	3,632.68	0.58

Construction Activity Source	Year 5 - Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Onroad Construction Equipment	0.07	0.00	0.03	0.00	0.00	0.01	20.86	0.00
Nonroad Construction Equipment	6.49	0.01	4.20	0.40	0.39	0.92	2,483.25	0.41
Boats/Tugs	0	0	0	0	0	0	0.00	0
Stationary Emission Units	64.74	20.93	75.90	52.46	52.46	69.30	922,824.41	3.61
Fugitive Sources	0	0	0	156.09	15.61	0	0.00	0
Material Delivery and Worker Commuting	1.16	0.00	4.53	0.04	0.04	0.32	527.88	0.08

Construction Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	350.93	0.35	119.85	267.55	39.28	22.78	53,396.78	7.37
Year 2	403.73	0.43	183.64	310.06	#####	31.86	66,708.24	11.04
Year 3	268.97	0.33	198.92	191.81	87.33	30.51	52,767.89	11.27
Year 4	43.14	0.08	80.99	17.51	17.39	9.90	13,614.63	3.66
Year 5	72.45	20.94	84.65	208.99	68.50	70.54	925,856.40	4.10

Jordan Cove - Construction Emissions Summary

Onroad Construction Equipment Emissions								
Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	3.50	0.01	2.76	0.21	0.19	0.51	1,049	0.09
Year 2	4.03	0.01	3.03	0.24	0.22	0.58	1,209	0.10
Year 3	3.77	0.01	2.89	0.22	0.20	0.55	1,132	0.10
Year 4	1.21	0.00	0.79	0.07	0.06	0.17	363	0.03
Year 5	0.07	0.00	0.03	0.00	0.00	0.01	21	0.00

Nonroad Construction Equipment Emissions								
Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	119.80	0.21	52.88	6.10	5.92	15.25	39,787	6.85
Year 2	176.16	0.27	95.89	9.75	9.46	22.90	50,674	10.09
Year 3	153.94	0.22	121.07	10.19	9.88	23.58	40,644	10.11
Year 4	33.42	0.05	48.49	2.81	2.72	7.53	9,619	3.05
Year 5	6.49	0.01	4.20	0.40	0.39	0.92	2,483	0.41

Boats/Tugs								
Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	223.02	0.11	51.11	3.73	3.62	5.96	10,643	0.16
Year 2	212.40	0.11	48.68	3.55	3.44	5.68	10,136	0.15
Year 3	95.58	0.05	21.90	1.60	1.55	2.55	4,561	0.07

Stationary Emission Units								
Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 5	64.74	20.93	75.90	52.46	52.46	69.30	922,824	3.61

Fugitive Emissions								
Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	0	0	0	257.32	29.38	0	0	0
Year 2	0	0	0	296.10	86.56	0	0	0
Year 3	0	0	0	179.26	75.21	0	0	0
Year 4	0	0	0	14.35	14.35	0	0	0
Year 5	0	0	0	156.09	15.61	0	0	0

Material Delivery and Worker Commuting Emissions								
Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	4.61	0.01	13.11	0.20	0.18	1.06	1918.59	0.27
Year 2	11.14	0.03	36.05	0.43	0.39	2.70	4689.67	0.69
Year 3	15.68	0.05	53.05	0.54	0.49	3.82	6430.47	0.99
Year 4	8.51	0.03	31.70	0.28	0.26	2.21	3632.68	0.58
Year 5	1.16	0.00	4.53	0.04	0.04	0.32	527.88	0.08

Total Emissions								
Year	Emissions (tons/year)							
	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Year 1	350.93	0.35	119.85	267.55	39.28	22.78	53,397	7.37
Year 2	403.73	0.43	183.64	310.06	100.07	31.86	66,708	11.04
Year 3	268.97	0.33	198.92	191.81	87.33	30.51	52,768	11.27
Year 4	43.14	0.08	80.99	17.51	17.39	9.90	13,615	3.66
Year 5	72.45	20.94	84.65	208.99	68.50	70.54	925,856	4.10

Jordan Cove **Construction Emissions Summary - Year 1**

Equipment Type	Fuel	SCC Code or MOVES Category	Engine Rating	Hours	Load Factor	Emission Factor									Emissions (tons/year)							
						NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS	Units	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Pickup Trucks	Gasoline	Light Commercial Truck	280 hp	88,200	NA	1.93	4.96E-03	3.59	0.12	0.11	0.41	575	7.06E-02	g/VMT	0.94	0.00	1.74	0.06	0.05	0.20	280	0.03
Large Trucks	ULSD	Single Unit Short-Haul Truck	316 hp	143,800	NA	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02	g/VMT	2.56	0.01	1.01	0.15	0.14	0.31	769	0.06
Offroad Trucks	ULSD	2270002051	464 hp	42,000	0.59	1.76	2.65E-03	0.45	0.05	0.05	0.19	537	8.23E-02	g/hp-hr	22.25	0.03	5.72	0.60	0.58	2.44	6,802	1.04
Hoe Ram / ATV	Gasoline	2265001030	21 hp	29,800	0.43	0.47	1.43E-03	36.55	0.07	0.06	3.75	242	1.18E+00	g/hp-hr	0.14	0.00	10.84	0.02	0.02	1.11	72	0.35
RT Cranes	ULSD	2270002045	260 hp	27,350	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	5.45	0.01	1.47	0.25	0.24	0.62	1,797	0.29
Dozers	ULSD	2270002069	166 hp	21,800	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	3.28	0.01	1.33	0.18	0.18	0.42	1,270	0.19
Forklifts	ULSD	2270002057	173 hp	33,200	0.59	1.81	3.14E-03	1.18	0.17	0.17	0.21	570	9.97E-02	g/hp-hr	6.75	0.01	4.41	0.64	0.63	0.77	2,127	0.37
Loaders	ULSD	2270002060	235 hp	30,200	0.59	1.77	2.95E-03	0.70	0.11	0.10	0.19	540	8.93E-02	g/hp-hr	8.16	0.01	3.25	0.49	0.48	0.88	2,492	0.41
Tractors	ULSD	2270002069	270 hp	4,200	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	1.03	0.00	0.42	0.06	0.06	0.13	398	0.06
Lifts / Hoists	ULSD	2270003010	75 hp	16,800	0.21	4.79	4.26E-03	4.54	0.63	0.61	1.02	693	4.59E-01	g/hp-hr	1.40	0.00	1.33	0.18	0.18	0.30	202	0.13
Rollers	ULSD	2270002015	157 hp	21,000	0.59	1.68	3.02E-03	0.83	0.12	0.12	0.19	560	9.36E-02	g/hp-hr	3.61	0.01	1.77	0.27	0.26	0.41	1,200	0.20
Scrapers	ULSD	2270002018	784 hp	4,200	0.59	1.36	2.88E-03	0.64	0.08	0.08	0.17	537	7.87E-02	g/hp-hr	2.91	0.01	1.37	0.17	0.17	0.36	1,149	0.17
Motor Graders	ULSD	2270002048	240 hp	12,600	0.59	0.90	2.73E-03	0.32	0.05	0.05	0.17	538	7.38E-02	g/hp-hr	1.77	0.01	0.62	0.10	0.10	0.33	1,057	0.15
Pile Vibrators / Hammers	ULSD	2270002054	1050 hp	16,800	0.43	2.15	3.05E-03	0.67	0.10	0.09	0.19	546	9.40E-02	g/hp-hr	17.96	0.03	5.64	0.82	0.79	1.61	4,563	0.79
Backhoes	ULSD	2270002036	244 hp	30,200	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	4.44	0.01	1.60	0.22	0.22	0.79	2,597	0.35
Compressors	ULSD	2270006015	69 hp	21,800	0.43	2.37	3.22E-03	1.02	0.14	0.14	0.22	574	1.11E-01	g/hp-hr	1.69	0.00	0.72	0.10	0.10	0.16	409	0.08
Generators / Light Plants	ULSD	2270002027	15 hp	59,560	0.43	4.15	3.73E-03	1.91	0.28	0.27	0.39	587	2.30E-01	g/hp-hr	1.76	0.00	0.81	0.12	0.12	0.17	248	0.10
Welders	ULSD	2270006025	20 hp	34,610	0.21	4.46	4.23E-03	3.89	0.57	0.55	0.83	693	3.83E-01	g/hp-hr	0.71	0.00	0.62	0.09	0.09	0.13	111	0.06
Crawler Cranes	ULSD	2270002045	400 hp	66,480	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	20.39	0.04	5.48	0.94	0.91	2.33	6,721	1.09
Augers/Soil Mix Equipment	ULSD	2270002033	440 hp	8,400	0.43	3.46	3.22E-03	1.05	0.18	0.18	0.30	540	1.37E-01	g/hp-hr	6.07	0.01	1.84	0.32	0.31	0.52	946	0.24
Pumps	ULSD	2270006010	75 hp	4,200	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0.55	0.00	0.25	0.04	0.04	0.06	85	0.03
Excavator	ULSD	2270002036	524 hp	30,000	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	9.47	0.03	3.40	0.48	0.46	1.69	5,540	0.75
Concrete Pumps	ULSD	2270006010	630 hp	0	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0	0	0	0	0	0	0	0
Suction Dredger	ULSD	2270002081	1435 hp	0	0.59	2.33	3.09E-03	1.03	0.14	0.14	0.21	538	9.88E-02	g/hp-hr	0	0	0	0	0	0	0	0
DB / Boats / Tugs	ULSD	NA	1475 hp	12,600	NA	2.40E-02	1.21E-05	5.50E-03	4.01E-04	3.89E-04	6.42E-04	1,689	2.50E-02	lb/hp-hr	223.02	0.11	51.11	3.73	3.62	5.96	10,643	0.16
Gas Turbines (5)	Natural Gas	NA	504.4 MMBtu/hr	0	NA	3.70	1.58E+00	4.40	4.90	4.90	1.32	58,019	2.13E-01	lb/hr	0	0	0	0	0	0	0	0
Duct Burners (5)	Natural Gas	NA	19.7 MMBtu/hr	0	NA	0.10	6.00E-02	0.15	0.50	0.50	0.38	2,262	3.91E-02	lb/hr	0	0	0	0	0	0	0	0
Gas Turbine Startup/Shutdown	Natural Gas	NA	44.6 MMBtu/SUSD	0	NA	7.50	1.46E-01	24.30	3.70	3.70	3.40	6,267	2.06E-02	lb/hr	0	0	0	0	0	0	0	0
Auxiliary Boiler	Natural Gas	NA	296.2 MMBtu/hr	0	NA	2.18	8.25E-01	2.66	2.96	2.96	1.52	34,688	5.46E-01	lb/hr	0	0	0	0	0	0	0	0
Thermal Oxidizer	Natural Gas	NA	110 MMBtu/hr	0	NA	14.44	4.53	8.79	0.88	0.88	6.00	261,758	2.04E-01	lb/hr	0	0	0	0	0	0	0	0
Generators (2)	ULSD	NA	4376 hp	0	NA	7.43	4.42E-02	1.04	0.23	0.23	0.45	5,012	7.42E-02	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	2.13 MMBtu/hr	0	NA	0.14	6.67E-03	0.66	0.07	0.07	1.41	329	7.27E-03	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	lb/hr	0	0	0	0	0	0	0	0
Fire Pumps (3)	ULSD	NA	700 hp	0	NA	5.31	7.08E-03	2.68	0.30	0.30	0.15	802	1.19E-02	lb/hr	0	0	0	0	0	0	0	0
Fugitives (Piles)	NA	NA	NA	NA	NA	NA	NA	NA	0.11	0.011	NA	NA	NA	ton/acre-month	NA	NA	NA	240.74	24.07	NA	NA	NA
Fugitives (Batch Plant)	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.47	NA	NA	NA	lb/ton cement	NA	NA	NA	4.05	4.05	NA	NA	NA
Delivery and Commute	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.61	0.01	13.11	0.20	0.18	1.06	1,918.59	0.27
														Subtotals	**350.93**	**0.35**	**119.85**	**255.01**	**38.02**	**22.78**	**53,397**	**7.37**

Jordan Cove **Construction Emissions Summary - Year 2**

						Emission Factor									Emissions (tons/year)							
Equipment Type	Fuel	SCC Code or MOVES Category	Engine Rating	Hours	Load Factor	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS	Units	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Pickup Trucks	Gasoline	Light Commercial Truck	280 hp	92,000	NA	1.93	4.96E-03	3.59	0.12	0.11	0.41	575	7.06E-02	g/VMT	0.98	0.00	1.82	0.06	0.06	0.21	292	0.04
Large Trucks	ULSD	Single Unit Short-Haul Truck	316 hp	171,500	NA	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02	g/VMT	3.05	0.01	1.21	0.18	0.16	0.37	917	0.07
Offroad Trucks	ULSD	2270002051	464 hp	40,000	0.59	1.76	2.65E-03	0.45	0.05	0.05	0.19	537	8.23E-02	g/hp-hr	21.19	0.03	5.44	0.57	0.55	2.32	6,478	0.99
Hoe Ram / ATV	Gasoline	2265001030	21 hp	86,000	0.43	0.47	1.43E-03	36.55	0.07	0.06	3.75	242	1.18E+00	g/hp-hr	0.40	0.00	31.29	0.06	0.05	3.21	207	1.01
RT Cranes	ULSD	2270002045	260 hp	44,000	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	8.77	0.02	2.36	0.41	0.39	1.00	2,891	0.47
Dozers	ULSD	2270002069	166 hp	26,500	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	3.99	0.01	1.62	0.22	0.21	0.51	1,544	0.23
Forklifts	ULSD	2270002057	173 hp	58,000	0.59	1.81	3.14E-03	1.18	0.17	0.17	0.21	570	9.97E-02	g/hp-hr	11.79	0.02	7.70	1.13	1.09	1.35	3,716	0.65
Loaders	ULSD	2270002060	235 hp	30,500	0.59	1.77	2.95E-03	0.70	0.11	0.10	0.19	540	8.93E-02	g/hp-hr	8.24	0.01	3.28	0.50	0.48	0.89	2,517	0.42
Tractors	ULSD	2270002069	270 hp	5,000	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	1.23	0.00	0.50	0.07	0.07	0.16	474	0.07
Lifts / Hoists	ULSD	2270003010	75 hp	40,000	0.21	4.79	4.26E-03	4.54	0.63	0.61	1.02	693	4.59E-01	g/hp-hr	3.33	0.00	3.16	0.44	0.43	0.71	482	0.32
Rollers	ULSD	2270002015	157 hp	20,000	0.59	1.68	3.02E-03	0.83	0.12	0.12	0.19	560	9.36E-02	g/hp-hr	3.44	0.01	1.69	0.25	0.25	0.39	1,143	0.19
Scrapers	ULSD	2270002018	784 hp	4,000	0.59	1.36	2.88E-03	0.64	0.08	0.08	0.17	537	7.87E-02	g/hp-hr	2.77	0.01	1.30	0.16	0.16	0.35	1,095	0.16
Motor Graders	ULSD	2270002048	240 hp	12,000	0.59	0.90	2.73E-03	0.32	0.05	0.05	0.17	538	7.38E-02	g/hp-hr	1.68	0.01	0.60	0.10	0.09	0.31	1,007	0.14
Pile Vibrators / Hammers	ULSD	2270002054	1050 hp	16,000	0.43	2.15	3.05E-03	0.67	0.10	0.09	0.19	546	9.40E-02	g/hp-hr	17.11	0.02	5.37	0.78	0.75	1.54	4,346	0.75
Backhoes	ULSD	2270002036	244 hp	30,500	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	4.48	0.01	1.61	0.23	0.22	0.80	2,623	0.36
Compressors	ULSD	2270006015	69 hp	27,500	0.43	2.37	3.22E-03	1.02	0.14	0.14	0.22	574	1.11E-01	g/hp-hr	2.13	0.00	0.91	0.13	0.13	0.20	516	0.10
Generators / Light Plants	ULSD	2270002027	15 hp	65,200	0.43	4.15	3.73E-03	1.91	0.28	0.27	0.39	587	2.30E-01	g/hp-hr	1.92	0.00	0.89	0.13	0.13	0.18	272	0.11
Welders	ULSD	2270006025	20 hp	38,700	0.21	4.46	4.23E-03	3.89	0.57	0.55	0.83	693	3.83E-01	g/hp-hr	0.80	0.00	0.70	0.10	0.10	0.15	124	0.07
Crawler Cranes	ULSD	2270002045	400 hp	68,100	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	20.89	0.04	5.61	0.97	0.94	2.38	6,884	1.12
Augers/Soil Mix Equipment	ULSD	2270002033	440 hp	48,000	0.43	3.46	3.22E-03	1.05	0.18	0.18	0.30	540	1.37E-01	g/hp-hr	34.68	0.03	10.50	1.83	1.78	2.99	5,404	1.37
Pumps	ULSD	2270006010	75 hp	4,000	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0.53	0.00	0.24	0.04	0.04	0.06	81	0.03
Excavator	ULSD	2270002036	524 hp	30,000	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	9.47	0.03	3.40	0.48	0.46	1.69	5,540	0.75
Concrete Pumps	ULSD	2270006010	630 hp	7,800	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	8.61	0.01	3.88	0.65	0.63	0.91	1323.44	0.43
Suction Dredger	ULSD	2270002081	1435 hp	4,000	0.59	2.33	3.09E-03	1.03	0.14	0.14	0.21	538	9.88E-02	g/hp-hr	8.70	0.01	3.85	0.53	0.52	0.78	2006.89	0.37
DB / Boats / Tugs	ULSD	NA	1475 hp	12,000	NA	2.40E-02	1.21E-05	5.50E-03	4.01E-04	3.89E-04	6.42E-04	1,689	2.50E-02	lb/hp-hr	212.40	0.11	48.68	3.55	3.44	5.68	10,136	0.15
Gas Turbines (5)	Natural Gas	NA	504.4 MMBtu/hr	0	NA	3.70	1.58E+00	4.40	4.90	4.90	1.32	58,019	2.13E-01	lb/hr	0	0	0	0	0	0	0	0
Duct Burners (5)	Natural Gas	NA	19.7 MMBtu/hr	0	NA	0.10	6.00E-02	0.15	0.50	0.50	0.38	2,262	3.91E-02	lb/hr	0	0	0	0	0	0	0	0
Gas Turbine Startup/Shutdown	Natural Gas	NA	44.567 MMBtu/SUSD	0	NA	7.50	1.46E-01	24.30	3.70	3.70	3.40	6,267	2.06E-02	lb/hr	0	0	0	0	0	0	0	0
Auxiliary Boiler	Natural Gas	NA	296.2 MMBtu/hr	0	NA	2.18	8.25E-01	2.66	2.96	2.96	1.52	34,688	5.46E-01	lb/hr	0	0	0	0	0	0	0	0
Thermal Oxidizer	Natural Gas	NA	110 MMBtu/hr	0	NA	14.44	4.53	8.79	0.88	0.88	6.00	261,758	2.04E-01	lb/hr	0	0	0	0	0	0	0	0
Generators (2)	ULSD	NA	4376 hp	0	NA	7.43	4.42E-02	1.04	0.23	0.23	0.45	5,012	7.42E-02	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	2.13 MMBtu/hr	0	NA	0.14	6.67E-03	0.66	0.07	0.07	1.41	329	7.27E-03	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	lb/hr	0	0	0	0	0	0	0	0
Fire Pumps (3)	ULSD	NA	700 hp	0	NA	5.31	7.08E-03	2.68	0.30	0.30	0.15	802	1.19E-02	lb/hr	0	0	0	0	0	0	0	0
Fugitives	NA	NA	NA	0	NA	NA	NA	NA	0.11	0.011	NA	NA	NA	ton/acre-month	NA	NA	NA	231.00	23.10	NA	NA	NA
Fugitives (Batch Plant)	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.47	NA	NA	NA	lb/ton cement	NA	NA	NA	63.28	63.28	NA	NA	NA
Delivery and Commute	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11.14	0.03	36.05	0.43	0.39	2.70	4,689.67	0.69
														Subtotals	**403.73**	**0.43**	**183.64**	**308.24**	**99.89**	**31.86**	**66,708**	**11.04**

Jordan Cove **Construction Emissions Summary - Year 3**

						Emission Factor									Emissions (tons/year)							
Equipment Type	Fuel	SCC Code or MOVES Category	Engine Rating	Hours	Load Factor	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS	Units	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Pickup Trucks	Gasoline	Light Commercial Truck	280 hp	89,800	NA	1.93	4.96E-03	3.59	0.12	0.11	0.41	575	7.06E-02	g/VMT	0.95	0.00	1.77	0.06	0.05	0.21	285	0.03
Large Trucks	ULSD	Single Unit Short-Haul Truck	316 hp	158,400	NA	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02	g/VMT	2.82	0.01	1.12	0.16	0.15	0.34	847	0.06
Offroad Trucks	ULSD	2270002051	464 hp	18,000	0.59	1.76	2.65E-03	0.45	0.05	0.05	0.19	537	8.23E-02	g/hp-hr	9.54	0.01	2.45	0.26	0.25	1.05	2,915	0.45
Hoe Ram / ATV	Gasoline	2265001030	21 hp	149,200	0.43	0.47	1.43E-03	36.55	0.07	0.06	3.75	242	1.18E+00	g/hp-hr	0.70	0.00	54.28	0.10	0.09	5.57	359	1.76
RT Cranes	ULSD	2270002045	260 hp	109,050	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	21.74	0.04	5.84	1.01	0.98	2.48	7,166	1.16
Dozers	ULSD	2270002069	166 hp	39,200	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	5.91	0.01	2.40	0.33	0.32	0.75	2,284	0.34
Forklifts	ULSD	2270002057	173 hp	111,300	0.59	1.81	3.14E-03	1.18	0.17	0.17	0.21	570	9.97E-02	g/hp-hr	22.62	0.04	14.77	2.16	2.10	2.59	7,132	1.25
Loaders	ULSD	2270002060	235 hp	16,800	0.59	1.77	2.95E-03	0.70	0.11	0.10	0.19	540	8.93E-02	g/hp-hr	4.54	0.01	1.81	0.27	0.26	0.49	1,386	0.23
Tractors	ULSD	2270002069	270 hp	18,000	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	4.41	0.01	1.79	0.24	0.24	0.56	1,706	0.26
Lifts / Hoists	ULSD	2270003010	75 hp	163,200	0.21	4.79	4.26E-03	4.54	0.63	0.61	1.02	693	4.59E-01	g/hp-hr	13.59	0.01	12.88	1.79	1.74	2.90	1,965	1.30
Rollers	ULSD	2270002015	157 hp	9,000	0.59	1.68	3.02E-03	0.83	0.12	0.12	0.19	560	9.36E-02	g/hp-hr	1.55	0.00	0.76	0.11	0.11	0.18	514	0.09
Scrapers	ULSD	2270002018	784 hp	1,800	0.59	1.36	2.88E-03	0.64	0.08	0.08	0.17	537	7.87E-02	g/hp-hr	1.25	0.00	0.59	0.07	0.07	0.16	493	0.07
Motor Graders	ULSD	2270002048	240 hp	5,400	0.59	0.90	2.73E-03	0.32	0.05	0.05	0.17	538	7.38E-02	g/hp-hr	0.76	0.00	0.27	0.04	0.04	0.14	453	0.06
Pile Vibrators / Hammers	ULSD	2270002054	1050 hp	7,200	0.43	2.15	3.05E-03	0.67	0.10	0.09	0.19	546	9.40E-02	g/hp-hr	7.70	0.01	2.42	0.35	0.34	0.69	1,955	0.34
Backhoes	ULSD	2270002036	244 hp	16,800	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	2.47	0.01	0.89	0.12	0.12	0.44	1,445	0.20
Compressors	ULSD	2270006015	69 hp	45,700	0.43	2.37	3.22E-03	1.02	0.14	0.14	0.22	574	1.11E-01	g/hp-hr	3.54	0.00	1.52	0.21	0.21	0.33	858	0.17
Generators / Light Plants	ULSD	2270002027	15 hp	65,740	0.43	4.15	3.73E-03	1.91	0.28	0.27	0.39	587	2.30E-01	g/hp-hr	1.94	0.00	0.89	0.13	0.13	0.18	274	0.11
Welders	ULSD	2270006025	20 hp	75,890	0.21	4.46	4.23E-03	3.89	0.57	0.55	0.83	693	3.83E-01	g/hp-hr	1.57	0.00	1.37	0.20	0.19	0.29	244	0.13
Crawler Cranes	ULSD	2270002045	400 hp	31,920	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	9.79	0.02	2.63	0.45	0.44	1.12	3,227	0.52
Augers/Soil Mix Equipment	ULSD	2270002033	440 hp	43,600	0.43	3.46	3.22E-03	1.05	0.18	0.18	0.30	540	1.37E-01	g/hp-hr	31.50	0.03	9.54	1.66	1.61	2.72	4,909	1.24
Pumps	ULSD	2270006010	75 hp	1,800	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0.24	0.00	0.11	0.02	0.02	0.03	36	0.01
Excavator	ULSD	2270002036	524 hp	0	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	0	0	0	0	0	0	0	0
Concrete Pumps	ULSD	2270006010	630 hp	7,800	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	8.61	0.01	3.88	0.65	0.63	0.91	1,323	0.43
Suction Dredger	ULSD	2270002081	1435 hp	0	0.59	2.33	3.09E-03	1.03	0.14	0.14	0.21	538	9.88E-02	g/hp-hr	0	0	0	0	0	0	0	0
DB / Boats / Tugs	ULSD	NA	1475 hp	5,400	NA	2.40E-02	1.21E-05	5.50E-03	4.01E-04	3.89E-04	6.42E-04	1,689	2.50E-02	lb/hp-hr	95.58	0.05	21.90	1.60	1.55	2.55	4,561	0.07
Gas Turbines (5)	Natural Gas	NA	504.4 MMBtu/hr	0	NA	3.70	1.58E+00	4.40	4.90	4.90	1.32	58,019	2.13E-01	lb/hr	0	0	0	0	0	0	0	0
Duct Burners (5)	Natural Gas	NA	19.7 MMBtu/hr	0	NA	0.10	6.00E-02	0.15	0.50	0.50	0.38	2,262	3.91E-02	lb/hr	0	0	0	0	0	0	0	0
Gas Turbine Startup/Shutdown	Natural Gas	NA	44.567 MMBtu/SUSD	0	NA	7.50	1.46E-01	24.30	3.70	3.70	3.40	6,267	2.06E-02	lb/hr	0	0	0	0	0	0	0	0
Auxiliary Boiler	Natural Gas	NA	296.2 MMBtu/hr	0	NA	2.18	8.25E-01	2.66	2.96	2.96	1.52	34,688	5.46E-01	lb/hr	0	0	0	0	0	0	0	0
Thermal Oxidizer	Natural Gas	NA	110 MMBtu/hr	0	NA	14.44	4.53	8.79	0.88	0.88	6.00	261,758	2.04E-01	lb/hr	0	0	0	0	0	0	0	0
Generators (2)	ULSD	NA	4376 hp	0	NA	7.43	4.42E-02	1.04	0.23	0.23	0.45	5,012	7.42E-02	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	2.13 MMBtu/hr	0	NA	0.14	6.67E-03	0.66	0.07	0.07	1.41	329	7.27E-03	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	lb/hr	0	0	0	0	0	0	0	0
Fire Pumps (3)	ULSD	NA	700 hp	0	NA	5.31	7.08E-03	2.68	0.30	0.30	0.15	802	1.19E-02	lb/hr	0	0	0	0	0	0	0	0
Fugitives	NA	NA	NA	0	NA	NA	NA	NA	0.11	0.011	NA	NA	NA	ton/acre-month	NA	NA	NA	115.50	11.55	NA	NA	NA
Fugitives (Batch Plant)	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.47	NA	NA	NA	lb/ton cement	NA	NA	NA	63.65	63.65	NA	NA	NA
Delivery and Commute	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	15.68	0.05	53.05	0.54	0.49	3.82	6,430.47	0.99
														Subtotals	**268.97**	**0.33**	**198.92**	**191.70**	**87.32**	**30.51**	**52,768**	**11.27**

Jordan Cove **Construction Emissions Summary - Year 4**

						Emission Factor									Emissions (tons/year)							
Equipment Type	**Fuel**	**SCC Code or MOVES Category**	**Engine Rating**	**Hours**	**Load Factor**	**NO_X**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**GHG**	**HAPS**	**Units**	**NO_X**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**GHG**	**HAPS**
Pickup Trucks	Gasoline	Light Commercial Truck	280 hp	20,000	NA	1.93	4.96E-03	3.59	0.12	0.11	0.41	575	7.06E-02	g/VMT	0.21	0.00	0.40	0.01	0.01	0.05	63	0.01
Large Trucks	ULSD	Single Unit Short-Haul Truck	316 hp	56,000	NA	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02	g/VMT	1.00	0.00	0.39	0.06	0.05	0.12	300	0.02
Offroad Trucks	ULSD	2270002051	464 hp	0	0.59	1.76	2.65E-03	0.45	0.05	0.05	0.19	537	8.23E-02	g/hp-hr	0	0	0	0	0	0	0	0
Hoe Ram / ATV	Gasoline	2265001030	21 hp	81,800	0.43	0.47	1.43E-03	36.55	0.07	0.06	3.75	242	1.18E+00	g/hp-hr	0.38	0.00	29.76	0.05	0.05	3.05	197	0.96
RT Cranes	ULSD	2270002045	260 hp	37,100	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	7.40	0.01	1.99	0.34	0.33	0.84	2,438	0.40
Dozers	ULSD	2270002069	166 hp	12,400	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	1.87	0.00	0.76	0.10	0.10	0.24	722	0.11
Forklifts	ULSD	2270002057	173 hp	56,900	0.59	1.81	3.14E-03	1.18	0.17	0.17	0.21	570	9.97E-02	g/hp-hr	11.56	0.02	7.55	1.10	1.07	1.32	3,646	0.64
Loaders	ULSD	2270002060	235 hp	2,900	0.59	1.77	2.95E-03	0.70	0.11	0.10	0.19	540	8.93E-02	g/hp-hr	0.78	0.00	0.31	0.05	0.05	0.08	239	0.04
Tractors	ULSD	2270002069	270 hp	500	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	0.12	0.00	0.05	0.01	0.01	0.02	47	0.01
Lifts / Hoists	ULSD	2270003010	75 hp	80,800	0.21	4.79	4.26E-03	4.54	0.63	0.61	1.02	693	4.59E-01	g/hp-hr	6.73	0.01	6.37	0.89	0.86	1.43	973	0.64
Rollers	ULSD	2270002015	157 hp	0	0.59	1.68	3.02E-03	0.83	0.12	0.12	0.19	560	9.36E-02	g/hp-hr	0	0	0	0	0	0	0	0
Scrapers	ULSD	2270002018	784 hp	0	0.59	1.36	2.88E-03	0.64	0.08	0.08	0.17	537	7.87E-02	g/hp-hr	0	0	0	0	0	0	0	0
Motor Graders	ULSD	2270002048	240 hp	0	0.59	0.90	2.73E-03	0.32	0.05	0.05	0.17	538	7.38E-02	g/hp-hr	0	0	0	0	0	0	0	0
Pile Vibrators / Hammers	ULSD	2270002054	1050 hp	0	0.43	2.15	3.05E-03	0.67	0.10	0.09	0.19	546	9.40E-02	g/hp-hr	0	0	0	0	0	0	0	0
Backhoes	ULSD	2270002036	244 hp	2,400	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	0.35	0.00	0.13	0.02	0.02	0.06	206	0.03
Compressors	ULSD	2270006015	69 hp	14,900	0.43	2.37	3.22E-03	1.02	0.14	0.14	0.22	574	1.11E-01	g/hp-hr	1.15	0.00	0.50	0.07	0.07	0.11	280	0.05
Generators / Light Plants	ULSD	2270002027	15 hp	17,300	0.43	4.15	3.73E-03	1.91	0.28	0.27	0.39	587	2.30E-01	g/hp-hr	0.51	0.00	0.24	0.03	0.03	0.05	72	0.03
Welders	ULSD	2270006025	20 hp	12,400	0.21	4.46	4.23E-03	3.89	0.57	0.55	0.83	693	3.83E-01	g/hp-hr	0.26	0.00	0.22	0.03	0.03	0.05	40	0.02
Crawler Cranes	ULSD	2270002045	400 hp	7,500	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	2.30	0.00	0.62	0.11	0.10	0.26	758	0.12
Augers/Soil Mix Equipment	ULSD	2270002033	440 hp	0	0.43	3.46	3.22E-03	1.05	0.18	0.18	0.30	540	1.37E-01	g/hp-hr	0	0	0	0	0	0	0	0
Pumps	ULSD	2270006010	75 hp	0	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0	0	0	0	0	0	0	0
Excavator	ULSD	2270002036	524 hp	0	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	0	0	0	0	0	0	0	0
Concrete Pumps	ULSD	2270006010	630 hp	0	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0	0	0	0	0	0	0	0
Suction Dredger	ULSD	2270002081	1435 hp	0	0.59	2.33	3.09E-03	1.03	0.14	0.14	0.21	538	9.88E-02	g/hp-hr	0	0	0	0	0	0	0	0
DB / Boats / Tugs	ULSD	NA	1475 hp	0	NA	2.40E-02	1.21E-05	5.50E-03	4.01E-04	3.89E-04	6.42E-04	1,689	2.50E-02	lb/hp-hr	0	0	0	0	0	0	0	0
Gas Turbines (5)	Natural Gas	NA	504.4 MMBtu/hr	0	NA	3.70	1.58E+00	4.40	4.90	4.90	1.32	58,019	2.13E-01	lb/hr	0	0	0	0	0	0	0	0
Duct Burners (5)	Natural Gas	NA	19.7 MMBtu/hr	0	NA	0.10	6.00E-02	0.15	0.50	0.50	0.38	2,262	3.91E-02	lb/hr	0	0	0	0	0	0	0	0
Gas Turbine Startup/Shutdown	Natural Gas	NA	44.567 MMBtu/SUSD	0	NA	7.50	1.46E-01	24.30	3.70	3.70	3.40	6,267	2.06E-02	lb/hr	0	0	0	0	0	0	0	0
Auxiliary Boiler	Natural Gas	NA	296.2 MMBtu/hr	0	NA	2.18	8.25E-01	2.66	2.96	2.96	1.52	34,688	5.46E-01	lb/hr	0	0	0	0	0	0	0	0
Thermal Oxidizer	Natural Gas	NA	110 MMBtu/hr	0	NA	14.44	4.53	8.79	0.88	0.88	6.00	261,758	2.04E-01	lb/hr	0	0	0	0	0	0	0	0
Generators (2)	ULSD	NA	4376 hp	0	NA	7.43	4.42E-02	1.04	0.23	0.23	0.45	5,012	7.42E-02	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	2.13 MMBtu/hr	0	NA	0.14	6.67E-03	0.66	0.07	0.07	1.41	329	7.27E-03	lb/hr	0	0	0	0	0	0	0	0
Flares	Natural Gas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	lb/hr	0	0	0	0	0	0	0	0
Fire Pumps (3)	ULSD	NA	700 hp	0	NA	5.31	7.08E-03	2.68	0.30	0.30	0.15	802	1.19E-02	lb/hr	0	0	0	0	0	0	0	0
Fugitives	NA	NA	NA	0	NA	NA	NA	NA	0.11	0.011	NA	NA	NA	ton/acre-month	NA	NA	NA	0.00	0.00	NA	NA	NA
Fugitives (Batch Plant)	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.47	NA	NA	NA	lb/ton cement	NA	NA	NA	14.35	14.35	NA	NA	NA
Delivery and Commute	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8.51	0.03	31.70	0.28	0.26	2.21	3,632.68	0.58
														Subtotals	**43.14**	**0.08**	**80.99**	**17.51**	**17.39**	**9.90**	**13,615**	**3.66**

Jordan Cove **Construction Emissions Summary - Year 5**

Equipment Type	Fuel	SCC Code or MOVES Category	Engine Rating	Hours	Load Factor	Emission Factor									Emissions (tons/year)							
						NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS	Units	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Pickup Trucks	Gasoline	Light Commercial Truck	280 hp	0	NA	1.93	4.96E-03	3.59	0.12	0.11	0.41	575	7.06E-02	g/VMT	0	0	0	0	0	0	0	0
Large Trucks	ULSD	Single Unit Short-Haul Truck	316 hp	3,900	NA	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02	g/VMT	0.07	0.00	0.03	0.00	0.00	0.01	21	0.00
Offroad Trucks	ULSD	2270002051	464 hp	0	0.59	1.76	2.65E-03	0.45	0.05	0.05	0.19	537	8.23E-02	g/hp-hr	0	0	0	0	0	0	0	0
Hoe Ram / ATV	Gasoline	2265001030	21 hp	3,200	0.43	0.47	1.43E-03	36.55	0.07	0.06	3.75	242	1.18E+00	g/hp-hr	0.01	0.00	1.16	0.00	0.00	0.12	8	0.04
RT Cranes	ULSD	2270002045	260 hp	400	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	0.08	0.00	0.02	0.00	0.00	0.01	26	0.00
Dozers	ULSD	2270002069	166 hp	100	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	0.02	0.00	0.01	0.00	0.00	0.00	6	0.00
Forklifts	ULSD	2270002057	173 hp	1,000	0.59	1.81	3.14E-03	1.18	0.17	0.17	0.21	570	9.97E-02	g/hp-hr	0.20	0.00	0.13	0.02	0.02	0.02	64	0.01
Loaders	ULSD	2270002060	235 hp	600	0.59	1.77	2.95E-03	0.70	0.11	0.10	0.19	540	8.93E-02	g/hp-hr	0.16	0.00	0.06	0.01	0.01	0.02	50	0.01
Tractors	ULSD	2270002069	270 hp	1,500	0.59	1.40	2.84E-03	0.57	0.08	0.07	0.18	540	8.09E-02	g/hp-hr	0.37	0.00	0.15	0.02	0.02	0.05	142	0.02
Lifts / Hoists	ULSD	2270003010	75 hp	0	0.21	4.79	4.26E-03	4.54	0.63	0.61	1.02	693	4.59E-01	g/hp-hr	0	0	0	0	0	0	0	0
Rollers	ULSD	2270002015	157 hp	3,600	0.59	1.68	3.02E-03	0.83	0.12	0.12	0.19	560	9.36E-02	g/hp-hr	0.62	0.00	0.30	0.05	0.04	0.07	206	0.03
Scrapers	ULSD	2270002018	784 hp	7,200	0.59	1.36	2.88E-03	0.64	0.08	0.08	0.17	537	7.87E-02	g/hp-hr	4.99	0.01	2.34	0.30	0.29	0.62	1,970	0.29
Motor Graders	ULSD	2270002048	240 hp	0	0.59	0.90	2.73E-03	0.32	0.05	0.05	0.17	538	7.38E-02	g/hp-hr	0	0	0	0	0	0	0	0
Pile Vibrators / Hammers	ULSD	2270002054	1050 hp	0	0.43	2.15	3.05E-03	0.67	0.10	0.09	0.19	546	9.40E-02	g/hp-hr	0	0	0	0	0	0	0	0
Backhoes	ULSD	2270002036	244 hp	100	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	0.01	0.00	0.01	0.00	0.00	0.00	9	0.00
Compressors	ULSD	2270006015	69 hp	100	0.43	2.37	3.22E-03	1.02	0.14	0.14	0.22	574	1.11E-01	g/hp-hr	0.01	0.00	0.00	0.00	0.00	0.00	2	0.00
Generators / Light Plants	ULSD	2270002027	15 hp	200	0.43	4.15	3.73E-03	1.91	0.28	0.27	0.39	587	2.30E-01	g/hp-hr	0.01	0.00	0.00	0.00	0.00	0.00	1	0.00
Welders	ULSD	2270006025	20 hp	100	0.21	4.46	4.23E-03	3.89	0.57	0.55	0.83	693	3.83E-01	g/hp-hr	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00
Crawler Cranes	ULSD	2270002045	400 hp	0	0.43	1.62	2.92E-03	0.43	0.07	0.07	0.18	533	8.66E-02	g/hp-hr	0	0	0	0	0	0	0	0
Augers/Soil Mix Equipment	ULSD	2270002033	440 hp	0	0.43	3.46	3.22E-03	1.05	0.18	0.18	0.30	540	1.37E-01	g/hp-hr	0	0	0	0	0	0	0	0
Pumps	ULSD	2270006010	75 hp	0	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0	0	0	0	0	0	0	0
Excavator	ULSD	2270002036	524 hp	0	0.59	0.93	2.73E-03	0.33	0.05	0.05	0.17	542	7.35E-02	g/hp-hr	0	0	0	0	0	0	0	0
Concrete Pumps	ULSD	2270006010	630 hp	0	0.43	3.70	3.44E-03	1.67	0.28	0.27	0.39	568	1.85E-01	g/hp-hr	0	0	0	0	0	0	0	0
Suction Dredger	ULSD	2270002081	1435 hp	0	0.59	2.33	3.09E-03	1.03	0.14	0.14	0.21	538	9.88E-02	g/hp-hr	0	0	0	0	0	0	0	0
DB / Boats / Tugs	ULSD	NA	1475 hp	0	NA	2.40E-02	1.21E-05	5.50E-03	4.01E-04	3.89E-04	6.42E-04	1,689	2.50E-02	lb/hp-hr	0	0	0	0	0	0	0	0
Gas Turbines (5)	Natural Gas	NA	504.4 MMBtu/hr	3,000	NA	3.70	1.58E+00	4.40	4.90	4.90	1.32	58,019	2.13E-01	lb/hr	27.75	11.85	33.00	36.75	36.75	9.91	435,142	2
Duct Burners (5)	Natural Gas	NA	19.7 MMBtu/hr	1,370	NA	0.10	6.00E-02	0.15	0.50	0.50	0.38	2,262	3.91E-02	lb/hr	0.34	0.21	0.51	1.71	1.71	1.30	7,749	0
Gas Turbine Startup/Shutdown	Natural Gas	NA	44.567 MMBtu/SUSD	NA	NA	7.50	1.46E-01	24.30	3.70	3.70	3.40	6,267	2.06E-02	lb/hr	0.23	0.00	0.73	0.11	0.11	0.10	188	0
Auxiliary Boiler	Natural Gas	NA	296.2 MMBtu/hr	4,380	NA	2.18	8.25E-01	2.66	2.96	2.96	1.52	34,688	5.46E-01	lb/hr	4.78	1.81	5.82	6.49	6.49	3.33	75,967	1
Thermal Oxidizer	Natural Gas	NA	110 MMBtu/hr	3,000	NA	14.44	4.53	8.79	0.88	0.88	6.00	261,758	2.04E-01	lb/hr	21.66	6.80	13.19	1.32	1.32	9.00	392,637	0
Generators (2)	ULSD	NA	4376 hp	500	NA	7.43	4.42E-02	1.04	0.23	0.23	0.45	5,012	7.42E-02	lb/hr	3.72	0.02	0.52	0.12	0.12	0.23	2,506	0
Flares	Natural Gas	NA	2.13 MMBtu/hr	8,760	NA	0.14	6.67E-03	0.66	0.07	0.07	1.41	329	7.27E-03	lb/hr	0.64	0.03	2.90	0.28	0.28	6.16	1,439	0
Flares	Natural Gas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	lb/hr	4.04	0.21	18.43	5.59	5.59	39.23	6,956	0
Fire Pumps (3)	ULSD	NA	700 hp	200	NA	5.31	7.08E-03	2.68	0.30	0.30	0.15	802	1.19E-02	lb/hr	1.59	0.00	0.80	0.09	0.09	0.05	241	0
Fugitives	NA	NA	NA	8,760	NA	NA	NA	NA	0.11	0.011	NA	NA	NA	ton/acre-month	NA	NA	NA	132.00	13.20	NA	NA	NA
Fugitives (Batch Plant)	NA	NA	NA	NA	NA	NA	NA	NA	0.47	0.47	NA	NA	NA	lb/ton cement	NA	NA	NA	0.00	0.00	NA	NA	NA
Delivery and Commute	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.16	0.00	4.53	0.04	0.04	0.32	527.88	0.08
														Subtotals	**72.45**	**20.94**	**84.65**	**184.90**	**66.09**	**70.54**	**925,856**	**4.10**

Jordan Cove **Construction Emission Units**

Equipment Type	Make/Model	Rating	Fuel	SCC Code	Load Factor	Onroad Vehicle (MOVES)	Nonroad Engine (MOVES)	Diesel Engines (AP-42)	Stationary Emission Units	Notes	Hours					Vehicle Miles Traveled				
											Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5
Pickup Trucks	Ford F-150	280 hp	Gasoline	Light Commercial Truck	NA	✓					88,200	92,000	89,800	20,000	0	441,000	460,000	449,000	100,000	0
Large Trucks	Ford F-350	316 hp	ULSD	Single Unit Short-Haul Truck	NA		✓				143,800	171,500	158,400	56,000	3,900	719,000	857,500	792,000	280,000	19,500
Offroad Trucks	Caterpillar 740	464 hp	ULSD	2270002051	0.59		✓				42,000	40,000	18,000	0	0	NA	NA	NA	NA	NA
Hoe Ram / ATV	John Deere HPX 4x4	21 hp	Gasoline	2265001030	0.43		✓				29,800	86,000	149,200	81,800	3,200	NA	NA	NA	NA	NA
RT Cranes	Grove RT770E	260 hp	ULSD	2270002045	0.43		✓				27,350	44,000	109,050	37,100	400	NA	NA	NA	NA	NA
Dozers	Caterpillar D6	166 hp	ULSD	2270002069	0.59		✓				21,800	26,500	39,200	12,400	100	NA	NA	NA	NA	NA
Forklifts	Xtreme XR3034	173 hp	ULSD	2270002057	0.59		✓				33,200	58,000	111,300	56,900	1,000	NA	NA	NA	NA	NA
Loaders	Caterpillar 966F	235 hp	ULSD	2270002060	0.59		✓				30,200	30,500	16,800	2,900	600	NA	NA	NA	NA	NA
Tractors	Caterpillar Challenger 65	270 hp	ULSD	2270002069	0.59		✓				4,200	5,000	18,000	500	1,500	NA	NA	NA	NA	NA
Lifts / Hoists	80' Manlift	75 hp	ULSD	2270003010	0.21		✓				16,800	40,000	163,200	80,800	0	NA	NA	NA	NA	NA
Rollers	Caterpillar 563 - 84"	157 hp	ULSD	2270002015	0.59		✓				21,000	20,000	9,000	0	3,600	NA	NA	NA	NA	NA
Scrapers	Caterpillar 657	784 hp	ULSD	2270002018	0.59		✓				4,200	4,000	1,800	0	7,200	NA	NA	NA	NA	NA
Motor Graders	Caterpillar 14H	240 hp	ULSD	2270002048	0.59		✓				12,600	12,000	5,400	0	0	NA	NA	NA	NA	NA
Pile Vibrators / Hammers	APE 400 (13,000 in-lb ECC MNT)	1050 hp	ULSD	2270002054	0.43		✓				16,800	16,000	7,200	0	0	NA	NA	NA	NA	NA
Backhoes	Caterpillar 330, John Deere 330	244 hp	ULSD	2270002036	0.59		✓				30,200	30,500	16,800	2,400	100	NA	NA	NA	NA	NA
Compressors	Air Compressor (185 CFM)	69 hp	ULSD	2270006015	0.43		✓				21,800	27,500	45,700	14,900	100	NA	NA	NA	NA	NA
Generators / Light Plants	Portable Light Plant	15 hp	ULSD	2270002027	0.43		✓				59,560	65,200	65,740	17,300	200	NA	NA	NA	NA	NA
Welders	Welder (400-450 Amp)	20 hp	ULSD	2270006025	0.21		✓				34,610	38,700	75,890	12,400	100	NA	NA	NA	NA	NA
Crawler Cranes	Manitowoc 999	400 hp	ULSD	2270002045	0.43		✓				66,480	68,100	31,920	7,500	0	NA	NA	NA	NA	NA
Augers/Soil Mix Equipment	Soilmec SR 90 Rotary Drill	440 hp	ULSD	2270002033	0.43		✓				8,400	48,000	43,600	0	0	NA	NA	NA	NA	NA
Pumps	Centrifugal Pump (10")	75 hp	ULSD	2270006010	0.43		✓				4,200	4,000	1,800	0	0	NA	NA	NA	NA	NA
Excavator	Caterpillar 390F L	524 hp	ULSD	2270002036	0.59		✓				30,000	30,000	0	0	0	NA	NA	NA	NA	NA
Concrete Pumps	BSA 14000 Series	630 hp	ULSD	2270006010	0.43		✓				0	7,800	7,800	0	0	NA	NA	NA	NA	NA
Suction Dredger	22 inch cutter	1435 hp	ULSD	2270002081	0.59		✓				0	4,000	0	0	0	NA	NA	NA	NA	NA
DB / Boats / Tugs	DB Pacific	1475 hp	ULSD	NA	NA			✓			12,600	12,000	5,400	0	0	NA	NA	NA	NA	NA
Gas Turbines (5)	GE LM6000PF+	504.4 MMBtu/hr	Natural Gas	NA	NA				✓	per turbine, 100% load	0	0	0	0	3,000	NA	NA	NA	NA	NA
Duct Burners (5)	DLN	19.7 MMBtu/hr	Natural Gas	NA	NA				✓	per turbine, 100% load	0	0	0	0	1,370	NA	NA	NA	NA	NA
Gas Turbine Startup/Shutdown	GE LM6000PF+	44.6 MMBtu/SUSD	Natural Gas	NA	NA				✓	12 startup/shutdown (SUSD) per turbine	0	0	0	0	NA	NA	NA	NA	NA	NA
Auxiliary Boiler	Unknown	296.2 MMBtu/hr	Natural Gas	NA	NA				✓		0	0	0	0	4,380	NA	NA	NA	NA	NA
Thermal Oxidizer	Zeeco	110 MMBtu/hr	Natural Gas	NA	NA				✓		0	0	0	0	3,000	NA	NA	NA	NA	NA
Generators (2)	Caterpillar	4376 hp	ULSD	NA	NA				✓		0	0	0	0	500	NA	NA	NA	NA	NA
Flares	Pilot and Purge	2.13 MMBtu/hr	Natural Gas	NA	NA				✓		0	0	0	0	8,760	NA	NA	NA	NA	NA
Flares	Startups	NA	Natural Gas	NA	NA				✓	24 hours AGRU at 10%, 10x5 hours, trains at 30%[1]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fire Pumps (3)	Caterpillar	700 hp	ULSD	NA	NA				✓		0	0	0	0	200	NA	NA	NA	NA	NA
Fugitives	NA	NA	NA	NA	NA				✓		0	0	0	0	8,760	NA	NA	NA	NA	NA

1 Emissions supplied by Jordan Cove.

Jordan Cove **Construction Nitrogen Oxide (NO_X) Emissions**

					Emission Factors				Emissions per Year (tons)				
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]					
Equipment Type	Rating	Fuel	SCC Code	Load Factor	g/VMT	g/hp-hr	lb/hp-hr	lb/hr or lb/(startup/shutdown)	Year 1	Year 2	Year 3	Year 4	Year 5
Pickup Trucks	280 hp	Gasoline	Light Commercial Truck	NA	1.93				0.94	0.98	0.95	0.21	0
Large Trucks	316 hp	ULSD	Single Unit Short-Haul Truck	NA	3.23				2.56	3.05	2.82	1.00	0.07
Offroad Trucks	464 hp	ULSD	2270002051	0.59		1.76			22.25	21.19	9.54	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		0.47			0.14	0.40	0.70	0.38	0.01
RT Cranes	260 hp	ULSD	2270002045	0.43		1.62			5.45	8.77	21.74	7.40	0.08
Dozers	166 hp	ULSD	2270002069	0.59		1.40			3.28	3.99	5.91	1.87	0.02
Forklifts	173 hp	ULSD	2270002057	0.59		1.81			6.75	11.79	22.62	11.56	0.20
Loaders	235 hp	ULSD	2270002060	0.59		1.77			8.16	8.24	4.54	0.78	0.16
Tractors	270 hp	ULSD	2270002069	0.59		1.40			1.03	1.23	4.41	0.12	0.37
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		4.79			1.40	3.33	13.59	6.73	0
Rollers	157 hp	ULSD	2270002015	0.59		1.68			3.61	3.44	1.55	0	0.62
Scrapers	784 hp	ULSD	2270002018	0.59		1.36			2.91	2.77	1.25	0	4.99
Motor Graders	240 hp	ULSD	2270002048	0.59		0.90			1.77	1.68	0.76	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		2.15			17.96	17.11	7.70	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		0.93			4.44	4.48	2.47	0.35	0.01
Compressors	69 hp	ULSD	2270006015	0.43		2.37			1.69	2.13	3.54	1.15	0.01
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		4.15			1.76	1.92	1.94	0.51	0.01
Welders	20 hp	ULSD	2270006025	0.21		4.46			0.71	0.80	1.57	0.26	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		1.62			20.39	20.89	9.79	2.30	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		3.46			6.07	34.68	31.50	0	0
Pumps	75 hp	ULSD	2270006010	0.43		3.70			0.55	0.53	0.24	0	0
Excavator	524 hp	ULSD	2270002036	0.59		0.93			9.47	9.47	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		3.70			0	8.61	8.61	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		2.33			0	8.70	0	0	0
DB / Boats / Tugs	1475 hp	ULSD	NA	NA			0.024		223.02	212.40	95.58	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas	NA	NA				3.70	0	0	0	0	27.75
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas	NA	NA				0.10	0	0	0	0	0.34
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUS	Natural Gas	NA	NA				7.50	0	0	0	0	0.23
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas	NA	NA				2.18	0	0	0	0	4.78
Thermal Oxidizer	110 MMBtu/hr	Natural Gas	NA	NA				14.44	0	0	0	0	21.66
Generators (2)	4376 hp	ULSD	NA	NA				7.43	0	0	0	0	3.72
Flares	2.13 MMBtu/hr	Natural Gas	NA	NA				0.14	0	0	0	0	0.64
Flares	NA	Natural Gas	NA	NA				NA	0	0	0	0	4.04
Fire Pumps (3)	700 hp	ULSD	NA	NA				5.31	0	0	0	0	1.59

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] EPA AP-42 Table 3.4-1, Gaseous Emission Factors for Large Stationary Diesel and All Stationary Dual-Fuel Engines, October 1996.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Sulfur Dioxide (SO_2) Emissions**

					Emission Factors								
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]	Emissions per Year (tons)				
Equipment Type	Rating	Fuel	SCC Code	Load Factor	g/VMT	g/hp-hr	lb/hp-hr	lb/hr or lb/(startup/shutdown)	Year 1	Year 2	Year 3	Year 4	Year 5
Pickup Trucks	280 hp	Gasoline			4.96E-03				2.41E-03	2.51E-03	2.45E-03	5.46E-04	0
Large Trucks	316 hp	ULSD			8.24E-03				6.53E-03	7.79E-03	7.19E-03	2.54E-03	1.77E-04
Offroad Trucks	464 hp	ULSD	2270002051	0.59		2.65E-03			3.36E-02	3.20E-02	1.44E-02	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		1.43E-03			4.25E-04	1.23E-03	2.13E-03	1.17E-03	4.56E-05
RT Cranes	260 hp	ULSD	2270002045	0.43		2.92E-03			9.85E-03	1.58E-02	3.93E-02	1.34E-02	1.44E-04
Dozers	166 hp	ULSD	2270002069	0.59		2.84E-03			6.69E-03	8.13E-03	1.20E-02	3.81E-03	3.07E-05
Forklifts	173 hp	ULSD	2270002057	0.59		3.14E-03			1.17E-02	2.05E-02	3.93E-02	2.01E-02	3.53E-04
Loaders	235 hp	ULSD	2270002060	0.59		2.95E-03			1.36E-02	1.38E-02	7.58E-03	1.31E-03	2.71E-04
Tractors	270 hp	ULSD	2270002069	0.59		2.84E-03			2.10E-03	2.50E-03	8.99E-03	2.50E-04	7.49E-04
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		4.26E-03			1.24E-03	2.96E-03	1.21E-02	5.98E-03	0
Rollers	157 hp	ULSD	2270002015	0.59		3.02E-03			6.47E-03	6.16E-03	2.77E-03	0	1.11E-03
Scrapers	784 hp	ULSD	2270002018	0.59		2.88E-03			6.18E-03	5.88E-03	2.65E-03	0	1.06E-02
Motor Graders	240 hp	ULSD	2270002048	0.59		2.73E-03			5.38E-03	5.12E-03	2.30E-03	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		3.05E-03			2.55E-02	2.43E-02	1.09E-02	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		2.73E-03			1.31E-02	1.32E-02	7.29E-03	1.04E-03	4.34E-05
Compressors	69 hp	ULSD	2270006015	0.43		3.22E-03			2.29E-03	2.89E-03	4.81E-03	1.57E-03	1.05E-05
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		3.73E-03			1.58E-03	1.73E-03	1.74E-03	4.58E-04	5.30E-06
Welders	20 hp	ULSD	2270006025	0.21		4.23E-03			6.77E-04	7.57E-04	1.48E-03	2.43E-04	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		2.92E-03			3.68E-02	3.77E-02	1.77E-02	4.15E-03	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		3.22E-03			5.63E-03	3.22E-02	2.92E-02	0	0
Pumps	75 hp	ULSD	2270006010	0.43		3.44E-03			5.14E-04	4.90E-04	2.20E-04	0	0
Excavator	524 hp	ULSD	2270002036	0.59		2.73E-03			2.79E-02	2.79E-02	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		3.44E-03			0	8.02E-03	8.02E-03	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		3.09E-03			0	1.15E-02	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					1.21E-05		1.13E-01	1.07E-01	4.83E-02	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas						1.58	0	0	0	0	11.85
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						0.06	0	0	0	0	0.21
Gas Turbine Startup/Shutdown	44.56716 MMBtu/SUSD	Natural Gas						0.15	0	0	0	0	4.38E-03
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						0.83	0	0	0	0	1.81
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						4.53	0	0	0	0	6.80
Generators (2)	4376 hp	ULSD						4.42E-02	0	0	0	0	2.21E-02
Flares	2.13 MMBtu/hr	Natural Gas						6.67E-03	0	0	0	0	0.03
Flares	NA	Natural Gas						NA	0	0	0	0	0.21
Fire Pumps (3)	700 hp	ULSD						7.08E-03	0	0	0	0	2.12E-03

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] EPA AP-42 Table 3.4-1, Gaseous Emission Factors for Large Stationary Diesel and All Stationary Dual-Fuel Engines, October 1996.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Carbon Monoxide (CO) Emissions**

					Emission Factors				Emissions per Year (tons)				
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]					
Equipment Type	**Rating**	**Fuel**	**SCC Code**	**Load Factor**	**g/VMT**	**g/hp-hr**	**lb/hp-hr**	**lb/hr or lb/(startup/shutdown)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Pickup Trucks	280 hp	Gasoline			3.59				1.74	1.82	1.77	0.40	0
Large Trucks	316 hp	ULSD			1.28				1.01	1.21	1.12	0.39	0.03
Offroad Trucks	464 hp	ULSD	2270002051	0.59		0.45			5.72	5.44	2.45	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		36.55			10.84	31.29	54.28	29.76	1.16
RT Cranes	260 hp	ULSD	2270002045	0.43		0.43			1.47	2.36	5.84	1.99	0.02
Dozers	166 hp	ULSD	2270002069	0.59		0.57			1.33	1.62	2.40	0.76	0.01
Forklifts	173 hp	ULSD	2270002057	0.59		1.18			4.41	7.70	14.77	7.55	0.13
Loaders	235 hp	ULSD	2270002060	0.59		0.70			3.25	3.28	1.81	0.31	0.06
Tractors	270 hp	ULSD	2270002069	0.59		0.57			0.42	0.50	1.79	0.05	0.15
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		4.54			1.33	3.16	12.88	6.37	0
Rollers	157 hp	ULSD	2270002015	0.59		0.83			1.77	1.69	0.76	0	0.30
Scrapers	784 hp	ULSD	2270002018	0.59		0.64			1.37	1.30	0.59	0	2.34
Motor Graders	240 hp	ULSD	2270002048	0.59		0.32			0.62	0.60	0.27	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		0.67			5.64	5.37	2.42	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		0.33			1.60	1.61	0.89	0.13	0.01
Compressors	69 hp	ULSD	2270006015	0.43		1.02			0.72	0.91	1.52	0.50	0.00
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		1.91			0.81	0.89	0.89	0.24	0.00
Welders	20 hp	ULSD	2270006025	0.21		3.89			0.62	0.70	1.37	0.22	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		0.43			5.48	5.61	2.63	0.62	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		1.05			1.84	10.50	9.54	0	0
Pumps	75 hp	ULSD	2270006010	0.43		1.67			0.25	0.24	0.11	0	0
Excavator	524 hp	ULSD	2270002036	0.59		0.33			3.40	3.40	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		1.67			0	3.88	3.88	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		1.03			0	3.85	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					5.50E-03		51.11	48.68	21.90	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas						4.40	0	0	0	0	33.00
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						0.15	0	0	0	0	0.51
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUSD	Natural Gas						24.30	0	0	0	0	0.73
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						2.66	0	0	0	0	5.82
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						8.79	0	0	0	0	13.19
Generators (2)	4376 hp	ULSD						1.04	0	0	0	0	0.52
Flares	2.13 MMBtu/hr	Natural Gas						0.66	0	0	0	0	2.90
Flares	NA	Natural Gas						NA	0	0	0	0	18.43
Fire Pumps (3)	700 hp	ULSD						2.68	0	0	0	0	0.80

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] EPA AP-42 Table 3.4-1, Gaseous Emission Factors for Large Stationary Diesel and All Stationary Dual-Fuel Engines, October 1996.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Particulate Matter Less Than 10 microns (PM_{10}) Emissions**

					Emission Factors				Emissions per Year (tons)				
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]					
Equipment Type	Rating	Fuel	SCC Code	Load Factor	g/VMT	g/hp-hr	lb/hp-hr	lb/hr or lb/(startup/shutdown)	Year 1	Year 2	Year 3	Year 4	Year 5
Pickup Trucks	280 hp	Gasoline			0.12				0.06	0.06	0.06	0.01	0
Large Trucks	316 hp	ULSD			0.19				0.15	0.18	0.16	0.06	0.00
Offroad Trucks	464 hp	ULSD	2270002051	0.59		0.05			0.60	0.57	0.26	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		0.07			0.02	0.06	0.10	0.05	0.00
RT Cranes	260 hp	ULSD	2270002045	0.43		0.07			0.25	0.41	1.01	0.34	0.00
Dozers	166 hp	ULSD	2270002069	0.59		0.08			0.18	0.22	0.33	0.10	0.00
Forklifts	173 hp	ULSD	2270002057	0.59		0.17			0.64	1.13	2.16	1.10	0.02
Loaders	235 hp	ULSD	2270002060	0.59		0.11			0.49	0.50	0.27	0.05	0.01
Tractors	270 hp	ULSD	2270002069	0.59		0.08			0.06	0.07	0.24	0.01	0.02
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		0.63			0.18	0.44	1.79	0.89	0
Rollers	157 hp	ULSD	2270002015	0.59		0.12			0.27	0.25	0.11	0	0.05
Scrapers	784 hp	ULSD	2270002018	0.59		0.08			0.17	0.16	0.07	0	0.30
Motor Graders	240 hp	ULSD	2270002048	0.59		0.05			0.10	0.10	0.04	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		0.10			0.82	0.78	0.35	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		0.05			0.22	0.23	0.12	0.02	0.00
Compressors	69 hp	ULSD	2270006015	0.43		0.14			0.10	0.13	0.21	0.07	0.00
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		0.28			0.12	0.13	0.13	0.03	0.00
Welders	20 hp	ULSD	2270006025	0.21		0.57			0.09	0.10	0.20	0.03	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		0.07			0.94	0.97	0.45	0.11	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		0.18			0.32	1.83	1.66	0	0
Pumps	75 hp	ULSD	2270006010	0.43		0.28			0.04	0.04	0.02	0	0
Excavator	524 hp	ULSD	2270002036	0.59		0.05			0.48	0.48	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		0.28			0	0.65	0.65	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		0.14			0	0.53	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					4.01E-04		3.73	3.55	1.60	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas						4.90	0	0	0	0	36.75
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						0.50	0	0	0	0	1.71
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUSD	Natural Gas						3.70	0	0	0	0	0.11
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						2.96	0	0	0	0	6.49
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						0.88	0	0	0	0	1.32
Generators (2)	4376 hp	ULSD						0.23	0	0	0	0	0.12
Flares	2.13 MMBtu/hr	Natural Gas						0.07	0	0	0	0	0.28
Flares	NA	Natural Gas						NA	0	0	0	0	5.59
Fire Pumps (3)	700 hp	ULSD						0.30	0	0	0	0	0.09

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] EPA AP-42 Table 3.4-2, Particulate and Particle-Sizing Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Particulate Matter Less Than 2.5 microns ($PM_{2.5}$) Emissions**

					Emission Factors								
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]	Emissions per Year (tons)				
Equipment Type	**Rating**	**Fuel**	**SCC Code**	**Load Factor**	**g/VMT**	**g/hp-hr**	**lb/hp-hr**	**lb/hr or lb/(startup/shutdown)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Pickup Trucks	280 hp	Gasoline			0.11				0.05	0.06	0.05	0.01	0
Large Trucks	316 hp	ULSD			0.17				0.14	0.16	0.15	0.05	0.00
Offroad Trucks	464 hp	ULSD	2270002051	0.59		0.05			0.58	0.55	0.25	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		0.06			0.02	0.05	0.09	0.05	0.00
RT Cranes	260 hp	ULSD	2270002045	0.43		0.07			0.24	0.39	0.98	0.33	0.00
Dozers	166 hp	ULSD	2270002069	0.59		0.07			0.18	0.21	0.32	0.10	0.00
Forklifts	173 hp	ULSD	2270002057	0.59		0.17			0.63	1.09	2.10	1.07	0.02
Loaders	235 hp	ULSD	2270002060	0.59		0.10			0.48	0.48	0.26	0.05	0.01
Tractors	270 hp	ULSD	2270002069	0.59		0.07			0.06	0.07	0.24	0.01	0.02
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		0.61			0.18	0.43	1.74	0.86	0
Rollers	157 hp	ULSD	2270002015	0.59		0.12			0.26	0.25	0.11	0	0.04
Scrapers	784 hp	ULSD	2270002018	0.59		0.08			0.17	0.16	0.07	0	0.29
Motor Graders	240 hp	ULSD	2270002048	0.59		0.05			0.10	0.09	0.04	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		0.09			0.79	0.75	0.34	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		0.05			0.22	0.22	0.12	0.02	0.00
Compressors	69 hp	ULSD	2270006015	0.43		0.14			0.10	0.13	0.21	0.07	0.00
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		0.27			0.12	0.13	0.13	0.03	0.00
Welders	20 hp	ULSD	2270006025	0.21		0.55			0.09	0.10	0.19	0.03	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		0.07			0.91	0.94	0.44	0.10	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		0.18			0.31	1.78	1.61	0	0
Pumps	75 hp	ULSD	2270006010	0.43		0.27			0.04	0.04	0.02	0	0
Excavator	524 hp	ULSD	2270002036	0.59		0.05			0.46	0.46	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		0.27			0	0.63	0.63	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		0.14			0	0.52	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					3.89E-04		3.62	3.44	1.55	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas						4.90	0	0	0	0	36.75
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						0.50	0	0	0	0	1.71
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUSD	Natural Gas						3.70	0	0	0	0	0.11
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						2.96	0	0	0	0	6.49
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						0.88	0	0	0	0	1.32
Generators (2)	4376 hp	ULSD						0.23	0	0	0	0	0.12
Flares	2.13 MMBtu/hr	Natural Gas						0.07	0	0	0	0	0.28
Flares	NA	Natural Gas						NA	0	0	0	0	5.59
Fire Pumps (3)	700 hp	ULSD						0.30	0	0	0	0	0.09

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] EPA AP-42 Table 3.4-2, Particulate and Particle-Sizing Emission Factors for Large Uncontrolled Stationary Diesel Engines, October 1996.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Volatile Organic Compounds (VOC) Emissions**

					Emission Factors				Emissions per Year (tons)				
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]					
Equipment Type	**Rating**	**Fuel**	**SCC Code**	**Load Factor**	**g/VMT**	**g/hp-hr**	**lb/hp-hr**	**lb/hr or lb/(startup/shutdown)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Pickup Trucks	280 hp	Gasoline			0.41				0.20	0.21	0.21	0.05	0
Large Trucks	316 hp	ULSD			0.39				0.31	0.37	0.34	0.12	0.01
Offroad Trucks	464 hp	ULSD	2270002051	0.59		0.19			2.44	2.32	1.05	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		3.75			1.11	3.21	5.57	3.05	0.12
RT Cranes	260 hp	ULSD	2270002045	0.43		0.18			0.62	1.00	2.48	0.84	0.01
Dozers	166 hp	ULSD	2270002069	0.59		0.18			0.42	0.51	0.75	0.24	0.00
Forklifts	173 hp	ULSD	2270002057	0.59		0.21			0.77	1.35	2.59	1.32	0.02
Loaders	235 hp	ULSD	2270002060	0.59		0.19			0.88	0.89	0.49	0.08	0.02
Tractors	270 hp	ULSD	2270002069	0.59		0.18			0.13	0.16	0.56	0.02	0.05
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		1.02			0.30	0.71	2.90	1.43	0
Rollers	157 hp	ULSD	2270002015	0.59		0.19			0.41	0.39	0.18	0	0.07
Scrapers	784 hp	ULSD	2270002018	0.59		0.17			0.36	0.35	0.16	0	0.62
Motor Graders	240 hp	ULSD	2270002048	0.59		0.17			0.33	0.31	0.14	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		0.19			1.61	1.54	0.69	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		0.17			0.79	0.80	0.44	0.06	0.00
Compressors	69 hp	ULSD	2270006015	0.43		0.22			0.16	0.20	0.33	0.11	0.00
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		0.39			0.17	0.18	0.18	0.05	0.00
Welders	20 hp	ULSD	2270006025	0.21		0.83			0.13	0.15	0.29	0.05	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		0.18			2.33	2.38	1.12	0.26	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		0.30			0.52	2.99	2.72	0	0
Pumps	75 hp	ULSD	2270006010	0.43		0.39			0.06	0.06	0.03	0	0
Excavator	524 hp	ULSD	2270002036	0.59		0.17			1.69	1.69	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		0.39			0	0.91	0.91	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		0.21			0	0.78	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					6.42E-04		5.96	5.68	2.55	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas						1.32	0	0	0	0	9.91
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						0.38	0	0	0	0	1.30
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUSD	Natural Gas						3.40	0	0	0	0	0.10
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						1.52	0	0	0	0	3.33
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						6.00	0	0	0	0	9.00
Generators (2)	4376 hp	ULSD						0.45	0	0	0	0	0.23
Flares	2.13 MMBtu/hr	Natural Gas						1.41	0	0	0	0	6.16
Flares	NA	Natural Gas						NA	0	0	0	0	39.23
Fire Pumps (3)	700 hp	ULSD						0.15	0	0	0	0	0.05

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] EPA AP-42 Table 3.4-1, Gaseous Emission Factors for Large Stationary Diesel and All Stationary Dual-Fuel Engines, October 1996.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Carbon Dioxide (CO_2) Emissions**

					Emission Factors								
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]	Emissions per Year (tons)				
Equipment Type	**Rating**	**Fuel**	**SCC Code**	**Load Factor**	**g/VMT**	**g/hp-hr**	**lb/hr**	**lb/hr or lb/(startup/shutdown)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Pickup Trucks	280 hp	Gasoline			574				279	291	284	63	0
Large Trucks	316 hp	ULSD			969				768	916	846	299	21
Offroad Trucks	464 hp	ULSD	2270002051	0.59		536			6,797	6,474	2,913	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		236			70	202	350	192	8
RT Cranes	260 hp	ULSD	2270002045	0.43		533			1,796	2,889	7,161	2,436	26
Dozers	166 hp	ULSD	2270002069	0.59		539			1,269	1,543	2,282	722	6
Forklifts	173 hp	ULSD	2270002057	0.59		569			2,126	3,714	7,127	3,643	64
Loaders	235 hp	ULSD	2270002060	0.59		540			2,490	2,515	1,385	239	49
Tractors	270 hp	ULSD	2270002069	0.59		539			398	474	1,705	47	142
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		693			202	481	1,963	972	0
Rollers	157 hp	ULSD	2270002015	0.59		559			1,199	1,142	514	0	206
Scrapers	784 hp	ULSD	2270002018	0.59		536			1,149	1,094	492	0	1,969
Motor Graders	240 hp	ULSD	2270002048	0.59		537			1,057	1,006	453	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		545			4,560	4,343	1,954	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		542			2,595	2,621	1,444	206	9
Compressors	69 hp	ULSD	2270006015	0.43		574			409	516	858	280	2
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		586			248	272	274	72	1
Welders	20 hp	ULSD	2270006025	0.21		692			111	124	243	40	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		533			6,716	6,880	3,225	758	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		540			945	5,401	4,906	0	0
Pumps	75 hp	ULSD	2270006010	0.43		568			85	81	36	0	0
Excavator	524 hp	ULSD	2270002036	0.59		542			5,536	5,536	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		568			0	1,322	1,322	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		537			0	2,006	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					1,684		10,606	10,101	4,546	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas						57,958	0	0	0	0	434,685
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						2,260	0	0	0	0	7,741
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUSD	Natural Gas						6,261	0	0	0	0	188
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						34,652	0	0	0	0	75,888
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						260,520	0	0	0	0	390,780
Generators (2)	4376 hp	ULSD						4,995	0	0	0	0	2,497
Flares	2.13 MMBtu/hr	Natural Gas						249	0	0	0	0	1,093
Fire Pumps (3)	700 hp	ULSD						799	0	0	0	0	240

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Methane (CH_4) Emissions**

					Emission Factors				Emissions per Year (tons)				
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]					
Equipment Type	Rating	Fuel	SCC Code	Load Factor	g/VMT	g/hp-hr	lb/hr	lb/hr or lb/(startup/shutdown)	Year 1	Year 2	Year 3	Year 4	Year 5
Pickup Trucks	280 hp	Gasoline			1.61E-02				0.01	0.01	0.01	0.00	0
Large Trucks	316 hp	ULSD			4.45E-02				0.04	0.04	0.04	0.01	0.00
Offroad Trucks	464 hp	ULSD	2270002051	0.59		1.51E-02			0.19	0.18	0.08	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		2.47E-01			0.07	0.21	0.37	0.20	0.01
RT Cranes	260 hp	ULSD	2270002045	0.43		1.43E-02			0.05	0.08	0.19	0.07	0.00
Dozers	166 hp	ULSD	2270002069	0.59		1.44E-02			0.03	0.04	0.06	0.02	0.00
Forklifts	173 hp	ULSD	2270002057	0.59		1.57E-02			0.06	0.10	0.20	0.10	0.00
Loaders	235 hp	ULSD	2270002060	0.59		1.45E-02			0.07	0.07	0.04	0.01	0.00
Tractors	270 hp	ULSD	2270002069	0.59		1.44E-02			0.01	0.01	0.05	0.00	0.00
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		2.74E-02			0.01	0.02	0.08	0.04	0
Rollers	157 hp	ULSD	2270002015	0.59		1.56E-02			0.03	0.03	0.01	0	0.01
Scrapers	784 hp	ULSD	2270002018	0.59		1.38E-02			0.03	0.03	0.01	0	0.05
Motor Graders	240 hp	ULSD	2270002048	0.59		1.38E-02			0.03	0.03	0.01	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		1.45E-02			0.12	0.12	0.05	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		1.38E-02			0.07	0.07	0.04	0.01	0.00
Compressors	69 hp	ULSD	2270006015	0.43		1.61E-02			0.01	0.01	0.02	0.01	0.00
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		3.37E-02			0.01	0.02	0.02	0.00	0.00
Welders	20 hp	ULSD	2270006025	0.21		2.87E-02			0.00	0.01	0.01	0.00	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		1.43E-02			0.18	0.18	0.09	0.02	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		1.35E-02			0.02	0.13	0.12	0	0
Pumps	75 hp	ULSD	2270006010	0.43		1.76E-02			0.00	0.00	0.00	0	0
Excavator	524 hp	ULSD	2270002036	0.59		1.38E-02			0.14	0.14	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		1.76E-02			0	0.04	0.04	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		1.37E-02			0	0.05	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					6.83E-02		0.43	0.41	0.18	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas						1.11	0	0	0	0	8.34
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						4.34E-02	0	0	0	0	0.15
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUSD	Natural Gas						0.11	0	0	0	0	0.00
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						0.65	0	0	0	0	1.43
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						49.24	0	0	0	0	73.86
Generators (2)	4376 hp	ULSD						0.20	0	0	0	0	0.10
Flares	2.13 MMBtu/hr	Natural Gas						0.80	0	0	0	0	3.52
Fire Pumps (3)	700 hp	ULSD						3.24E-02	0	0	0	0	0.01

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Nitrogen Oxide (N_2O) Emissions**

					Emission Factors								
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]	Emissions per Year (tons)				
Equipment Type	**Rating**	**Fuel**	**SCC Code**	**Load Factor**	**g/VMT**	**g/hp-hr**	**lb/hr**	**lb/hr or lb/(startup/shutdown)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Pickup Trucks	280 hp	Gasoline	Light Commercial Truck	NA	1.56E-03				0.00	0.00	0.00	0.00	0
Large Trucks	316 hp	ULSD	Single Unit Short-Haul Truck	NA	2.21E-03				0.00	0.00	0.00	0.00	0.00
Offroad Trucks	464 hp	ULSD	2270002051	0.59					0	0	0	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43					0	0	0	0	0
RT Cranes	260 hp	ULSD	2270002045	0.43					0	0	0	0	0
Dozers	166 hp	ULSD	2270002069	0.59					0	0	0	0	0
Forklifts	173 hp	ULSD	2270002057	0.59					0	0	0	0	0
Loaders	235 hp	ULSD	2270002060	0.59					0	0	0	0	0
Tractors	270 hp	ULSD	2270002069	0.59					0	0	0	0	0
Lifts / Hoists	75 hp	ULSD	2270003010	0.21					0	0	0	0	0
Rollers	157 hp	ULSD	2270002015	0.59					0	0	0	0	0
Scrapers	784 hp	ULSD	2270002018	0.59					0	0	0	0	0
Motor Graders	240 hp	ULSD	2270002048	0.59					0	0	0	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43					0	0	0	0	0
Backhoes	244 hp	ULSD	2270002036	0.59					0	0	0	0	0
Compressors	69 hp	ULSD	2270006015	0.43					0	0	0	0	0
Generators / Light Plants	15 hp	ULSD	2270002027	0.43					0	0	0	0	0
Welders	20 hp	ULSD	2270006025	0.21					0	0	0	0	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43					0	0	0	0	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43					0	0	0	0	0
Pumps	75 hp	ULSD	2270006010	0.43					0	0	0	0	0
Excavator	524 hp	ULSD	2270002036	0.59					0	0	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43					0	0	0	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59					0	0	0	0	0
DB / Boats / Tugs	1475 hp	ULSD	NA	NA			1.37E-02		0.09	0.08	0.04	0	0
Gas Turbines (5)	504.4 MMBtu/hr	Natural Gas	NA	NA				1.11E-01	0	0	0	0	0.83
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas	NA	NA				4.34E-03	0	0	0	0	0.01
Gas Turbine Startup/Shutdown	44.5671591 MMBtu/SUSD	Natural Gas	NA	NA				1.14E-02	0	0	0	0	0.00
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas	NA	NA				6.53E-02	0	0	0	0	0.14
Thermal Oxidizer	110 MMBtu/hr	Natural Gas	NA	NA				2.43E-02	0	0	0	0	0.04
Generators (2)	4376 hp	ULSD	NA	NA				4.05E-02	0	0	0	0	0.02
Flares	2.13 MMBtu/hr	Natural Gas	NA	NA				1.98E-01	0	0	0	0	0.87
Fire Pumps (3)	700 hp	ULSD	NA	NA				6.48E-03	0	0	0	0	0.00

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019 does not include emission factors for N_2O.

[3] Emission Factors from Tables C-1 and C-2 to Subpart C of 40 CFR Part 98 - Default CO_2, CH_4 and N_2O Emission Factors for Various Types of Fuel.

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Hazardous Air Pollutant (HAP) Emissions**

					Emission Factors				Emissions per Year (tons)				
					On-road [1]	Nonroad [2]	AP-42 [3]	Stationary Units [4]	Total HAPs				
Equipment Type	**Rating**	**Fuel**	**SCC Code**	**Load Factor**	**g/VMT**	**g/hp-hr**	**lb/hr**	**lb/hr or lb/(startup/shutdown)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Pickup Trucks	280 hp	Gasoline			7.06E-02				0.03	0.04	0.03	0.01	0
Large Trucks	316 hp	ULSD			7.30E-02				0.06	0.07	0.06	0.02	0
Offroad Trucks	464 hp	ULSD	2270002051	0.59		8.23E-02			1.04	0.99	0.45	0	0
Hoe Ram / ATV	21 hp	Gasoline	2265001030	0.43		1.18			0.35	1.01	1.76	0.96	0.04
RT Cranes	260 hp	ULSD	2270002045	0.43		8.66E-02			0.29	0.47	1.16	0.40	0.00
Dozers	166 hp	ULSD	2270002069	0.59		8.09E-02			0.19	0.23	0.34	0.11	0.00
Forklifts	173 hp	ULSD	2270002057	0.59		9.97E-02			0.37	0.65	1.25	0.64	0.01
Loaders	235 hp	ULSD	2270002060	0.59		8.93E-02			0.41	0.42	0.23	0.04	0.01
Tractors	270 hp	ULSD	2270002069	0.59		8.09E-02			0.06	0.07	0.26	0.01	0.02
Lifts / Hoists	75 hp	ULSD	2270003010	0.21		4.59E-01			0.13	0.32	1.30	0.64	0
Rollers	157 hp	ULSD	2270002015	0.59		9.36E-02			0.20	0.19	0.09	0	0.03
Scrapers	784 hp	ULSD	2270002018	0.59		7.87E-02			0.17	0.16	0.07	0	0.29
Motor Graders	240 hp	ULSD	2270002048	0.59		7.38E-02			0.15	0.14	0.06	0	0
Pile Vibrators / Hammers	1050 hp	ULSD	2270002054	0.43		9.40E-02			0.79	0.75	0.34	0	0
Backhoes	244 hp	ULSD	2270002036	0.59		7.35E-02			0.35	0.36	0.20	0.03	0.00
Compressors	69 hp	ULSD	2270006015	0.43		1.11E-01			0.08	0.10	0.17	0.05	0.00
Generators / Light Plants	15 hp	ULSD	2270002027	0.43		2.30E-01			0.10	0.11	0.11	0.03	0.00
Welders	20 hp	ULSD	2270006025	0.21		3.83E-01			0.06	0.07	0.13	0.02	0
Crawler Cranes	400 hp	ULSD	2270002045	0.43		8.66E-02			1.09	1.12	0.52	0.12	0
Augers/Soil Mix Equipment	440 hp	ULSD	2270002033	0.43		1.37E-01			0.24	1.37	1.24	0	0
Pumps	75 hp	ULSD	2270006010	0.43		1.85E-01			0.03	0.03	0.01	0	0
Excavator	524 hp	ULSD	2270002036	0.59		7.35E-02			0.75	0.75	0	0	0
Concrete Pumps	630 hp	ULSD	2270006010	0.43		1.85E-01			0	0.43	0.43	0	0
Suction Dredger	1435 hp	ULSD	2270002081	0.59		9.88E-02			0	0.37	0	0	0
DB / Boats / Tugs	1475 hp	ULSD					2.50E-02		0.16	0.15	0.07	0	0
Gas Turbines	504.4 MMBtu/hr	Natural Gas						2.13E-01	0	0	0	0	1.60
Duct Burners (5)	19.7 MMBtu/hr	Natural Gas						3.91E-02	0	0	0	0	0.13
Gas Turbine Startup/Shutdown	44.57 MMBtu/SUSD	Natural Gas						2.06E-02	0	0	0	0	0.00
Auxiliary Boiler	296.2 MMBtu/hr	Natural Gas						5.46E-01	0	0	0	0	1.20
Thermal Oxidizer	110 MMBtu/hr	Natural Gas						2.04E-01	0	0	0	0	0.31
Generators (2)	4376 hp	ULSD						7.42E-02	0	0	0	0	0.04
Flares	2.13 MMBtu/hr	Natural Gas						7.27E-03	0	0	0	0	0.16
Flares	NA	Natural Gas						NA	0	0	0	0	0.17
Fire Pumps (3)	700 hp	ULSD						1.19E-02	0	0	0	0	0.00

[1] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 12 (22.5 to 57.5 mph).

[2] EPA MOVES 2014a for year 2019.

[3] EPA AP-42 Table 3.4-3, Speciated Organic Compound Emission Factors for Large Uncontrolled Stationary Diesel Engines (October 1996), Table 3.4-4, PAH Emission Factors for Large Uncontrolled Stationary Diesel Engines (October 1996), and Table 3.1-2a, Emission Factors for Criteria Pollutants and Greenhouse Gases from Stationary Gas. Turbines

[4] Emission in pounds per hour from stationary emission unit calculations.

Jordan Cove **Construction Fugitive Emissions - Land Disturbing Activities and Concrete Batch Plant**

	Total Acres Disturbed					Yards of Concrete Delivered [1]					Duration (months)					PM_{10} Emissions (tons) [2,3,4]					$PM_{2.5}$ Emissions (tons)				
Land Disturbing Activity [5]	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5
All Project Site Disturbance [6]	350	350	175	0	200	NA	NA	NA	NA	NA	12	12	12	0	12	231.00	231.00	115.50	0	132.00	23.10	23.10	11.55	0	13.20
All APCO Site Disturbance	19	0	0	0	19	NA	NA	NA	NA	NA	3	0	0	0	3	3.14	0	0	0	3.14	0.31	0	0	0	0.31
All Boxcar Hill Site Disturbance	10	0	0	0	10	NA	NA	NA	NA	NA	12	0	0	0	12	6.60	0	0	0	6.60	0.66	0	0	0	0.66
Met Tower Location	0	0	1	0	0	NA	NA	NA	NA	NA	0	0	2	0	0	0	0	0.11	0	0	0.00	0	0.011	0	0
Port Laydown Site	38	0	0	0	38	NA	NA	NA	NA	NA	6	0	0	0	6	12.54	0	0	0	12.54	1.25	0	0	0	1.25
Myrtlewood	0	5	0	0	5	NA	NA	NA	NA	NA	0	3	0	0	3	0	0.83	0	0	0.83	0.00	0.083	0	0	0.083
Mill Casino	0	6	0	0	6	NA	NA	NA	NA	NA	0	3	0	0	3	0	0.99	0	0	0.99	0.00	0.099	0	0	0.099
Concrete Batch Plant	NA	NA	NA	NA	NA	8,610	134,590	135,370	30,520	0	NA	NA	NA	NA	NA	4.05	63.28	63.65	14.35	0	4.05	63.28	63.65	14.35	0

[1] A concrete truck holds 10 cubic yards and a cubic yard is approximately 2 tons. Amounts delivered are based on truck deliveries.

[2] WRAP Fugitive Dust Handbook, Countess Environmental, September 2006, Section 3.4.1. Water and otherapproved dust suppressants would be used at construction sites.

Dust Control Efficiency = 50%

[3] WRAP Fugitive Dust Handbook, Table 3-2 "Recommended PM10 Emission Factors for Construction Operations", level 1, average conditions.

According to Section 3.3.1, "The PM2.5/PM10 ratio for fugitive dust from construction and demolition activities is 0.1based on the analysis conducted by MRI on behalf of WRAP."

PM_{10} Emission Factor = 0.11 tons/acre-month

$PM_{2.5}$ Emission Factor = 0.011 tons/acre-month

[4] AP-42 Table 11.12-2, Emission Factors for Concrete Batching, Uncontrolled

Aggregate Transfer = 0.0033 lb PM_{10}/ton of material, 1865 pounds aggregate per cubic yard of cement

Sand Transfer = 0.00099 lb PM_{10}/ton of material, 1428 pounds sand per cubic yard of cement

Weigh Hopper Loading = 0.00280 lb PM_{10}/ton of material (aggregate and sand)

Mixer Loading = 0.156 lb PM_{10}/ton of cement

Truck Loading = 0.310 lb PM_{10}/ton of cement

Total Emission Factor = 0.47017 lb PM_{10}/ton of cement

[5] Data does not include TPP/101, Kentuck Slough, and potential utilities installation.

[5] Terminal (Ingram Yard, South Dunes, Corridor, Berth), plus Roseburg.

Jordan Cove **Construction Material Deliver and Worker Commuting Emissions**

Traffic	Category	Trip Distance (Round Trip)	Round Trips per Year [1]					Emission Factor (g/VMT) [2]							
			Year 1	Year 2	Year 3	Year 4	Year 5	NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Single Cars to/from Site	Gasoline Passenger Cars	20	154,153	243,905	140,850	136,625	44,446	0.55	2.06E-03	3.49	0.01	0.01	0.21	310	5.87E-02
Diesel Buses to/from Site	Diesel Transit Buses	20	0	3,521	14,007	5,791	0	7.98	9.64E-03	2.92	0.22	0.21	0.57	1116	9.60E-02
Long Haul Delivery Truck to Site/Boxcar	Diesel Single Unit Long-Haul Trucks	40	14,242	35,369	33,882	11,268	2,974	2.84	7.68E-03	1.14	0.16	0.15	0.36	907	6.71E-02
Local Delivery Truck to Site/Boxcar	Diesel Single Unit Short-Haul Trucks	20	1,565	2,504	3,443	2,035	783	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02
Long Haul Delivery Truck to APCO Offsite Daily	Diesel Single Unit Long-Haul Trucks	40	313	626	1,409	391	0	2.84	7.68E-03	1.14	0.16	0.15	0.36	907	6.71E-02
Local Truck from APCO Offsite Laydown to Site	Diesel Single Unit Short-Haul Trucks	10	313	1,096	5,008	1,096	0	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02
Single Cars to/from APCO Laydown	Gasoline Passenger Cars	20	2,191	7,043	10,642	4,304	0	0.55	2.06E-03	3.49	0.01	0.01	0.21	310	5.87E-02
Local Truck - Civil Topsoil	Diesel Single Unit Short-Haul Trucks	10	21,128	0	0	21,128	0	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02
Concrete Truck Delivers from Boxcar to Project	Diesel Single Unit Short-Haul Trucks	4	861	13,459	13,537	3,052	0	3.23	8.24E-03	1.28	0.19	0.17	0.39	971	7.30E-02
Workers Bussed to Site from Man Camp	Diesel Transit Buses	4	0	7,512	7,512	7,512	1,252	7.98	9.64E-03	2.92	0.22	0.21	0.57	1116	9.60E-02
Workers Leaving Man Camp on Weekends	Gasoline Passenger Cars	40	0	32,760	32,760	32,760	4,680	0.55	2.06E-03	3.49	0.01	0.01	0.21	310	5.87E-02
Workers Leaving Man Camp on Weekdays	Gasoline Passenger Cars	20	0	18,200	18,200	18,200	2,600	0.55	2.06E-03	3.49	0.01	0.01	0.21	310	5.87E-02
Offsite Parking Traffic (Non-Camp)	Gasoline Passenger Cars	20	0	104,229	415,351	168,785	0	0.55	2.06E-03	3.49	0.01	0.01	0.21	310	5.87E-02

[1] 2017 Traffic Study

[2] EPA MOVES 2014a for year 2019, unrestricted urban roads, and average emission factor from bins 6 through 13 (22.5 to 62.5 mph).

Traffic	Category	Year 1 - Emissions (tons)							
		NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Single Cars to/from Site	Gasoline Passenger Cars	1.88	7.0E-03	11.86	4.2E-02	3.7E-02	0.71	1054.99	0.20
Diesel Buses to/from Site	Diesel Transit Buses	0	0	0	0	0	0	0	0
Long Haul Delivery Truck to Site/Boxcar	Diesel Single Unit Long-Haul Trucks	1.78	4.8E-03	0.72	1.0E-01	9.4E-02	0.22	569.53	4.2E-02
Local Delivery Truck to Site/Boxcar	Diesel Single Unit Short-Haul Trucks	1.1E-01	2.8E-04	4.4E-02	6.4E-03	5.9E-03	1.4E-02	33.49	2.5E-03
Long Haul Delivery Truck to APCO Offsite Daily	Diesel Single Unit Long-Haul Trucks	3.9E-02	1.1E-04	1.6E-02	2.3E-03	2.1E-03	4.9E-03	12.52	9.3E-04
Local Truck from APCO Offsite Laydown to Site	Diesel Single Unit Short-Haul Trucks	1.1E-02	2.8E-05	4.4E-03	6.4E-04	5.9E-04	1.4E-03	3.35	2.5E-04
Single Cars to/from APCO Laydown	Gasoline Passenger Cars	2.7E-02	9.9E-05	1.7E-01	5.9E-04	5.3E-04	1.0E-02	14.99	2.8E-03
Local Truck - Civil Topsoil	Diesel Single Unit Short-Haul Trucks	0.75	1.9E-03	0.30	4.3E-02	4.0E-02	9.1E-02	226.04	1.7E-02
Concrete Truck Delivers from Boxcar to Project	Diesel Single Unit Short-Haul Trucks	1.2E-02	3.1E-05	4.9E-03	7.1E-04	6.5E-04	1.5E-03	3.68	2.8E-04
Workers Bussed to Site from Man Camp	Diesel Transit Buses	0	0	0	0	0	0	0	0
Workers Leaving Man Camp on Weekends	Gasoline Passenger Cars	0	0	0	0	0	0	0	0
Workers Leaving Man Camp on Weekdays	Gasoline Passenger Cars	0	0	0	0	0	0	0	0
Offsite Parking Traffic (Non-Camp)	Gasoline Passenger Cars	0	0	0	0	0	0	0	0

Traffic	Category	Year 2 - Emissions (tons)							
		NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Single Cars to/from Site	Gasoline Passenger Cars	2.97	1.1E-02	18.76	6.6E-02	5.9E-02	1.13	1669.23	0.32
Diesel Buses to/from Site	Diesel Transit Buses	0.62	7.5E-04	0.23	1.7E-02	1.6E-02	4.4E-02	86.66	0
Long Haul Delivery Truck to Site/Boxcar	Diesel Single Unit Long-Haul Trucks	4.43	1.2E-02	1.78	0.25	0.23	0.55	1414.39	1.0E-01
Local Delivery Truck to Site/Boxcar	Diesel Single Unit Short-Haul Trucks	1.8E-01	4.5E-04	7.1E-02	1.0E-02	9.4E-03	2.2E-02	53.58	4.0E-03
Long Haul Delivery Truck to APCO Offsite Daily	Diesel Single Unit Long-Haul Trucks	7.8E-02	2.1E-04	3.1E-02	4.5E-03	4.1E-03	9.8E-03	25.03	1.9E-03
Local Truck from APCO Offsite Laydown to Site	Diesel Single Unit Short-Haul Trucks	3.9E-02	1.0E-04	1.5E-02	2.2E-03	2.1E-03	4.7E-03	11.73	8.8E-04
Single Cars to/from APCO Laydown	Gasoline Passenger Cars	8.6E-02	3.2E-04	0.54	1.9E-03	1.7E-03	3.2E-02	48.20	9.1E-03
Local Truck - Civil Topsoil	Diesel Single Unit Short-Haul Trucks	0	0	0	0	0	0	0	0
Concrete Truck Delivers from Boxcar to Project	Diesel Single Unit Short-Haul Trucks	1.9E-01	4.9E-04	7.6E-02	1.1E-02	1.0E-02	2.3E-02	57.60	4.3E-03
Workers Bussed to Site from Man Camp	Diesel Transit Buses	0.26	3.2E-04	9.7E-02	7.4E-03	6.8E-03	1.9E-02	36.98	3.2E-03
Workers Leaving Man Camp on Weekends	Gasoline Passenger Cars	0.80	3.0E-03	5.04	1.8E-02	1.6E-02	0.30	448.40	8.5E-02
Workers Leaving Man Camp on Weekdays	Gasoline Passenger Cars	0.22	8.2E-04	1.40	4.9E-03	4.4E-03	8.4E-02	124.56	2.4E-02
Offsite Parking Traffic (Non-Camp)	Gasoline Passenger Cars	1.27	4.7E-03	8.02	2.8E-02	2.5E-02	0.48	713.32	1.3E-01

Traffic	Category	Year 3 - Emissions (tons)							
		NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Single Cars to/from Site	Gasoline Passenger Cars	1.71	6.4E-03	10.83	3.8E-02	3.4E-02	0.65	963.95	1.8E-01
Diesel Buses to/from Site	Diesel Transit Buses	2.47	3.0E-03	0.90	6.9E-02	6.3E-02	1.8E-01	344.73	3.0E-02
Long Haul Delivery Truck to Site/Boxcar	Diesel Single Unit Long-Haul Trucks	4.24	1.1E-02	1.70	0.24	0.22	0.53	1354.93	1.0E-01
Local Delivery Truck to Site/Boxcar	Diesel Single Unit Short-Haul Trucks	0.25	6.3E-04	9.7E-02	1.4E-02	1.3E-02	3.0E-02	73.67	5.5E-03
Long Haul Delivery Truck to APCO Offsite Daily	Diesel Single Unit Long-Haul Trucks	1.8E-01	4.8E-04	7.1E-02	1.0E-02	9.3E-03	2.2E-02	56.35	4.2E-03
Local Truck from APCO Offsite Laydown to Site	Diesel Single Unit Short-Haul Trucks	1.8E-01	4.5E-04	7.1E-02	1.0E-02	9.4E-03	2.2E-02	53.58	4.0E-03
Single Cars to/from APCO Laydown	Gasoline Passenger Cars	1.3E-01	4.8E-04	0.82	2.9E-03	2.6E-03	4.9E-02	72.83	1.4E-02
Local Truck - Civil Topsoil	Diesel Single Unit Short-Haul Trucks	0	0	0	0	0	0	0	0
Concrete Truck Delivers from Boxcar to Project	Diesel Single Unit Short-Haul Trucks	0.19	4.9E-04	7.6E-02	1.1E-02	1.0E-02	2.3E-02	57.93	4.4E-03
Workers Bussed to Site from Man Camp	Diesel Transit Buses	0.26	3.2E-04	9.7E-02	7.4E-03	6.8E-03	1.9E-02	36.98	3.2E-03
Workers Leaving Man Camp on Weekends	Gasoline Passenger Cars	0.80	3.0E-03	5.04	1.8E-02	1.6E-02	0.30	448.40	8.5E-02
Workers Leaving Man Camp on Weekdays	Gasoline Passenger Cars	0.22	8.2E-04	1.40	4.9E-03	4.4E-03	8.4E-02	124.56	2.4E-02
Offsite Parking Traffic (Non-Camp)	Gasoline Passenger Cars	5.05	1.9E-02	31.95	1.1E-01	1.0E-01	1.92	2842.57	0.54

Traffic	Category	Year 4 - Emissions (tons)							
		NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Single Cars to/from Site	Gasoline Passenger Cars	1.66	6.2E-03	10.51	3.7E-02	3.3E-02	0.63	935.03	1.8E-01
Diesel Buses to/from Site	Diesel Transit Buses	1.02	1.2E-03	0.37	2.8E-02	2.6E-02	7.3E-02	142.52	1.2E-02
Long Haul Delivery Truck to Site/Boxcar	Diesel Single Unit Long-Haul Trucks	1.41	3.8E-03	0.57	8.1E-02	7.5E-02	1.8E-01	450.60	3.3E-02
Local Delivery Truck to Site/Boxcar	Diesel Single Unit Short-Haul Trucks	1.4E-01	3.7E-04	5.7E-02	8.3E-03	7.7E-03	1.8E-02	43.54	3.3E-03
Long Haul Delivery Truck to APCO Offsite Daily	Diesel Single Unit Long-Haul Trucks	4.9E-02	1.3E-04	2.0E-02	2.8E-03	2.6E-03	6.1E-03	15.64	1.2E-03
Local Truck from APCO Offsite Laydown to Site	Diesel Single Unit Short-Haul Trucks	3.9E-02	1.0E-04	1.5E-02	2.2E-03	2.1E-03	4.7E-03	11.73	8.8E-04
Single Cars to/from APCO Laydown	Gasoline Passenger Cars	5.2E-02	2.0E-04	0.33	1.2E-03	1.0E-03	2.0E-02	29.46	5.6E-03
Local Truck - Civil Topsoil	Diesel Single Unit Short-Haul Trucks	0.75	1.9E-03	0.30	4.3E-02	4.0E-02	9.1E-02	226.04	1.7E-02
Concrete Truck Delivers from Boxcar to Project	Diesel Single Unit Short-Haul Trucks	4.3E-02	1.1E-04	1.7E-02	2.5E-03	2.3E-03	5.3E-03	13.06	9.8E-04
Workers Bussed to Site from Man Camp	Diesel Transit Buses	0.26	3.2E-04	9.7E-02	7.4E-03	6.8E-03	1.9E-02	36.98	3.2E-03
Workers Leaving Man Camp on Weekends	Gasoline Passenger Cars	0.80	3.0E-03	5.04	1.8E-02	1.6E-02	0.30	448.40	8.5E-02
Workers Leaving Man Camp on Weekdays	Gasoline Passenger Cars	0.22	8.2E-04	1.40	4.9E-03	4.4E-03	8.4E-02	124.56	2.4E-02
Offsite Parking Traffic (Non-Camp)	Gasoline Passenger Cars	2.05	7.6E-03	12.98	4.6E-02	4.1E-02	0.78	1155.13	0.22

Traffic	Category	Year 5 - Emissions (tons)							
		NO_X	SO_2	CO	PM_{10}	$PM_{2.5}$	VOC	GHG	HAPS
Single Cars to/from Site	Gasoline Passenger Cars	0.54	2.0E-03	3.42	1.2E-02	1.1E-02	0.21	304.18	5.7E-02
Diesel Buses to/from Site	Diesel Transit Buses	0	0	0	0	0	0	0	0
Long Haul Delivery Truck to Site/Boxcar	Diesel Single Unit Long-Haul Trucks	0.37	1.0E-03	1.5E-01	2.1E-02	2.0E-02	4.7E-02	118.93	8.8E-03
Local Delivery Truck to Site/Boxcar	Diesel Single Unit Short-Haul Trucks	5.6E-02	1.4E-04	2.2E-02	3.2E-03	3.0E-03	6.8E-03	16.75	1.3E-03
Long Haul Delivery Truck to APCO Offsite Daily	Diesel Single Unit Long-Haul Trucks	0	0	0	0	0	0	0	0
Local Truck from APCO Offsite Laydown to Site	Diesel Single Unit Short-Haul Trucks	0	0	0	0	0	0	0	0
Single Cars to/from APCO Laydown	Gasoline Passenger Cars	0	0	0	0	0	0	0	0
Local Truck - Civil Topsoil	Diesel Single Unit Short-Haul Trucks	0	0	0	0	0	0	0	0
Concrete Truck Delivers from Boxcar to Project	Diesel Single Unit Short-Haul Trucks	0	0	0	0	0	0	0	0
Workers Bussed to Site from Man Camp	Diesel Transit Buses	4.4E-02	5.3E-05	1.6E-02	1.2E-03	1.1E-03	3.1E-03	6.16	5.3E-04
Workers Leaving Man Camp on Weekends	Gasoline Passenger Cars	1.1E-01	4.2E-04	0.72	2.5E-03	2.2E-03	4.3E-02	64.06	1.2E-02
Workers Leaving Man Camp on Weekdays	Gasoline Passenger Cars	3.2E-02	1.2E-04	0.20	7.1E-04	6.2E-04	1.2E-02	17.79	3.4E-03
Offsite Parking Traffic (Non-Camp)	Gasoline Passenger Cars	0	0	0	0	0	0	0	0

APPENDIX F.9

Marine Vessel Inventory and Emission Calculations

The fleet of LNG vessels expected to call at the JCEP terminal consists of both vessels that have boiler/steam turbine driven (ST) propulsion systems, as well as vessels powered by duel-fuel diesel-electric (DFDE) propulsion. Further, each type of vessel may be operated on either natural gas or fuel oil. For the DFDE ships, however, operation on oil versus operation on natural gas was confined to different activities during the ship's call. Therefore, three vessel emissions scenarios were created in order to determine worst-case air emissions calculations and associated air quality impacts:

- ST vessels operating on oil
- ST vessels operating on natural gas
- DFDE ships

JCEP expects up to 120 LNG vessel calls per year. For the purposes of the modeling, in each of the three scenarios, it is assumed that all of the 120 vessel calls will be of ships of the same propulsion and fuel type.

The LNG vessel call activities can be divided into the following activities and operating periods per visit. These activity times are not dependent on the ship or fuel type. As can be seen in table F-1 the activities in total will last 29 hours per vessel call.

Emission rates for different activities during the ship's call are developed from the emission factors shown in Table F-2, and the amount of power expected to be consumed during that particular activity. As the emission factors are in a g/kWh basis, and the power will vary depending on activity, the emission rates (on a mass per unit time basis) will vary depending on the activity in which the ship is engaged.

If a ship is engaged in a particular activity for the full averaging period, than the full mass per unit time rate is used for modeling of that activity. If a ship is engaged for the activity for a portion of the averaging period, then the mass per unit time emission factor is weighted by the proportion of the activity time to the time of the averaging period. For example, for an activity that takes four hours, the full mass per unit time emission rate calculated will be used for 1-hour averaging periods (as the activity time is longer than that averaging period), but one-sixth of the full mass per unit time emission rate will be used for 24-hour averaging periods (as the four hours of activity time is one-sixth of the averaging period).

The emission factors are shown in Table F-2. The mass per unit time emission calculations for each of the three types of ships are shown in Tables F-3 through F-5, respectively. The emission rates by pollutant and averaging period for model input are shown in Tables F-6 through F-8, respectively. Vessel source locations and stack parameters are shown in Tables F-9 through F-11, respectively.

In addition to the activities at and in the immediate vicinity of the terminal, the emissions of the ship's transit of the channel and near-shore open water are considered by setting up 68 sources along the geographic track of arriving and departing ships. The transit emission rates are used for these surrogate sources, with the emissions divided equally over the 68 surrogate sources.

In addition to the LNG vessels, tugboats will also be deployed in operation at the JCEP LNG terminal. The worst-case scenario involves use of one tugboat. Since the tugboat will be maneuvering around the ship during the worst case, the tugboat is represented as a series of four surrogate sources in the channel adjacent to the ship dock, with one-quarter of the total tugboat emissions assigned to each surrogate source. The tugboat emissions are shown in Table F-12, and stack parameters and location information of the tugboat are detailed in Table F-13.

Marine vessel emissions scenario summaries for the annual, 24-hour, and 1-hour averaging periods are shown in Tables F-14 through F-16.

Table F-1. LNG Vessel Activities and Operating Periods per Visit

Category	Activity	Time (hours)
Transit	Arrival to Berth	2
	Transit Berth to Pilot Station	2
Hoteling	Berthing Vessel	1
	Berthed, Not Carrying Out Cargo Transfer	6
	Vessel warm up of main engine and departure preparation	2
	Unberthing time	1
Loading	Berthed carrying out cargo transfer	15

Table F-2. Emission Factors for LNG Vessels (g/kWh)				
Pollutant	DFDE Ships		Steam Turbine Ships	
	Gas	Oil	Gas	Oil
NO_x (1)	1.71E+00	3.40E+00	1.05E+00	1.98E+00
CO (2)	1.09E+00	2.80E+00	4.71E-01	2.10E-01
PM (2)	3.46E-02	1.89E-01	4.21E-02	2.33E-01
VOC (2)	6.59E-01	2.70E-01	3.10E-02	1.18E-02
SO_2 (2,3)	5.60E-02	3.33E-01	3.10E-03	6.69E-01
CO_2 (4)	3.62E+02	5.43E+02	7.28E+02	1.03E+03
CH_4 (5)	4.28E-02	1.45E-02	1.40E-02	4.13E-02
N_2O (5)	7.26E-04	4.84E-03	1.34E-02	4.54E-03

(1) Based on IMO Marine Tier III standards.

(2) Based on Afton, Y. and Ervin, D., "An Assessment of Air Emissions from Liquefied Natural Gas Ships Using Different Power Systems and Different Fuels, " J. Air Waste Management Assoc., vol. 58 (2008), pp. 404-411. DFDE ships are assumed to have a 47% efficiency factor and ST ships a 25% efficiency factor.

(3) Fuel Oil sulfur content was assumed 0.1%.

(4) Based on AP-42 Table 3.4.-1 for Diesel Engines and Tables 1.3-12 and 1.4-2 for ST ships.

(5) ST emission factors based upon AP-42 Tables 1.3-3, 1.3-8, and 1.4-2. DFDE ship emission factors based on California Climate Action Registry General Reporting Protvol, Version 3.0, April 2008, Table C.7.

Table F-3. Emission Calculations Steam Turbine Vessels Powered by Fuel Oil

Period		Transit Time (hr)	Marine Grade Oil - MGO (tonnes)	Marine Grade Oil - MGO (gallons)	NOX			CO			PM			VOC			SO2			CO2			CH4			N2O		
					lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy
Transit																												
	Arrival to Berth at 4-5 knots	2.00	1.2	367	27.06	0.0271	3.25	2.87	0.003	0.34	3.18	0.003	0.38	0.16	0.0002	0.02	9.14	0.01	1.10	14078.72	14.08	1689.45	0.56	0.00	0.07	0.06	0.00	0.01
	Transit Berth to Pilot Station	2.00	1.2	367	27.06	0.0271	3.25	2.87	0.003	0.34	3.18	0.003	0.38	0.16	0.0002	0.02	9.14	0.01	1.10	14078.72	14.08	1689.45	0.56	0.00	0.07	0.06	0.00	0.01
Hotelling																												
	Berthing Vessel	1.00	0.6	184	6.55	0.0033	0.39	0.69	0.000	0.04	0.77	0.000	0.05	0.04	0.0000	0.00	2.21	0.00	0.13	3406.14	1.70	204.37	0.14	0.00	0.01	0.02	0.00	0.00
	Berthed Not Carrying Out Cargo Transfer	6.00	7.2	2,205	6.55	0.0196	2.36	0.69	0.002	0.25	0.77	0.002	0.28	0.04	0.0001	0.01	2.21	0.01	0.80	3406.14	10.22	1226.21	0.14	0.00	0.05	0.02	0.00	0.01
	Vessel warm up of main engine and prep to depart berth	2.00	1.2	367	6.55	0.0065	0.79	0.69	0.001	0.08	0.77	0.001	0.09	0.04	0.0000	0.00	2.21	0.00	0.27	3406.14	3.41	408.74	0.14	0.00	0.02	0.02	0.00	0.00
	Unberthing time	1.00	0.6	184	6.55	0.0033	0.39	0.69	0.000	0.04	0.77	0.000	0.05	0.04	0.0000	0.00	2.21	0.00	0.13	3406.14	1.70	204.37	0.14	0.00	0.01	0.02	0.00	0.00
LNG Loading																												
	Berthed carrying out cargo transfer	15.00	9.0	2,756	19.64	0.1473	17.68	2.08	0.016	1.88	2.31	0.017	2.08	0.12	0.0009	0.11	6.64	0.05	5.97	10218.43	76.64	9196.58	0.41	0.00	0.37	0.05	0.00	0.04
Total		29.00			99.96	0.23	28.10	10.60	0.02	2.98	11.76	0.03	3.31	0.596	0.001	0.17	33.78	0.08	9.50	52,000.43	121.83	14,619.16	2.09	0.00	0.59	0.23	0.00	0.06

Notes:

1.	LNG Capacity (m3)	142,950
	Number of Ship Calls per Year	120
	Total Electric Power Engine Rating (kW)	10,350
	Fuel Consumption Rate (at NCR)	182.2 metric tonnes per day
	Fuel Type	RMH 55
	HHV (kcal/kg)	10,280
	Density (lb/gal)	7.2

Table F-4. Emission Factors Steam Turbine Calculations Powered by Natural Gas

Period		Transit Time (hr)	Total Required Power (kW)	BOG - (tonnes)	BOG (MMscf)	NOX			CO			PM			VOC			SO2			CO2			CH4			N2O		
						lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy
Transit	Arrival to Berth at 4-5 knots	2.00	6,200	4.6	0.230	14.35	0.0144	1.72	6.44	0.006	0.77	0.58	0.001	0.07	0.42	0.0004	0.05	0.04	0.00	0.01	9950.78	9.95							
	Transit Berth to Pilot Station	2.00	6,200	4.6	0.230	14.35	0.0144	1.72	6.44	0.006	0.77	0.58	0.001	0.07	0.42	0.0004	0.05	0.04	0.00	0.01	9950.78	9.95	1194.09	0.19	0.00	0.02	0.18	0.00	0.02
																							1194.09	0.19	0.00	0.02	0.18	0.00	0.02
Hotelling																													
	Berthing Vessel	1.00	1,500	2.3	0.115	3.47	0.0017	0.21	1.56	0.001	0.09	0.14	0.000	0.01	0.10	0.0001	0.01	0.01	0.00	0.00	2407.45	1.20	144.45	0.05	0.00	0.00	0.04	0.00	0.00
	Berthed Not Carrying Out Cargo Transfer	6.00	1,500	0.0	0.000	3.47	0.0104	1.25	1.56	0.005	0.56	0.14	0.000	0.05	0.10	0.0003	0.04	0.01	0.00	0.00	2407.45	7.22	866.68	0.05	0.00	0.02	0.04	0.00	0.02
	Vessel warm up of main engine and prep to depart berth	2.00	1,500	4.8	0.241	3.47	0.0035	0.42	1.56	0.002	0.19	0.14	0.000	0.02	0.10	0.0001	0.01	0.01	0.00	0.00	2407.45	2.41	288.89	0.05	0.00	0.01	0.04	0.00	0.01
	Unberthing time	1.00	1,500	2.4	0.120	3.47	0.0017	0.21	1.56	0.001	0.09	0.14	0.000	0.01	0.10	0.0001	0.01	0.01	0.00	0.00	2407.45	1.20	144.45	0.05	0.00	0.00	0.04	0.00	0.00
LNG Loading																													
	Berthed carrying out cargo transfer	15.00	4,500	51.0	2.555	10.42	0.0781	9.38	4.67	0.035	4.21	0.42	0.003	0.38	0.31	0.0023	0.28	0.10	0.00	0.09	7222.34	54.17	6500.11	0.14	0.00	0.13	0.13	0.00	0.12
Total		29.00	22,900	70	3	53.01	0.12	14.90	23.78	0.06	6.69	2.13	0.00	0.60	1.57	0.004	0.44	0.23	0.00	0.11	36,753.70	86.11	10,332.77	0.71	0.00	0.20	0.68	0.00	0.19

Notes:

1.	LNG Capacity (m3)	142,950
	Number of Ship Calls per Year	120
	Total Electric Power Engine Rating (kW)	10,350
	Fuel Consumption Rate (at NCR)	182.2 metric tonnes per day
	Fuel Type	BOG
	HHV (Btu/scf)	946
	Density (lb/scf)	0.044

Table F-5. Emission Calculations DFDE Vessels

Period		Transit Time (hr)	Required Power per Hour (kW)	Total Required Power (kWhr)	Fuel Burned	NOX			CO			PM			VOC			SO2			CO2			CH4			N2O		
						lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy	lb/hr	ton/call	tpy
Transit																													
	Arrival to Berth at 4-5 knots	2.00	4,500	9,000	Gas	16.96	0.0170	2.04	10.81	0.011	1.30	0.34	0.000	0.04	6.54	0.0065	0.78	0.56	0.00	0.07	3591.35	3.59	430.96	0.42	0.00	0.05	0.01	0.00	0.00
	Transit Berth to Pilot Station	2.00	4,500	9,000	Gas	16.96	0.0170	2.04	10.81	0.011	1.30	0.34	0.000	0.04	6.54	0.0065	0.78	0.56	0.00	0.07	3591.35	3.59	430.96	0.42	0.00	0.05	0.01	0.00	0.00
Hotelling																													
	Berthing Vessel	1.00	4,500	4,500	Gas	16.96	0.0085	1.02	10.81	0.005	0.65	0.34	0.000	0.02	6.54	0.0033	0.39	0.56	0.00	0.03	3591.35	1.80	215.48	0.42	0.00	0.03	0.01	0.00	0.00
	Berthed Not Carrying Out Cargo Transfer	6.00	4,500	27,000	Gas	16.96	0.0509	6.11	10.81	0.032	3.89	0.34	0.001	0.12	6.54	0.0196	2.35	0.56	0.00	0.20	3591.35	10.77	1292.89	0.42	0.00	0.15	0.01	0.00	0.00
	Vessel warm up of main engine and prep to depart berth	2.00	13,500	27,000	Gas	50.89	0.0509	6.11	32.44	0.032	3.89	1.03	0.001	0.12	19.61	0.0196	2.35	1.67	0.00	0.20	10774.05	10.77	1292.89	1.27	0.00	0.15	0.02	0.00	0.00
	Unberthing time	1.00	4,500	4,500	Gas	16.96	0.0085	1.02	10.81	0.005	0.65	0.34	0.000	0.02	6.54	0.0033	0.39	0.56	0.00	0.03	3591.35	1.80	215.48	0.42	0.00	0.03	0.01	0.00	0.00
LNG Loading																													
	Berthed carrying out cargo transfer	15.00	0	0	Fuel Oil	33.73	0.2530	30.36	27.78	0.208	25.00	1.88	0.014	1.69	2.68	0.0201	2.41	3.30	0.02	2.97	5387.02	40.40	4848.32	0.14	0.00	0.13	0.05	0.00	0.04
Total		29.00	36,000	81,000		169.45	0.41	48.68	114.29	0.31	36.68	4.62	0.02	2.06	54.98	0.079	9.47	7.75	0.03	3.57	34,117.82	72.72	8,726.98	3.54	0.00	0.59	0.11	0.00	0.05

Notes:

1.	LNG Capacity (m3)	168,162
	Number of Ship Calls per Year	120
	Total Propulsion Engine Rating (kW)	25,400
	Total Electric Power Engine Rating (kW)	39,900

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Table F-6. Emission Rates for Model Input - Steam Turbine Vessels Operating on Fuel Oil

Activity		NOx (g/s)		SO2 (g/s)				CO (g/s)		PM (g/s)	
		1 hour	Annual	1 hour	3 hour	24 hour	Annual	1 hour	8 hour	24 hour	Annual
Transit											
	Arrival to Berth at 4-5 knots	3.41E+00	9.34E-02	1.15E+00	7.68E-01	9.60E-02	1.58E-05	3.62E-01	9.04E-02	3.34E-02	1.10E-02
	Transit Berth to Pilot Station	3.41E+00	9.34E-02	1.15E+00	7.68E-01	9.60E-02	1.58E-05	3.62E-01	9.04E-02	3.34E-02	1.10E-02
Hotelling											
	Berthing Vessel	8.25E-01	1.13E-02	2.79E-01	9.29E-02	1.16E-02	1.91E-06	8.75E-02	1.09E-02	4.05E-03	1.33E-03
	Berthed Not Carrying Out Cargo Transfer	8.25E-01	6.78E-02	2.79E-01	2.79E-01	6.97E-02	1.15E-05	8.75E-02	6.56E-02	2.43E-02	7.98E-03
	Vessel warm up of main engine and prep to depart berth	8.25E-01	2.26E-02	2.79E-01	1.86E-01	2.32E-02	3.82E-06	8.75E-02	2.19E-02	8.09E-03	2.66E-03
	Unberthing time	8.25E-01	1.13E-02	2.79E-01	9.29E-02	1.16E-02	1.91E-06	8.75E-02	1.09E-02	4.05E-03	1.33E-03
LNG Loading											
	Berthed carrying out cargo transfer	2.48E+00	5.09E-01	8.36E-01	8.36E-01	5.23E-01	8.59E-05	2.63E-01	2.63E-01	1.82E-01	5.98E-02

Table F-7. Emission Rates for Model Input - Steam Turbine Vessels Operating on Natural Gas

Activity		NOx (g/s)		SO2 (g/s)				CO (g/s)		PM (g/s)	
		1 hour	Annual	1 hour	3 hour	24 hour	Annual	1 hour	8 hour	24 hour	Annual
Transit											
	Arrival to Berth at 4-5 knots	1.81E+00	4.95E-02	5.34E-03	3.56E-03	4.45E-04	7.31E-08	8.11E-01	2.03E-01	6.04E-03	1.99E-03
	Transit Berth to Pilot Station	1.81E+00	4.95E-02	5.34E-03	3.56E-03	4.45E-04	7.31E-08	8.11E-01	2.03E-01	6.04E-03	1.99E-03
Hotelling											
	Berthing Vessel	4.38E-01	5.99E-03	1.29E-03	4.31E-04	5.38E-05	8.85E-09	1.96E-01	2.45E-02	7.31E-04	2.40E-04
	Berthed Not Carrying Out Cargo Transfer	4.38E-01	3.60E-02	1.29E-03	1.29E-03	3.23E-04	5.31E-08	1.96E-01	1.47E-01	4.39E-03	1.44E-03
	Vessel warm up of main engine and prep to depart berth	4.38E-01	1.20E-02	1.29E-03	8.61E-04	1.08E-04	1.77E-08	1.96E-01	4.91E-02	1.46E-03	4.81E-04
	Unberthing time	4.38E-01	5.99E-03	1.29E-03	4.31E-04	5.38E-05	8.85E-09	1.96E-01	2.45E-02	7.31E-04	2.40E-04
LNG Loading											
	Berthed carrying out cargo transfer	1.31E+00	2.70E-01	1.29E-02	1.29E-02	8.05E-03	1.32E-06	5.89E-01	5.89E-01	3.29E-02	1.08E-02

Table F-8. Emission Rates for Model Input - DFDE Vessels

Activity		NOx (g/s)		SO2 (g/s)				CO (g/s)		PM (g/s)	
		1 hour	Annual	1 hour	3 hour	24 hour	Annual	1 hour	8 hour	24 hour	Annual
Transit											
	Arrival to Berth at 4-5 knots	2.14E+00	5.86E-02	7.00E-02	4.67E-02	5.83E-03	1.92E-03	1.36E+00	3.41E-01	3.60E-03	1.18E-03
	Transit Berth to Pilot Station	2.14E+00	5.86E-02	7.00E-02	4.67E-02	5.83E-03	1.92E-03	1.36E+00	3.41E-01	3.60E-03	1.18E-03
Hotelling											
	Berthing Vessel	2.14E+00	2.93E-02	7.00E-02	2.33E-02	2.92E-03	9.59E-04	1.36E+00	1.70E-01	1.80E-03	5.92E-04
	Berthed Not Carrying Out Cargo Transfer	2.14E+00	1.76E-01	7.00E-02	7.00E-02	1.75E-02	5.75E-03	1.36E+00	1.02E+00	1.08E-02	3.55E-03
	Vessel warm up of main engine and prep to depart berth	6.41E+00	1.76E-01	2.10E-01	1.40E-01	1.75E-02	5.75E-03	4.09E+00	1.02E+00	1.08E-02	3.55E-03
	Unberthing time	2.14E+00	2.93E-02	7.00E-02	2.33E-02	2.92E-03	9.59E-04	1.36E+00	1.70E-01	1.80E-03	5.92E-04
LNG Loading											
	Berthed carrying out cargo transfer	4.25E+00	8.73E-01	4.16E-01	4.16E-01	2.60E-01	8.55E-02	3.50E+00	3.50E+00	1.48E-01	4.85E-02

Table F-9. Locations and Stack Parameters for Steam Turbine Ships Operating on Oil

Activity	AERMOD Source ID	Stack Location			Stack Parameters			
		UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
Berthed Not Carrying Out Cargo Transfer	STHTL1	397540.7	4809097.7	0.0	40.0	408.2	6.9	1.5
Berthed carrying out cargo transfer	STHTL4	397540.7	4809097.7	0.0	40.0	408.2	5.9	1.5
Tugboat	TUGS01	397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
	TUGS02	397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
	TUGS03	397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
	TUGS04	397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3
Arrival to Berth at 4-5 knots	LNG01	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Berthing Vessel	LNG02	397540.7	4809097.7	0.0	40.0	408.2	8.4	1.5
Vessel warm up and unberthing	LNG08	397540.7	4809097.7	0.0	40.0	408.2	8.4	1.5
Transit Berth to Pilot Station	LNG09	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Transit in Channel/Near Shore	VES1	389899.8	4801854.5	0.0	40.0	408.2	34.5	1.5
	VES2	390078.0	4801763.5	0.0	40.0	408.2	34.5	1.5
	VES3	390256.2	4801672.5	0.0	40.0	408.2	34.5	1.5
	VES4	390434.4	4801581.5	0.0	40.0	408.2	34.5	1.5
	VES5	390612.5	4801490.5	0.0	40.0	408.2	34.5	1.5
	VES6	390790.7	4801399.5	0.0	40.0	408.2	34.5	1.5
	VES7	390968.9	4801308.5	0.0	40.0	408.2	34.5	1.5
	VES8	391147.1	4801217.5	0.0	40.0	408.2	34.5	1.5
	VES9	391325.3	4801126.5	0.0	40.0	408.2	34.5	1.5
	VES10	391503.5	4801035.5	0.0	40.0	408.2	34.5	1.5
	VES11	391681.7	4800944.5	0.0	40.0	408.2	34.5	1.5
	VES12	391859.9	4800853.5	0.0	40.0	408.2	34.5	1.5
	VES13	392038.2	4800765.0	0.0	40.0	408.2	34.5	1.5
	VES14	392206.6	4800822.0	0.0	40.0	408.2	34.5	1.5
	VES15	392375.1	4800879.0	0.0	40.0	408.2	34.5	1.5
	VES16	392543.4	4800936.0	0.0	40.0	408.2	34.5	1.5
	VES17	392711.8	4800993.0	0.0	40.0	408.2	34.5	1.5
	VES18	392839.0	4801112.0	0.0	40.0	408.2	34.5	1.5
	VES19	392924.7	4801293.0	0.0	40.0	408.2	34.5	1.5
	VES20	393010.5	4801474.0	0.0	40.0	408.2	34.5	1.5
	VES21	393096.2	4801655.0	0.0	40.0	408.2	34.5	1.5
	VES22	393182.0	4801836.0	0.0	40.0	408.2	34.5	1.5
	VES23	393267.7	4802017.0	0.0	40.0	408.2	34.5	1.5
	VES24	393381.2	4802176.5	0.0	40.0	408.2	34.5	1.5
	VES25	393522.3	4802318.5	0.0	40.0	408.2	34.5	1.5
	VES26	393663.4	4802460.5	0.0	40.0	408.2	34.5	1.5
	VES27	393804.4	4802602.5	0.0	40.0	408.2	34.5	1.5
	VES28	393945.5	4802744.5	0.0	40.0	408.2	34.5	1.5
	VES29	394086.6	4802886.5	0.0	40.0	408.2	34.5	1.5
	VES30	394227.6	4803028.5	0.0	40.0	408.2	34.5	1.5
	VES31	394368.7	4803170.5	0.0	40.0	408.2	34.5	1.5
	VES32	394509.7	4803312.5	0.0	40.0	408.2	34.5	1.5
	VES33	394650.8	4803454.5	0.0	40.0	408.2	34.5	1.5
	VES34	394791.9	4803596.5	0.0	40.0	408.2	34.5	1.5
	VES35	394932.9	4803738.5	0.0	40.0	408.2	34.5	1.5
	VES36	395074.0	4803880.5	0.0	40.0	408.2	34.5	1.5
	VES37	395215.1	4804022.5	0.0	40.0	408.2	34.5	1.5
	VES38	395356.0	4804161.0	0.0	40.0	408.2	34.5	1.5
	VES39	395438.1	4804335.0	0.0	40.0	408.2	34.5	1.5
	VES40	395520.2	4804509.1	0.0	40.0	408.2	34.5	1.5
	VES41	395602.4	4804683.1	0.0	40.0	408.2	34.5	1.5
	VES42	395684.5	4804857.1	0.0	40.0	408.2	34.5	1.5
	VES43	395766.6	4805031.1	0.0	40.0	408.2	34.5	1.5
	VES44	395848.7	4805205.1	0.0	40.0	408.2	34.5	1.5
	VES45	395930.9	4805379.1	0.0	40.0	408.2	34.5	1.5
	VES46	396013.0	4805553.1	0.0	40.0	408.2	34.5	1.5
	VES47	396095.1	4805727.1	0.0	40.0	408.2	34.5	1.5
	VES48	396177.2	4805901.1	0.0	40.0	408.2	34.5	1.5
	VES49	396259.4	4806075.1	0.0	40.0	408.2	34.5	1.5
	VES50	396341.5	4806249.1	0.0	40.0	408.2	34.5	1.5
	VES51	396423.9	4806421.6	0.0	40.0	408.2	34.5	1.5
	VES52	396453.3	4806604.6	0.0	40.0	408.2	34.5	1.5
	VES53	396482.6	4806787.6	0.0	40.0	408.2	34.5	1.5
	VES54	396512.0	4806970.6	0.0	40.0	408.2	34.5	1.5
	VES55	396541.4	4807153.6	0.0	40.0	408.2	34.5	1.5
	VES56	396570.8	4807336.6	0.0	40.0	408.2	34.5	1.5
	VES57	396600.1	4807519.6	0.0	40.0	408.2	34.5	1.5
	VES58	396629.7	4807705.6	0.0	40.0	408.2	34.5	1.5
	VES59	396732.8	4807876.6	0.0	40.0	408.2	34.5	1.5
	VES60	396848.9	4808023.6	0.0	40.0	408.2	34.5	1.5
	VES61	396978.0	4808145.6	0.0	40.0	408.2	34.5	1.5
	VES62	397107.1	4808267.6	0.0	40.0	408.2	34.5	1.5
	VES63	397236.2	4808389.6	0.0	40.0	408.2	34.5	1.5
	VES64	397365.3	4808512.6	0.0	40.0	408.2	34.5	1.5
	VES65	397560.9	4808554.1	0.0	40.0	408.2	34.5	1.5
	VES66	397561.4	4808721.1	0.0	40.0	408.2	34.5	1.5
	VES67	397561.9	4808888.1	0.0	40.0	408.2	34.5	1.5
	VES68	397562.5	4809054.1	0.0	40.0	408.2	34.5	1.5

Table F-10. Locations and Stack Parameters for Steam Turbine Ships Operating on Gas

Activity	AERMOD Source ID	Stack Location			Stack Parameters			
		UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
Berthed Not Carrying Out Cargo Transfer	GSTHTL1	397540.7	4809097.7	0.0	40.0	408.2	7.1	1.5
Berthed carrying out cargo transfer	GSTHTL4	397540.7	4809097.7	0.0	40.0	408.2	6.1	1.5
Tugboat	TUGS01	397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
	TUGS02	397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
	TUGS03	397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
	TUGS04	397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3
Arrival to Berth at 4-5 knots	GLNG01	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Berthing Vessel	GLNG02	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Vessel warm up and unberthing	GLNG08	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Transit Berth to Pilot Station	GLNG09	397540.7	4809097.7	0.0	40.0	408.2	34.5	1.5
Transit in Channel/Near Shore	GVES1	389899.8	4801854.5	0.0	40.0	408.2	34.5	1.5
	GVES2	390078.0	4801763.5	0.0	40.0	408.2	34.5	1.5
	GVES3	390256.2	4801672.5	0.0	40.0	408.2	34.5	1.5
	GVES4	390434.4	4801581.5	0.0	40.0	408.2	34.5	1.5
	GVES5	390612.5	4801490.5	0.0	40.0	408.2	34.5	1.5
	GVES6	390790.7	4801399.5	0.0	40.0	408.2	34.5	1.5
	GVES7	390968.9	4801308.5	0.0	40.0	408.2	34.5	1.5
	GVES8	391147.1	4801217.5	0.0	40.0	408.2	34.5	1.5
	GVES9	391325.3	4801126.5	0.0	40.0	408.2	34.5	1.5
	GVES10	391503.5	4801035.5	0.0	40.0	408.2	34.5	1.5
	GVES11	391681.7	4800944.5	0.0	40.0	408.2	34.5	1.5
	GVES12	391859.9	4800853.5	0.0	40.0	408.2	34.5	1.5
	GVES13	392038.2	4800765.0	0.0	40.0	408.2	34.5	1.5
	GVES14	392206.6	4800822.0	0.0	40.0	408.2	34.5	1.5
	GVES15	392375.1	4800879.0	0.0	40.0	408.2	34.5	1.5
	GVES16	392543.4	4800936.0	0.0	40.0	408.2	34.5	1.5
	GVES17	392711.8	4800993.0	0.0	40.0	408.2	34.5	1.5
	GVES18	392839.0	4801112.0	0.0	40.0	408.2	34.5	1.5
	GVES19	392924.7	4801293.0	0.0	40.0	408.2	34.5	1.5
	GVES20	393010.5	4801474.0	0.0	40.0	408.2	34.5	1.5
	GVES21	393096.2	4801655.0	0.0	40.0	408.2	34.5	1.5
	GVES22	393182.0	4801836.0	0.0	40.0	408.2	34.5	1.5
	GVES23	393267.7	4802017.0	0.0	40.0	408.2	34.5	1.5
	GVES24	393381.2	4802176.5	0.0	40.0	408.2	34.5	1.5
	GVES25	393522.3	4802318.5	0.0	40.0	408.2	34.5	1.5
	GVES26	393663.4	4802460.5	0.0	40.0	408.2	34.5	1.5
	GVES27	393804.4	4802602.5	0.0	40.0	408.2	34.5	1.5
	GVES28	393945.5	4802744.5	0.0	40.0	408.2	34.5	1.5
	GVES29	394086.6	4802886.5	0.0	40.0	408.2	34.5	1.5
	GVES30	394227.6	4803028.5	0.0	40.0	408.2	34.5	1.5
	GVES31	394368.7	4803170.5	0.0	40.0	408.2	34.5	1.5
	GVES32	394509.7	4803312.5	0.0	40.0	408.2	34.5	1.5
	GVES33	394650.8	4803454.5	0.0	40.0	408.2	34.5	1.5
	GVES34	394791.9	4803596.5	0.0	40.0	408.2	34.5	1.5
	GVES35	394932.9	4803738.5	0.0	40.0	408.2	34.5	1.5
	GVES36	395074.0	4803880.5	0.0	40.0	408.2	34.5	1.5
	GVES37	395215.1	4804022.5	0.0	40.0	408.2	34.5	1.5
	GVES38	395356.0	4804161.0	0.0	40.0	408.2	34.5	1.5
	GVES39	395438.1	4804335.0	0.0	40.0	408.2	34.5	1.5
	GVES40	395520.2	4804509.1	0.0	40.0	408.2	34.5	1.5
	GVES41	395602.4	4804683.1	0.0	40.0	408.2	34.5	1.5
	GVES42	395684.5	4804857.1	0.0	40.0	408.2	34.5	1.5
	GVES43	395766.6	4805031.1	0.0	40.0	408.2	34.5	1.5
	GVES44	395848.7	4805205.1	0.0	40.0	408.2	34.5	1.5
	GVES45	395930.9	4805379.1	0.0	40.0	408.2	34.5	1.5
	GVES46	396013.0	4805553.1	0.0	40.0	408.2	34.5	1.5
	GVES47	396095.1	4805727.1	0.0	40.0	408.2	34.5	1.5
	GVES48	396177.2	4805901.1	0.0	40.0	408.2	34.5	1.5
	GVES49	396259.4	4806075.1	0.0	40.0	408.2	34.5	1.5
	GVES50	396341.5	4806249.1	0.0	40.0	408.2	34.5	1.5
	GVES51	396423.9	4806421.6	0.0	40.0	408.2	34.5	1.5
	GVES52	396453.3	4806604.6	0.0	40.0	408.2	34.5	1.5
	GVES53	396482.6	4806787.6	0.0	40.0	408.2	34.5	1.5
	GVES54	396512.0	4806970.6	0.0	40.0	408.2	34.5	1.5
	GVES55	396541.4	4807153.6	0.0	40.0	408.2	34.5	1.5
	GVES56	396570.8	4807336.6	0.0	40.0	408.2	34.5	1.5
	GVES57	396600.1	4807519.6	0.0	40.0	408.2	34.5	1.5
	GVES58	396629.7	4807705.6	0.0	40.0	408.2	34.5	1.5
	GVES59	396732.8	4807876.6	0.0	40.0	408.2	34.5	1.5
	GVES60	396848.9	4808023.6	0.0	40.0	408.2	34.5	1.5
	GVES61	396978.0	4808145.6	0.0	40.0	408.2	34.5	1.5
	GVES62	397107.1	4808267.6	0.0	40.0	408.2	34.5	1.5
	GVES63	397236.2	4808389.6	0.0	40.0	408.2	34.5	1.5
	GVES64	397365.3	4808512.6	0.0	40.0	408.2	34.5	1.5
	GVES65	397560.9	4808554.1	0.0	40.0	408.2	34.5	1.5
	GVES66	397561.4	4808721.1	0.0	40.0	408.2	34.5	1.5
	GVES67	397561.9	4808888.1	0.0	40.0	408.2	34.5	1.5
	GVES68	397562.5	4809054.1	0.0	40.0	408.2	34.5	1.5

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Table F-11. Locations and Stack Parameters for DFDE Ships

Activity	AERMOD Source ID	Stack Location			Stack Parameters			
		UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
Berthed Not Carrying Out Cargo Transfer	DFDEHTL1	397540.7	4809097.7	0.0	40.0	623.2	5.6	1.5
Berthed carrying out cargo transfer	DFDEHTL4	397540.7	4809097.7	0.0	40.0	623.2	4.8	1.5
Tugboat	TUGS01	397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
	TUGS02	397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
	TUGS03	397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
	TUGS04	397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3
Arrival to Berth at 4-5 knots	DFDLNG01	397540.7	4809097.7	0.0	40.0	623.2	35.5	1.5
Berthing Vessel	DFDLNG02	397540.7	4809097.7	0.0	40.0	623.2	8.7	1.5
Vessel warm up and unberthing	DFDLNG08	397540.7	4809097.7	0.0	40.0	623.2	8.7	1.5
Transit Berth to Pilot Station	DFDLNG09	397540.7	4809097.7	0.0	40.0	623.2	35.5	1.5
Transit in Channel/Near Shore	DFDVES1	389899.8	4801854.5	0.0	40.0	623.2	35.5	1.5
	DFDVES2	390078.0	4801763.5	0.0	40.0	623.2	35.5	1.5
	DFDVES3	390256.2	4801672.5	0.0	40.0	623.2	35.5	1.5
	DFDVES4	390434.4	4801581.5	0.0	40.0	623.2	35.5	1.5
	DFDVES5	390612.5	4801490.5	0.0	40.0	623.2	35.5	1.5
	DFDVES6	390790.7	4801399.5	0.0	40.0	623.2	35.5	1.5
	DFDVES7	390968.9	4801308.5	0.0	40.0	623.2	35.5	1.5
	DFDVES8	391147.1	4801217.5	0.0	40.0	623.2	35.5	1.5
	DFDVES9	391325.3	4801126.5	0.0	40.0	623.2	35.5	1.5
	DFDVES10	391503.5	4801035.5	0.0	40.0	623.2	35.5	1.5
	DFDVES11	391681.7	4800944.5	0.0	40.0	623.2	35.5	1.5
	DFDVES12	391859.9	4800853.5	0.0	40.0	623.2	35.5	1.5
	DFDVES13	392038.2	4800765.0	0.0	40.0	623.2	35.5	1.5
	DFDVES14	392206.6	4800822.0	0.0	40.0	623.2	35.5	1.5
	DFDVES15	392375.1	4800879.0	0.0	40.0	623.2	35.5	1.5
	DFDVES16	392543.4	4800936.0	0.0	40.0	623.2	35.5	1.5
	DFDVES17	392711.8	4800993.0	0.0	40.0	623.2	35.5	1.5
	DFDVES18	392839.0	4801112.0	0.0	40.0	623.2	35.5	1.5
	DFDVES19	392924.7	4801293.0	0.0	40.0	623.2	35.5	1.5
	DFDVES20	393010.5	4801474.0	0.0	40.0	623.2	35.5	1.5
	DFDVES21	393096.2	4801655.0	0.0	40.0	623.2	35.5	1.5
	DFDVES22	393182.0	4801836.0	0.0	40.0	623.2	35.5	1.5
	DFDVES23	393267.7	4802017.0	0.0	40.0	623.2	35.5	1.5
	DFDVES24	393381.2	4802176.5	0.0	40.0	623.2	35.5	1.5
	DFDVES25	393522.3	4802318.5	0.0	40.0	623.2	35.5	1.5
	DFDVES26	393663.4	4802460.5	0.0	40.0	623.2	35.5	1.5
	DFDVES27	393804.4	4802602.5	0.0	40.0	623.2	35.5	1.5
	DFDVES28	393945.5	4802744.5	0.0	40.0	623.2	35.5	1.5
	DFDVES29	394086.6	4802886.5	0.0	40.0	623.2	35.5	1.5
	DFDVES30	394227.6	4803028.5	0.0	40.0	623.2	35.5	1.5
	DFDVES31	394368.7	4803170.5	0.0	40.0	623.2	35.5	1.5
	DFDVES32	394509.7	4803312.5	0.0	40.0	623.2	35.5	1.5
	DFDVES33	394650.8	4803454.5	0.0	40.0	623.2	35.5	1.5
	DFDVES34	394791.9	4803596.5	0.0	40.0	623.2	35.5	1.5
	DFDVES35	394932.9	4803738.5	0.0	40.0	623.2	35.5	1.5
	DFDVES36	395074.0	4803880.5	0.0	40.0	623.2	35.5	1.5
	DFDVES37	395215.1	4804022.5	0.0	40.0	623.2	35.5	1.5
	DFDVES38	395356.0	4804161.0	0.0	40.0	623.2	35.5	1.5
	DFDVES39	395438.1	4804335.0	0.0	40.0	623.2	35.5	1.5
	DFDVES40	395520.2	4804509.1	0.0	40.0	623.2	35.5	1.5
	DFDVES41	395602.4	4804683.1	0.0	40.0	623.2	35.5	1.5
	DFDVES42	395684.5	4804857.1	0.0	40.0	623.2	35.5	1.5
	DFDVES43	395766.6	4805031.1	0.0	40.0	623.2	35.5	1.5
	DFDVES44	395848.7	4805205.1	0.0	40.0	623.2	35.5	1.5
	DFDVES45	395930.9	4805379.1	0.0	40.0	623.2	35.5	1.5
	DFDVES46	396013.0	4805553.1	0.0	40.0	623.2	35.5	1.5
	DFDVES47	396095.1	4805727.1	0.0	40.0	623.2	35.5	1.5
	DFDVES48	396177.2	4805901.1	0.0	40.0	623.2	35.5	1.5
	DFDVES49	396259.4	4806075.1	0.0	40.0	623.2	35.5	1.5
	DFDVES50	396341.5	4806249.1	0.0	40.0	623.2	35.5	1.5
	DFDVES51	396423.9	4806421.6	0.0	40.0	623.2	35.5	1.5
	DFDVES52	396453.3	4806604.6	0.0	40.0	623.2	35.5	1.5
	DFDVES53	396482.6	4806787.6	0.0	40.0	623.2	35.5	1.5
	DFDVES54	396512.0	4806970.6	0.0	40.0	623.2	35.5	1.5
	DFDVES55	396541.4	4807153.6	0.0	40.0	623.2	35.5	1.5
	DFDVES56	396570.8	4807336.6	0.0	40.0	623.2	35.5	1.5
	DFDVES57	396600.1	4807519.6	0.0	40.0	623.2	35.5	1.5
	DFDVES58	396629.7	4807705.6	0.0	40.0	623.2	35.5	1.5
	DFDVES59	396732.8	4807876.6	0.0	40.0	623.2	35.5	1.5
	DFDVES60	396848.9	4808023.6	0.0	40.0	623.2	35.5	1.5
	DFDVES61	396978.0	4808145.6	0.0	40.0	623.2	35.5	1.5
	DFDVES62	397107.1	4808267.6	0.0	40.0	623.2	35.5	1.5
	DFDVES63	397236.2	4808389.6	0.0	40.0	623.2	35.5	1.5
	DFDVES64	397365.3	4808512.6	0.0	40.0	623.2	35.5	1.5
	DFDVES65	397560.9	4808554.1	0.0	40.0	623.2	35.5	1.5
	DFDVES66	397561.4	4808721.1	0.0	40.0	623.2	35.5	1.5
	DFDVES67	397561.9	4808888.1	0.0	40.0	623.2	35.5	1.5
	DFDVES68	397562.5	4809054.1	0.0	40.0	623.2	35.5	1.5

Table F-12. Tugboat Emissions Information[1]							
Pollutant	Emission Factor (g/kWh)	Tug Emissions per Port Call (kg)	Emission Factors for Modeling (per surrogate source, g/s)[1]				
			1-hour	3-hour	8-hour	24-hour	Annual
NO_x[2]	1.80E+00	72	2.38E-01	N/A	N/A	N/A	5.70E-04
CO[3]	3.35E+00	134	4.42E-01	N/A	4.42E-01	N/A	N/A
PM[2]	6.00E-02	2	N/A	N/A	N/A	7.93E-03	1.90E-05
SO_2[3]	4.92E-01	20	6.50E-02	6.50E-02	N/A	6.50E-02	1.56E-04
VOC[2]	1.90E-01	8	N/A	N/A	N/A	N/A	N/A
CO_2[3]	7.06E+02	28183	N/A	N/A	N/A	N/A	N/A

Notes:
(1) Tug is represented as four surrogate sources to account for manuevering about the berthed ship.
(2) NOx, PM, and VOC emissions are EPA Marine Tier 4 standards (40 CFR Section 1042.1, Table 3)
(3) CO, SO2, and CO2 emission factors from AP42 Table 3.4-1. Sulfur content of fuel assumed 0.1%.
(4) Emissions per call calculated by multiplying emisison factor by 39942 kWh, the total energy expended per ship call. Rates determined by dividing total emissions by 1260 minutes operation per ship call. Emission rate for each surrogate source is one-quarter of the overall emission rate. Annual emissions based on 120 ship calls per year.

Tug Activities and Operating Times per Ship Call

Activity	Time (min)	Kw	Kw-Hour
Maneuvering Around Ship	1200	1902	38040
Maneuvering Around Ship/Easy Push	60	1902	1902
Total Tug Activity per LNG Ship Call	1260	1902	39942

Table F-13. Tugboat Stack and Location Information[1]						
Location			Stack Parameters			
UTM E (m)	UTM N (m)	Elevation (m)	Height (m)	Temp (K)	Velocity (m/s)	Diameter (m)
397485.0	4809200.0	0.0	10.7	801.0	61.8	0.3
397485.0	4809100.0	0.0	10.7	801.0	61.8	0.3
397485.0	4809000.0	0.0	10.7	801.0	61.8	0.3
397485.0	4808900.0	0.0	10.7	801.0	61.8	0.3

Table F-14. Emissions Scenarios for Annual Averaging Periods					
Scenario	Source	Description	Emission Factors for Modeling (g/s)		
			PM_{10}	PM_{25}	NO_2
Steam Turbine Ships Operating on Oil	STHTL1	Berthed, Not Carrying Out Cargo Transfer	7.979E-03	7.979E-03	6.781E-02
	STHTL4	Berthed, Carrying Out Cargo Transfer	5.985E-02	5.985E-02	5.086E-01
	LNG01	Arrival to Berth	1.099E-02	1.099E-02	9.342E-02
	LNG02	Berthing Vessel	1.330E-03	1.330E-03	1.130E-02
	LNG08	Vessel Warm Up and Unberthing	3.990E-03	3.990E-03	3.390E-02
	LNG09	Departure from Berth to Pilot Station	1.099E-02	1.099E-02	9.342E-02
	TUGS01-TUGS04	Tugboats(1)	1.900E-05	1.900E-05	6.500E-02
	VES01-VES68	Vessel Transit through Channel(1)	3.234E-04	3.234E-04	1.694E-02
Steam Turbine Ships Operating on Gas	GSTHTL1	Berthed, Not Carrying Out Cargo Transfer	1.442E-03	1.442E-03	1.292E-03
	GSTHTL4	Berthed, Carrying Out Cargo Transfer	1.081E-02	1.081E-02	1.288E-02
	GLNG01	Arrival to Berth	1.986E-03	1.986E-03	5.339E-03
	GLNG02	Berthing Vessel	2.403E-04	2.403E-04	1.292E-03
	GLNG08	Vessel Warm Up and Unberthing	7.209E-04	7.209E-04	2.583E-03
	GLNG09	Departure from Berth to Pilot Station	1.986E-03	1.986E-03	5.339E-03
	TUGS01-TUGS04	Tugboats(1)	1.900E-05	1.900E-05	6.500E-02
	GVES01-GVES68	Vessel Transit through Channel(1)	5.843E-05	5.843E-05	1.457E-03
DFDE Ships	DFDHTL1	Berthed, Not Carrying Out Cargo Transfer	3.555E-03	3.555E-03	1.757E-01
	DFDHTL4	Berthed, Carrying Out Cargo Transfer	4.854E-02	4.854E-02	8.733E-01
	DFDLNG01	Arrival to Berth	1.185E-03	1.185E-03	5.856E-02
	DFDLNG02	Berthing Vessel	5.925E-04	5.925E-04	2.928E-02
	DFDLNG08	Vessel Warm Up and Unberthing	4.147E-03	4.147E-03	2.050E-01
	DFDLNG09	Departure from Berth to Pilot Station	1.185E-03	1.185E-03	5.856E-02
	TUGS01-TUGS04	Tugboats(1)	1.900E-05	1.900E-05	6.500E-02
	DFDVES01-DFDVES68	Vessel Transit through Channel(1)	3.485E-05	3.485E-05	1.722E-03

(1) Four surrogate tugboat sources and 68 surrogate vessel sources are used to represent the motion of these vessels.
Each surrogate tug is assigned 1/4 of the total tug emissions, and each surrogate vessel 1/68 of the total vessel emissions

Table F-15. Emissions Scenarios for 24-Hour Averaging Periods				
Scenario	Source	Description	Emission Factors for Modeling (g/s)	
			PM_{10}	PM_{25}
Steam Turbine Ships Operating on Oil	STHTL1	Berthed, Not Carrying Out Cargo Transfer	2.427E-02	2.427E-02
	STHTL4	Berthed, Carrying Out Cargo Transfer	1.820E-01	1.820E-01
	LNG01	Arrival to Berth	3.344E-02	3.344E-02
	LNG02	Berthing Vessel	4.045E-03	4.045E-03
	LNG08	Vessel Warm Up and Unberthing	1.214E-02	1.214E-02
	LNG09	Departure from Berth to Pilot Station	3.344E-02	3.344E-02
	TUGS01-TUGS04	Tugboats[(1)]	7.925E-03	7.925E-03
	VES01-VES68	Vessel Transit through Channel[(1)]	9.835E-04	9.835E-04
Steam Turbine Ships Operating on Gas	GSTHTL1	Berthed, Not Carrying Out Cargo Transfer	4.385E-03	4.385E-03
	GSTHTL4	Berthed, Carrying Out Cargo Transfer	3.289E-02	3.289E-02
	GLNG01	Arrival to Berth	6.042E-03	6.042E-03
	GLNG02	Berthing Vessel	7.309E-04	7.309E-04
	GLNG08	Vessel Warm Up and Unberthing	2.193E-03	2.193E-03
	GLNG09	Departure from Berth to Pilot Station	6.042E-03	6.042E-03
	TUGS01-TUGS04	Tugboats[(1)]	7.925E-03	7.925E-03
	GVES01-GVES68	Vessel Transit through Channel[(1)]	1.777E-04	1.777E-04
DFDE Ships	DFDHTL1	Berthed, Not Carrying Out Cargo Transfer	1.081E-02	1.081E-02
	DFDHTL4	Berthed, Carrying Out Cargo Transfer	1.477E-01	1.477E-01
	DFDLNG01	Arrival to Berth	3.604E-03	3.604E-03
	DFDLNG02	Berthing Vessel	1.802E-03	1.802E-03
	DFDLNG08	Vessel Warm Up and Unberthing	1.261E-02	1.261E-02
	DFDLNG09	Departure from Berth to Pilot Station	3.604E-03	3.604E-03
	TUGS01-TUGS04	Tugboats[(1)]	7.925E-03	7.925E-03
	DFDVES01-DFDVES68	Vessel Transit through Channel[(1)]	1.060E-04	1.060E-04

[(1)] Four surrogate tugboat sources and 68 surrogate vessel sources are used to represent the motion of these vessels.
Each surrogate tug is assigned 1/4 of the total tug emissions, and each surrogate vessel 1/68 of the total vessel emissions.

Table F-16. Emissions Scenarios for 1-Hour Averaging Periods				
Scenario	Source	Description	Emission Factors for Modeling (g/s)	
			NO_2	SO_2
All 1-Hour Scenarios[1]	TUGS01-TUGS04	Tugboats[2]	2.378E-01	6.500E-02
Steam Turbine Ships Operating on Oil in Transit	VES01-VES68	Vessel Transit through Channel[2]	5.015E-02	1.694E-02
Steam Turbine Ships Operating on Gas in Transit	GVES01-GVES68	Vessel Transit through Channel[2]	2.659E-02	7.851E-05
DFDE Ships in Transit	DFDVES01-DFDVES68	Vessel Transit through Channel[2]	3.143E-02	1.029E-03
Steam Turbine Ships Operating on Oil Arriving at Berth	LNG01	Arrival to Berth	3.410E+00	1.152E+00
Steam Turbine Ships Operating on Gas Arriving at Berth	GLNG01	Arrival to Berth	1.808E+00	5.339E-03
DFDE Ships Arriving at Berth	DFDLNG01	Arrival to Berth	2.138E+00	7.000E-02
Steam Turbine Ships Operating on Oil Berthing	LNG02	Berthing Vessel	8.250E-01	2.788E-01
Steam Turbine Ships Operating on Gas Berthing	GLNG02	Berthing Vessel	4.375E-01	1.292E-03
DFDE Ships Berthing	DFDLNG02	Berthing Vessel	2.138E+00	7.000E-02
Steam Turbine Ships Operating on Oil Hoteling	STHTL1	Berthed, Not Carrying Out Cargo Transfer	8.250E-01	2.788E-01
Steam Turbine Ships Operating on Gas Hoteling	GSTHTL1	Berthed, Not Carrying Out Cargo Transfer	4.375E-01	1.292E-03
DFDE Ships Hoteling	DFDHTL1	Berthed, Not Carrying Out Cargo Transfer	2.138E+00	7.000E-02
Steam Turbine Ships Operating on Oil Loading	STHTL4	Berthed, Carrying Out Cargo Transfer	2.475E+00	8.363E-01
Steam Turbine Ships Operating on Gas Loading	GSTHTL4	Berthed, Carrying Out Cargo Transfer	1.313E+00	1.288E-02
DFDE Ships Loading	DFDHTL4	Berthed, Carrying Out Cargo Transfer	4.250E+00	4.163E-01
Steam Turbine Ships Operating on Oil Warmup/Unberth	LNG08	Vessel Warm Up and Unberthing	1.650E+00	5.575E-01
Steam Turbine Ships Operating on Gas Warmup/Unberth	GLNG08	Vessel Warm Up and Unberthing	8.750E-01	2.583E-03
DFDE Ships Warmup/Unberth	DFDLNG08	Vessel Warm Up and Unberthing	6.413E+00	2.100E-01
Steam Turbine Ships Operating on Oil Departing	LNG09	Departure from Berth to Pilot Station	3.410E+00	1.152E+00
Steam Turbine Ships Operating on Gas Departing	GLNG09	Departure from Berth to Pilot Station	1.808E+00	5.339E-03
DFDE Ships Departing	DFDLNG09	Departure from Berth to Pilot Station	2.138E+00	7.000E-02

(1) The tug emissions are included in all 1-hour scenarios, along with one of the individual activities below.
The ship activities included in the source groups differ for the 1-hour NO2 and SO2 full impact modeling versus the 24-hour and annual full impact modeling for PM2.5 and PM10 and annual full impact modeling for NO2 because of the length of the ship calls at the Terminal and the time the ship is engaged in each activity during its call. For the 1-hour averaging periods, source groups include the emissions from one activity of the LNG tanker (transit, arrival to berth, departure from berth, berthing, berthed but not carrying out cargo transfer, berthed and carrying out cargo transfer, warmup and unberthing time." Each of these activities take at least one hour. Therefore, 1-hour source groups for marine vessels are designed to include one of these individual activities, in addition to the activities of the tugboats. For the 24-hour and annual averaging periods, relevant source groups include multiple activities from the LNG tanker in addition to the tugboats.

(2) Four surrogate tugboat sources and 68 surrogate vessel sources are used to represent the motion of these vessels.
Each surrogate tug is assigned 1/4 of the total tug emissions, and each surrogate vessel 1/68 of the total vessel emissions

APPENDIX G.9

Computer Noise Modeling and Mitigation Report

Acoustical Modeling Report

REV	DATE	DESCRIPTION	BY	CHKD	APPVD	COMPANY APPROVAL
			JDS	KJL	SPH	
1	29-Aug-17	Issue for FERC Filing	JDS	KJL	SPH	

IP SECURITY	☐ Confidential	Total amount of pages including coversheet:	10
FOR CONTRACTOR DOCUMENTS	Contract No.	Contractor Document No.	Contractor Rev.
	KBJ-029	J1-000-RGL-RPT-KBJ-51300-00	1

JCL DOCUMENT NUMBER	Proj. Code	Unit / Location	Discipline	Doc. Type	Orig. Code	Sequence No.	Sheet No.
	J1	000	RGL	RPT	KBJ	51300	00

Revision Modification Log

Document Title :	Acoustical Modeling Report	Rev. :	1
Document No. :	J1-000-RGL-RPT-KBJ-51300-00	Rev. Date :	29-Aug-2017

Page No.	Section	Change Description

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1 Scope

This document describes the basis, methodology, and results of acoustical modeling for the JCLNG project. It includes updated acoustical design and performance information that is consistent with the Acoustical BOD, along with acoustical calculation results in accordance with design standards.

2 Applicable Documents

2.1 SUPPORTING AND SUPPLEMENTAL DOCUMENTS

2.1.1 Supporting Documents

Supporting documents are those documents that are used in conjunction with this document.

Document Title	Document Number
1. Acoustical BOD	J1-000-MEC-BOD-KBJ-50002

2.1.2 Drawings

JCLNG Project Drawing Title	JCLNG Document Number
1. Overall Plot Plan	J1-000-TEC-PLT-KBJ-51000-01 (Proj. Dwg. No. 189980-0000-FG2000)
2. Liquefaction Plot Plan	J1-000-TEC-PLT-KBJ-51001-01 (Proj. Dwg. No. 189980-0000-FG2001)
3. Equipment Layout Liquefaction – Train #1	J1-000-PIP-PLT-KBJ-50002-01 (Proj. Dwg. No. 189980-0000-FM0011)

3 Codes and Standards

Codes and Standards to be used on the JCLNG Project are the latest version of the codes and standards identified in 189980-0000-FU0200 Applicable Code and Standards, including ISO 9613 for calculation of outdoor sound levels, unless otherwise noted therein.

4 Calculation Methodology

Calculations were completed in accordance with ISO 9613 methodology using DataKustik Cadna/A™ software (version 2017). Modeling configuration was as follows:

- Source-to-receiver search radius: 6 km
- Temperature: 10 °C
- Relative humidity: 70 percent
- Default ground absorption value, G: 0.50 ("mixed" ground)

ISO 9613 calculations inherently assume a downwind condition from all sources to all receivers, and a moderate temperature inversion akin to a clear, calm, nighttime condition. Effects of local topography were included via project site grading information and GIS terrain data. Water surfaces—i.e., Coos Bay—were included with G=0.0 ("hard" ground). Shielding from major project equipment and structures, including impermeable vapor barrier walls, was included. Shielding from off-site structures was not included. All other calculation parameters were default ISO 9613 values.

5 Model Input (Sources)

Equipment packages considered in the acoustical model are detailed in Table 5-1. Information is consistent with the referenced Acoustical BOD. Items not originally included in the Acoustical BOD, but considered for this updated analysis are as indicated in Table 5-1. Octave-band sound levels for equipment were included in the model, as shown in Table 5-2. The basis for octave-band sound levels was in-house data sources for similar equipment, or empirically calculated data adjusted to conform to project specifications and requirements. For reference, a 3-D view of the acoustical model is provided in Figure 5-1. Note that some sources that will not operate continuously, such as ground flares and tanker hoteling, were conservatively included in the model. No supplemental noise mitigation measures have been included in the model.

Table 5-1 JCLNG Project Equipment Broadband Sound Levels

Equipment Package	Qty	Sound Level Specification (L_p re 20 µPa)	Associated Sound Power Level (L_w re 1 pW)
Refrigerant compressor	5	95dBA @ 3 ft	112 dBA
Combustion turbine	5	85 dBA @ 3 ft 62 dBA @ 400 ft	CT enclosure: 103 dBA CT air inlet: 90 dBA
Heat recovery steam generator	5	85 dBA @ 3 ft 58 dBA @ 400 ft	Boiler: 110 dBA Stack exit: 112 dBA
Compressor suction piping	NA	95 dBA @ 3 ft	≤ 114 dBA
Compressor discharge piping	NA	100 dBA @ 3 ft	≤ 118 dBA
JT valve	40	85 dBA @ 3 ft	100 dBA
Interstage aftercooler (42 cells)	5	85 dBA @ 3 ft	96 dBA per fan
Discharge and LO cooler (42 cells)	5	85 dBA @ 3 ft	96 dBA per fan
Amine cooler (12 cells)	1	85 dBA @ 3 ft	97 dBA per fan
Stripper reflux condenser (3 cells)	1	85 dBA @ 3 ft	97 dBA per fan
Regen gas cooler (6 cells)	1	85 dBA @ 3 ft	97 dBA per fan
BOG compressor interstage cooler (6 cells)	1	85 dBA @ 3 ft	97 dBA per fan
BOG compressor discharge cooler (6 cells)	1	85 dBA @ 3 ft	97 dBA per fan
Steam turbine	3	85 dBA @ 3 ft	HP/IP Turbine: 98 dBA LP Turbine: 94 dBA
Air-cooled condenser (4 cells)	3	85 dBA @ 3 ft	96 dBA per fan
BOG compressor	2	85 dBA @ 3 ft	105 dBA
Boiler feedwater pump	4	87 dBA @ 3 ft	107 dBA
Instrument air compressor	3	85 dBA @ 3 ft	100 dBA
Ground flares	2	85 to 100 dBA @ 3 ft	111 to 126 dBA
Tanker (hoteling) – idling engine noise	1	85 dBA @ 3 ft (interior)	90 dBA (idling exhaust)
Gas metering valve	1	85 dBA @ 3 ft	100 dBA

Table 5-2 JCLNG Project Equipment Octave-band Sound Level (dB) Modeling Input

Equipment Source	Sound Level Type	32 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Refrigerant compressor	L_w	100	92	89	87	88	95	83	78	73
CT air inlet	L_w	101	105	98	93	86	77	73	81	76
CT turbine enclosure	L_w	107	108	106	106	102	95	92	93	90
HRSG boiler casing	L_p @ 3 ft	88	93	89	81	71	70	58	38	8
HRSG stack exit	L_w	109	117	119	116	107	106	93	68	49
Refrigerant compressor suction piping	L_p @ 3 ft	101	94	90	88	91	93	86	79	75
Refrigerant compressor discharge piping	L_p @ 3 ft	106	99	95	93	96	98	91	84	80
Valve	L_w	82	82	81	81	86	99	85	85	90
Interstage aftercooler fan	L_w	103	102	98	94	94	91	87	83	75
Discharge & LO cooler fan	L_w	103	102	98	94	94	91	87	83	75
All other cooler fans (Amine, stripper reflux condenser, regen gas, BOG compressor interstage anddischarge)	L_w	100	102	102	98	95	92	84	80	76
HP/IP steam turbine	L_w	109	109	98	97	96	92	89	86	85
LP steam turbine	L_w	110	100	96	95	93	88	82	79	78
ACC fan	L_w	100	99	95	91	97	88	84	80	72
BOG compressor	L_p @ 3 ft	82	82	83	82	82	83	85	83	78
Boiler feedwater pump	L_w	100	106	104	103	102	101	100	99	95
Air compressor	L_w	93	99	97	96	95	94	93	92	88
Flare (max)	L_w	100	105	111	114	116	118	120	119	118
Engine noise	L_w	96	92	98	94	86	82	76	66	58

Note: L_w = sound power levels re 1 pW and L_p = sound pressure levels re 20 µPa. Sound levels are unweighted.

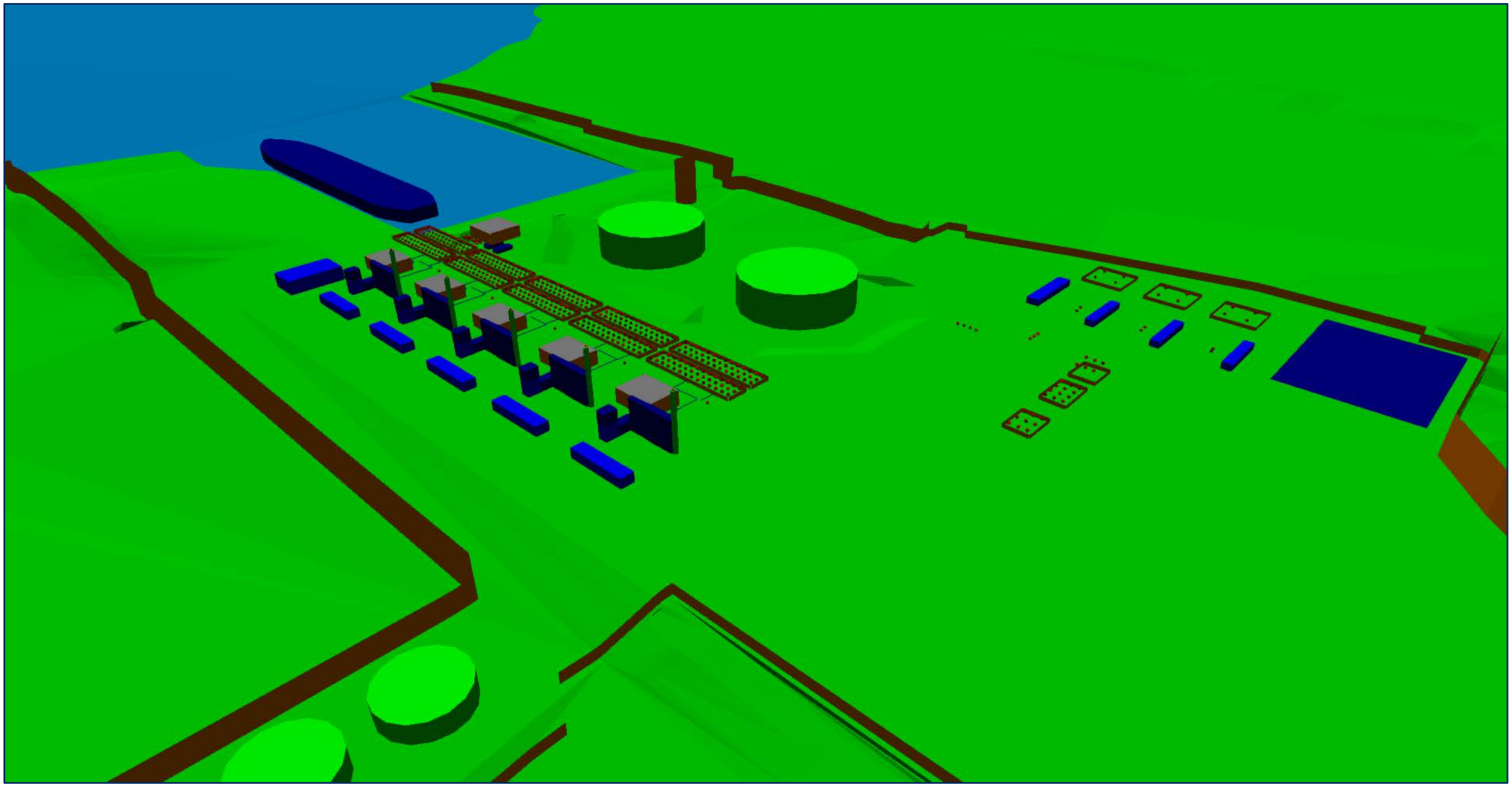


Figure 5-1 3D view of JCLNG acoustical model (from north).

6 Model Output (Results)

The results of the acoustical model were evaluated at three "noise-sensitive areas" (NSAs) that have been identified. Information regarding the location and predicted project sound levels at the NSAs is provided in Table 6-1. Figure 6-1 provides a sound level contour plot for the project and vicinity. Note that the sound levels include only project noise sources and do not include of any other sound sources, such as background noise.

Table 6-1 JCLNG Acoustical Modeling Results at NSAs

Location & Description	UTM Zone 10 Easting	UTM Zone 10 Northing	Elevation (AMSL)	Project L_{dn}	Project L_{eq}
NSA 1 – Residential	398481 m	4807460 m	29 m	51 dBA	45 dBA
NSA 2 – Residential	401292 m	4809791 m	34 m	43 dBA	37 dBA
NSA 3 – Horsfall Campground	399204 m	4810573 m	19 m	49 dBA	43 dBA

Note: L_{dn} = day-night average sound level (24-hour average sound level that includes a 10 dBA penalty for nighttime sound levels between 10 p.m. and 7 a.m.) and L_{eq} = equivalent-continuous ("steady-state" or "average") sound pressure level.

7 Mitigation

The modeling results include the effects of any standard noise control measures provided by equipment suppliers to meet the sound level specifications. Supplemental mitigation measures such as acoustical enclosures, acoustical barrier walls, and additional silencers, are not anticipated to be required for the project to achieve the sound levels noted above in Table 6-1.

Figure 7-1 JCLNG normal operations L_{dn} sound level contour plot (aerial from Google™ Earth).

APPENDIX H.9

Marine Mammal Airborne Noise Impact Assessment

Memorandum

To: Bill Gorham, AECOM

From: Briony Croft

Date: 20 September 2017

Subject: Jordan Cove LNG – Marine Mammal Airborne Noise Impact Assessment

This technical memorandum provides information on the airborne noise impacts of construction and operation of the Jordan Cove Energy Project (JCEP) LNG Terminal on marine mammals (hauled out).

Noise predictions provided in this memo have been determined using the Project's Resource Report 9 (RR9) noise model, but with noise levels presented in an unweighted format appropriate for a review of impacts to marine mammals (noting that A-weighted levels described in RR9 are appropriate for human impact assessment purposes only).

1.0 INTRODUCTION

1.1 Project Description

The marine facilities associated with the Jordan Cove Energy Project (JCEP) LNG Terminal will be on the bay side of the North Spit of Coos Bay, Oregon. Construction of the marine facilities will include several activities with the potential to generate noise affecting marine mammals in air (hauled out):

- General construction activities
- Dredging of the marine slip, access channel and materials offloading facility (MOF);
- Piling

These activities with potential for airborne noise generation are described in detail in the documents submitted to The Federal Energy Regulatory Commission (FERC) for the purpose of review of the potential environmental impacts of a proposed project under the National Environmental Policy Act (NEPA).

The most prevalent sound source during general construction is anticipated to be the internal combustion engines used to provide mobility and operating power to construction equipment.

Dredging would occur in a staged approach, with as much material as possible removed by excavation in isolation from Coos Bay behind a temporary berm. The noise levels of this activity would be broadly similar to general construction noise. Some in water dredging would also be required.

Approximately 3600 pipe piles and over 11,800 sheet piles will be will be required for the project in total, including marine and upland piles.

During operation of the LNG facility, the primary airborne noise sources would be compressors, condensers, steam turbine generators, coolers, pumps, valves and piping. The noise impacts to marine mammals during operation would generally be less than during construction.

1.2 Marine Mammal Species Considered

This assessment considers the potential for construction noise from the JCEP LNG Terminal Project to impact on hauled out marine mammals (ie, the potential for airborne noise to affect marine mammals who are on land, above the surface of the water).

RR3 Section 3.1.3 lists non-endangered marine mammals potentially occurring in the region, and Table 3.4-1 lists threatened and endangered species. Non-endangered marine mammal species potentially occurring in haul outs in the Coos Bay estuary include the California sea lion, Steller sea lion, and harbor seal.

2.0 MARINE MAMMAL NOISE IMPACT THRESHOLDS

Guidance on in-air acoustic thresholds for marine mammal disturbance are provided by the National Oceanic and Atmospheric Administration (NOAA) and the National Marine Fisheries Service (NMFS)[1]. There are no established thresholds for injury (hearing damage) applicable to marine mammals in air. The NMFS interim in-air thresholds behavioral effects are shown in Table 1.

Table 1 Interim in-air marine mammal acoustic thresholds

Criterion Definition	Threshold
Behavioral disruption for harbor seals	90 dB_{rms}
Behavioral disruption for non harbor seal pinnipeds	100 dB_{rms}

Notes: dB referenced to 20 micro Pascal (re: 20µPa).
All thresholds are based off root mean square (rms) levels and are broadband (unweighted).

Of the construction noise sources considered in this assessment, the majority are considered approximately “continuous” for the purpose of this assessment. For continuous noise sources, the rms noise level is equivalent to L_{eq} parameter. The L_{eq} is defined as the energy equivalent sound level, or the sound energy average over a defined time period. For this assessment, the rms in-air marine mammal acoustic thresholds are directly compared with the L_{eq} noise levels from general construction, dredging and operations.

Noise from impact pile driving is impulsive, characterized by rapid noise pulses with each strike of the pile. For an impulsive noise source, the rms sound level is defined as the average sound level for a duration that contains 90 percent of the total sound energy of the impulsive event. For the purpose of this assessment, the short term maximum sound level during pile driving (L_{max}) is compared directly with the rms behavioral disruption threshold. This is a conservative assessment approach, since the rms noise level for an impulsive event will always be less than the maximum sound level.

3.0 NOISE LEVEL VERSUS DISTANCE

For the purpose of this impact assessment, the objective is to quantify the noise level for the various scenarios considered, across the areas in the vicinity of the project where marine mammals may be present in air. Examples of the extent of noise impacts are provided in the form of noise isopleths corresponding to the 90 decibel (dB) and 100 dB impact thresholds in the following figures. The noise modelling process, inputs and assumptions are as described in the documents submitted to The FERC for the purpose of review of the potential environmental impacts of the project. An example of the general construction noise impacts to marine mammals in air are shown in Figure 1. Corresponding figures for in-air noise impacts to marine mammals during dredging and piling are shown in Figure 2 and Figure 3 respectively. These figures are indicative – the location of construction noise sources will move around the site, and the noise impacts will shift accordingly.

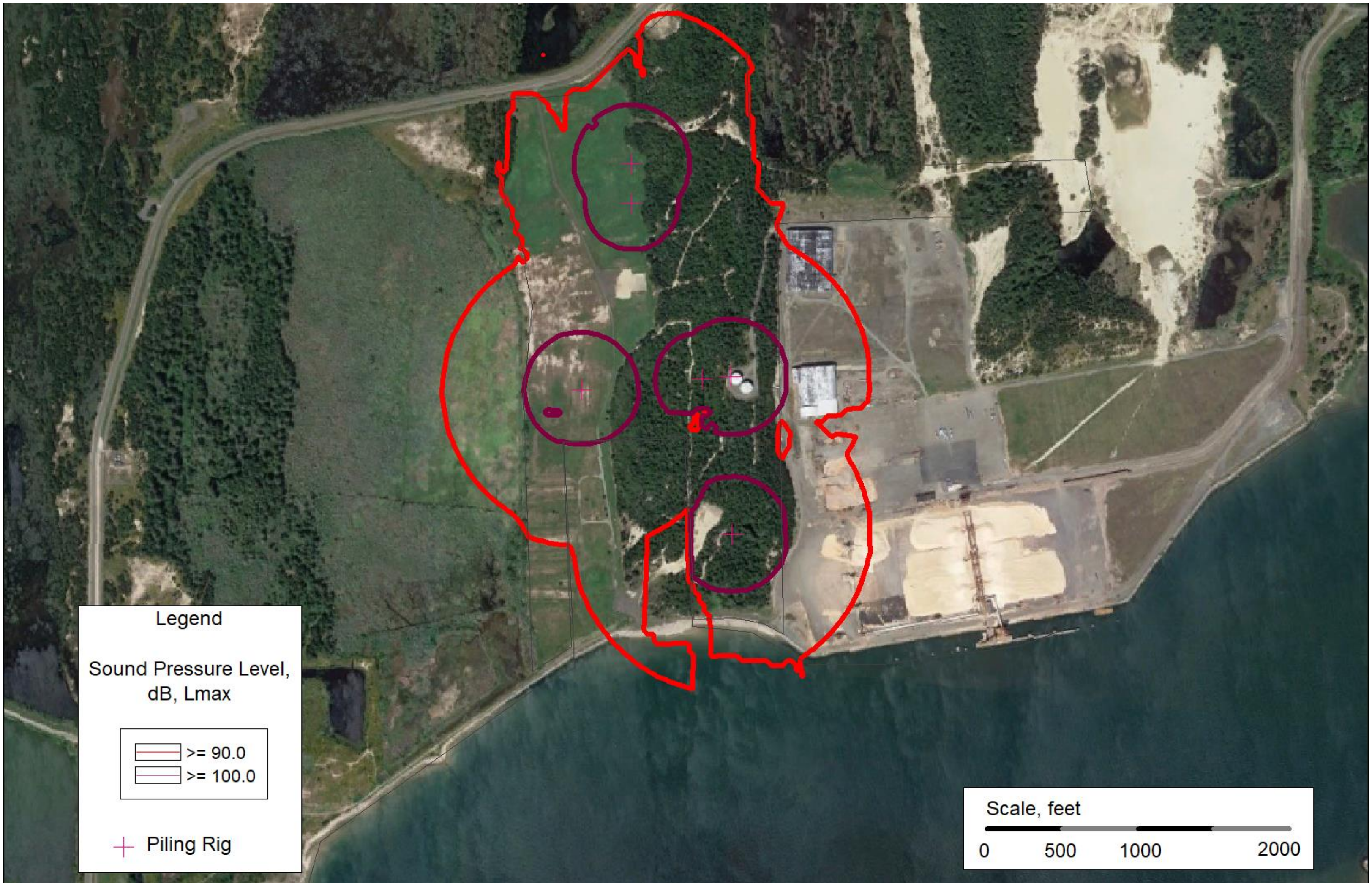
[1] http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/threshold_guidance.html

Figure 1 Indicative general construction in air marine mammal noise impacts

Figure 2 Indicative dredging in air marine mammal noise impacts

Note that the 100 dB threshold is not exceeded by dredging, and the 90 dB contour is exceeded only within 40 feet of the dredge.

Figure 3 Indicative pile driving in air marine mammal noise impacts



Note: the active location of piling rigs will vary from day to day, with the location of noise isopleths shifting accordingly.

4.0 SUMMARY OF IN-AIR NOISE IMPACTS TO MARINE MAMMALS

The extent of noise in-air above the NMFS interim marine mammal behavioral disturbance thresholds is limited to areas in the immediate vicinity of the noise sources. The distances to the in air thresholds for each of the various noise prediction modelling scenarios considered are summarized as follows:

- During general construction, noise levels in air would decrease to below the most stringent threshold of 90 dB rms for harbor seals at distances of the order of 275 feet from the facility boundary.
- During dredging, noise levels in air would decrease to below the most stringent threshold of 90 dB rms for harbor seals at distances of the order of 40 feet from the noise source.
- During pile driving, noise levels in air would decrease to below the most stringent threshold of 90 dB rms for harbor seals at distances of the order of 920 feet from the nearest piling rig.

The noise impacts to marine mammals during operation would generally be less than during construction.

5.0 STATEMENT OF LIMITATIONS

The services described in this work product were performed in accordance with generally accepted professional consulting principles and practices. No other representations or warranties, expressed or implied, are made. These services were performed consistent with our agreement with our client. This work product is intended solely for the use and information of our client unless otherwise noted. Any reliance on this work product by a third party is at such party's sole risk.

Opinions and recommendations contained in this work product are based on conditions that existed at the time the services were performed and are intended only for the client, purposes, positions, time frames, and project parameters indicated. The data reported and the findings, observations, and conclusions expressed are limited by the scope of work. We are not responsible for the impacts of any changes in environmental standards, practices, or regulations subsequent to performance of services. We do not warrant the accuracy of information supplied by others, or the use of segregated portions of this work product.

This work product presents professional opinions and findings of a scientific and technical nature. The work product shall not be construed to offer legal opinion or representations as to the requirements of, nor the compliance with, environmental laws rules, regulations, or policies of federal, state or local governmental agencies.

APPENDIX I.9

Underwater Noise Impact Assessment

Memorandum

To: Drew Jackson

From: Briony Croft

Date: 15 September 2017

Subject: Jordan Cove LNG - Underwater Noise Impact Assessment

This technical memorandum provides a response to Items 8 and 11 from the FERC Environmental Information Request to the Jordan Cove and Pacific Connector Project (Docket No. PF17-4-000). These items request additional information to supplement the RR9 assessment of underwater noise impacts as follows:

8. *Include an evaluation and quantification of noise impacts from sound pressure waves generated within the water due to pile driving and dredging operations, as well as noise due to the operation of the tugs and LNG vessels. Quantify sound pressure levels in the aquatic environment (in dB re: 1µPa) to a distance of 1 mile and discuss impacts to all threatened and endangered aquatic species, marine mammals, and commercial and recreational fish species.*

11. *Estimate potential in-air and underwater noise impacts associated with the construction activities and equipment needed to widen and/or modify the Coos Bay Channel as part of the proposed Pilots Project.*

In addition to this memorandum, supporting documents are attached as follows:

Appendix A – NMFS spreadsheet calculations of potential for permanent threshold shift due to dredging and vessel operations.

Appendix B – JASCO Applied Sciences technical memorandum on vibratory pile driving

Appendix C - JASCO Applied Sciences technical memorandum on impact pile driving

1.0 INTRODUCTION

1.1 Project Description

The marine facilities associated with the Jordan Cove Energy Project (JCEP) LNG Terminal will be on the bay side of the North Spit of Coos Bay, Oregon. Construction of the marine facilities will include several activities with the potential to generate underwater noise:

- Dredging of the marine slip, access channel and materials offloading facility (MOF);
- Dredging in areas along the Coos Bay navigation channel as part of the proposed Pilots project;
- Placement of a sheet pile bulkhead; and
- Construction of platforms, fenders and mooring structures.

The construction activities with the most potential for underwater noise generation are dredging and pile driving. Dredging would occur in a staged approach, with as much material as possible removed through excavation in isolation from Coos Bay behind a temporary berm. In-water work including dredging and removal the temporary berm would be undertaken with a cutter suction dredge and a clamshell dredge. The equipment to dredge the Coos Bay navigation channel is yet to be confirmed, but on the basis of comparable projects use of a cutter suction dredge is likely and represents a reasonable worst case for indicative noise impact assessment.

Approximately 3600 pipe piles and over 11,800 sheet piles will be will be required for the project in total, including marine and upland piles. The average length of steel pipe piles will be around 93 feet in length. The largest steel pipe piles to be installed in water are the MOF bollards at 36-inches in diameter. These piles will be installed by hydraulic pile driving (impact hammer). The sheet pile bulkhead forming the MOF and berth walls would be installed by vibratory pile driving.

During operation of the LNG facility, the primary underwater noise sources would be vessels, including LNG ships and tugs. The JCEP LNG Terminal will add approximately 110-120 additional LNG carriers on an annual basis to the existing approximately 50 deep draft vessels per year operating in the area.

1.2 Aquatic Species Considered

Fisheries resources are described in JCEP LNG Terminal Project Resource Report 3 (RR3) Section 3.1. Fish habitat near the JCEP LNG Terminal supports a mix of marine and estuarine species, and both recreational and commercial fishing. Federally listed fish species spending a portion of their life cycle within the estuarine environment of Coos Bay are coho salmon; green sturgeon and eulachon.

RR3 Section 3.1.3 lists non-endangered marine mammals potentially occurring in the region, and Table 3.4-1 lists threatened and endangered species. Non-endangered marine mammal species potentially occurring in the Coos Bay estuary include the California sea lion, Steller sea lion, harbor porpoise, harbor seal, and northern elephant seal. Listed marine mammals occurring in the marine analysis area (which includes the JCEP project area and the LNG carrier transit route) are the blue whale; fin whale; gray whale; humpback whale; sei whale; sperm whale; killer whale and North Pacific right whale. Of these listed marine mammal species, humpbacks, gray whales and killer whales may occasionally enter Coos Bay within the JCEP project area.

Listed sea turtle species in the marine analysis area are loggerhead; leatherback; green; and olive ridley. These species are not expected to occur within the JCEP project area.

This assessment considers the potential for operational noise from vessel traffic in the marine analysis area to affect threatened and endangered aquatic species (fish, marine mammals and sea turtles). Noise from Facility construction activities including piling and dredging is assessed for potential to impact on fish and marine mammals.

1.3 Underwater Noise Sources and Scenarios

The project description has been used to develop a list of equipment with the potential to generate underwater noise. Overall broadband source noise levels at a 1m (3.3 feet) reference distance have been determined for each potential noise source from literature as shown in Table 1. Two different parameters are used to describe the source levels. The peak noise level is the short term maximum sound pressure level (SPL). It is used to describe the maximum noise level from an impulsive or short term event such as a hydraulic hammer striking a pile. The Root Mean Square (RMS) noise level is a type of average noise level over a time period of interest. RMS can be used to describe noise from a continuous source or the average noise during an impulsive event over a defined time period. All peak and RMS underwater sound levels in this report are described in decibels (dB) referenced to 1 micro Pascal (1 μPa).

A third parameter is used in this assessment as a descriptor of potential impacts, the Cumulative Sound Exposure Level (SEL_{cum}). This parameter describes the cumulative noise exposure from repeated or extended duration events such as piling hammer strikes or long term exposure to continuous noise. SEL_{cum} has units of dB re 1 $\mu Pa^2 s$.

Source levels for a range of sizes of support vessels have been estimated by scaling from frequency dependent reference vessel noise measurements, using the formulation described in Ross (1976) to adjust source levels on the basis of ship length, power and speed, as applied by Wales and Heitmeyer (2002).

Noise from large vessels (adjusted to a 1m reference distance) can range up to 188 dB re 1μPa (McKenna et al. 2012). In practice, noise from vessels will vary depending on vessel size and power, propulsion system loading and vessel speed. A typical transit speed for vessels within the Coos Bay navigation channel of 7 knots has been assumed for this assessment. At these speeds, transiting vessel noise emissions are reduced relative to noise at higher speeds. JASCO (2006) state that broadband noise from LNG vessels at half speed is expected to be around 175 dB re 1μPa at the 1m reference distance.

Noise from tugs under load is less speed dependent. Tugs under load can be noisier than larger vessels.

Noise from cutter suction dredges varies with the capacity of the dredger and the type of material being dredged. Reine et al (2014) measured source levels for a cutter suction dredger removing rock in New York Harbor of up to 175 dB re 1µPa at 1m. A smaller dredger with overall length approximately 100 ft., a total power of 1000 hp operating the main pumps, and with dredged material moving through a 16-in. pipeline undertaking maintenance dredging in a deep water shipping channel has been recorded with source levels up to 157 dB re 1µPa at 1m (Reine and Dickerson, 2014). Use of a similar dredge is anticipated for JCEP dredging. For this assessment, a dredging source noise level of 157 dB re 1µPa at 1m is assumed. The potential noise impacts of a larger dredger are also considered in this assessment as a worst case to assess the potential impact of dredging work in the Coos Bay navigation channel.

Underwater noise from piling is described in Caltrans (2015). This reference includes specific source levels for driving steel sheet piles and 36 inch diameter steel pipe piles.

Table 1 Broadband Source Noise Levels

Noise Source	Description	Peak dB re. 1µPa @ 1 m	RMS dB re. 1µPa @ 1 m	Reference
LNG vessel	Transiting 7 knots / half speed	n/a	175	McKenna et al 2012; JASCO, 2006.
Tugs and smaller support vessels	120' and up to 5400 HP	n/a	170	Warner et al, 2014
	150' and up to 6600 HP	n/a	175	Li et al, 2011
	220' and up to 10560 HP (LNG escort tug)	n/a	185	Jasco, 2006
Cutter Suction Dredging	Marine slip, access channel and MOF	n/a	157	Reine & Dickerson, 2014
	Coos Bay navigation channel	n/a	175	Reine et al, 2014
Sheet pile driving	Vibratory pile driving	195	180	Caltrans, 2015
	Impact hammer driving	225	210	Caltrans, 2015
36 inch steel pipe pile driving	Vibratory pile driving	200	190	Caltrans, 2015
	Impact hammer driving	230	213	Caltrans, 2015

Note 1: Source levels may vary over time with variations in propulsion system loading and vessel speed.

2.0 FISH AND SEA TURTLE NOISE IMPACT THRESHOLDS

Threshold levels for underwater noise impacts on fish and sea turtles have been the subject of research over many years. The majority of research has focused on the potential for physiological effects (injury or mortality) rather than on quantifying noise levels with behavioral effects. A review of the literature and guidance on appropriate thresholds for assessment of underwater noise impacts are provided in the 2014 Acoustical Society of America (ASA) Technical Report *Sound Exposure Guidelines for Fishes and Sea Turtles* (ASA, 2014).

The ASA Technical Report includes thresholds for mortality (or potentially mortal injury) as well as degrees of impairment such as temporary or permanent threshold shifts (TTS or PTS, indicators of hearing damage). Thresholds are defined for peak noise and cumulative impacts (due to continuous or repeated noise events) and for different noise sources (eg pile driving, and continuous noise from vessels or dredging). For continuous noise from vessels or dredging, there is a low risk of mortality or injury for any fish types or sea turtles. Piling noise results in higher noise levels and hence an increased potential for injury. The ASA guideline injury thresholds for piling noise for fish and sea turtles are summarized in Table 2.

Table 2 Underwater acoustic thresholds for fish and sea turtles during piling

Type of Animal	Mortality	Recoverable Injury	TTS
Fish: no swim bladder	> 219 dB SEL_{cum}; or > 213 dB Peak	>216 dB SEL_{cum}; or > 213 dB Peak	>> 186 dB SEL_{cum}
Fish: swim bladder not involved in hearing	210 dB SEL_{cum}; or > 207 dB Peak	203 dB SEL_{cum}; or > 207 dB Peak	> 186 dB SEL_{cum}
Fish: swim bladder involved in hearing	207 dB SEL_{cum}; or > 207 dB Peak	203 dB SEL_{cum}; or > 207 dB Peak	186 dB SEL_{cum}
Sea turtles	210 dB SEL_{cum}; or > 207 dB Peak	High risk near the source only (within tens of meters)	

Notes: Peak sound pressure has a reference value of 1 μPa and is “flat” or unweighted.
Cumulative sound exposure level (SEL_{cum}) has a reference value of $1 \mu Pa^2 s$.

Since soft start methods will be used as a mitigation measure for piling, and animals in the vicinity of noise sources will be free to move away, this assessment of impacts to fish focusses on the potential for peak noise levels during piling to cause mortality or injury. These effects are not anticipated at noise levels below about 207 dB re 1μPa, or at higher levels for species without swim bladders.

3.0 MARINE MAMMAL NOISE IMPACT THRESHOLDS

Guidance on acoustic thresholds for injury (hearing damage) in the form of permanent threshold shift (PTS) and disturbance are provided by the National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS).

3.1 Acoustic Thresholds for Disturbance

The NMFS interim underwater thresholds for behavioral effects are shown in Table 3 (NMFS, 2012). Of the sources considered, the majority are "continuous" for the purpose of this assessment, with only the noise from impact pile driving treated as impulsive.

Table 3 Interim underwater acoustic thresholds for behavioral disruption

Criterion Definition	Threshold
Behavioral disruption for impulsive noise (e.g., impact pile driving)	160 dB_{rms}
Behavioral disruption for non-impulsive noise (e.g., vibratory pile driving, vessels)	120 dB_{rms}

Notes: dB referenced to 1 micro Pascal (re: 1μPa).
All thresholds are based off root mean square (rms) levels and are broadband (unweighted).
The 120 dB threshold may be slightly adjusted if background noise levels are at or above this level.

3.2 Acoustic Thresholds for Injury (Permanent Hearing Damage, PTS)

Acoustic thresholds related to PTS are provided by Technical Memorandum NMFS-OPR-55 *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts* (NMFS, 2016).

A dual metric approach is used for impulsive sounds, considering both cumulative sound exposure level and peak sound level. Different thresholds and auditory weighting functions are provided for different marine mammal hearing groups, which are defined in the Technical Guidance (NMFS, 2016). The generalized hearing range of each hearing group is reproduced in Table 4. The PTS thresholds are shown in Table 5. The non-endangered marine mammal species potentially occurring in the Coos Bay estuary include otariid pinnipeds (California sea lion, Steller sea lion), phocid pinnipeds (harbor seal, northern elephant seal) and the high frequency cetacean harbor porpoise. The listed marine mammal species which may occasionally enter Coos Bay within the JCEP project area are humpbacks and gray whales (low frequency cetaceans) and killer whales (mid frequency cetaceans).

Table 4 Cetacean hearing groups (from NMFS, 2016)

Hearing Group	Generalized Hearing Range
Low-frequency cetaceans	7 Hz to 35 kHz
Mid-frequency cetaceans	150 Hz to 160 kHz
High-frequency cetaceans	275 Hz to 160 kHz
Phocid pinnipeds	50 Hz to 86 kHz
Otariid pinnipeds	60 Hz to 39 kHz

Table 5 Underwater acoustic thresholds for PTS onset

Hearing Group	PTS Onset Acoustic Thresholds (Received Level)		
	Impulsive (Peak, L_{pk}, flat)	Impulsive (SEL_{cum}, weighted, 24h)	Non-impulsive (SEL_{cum}, weighted, 24h)
Low-frequency cetaceans	219 dB	183 dB	199 dB
Mid-frequency cetaceans	230 dB	185 dB	198 dB
High-frequency cetaceans	202 dB	155 dB	173 dB
Phocid pinnipeds	218 dB	185 dB	201 dB
Otariid pinnipeds	232 dB	203 dB	219 dB

Notes: Peak sound pressure (L_{pk}) has a reference value of 1 μPa and is "flat" or unweighted.
Cumulative sound exposure level (SEL_{cum}) has a reference value of 1μPa^{2}s.
SEL_{cum} received levels should be appropriately weighted for the hearing group for assessment.

4.0 NOISE LEVEL VS DISTANCE

For the purpose of this impact assessment, the objective is to quantify the noise level due to various sources at a range of distances out to 1 mile. These noise levels will then be discussed in relation to their potential to cause injury or disturbance to the species of interest, with reference to the identified thresholds.

4.1 Noise Level vs Distance

The magnitude of the noise level at a particular location depends strongly on the distance from the noise source. Underwater noise propagation models predict the sound transmission loss between the noise source and the receiver. When the source level (SL) of the noise source is known, the predicted transmission loss (TL) is then used to predict the received level (RL) at the receiver location as:

$$\mathrm{RL} = \mathrm{SL} - \mathrm{TL}$$

The transmission loss between two distances D1 and D2 may be described by a logarithmic relationship with an attenuation factor F:

$$\mathrm{TL} = \mathrm{F} \cdot \log(\mathrm{D}_1/\mathrm{D}_2)$$

If all losses due to factors other than geometric spreading are neglected, then the transmission loss would be wholly due to spherical spreading (in deep water) or cylindrical spreading (in shallow water, bounded above and below). Spherical spreading means underwater noise would attenuate by 6 dB with each doubling of distance, or F = 20. Cylindrical spreading means an attenuation of 3 dB with each doubling of distance, or F = 10.

In shallow water, noise propagation is highly dependent on the properties of the bottom and the surface as well as the properties of the fluid. Parameters such as depth and the bottom properties can vary with distance from the source. Sound energy at low frequencies may be transferred directly into the sea floor, rather than propagating through the water. Overall, the transmission loss in shallow water is a combination of cylindrical spreading effects, bottom interaction effects (absorption) at lower frequencies and scattering losses at high frequencies.

In practical cases the attenuation factor F can range from 5 up to 30. A "practical spreading loss model" based on an attenuation factor of 15 for sound transmission is commonly assumed for projects near shore (NMFS, 2012) and has been adopted for this study.

The noise attenuation vs distance is shown in Figure 1. The noise level from the various sources at a range of distances out to 1 mile is summarized in Table 6. Note that in situations with more than one noise source or several vessels operating in an area, the loudest or closest source may be assumed to dominate at any particular receiver location.

Figure 1 Noise Attenuation vs Distance – Practical Spreading Loss Model

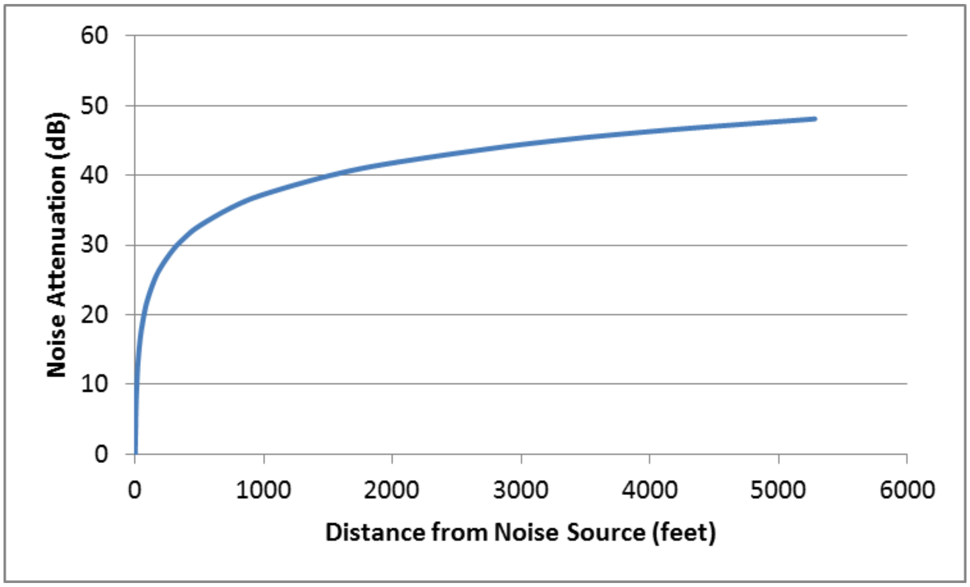


Table 6 Peak and RMS Noise Level vs Distance by Source

Parameter	Noise Source	3.3 ft	50 ft	100 ft	500 ft	1000 ft	1 mile
RMS dB re. 1µPa	LNG Vessel	175	157	153	142	138	127
	120' Support Vessel	170	152	148	137	133	122
	150' Support Vessel	175	157	153	142	138	127
	220' LNG escort tug	185	167	163	152	148	137
	CSD – marine slip, access channel, MOF	157	139	135	124	120	109
	CSD – worst case Coos Bay nav. channel	175	157	153	142	138	127
	Vibratory sheet pile driving	180	162	158	147	143	132
	Impact sheet pile driving	210	192	188	177	173	162
	Vibratory steel pipe pile driving	190	172	168	157	153	142
	Impact hammer steel pipe pile driving	213	195	191	180	176	165
Peak dB re. 1µPa	Vibratory sheet pile driving	195	177	173	162	158	147
	Impact sheet pile driving	225	207	203	192	188	177
	Vibratory steel pipe pile driving	200	182	178	167	163	152
	Impact hammer steel pipe pile driving	230	212	208	197	193	182

5.0 DISCUSSION OF POTENTIAL PROJECT UNDERWATER NOISE IMPACTS TO FISH AND SEA TURTLES

As identified in Section 2.0, mortality or injury to fish or sea turtles of any species is not anticipated at peak noise levels below about 207 dB re 1μPa, or at higher levels for species without swim bladders.

Of the various activities with the potential to generate underwater noise, only piling using an impact hammer has source levels that are high enough to potentially cause injury or mortality to fish. Impact driving of steel pipe piles is noisier than impact driving of sheet piles. For sheet piles, the potential for injury to fish is limited to within 50 feet of the noise source, in a worst case situation. For steel pipe piles, this distances increases to about 100 feet, again under worst case assumptions. Soft start methods will be used as a mitigation measure for piling, with the initial strikes applied at lower power with reduced noise levels. The areas with potential piling noise physical impacts to fish would be within the excavated and dredged area required to construct the marine facility.

Fish behavioral responses to noise from piling activity may occur over greater distances. ASA (2014) indicates a high risk of behavioral effects to fish during piling in the near to intermediate field, ie within distances of tens to hundreds of meters. The risk of behavioral effects in the far field (of the order of thousands of meters or miles) reduces to moderate. In light of the Facility location in Coos Bay, the potential for adverse behavioral impacts to fish outside of the immediate project construction vicinity (within about 1 mile) is considered to be low.

With reference to ASA (2014), the risk of adverse fish behavioral responses to noise from dredging and vessel activity is also expected to be low except in the immediate vicinity of the noise source. The noise from project dredging and vessel movements will be similar to noise from existing dredging activity and vessel movements in the Coos Bay navigation channel. Similarly the risk of adverse sea turtle behavioral responses to noise from vessel activity is low, with the noise from project activity similar to noise from existing shipping activity.

6.0 DISCUSSION OF POTENTIAL PROJECT UNDERWATER NOISE IMPACTS TO MARINE MAMMALS

6.1 Marine Mammal Impulsive Peak Noise PTS Potential

As identified in Section 3.2, permanent hearing damage to marine mammals of any species is not anticipated at impulsive peak noise levels below 202 dB re 1μPa, with the lowest threshold applicable to high frequency cetaceans which include harbor porpoises. For low and mid frequency cetaceans and pinnipeds (ie for all other species potentially affected by the project), the impulsive peak noise injury threshold is higher, above 218 dB re 1μPa.

Marine mammals inside Coos Bay in the vicinity of the Facility may be affected by noise from piling during construction. Of the various piling scenarios, only the use of an impact hammer has impulsive peak source levels that are high enough to cause PTS in any species. The greatest distance at which PTS due to impulsive peak noise may possibly occur is around 250 feet for the harbor porpoise. Soft start methods will be used as a mitigation measure for piling, with the initial impacts applied at lower power with reduced noise levels and hence reduced potential for impacts. On this basis, injury in the form of PTS to any marine mammal species is not anticipated as a result of impulsive peak noise emissions during project piling.

6.2 Marine Mammal Cumulative Noise Exposure PTS Potential

The NMFS 2016 Technical Guidance provides a calculation method for determining the potential for cumulative noise to have adverse effects to marine mammal hearing. This method includes multiple conservative assumptions and is therefore expected to result in higher estimates of hearing impairment that would be the case in a practical situation. An assessment using the NMFS spreadsheet calculator has been undertaken for each of the vessel and dredging noise sources and scenarios. Calculation sheets detailing the various assumptions and the distance to the cumulative noise PTS threshold for each noise source are attached as Appendix A. More detailed site specific investigations of the potential for cumulative piling noise impacts have been investigated by JASCO (Deveau and MacGillvray 2017, O'Neill and MacGillivray 2017) and are attached as Appendices B and C. For most species, activities and scenarios, there is very low risk of cumulative PTS in practice since individual animals would need to remain in close proximity to the noise source for an extended period of time, without moving away. The results of these various cumulative noise impact calculations are summarized as follows:

- During dredging to construct the marine facility, individual harbor porpoises would need to remain within about 500 feet of the dredge for 24 hours for there to be a potential for PTS. Other marine mammals would need to remain effectively immediately adjacent to the dredge for the same duration.
- During dredging of the navigation channel, individual harbor porpoises would need to remain within about 1.6 miles of the dredge for 24 hours for there to be a potential for PTS. Killer whales would need to remain within about 180 feet of the dredge again for 24 hours for there to be potential for PTS. Other marine mammals would need to remain effectively immediately adjacent to the dredge for the same duration.
- When tugs are operating semi-stationary under full power near the Facility, individual harbor porpoises would need to remain within about 1 mile of the tug for 1 hour for there to be a potential for PTS. Killer whales would need to remain within about 100 feet of the tug for 1 hour for there to be potential for PTS.
- During 36" steel pipe pile installation using a vibratory driver, individual harbor porpoises would need to remain within about 1.3 miles of the noise source during the driving of approximately 3 individual piles (1000 strikes) for there to be potential for PTS. Harbor seals and killer whales would need to remain within 1.1 miles of the noise source for the same duration for PTS to potentially occur.
- The noise from transiting vessels and tugs does not represent a potential risk of PTS to any of the identified marine mammal species, at any realistically occurring distance.

There is potential for cumulative noise exposure to cause PTS in harbor porpoises (high frequency cetaceans) during in water piling, particularly when a hydraulic impact hammer is used. For PTS to occur, harbor porpoises would need to remain in the vicinity during extended periods of impact piling. The potential for PTS to occur in other marine mammals is less, due to the differing hearing sensitivities of other species. The use of a combination of engineered underwater noise mitigation measures (such as pile cushions, bubble curtains) and management techniques (including soft starts, protected species observers and exclusion zones) is expected to minimize the potential for acoustic injury to marine mammals.

6.3 Marine Mammal Behavioral Disturbance Potential

Away from the JCEP project area, the potential for effects to threatened and endangered marine mammals is limited to behavioral disturbance due to noise from piling, navigation channel dredging, LNG vessels, tugs and potentially other support vessels. Vibratory sheet pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 120 dB re 1 µPa at distances of up to 1.2 miles (Deveau and MacGillvray, 2017). Impact pipe pile driving has the potential to exceed the NMFS interim behavioral disturbance threshold of 160 dB re 1 µPa at similar distances (O'Neill and MacGillvray, 2017).

The noise from project vessel movements and dredging will be similar to noise from existing vessel and dredging activity in the Coos Bay navigation channel.

7.0 SUMMARY

This assessment provides quantitative levels for underwater noise generated by the Jordan Cove LNG project and potential impacts to marine mammals, threatened and endangered aquatic species and to commercial and recreational fish species.

Of the various activities with the potential to generate underwater noise, only piling using an impact hammer has source levels that are high enough to cause potential injury or mortality to fish. In the noisiest scenario, potential physical impacts to fish would be restricted to areas within about 100 feet of the noise source, inside the excavated and dredged area required to construct the marine facility. The potential for adverse behavioral impacts to fish outside of the immediate project construction vicinity (at distances greater than about 1 mile) is considered to be low, for all construction scenarios.

The noise from project dredging and vessel movements will be similar to noise from existing dredging activity and vessel movements in the Coos Bay navigation channel, with a low risk of adverse fish behavioral responses to these noise sources.

Harbor porpoises (which are not endangered) are the only high frequency cetacean that may occur in the vicinity of the Facility. If present, this marine mammal species has the greatest potential to be affected by noise from piling or other marine facility construction noise sources. Permanent hearing impairment harbor porpoises is not anticipated as a result of impulsive peak noise emissions during project piling, provided they are not present with 250 feet of piling using an impact hammer. Individual harbor porpoises would need to remain with about 1.3 miles of the facility for the full duration of driving 3 of the largest marine pipe piles to risk permanent hearing impairment due to the cumulative noise effects of piling.

In relation to other marine mammals and the identified threatened and endangered species, there is a lower risk of permanent hearing impairment due to project noise. There is potential for behavioral disturbance due to noise from dredgers, LNG vessels, tugs and other support vessels. The noise disturbance from project vessel movements and dredges will be similar to noise from existing vessel and dredging activity in the Coos Bay navigation channel.

8.0 REFERENCES

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9.0 STATEMENT OF LIMITATIONS

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This work product presents professional opinions and findings of a scientific and technical nature. The work product shall not be construed to offer legal opinion or representations as to the requirements of, nor the compliance with, environmental laws rules, regulations, or policies of federal, state or local governmental agencies.

APPENDIX A
NMFS spreadsheet calculations of potential for permanent threshold shift due to dredging and vessel operations

Jordan Cove LNG - Underwater Noise Impact Assessment

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG - Dredging
PROJECT/SOURCE INFORMATION	As per information contained in Resource Reports 1,3,9
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	157
Activity Duration (hours) within 24-h period	24
Activity Duration (seconds)	86400
10 Log (duration)	49.37
Propagation (xLogR)	15
Distance of source level measurement (meters)⁺	1

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.3**	**3.5**	**167.6**	**0.6**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-15.27**	**-0.28**	**0.00**	**-8.68**	**-11.01**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	Dredging Coos Bay navigation channel
PROJECT/SOURCE INFORMATION	As per information contained in Resource Reports 1,3,9
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	175
Activity Duration (hours) within 24-h period	24
Activity Duration (seconds)	86400
10 Log (duration)	49.37
Propagation (xLogR)	15
Distance of source level measurement (meters)[+]	1

[+]Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**4.7**	**54.8**	**2,655.9**	**9.5**	**0.4**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-15.27**	**-0.28**	**0.00**	**-8.68**	**-11.01**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

A: STATIONARY SOURCE: Non-Impulsive, Continuous

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG - Stationary tug
PROJECT/SOURCE INFORMATION Please include any assumptions	As per information contained in Resource Reports 1,3,9. Stationary tug assumed working near facility 4 hours active in any one day.
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	185
Activity Duration (hours) within 24-h period	1
Activity Duration (seconds)	3600
10 Log (duration)	35.56
Propagation (xLogR)	15
Distance of source level measurement (meters)⁺	1

⁺Unless otherwise specified, source levels are referenced 1 m from the source.

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW): true seals
Otariid pinnipeds (OW): sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**2.6**	**30.6**	**1,481.6**	**5.3**	**0.2**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	**-15.27**	**-0.28**	**0.00**	**-8.68**	**-11.01**

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

C: MOBILE SOURCE: Non-Impulsive, Continuous (SAFE DISTANCE METHODOLOGY[‡])

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG -LNG Vessel in transit 7 knots
PROJECT/SOURCE INFORMATION	As per information contained in Resource Reports 1,3,9
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)[¥]	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

[¥] Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	175
Source Velocity (meters/second)	3.6
Duty cycle	1
Source Factor	3.16228E+17

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.0**	**0.0**	**1.4**	**0.0**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-15.27	-0.28	0.00	-8.68	-11.01

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

C: MOBILE SOURCE: Non-Impulsive, Continuous (SAFE DISTANCE METHODOLOGY‡)

VERSION: 1.1 (Aug-16)

KEY

(green)	Action Proponent Provided Information
(pink)	NMFS Provided Information (Acoustic Guidance)
(blue)	Resultant Isopleth

STEP 1: GENERAL PROJECT INFORMATION

PROJECT TITLE	JCEP LNG - Escort Tug in transit 7 knots
PROJECT/SOURCE INFORMATION	As per information contained in Resource Reports 1,3,9
Please include any assumptions	
PROJECT CONTACT	

STEP 2: WEIGHTING FACTOR ADJUSTMENT

Specify if relying on source-specific WFA, alternative weighting/dB adjustment, or if using default value

Weighting Factor Adjustment (kHz)¥	42	Default for high-frequency cetaceans (harbor porpoises) as a worst case

¥ Broadband: 95% frequency contour percentile (kHz) OR Narrowband: frequency (kHz); For appropriate default WFA: See INTRODUCTION tab

† If a user relies on alternative weighting/dB adjustment rather than relying upon the WFA (source-specific or default), they may override the Adjustment (dB) (row 43), and enter the new value directly. However, they must provide additional support and documentation supporting this modification.

*** BROADBAND Sources: Cannot use WFA higher than maximum applicable frequency (See GRAY tab for more information on WFA applicable frequencies)**

STEP 3: SOURCE-SPECIFIC INFORMATION

Source Level (RMS SPL)	185
Source Velocity (meters/second)	3.6
Duty cycle	1
Source Factor	3.16228E+18

‡Methodology assumes propagation of 20 log R; Activity duration (time) independent

Marine Mammal Hearing Group
Low-frequency (LF) cetaceans: baleen whales
Mid-frequency (MF) cetaceans: dolphins, toothed whales, beaked whales, bottlenose whales
High-frequency (HF) cetaceans: true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*
Phocid pinnipeds (PW):true seals
Otariid pinnipeds (OW):sea lions and fur seals

RESULTANT ISOPLETHS

Hearing Group	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
SEL_{cum} Threshold	199	198	173	201	219
PTS Isopleth to threshold (meters)	**0.0**	**0.0**	**13.8**	**0.0**	**0.0**

WEIGHTING FUNCTION CALCULATIONS

Weighting Function Parameters	Low-Frequency Cetaceans	Mid-Frequency Cetaceans	High-Frequency Cetaceans	Phocid Pinnipeds	Otariid Pinnipeds
a	1	1.6	1.8	1	2
b	2	2	2	2	2
f_1	0.2	8.8	12	1.9	0.94
f_2	19	110	140	30	25
C	0.13	1.2	1.36	0.75	0.64
Adjustment (dB)†	-15.27	-0.28	0.00	-8.68	-11.01

$$W(f) = C + 10\log_{10}\left\{\frac{(f/f_1)^{2a}}{[1+(f/f_1)^2]^a[1+(f/f_2)^2]^b}\right\}$$

APPENDIX B
JASCO Applied Sciences
Technical memorandum on vibratory pile driving

Jordan Cove LNG - Underwater Noise Impact Assessment

Jordan Cove Vibratory Pile Driving Underwater Noise Modeling

Technical Memorandum

Submitted to: William Gorham, Ph.D.
AECOM Environment
Contract: 86019

Authors:
Terry J. Deveau
Alex MacGillvray

21 February 2017

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Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

1. Introduction

This technical memorandum presents results from an underwater noise modeling study undertaken by JASCO on behalf of AECOM to support a Marine Mammal Protection Act Incidental Harassment Authorization application. The planned noise-generating activity is "in the dry" vibratory sheet pile installation that will be conducted as part of the construction of a Materials Off-loading Facility (MOF) at the proposed Jordon Cove LNG Terminal at Coos Bay, Oregon. The modeling presented in this technical memorandum is based on draft engineering plans for the Jordan Cove facility and is intended to provide a screening-level assessment of potential underwater noise from sheet-pile wall construction at the MOF.

The draft construction plans call for a 30-feet wide soil berm to be installed between the water and the location of the sheet piles. The sheet piles will be installed behind the berm prior to excavation of a marine slip at the proposed facility. The purpose of the present study is to model underwater noise that would be transmitted from the sheet piles to the water, through the soils, during vibratory driving. Noise from sheet pile driving may have the potential to negatively impact nearby marine mammals in Coos Bay. The impacts of underwater noise generated by vibratory pile driving at the MOF is expected to be mainly limited to harbor seals that may be foraging near or transiting past the construction site, though other species of marine mammals may occasionally be present.

A hydrographic chart of Coos Bay is shown in Figure 1, with the location of the proposed sheet pile wall and the two transects used for underwater noise modelling in this study.

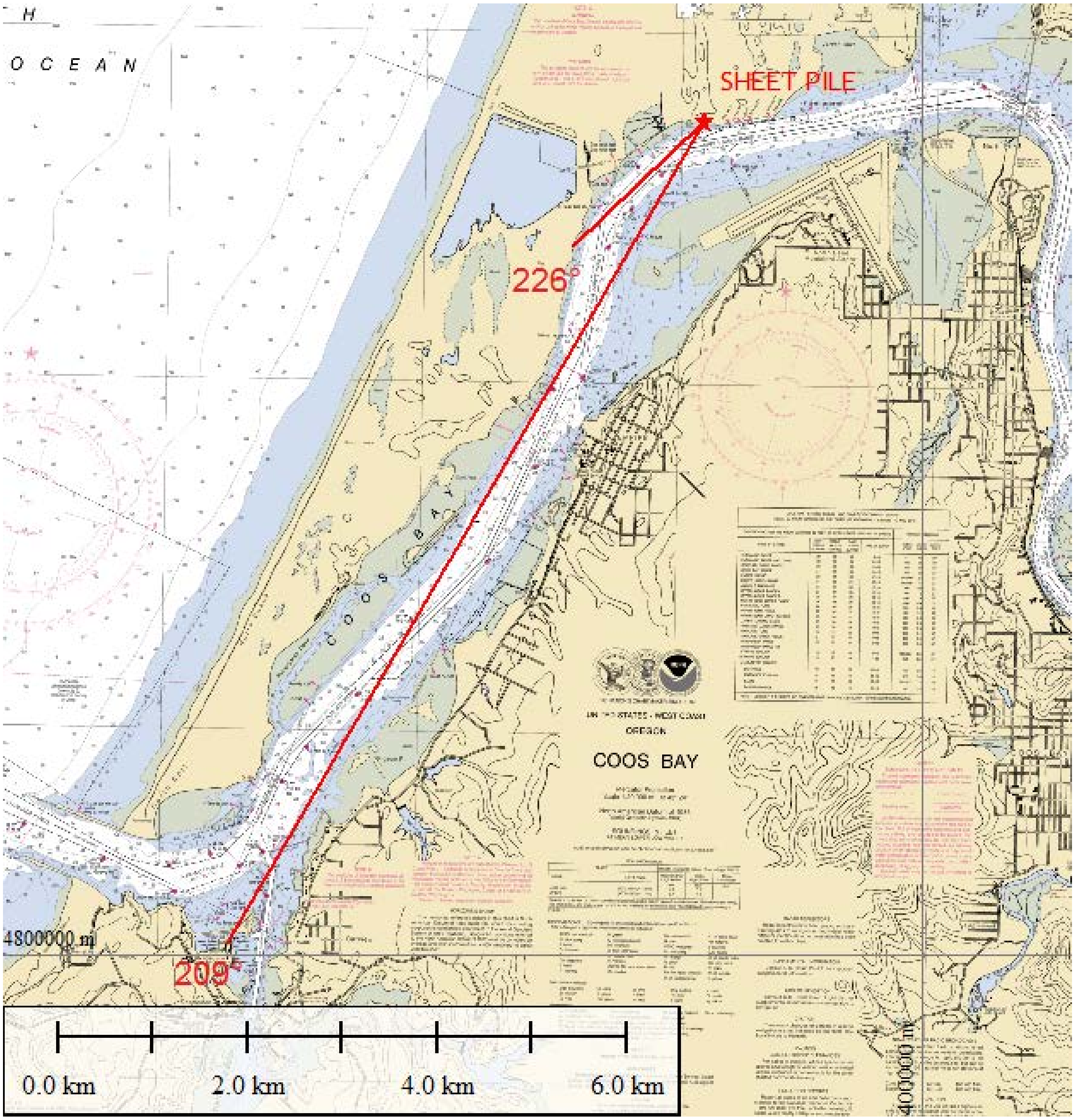

Figure 1. Annotated hydrographic chart of Coos Bay showing the location of the proposed sheet pile driving (red star) and the underwater noise modelling transects (red lines). An expanded distance scale is also provided.

2. Methods

A numerical sound propagation model was used to simulate the transmission of sheet piling noise through water-saturated soils into water. Source levels for this activity were based on published hydrophone measurements of in-water sheet pile driving. To translate the source levels from water into soil, it was assumed that the sheet piles would generate the same magnitude of vibration in soil as in water.

For modeling the sound propagation, JASCO collected environmental data describing the bathymetry, water sound speed, and seabed geoacoustics in Coos Bay. The environmental data and source levels were input to underwater noise modelling software to estimate the underwater noise received levels (RL) that would be present in the water near the pile driving.

2.1. Bathymetry

A bathymetry grid for the acoustic propagation model was constructed based on two datasets:

- U.S. Coastal Relief Model digital elevation model (DEM) with a 3-arc-second resolution (National Centers for Environmental Information, 2017)
- Coos Bay hydrographic chart, no. 18587, at 1:20,000 scale, from the Coast Survey, National Ocean Service, NOAA. (Coast Survey, 2017).

The DEM downloaded from the NCEI website provided only positive elevation values inland of the Pacific Ocean coastline. To accurately represent the bathymetry of the Coos Bay channel, 16433 spot bathymetry values were sampled from the NOAA Bathymetric Chart. These spot bathymetric readings are relative to Mean Lower Low Water (MLLW), while the DEM is relative to the mean high water (MHW) tidal level. Based on the tide information published on the Coos Bay hydrographic chart, an adjustment of 6 feet was made to the spot bathymetry samples from the chart before incorporating them into the revised DEM.

The depth/elevations from the NCEI DEM and the spot bathymetry samples from the NOAA hydrographic chart were combined into a new DEM with a 9-meter horizontal grid spacing. The underwater acoustic noise modelling has been carried-out on the basis of a tidal water level equal to the mean high water (MHW). On the basis of NOAA tidal data, this water level has been taken to be 6 feet higher than the mean lower low water (MLLW) level, which is the basis for the depth soundings and depth contours portrayed on the NOAA hydrographic charts (Coast Survey, 2017).

2.2. Sound Speed Profile

For this particular study, a uniform sound speed of 1500 m/s was assumed for the entire water column. This is a common laboratory reference value for speed of sound in sea-water. Since the water depth in this modelling area is very shallow (less than 14 m), and located in an estuary, it is reasonable to assume that that water column is well mixed and that that the speed of sound is uniform with depth.

2.3. Geoacoustics

In shallow water environments where there is increased interaction with the sea-floor, the properties of the substrate have a large influence over the sound propagation. Information on the composition of the soils at the measurement site was not available at the time of writing, therefore the geoacoustic model used in this work is based on estimated values that are thought to be typical for this environment, consisting of soft silty sand sediments of undetermined depth. The required parameters for modelling sound propagation are the density (ρ), compressional-wave speed, (c_p), shear-wave speed (c_s), compressional-wave attenuation (α_p), and shear-wave attenuation (α_s). A geoacoustic profile, Table 1, has been constructed to represent these geological conditions.

Table 1. Geoacoustic properties as a function of depth, in metres below the seafloor (mbsf). Within an indicated depth range, the parameter varies linearly within the stated range.

Depth (mbsf)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0–50	Silty sand	1.83	1680–1730	0.5	250	0.1
> 50			1730			

2.4. Source Level

Based on the draft engineering designs, it was assumed that individual sheet piles were 50 feet tall and 18 inches wide, embedded to a maximum penetration depth of 36 feet below MHW. For the purpose of this study, we assumed that the underwater noise of vibratory driving of the pile can be modelled as a point source located at the midpoint of the underground portion of the pile. Therefore, we used a source depth of 5.48 meters (i.e., 18 feet below MHW).

The source level (SL) spectrum of the vibratory driving of this pile for the purpose of this study was assumed to be equivalent to the SL spectrum reported for Berth 23, Port of Oakland (APE 400 3200 kN vibe hammer) vibratory pile driving (Buehler, et al., 2016). The SL, in terms of sound pressure level (SPL) at 1 meter from the source location, in 1/3-octave bands, was taken to be as shown in Table 2.

Table 2. SL of vibratory pile driving, in terms of SPL band-level at 1 meter from the source location, in 1/3-octave bands.

Frequency (Hz)	10	13	16	20	25	32	40	50	63	80	100	125	160	200
SL (dB re 1 µPa)	136.8	138.2	139.6	141.0	149.7	146.4	141.1	140.5	146.1	149.3	146.1	154.2	153.7	157.1

Frequency (Hz)	250	315	400	500	630	800	1000	1250	1600	2000	2500	3150	4000
SL (dB re 1 µPa)	158.9	156.1	158.4	160.4	165.3	171.1	174.2	170.8	172.0	170.9	166.9	163.8	162.6

2.5. Underwater Acoustic Propagation Model

The underwater acoustic propagation modeling for this study was performed using a modified version of the RAM parabolic-equation model (Collins 1993, 1996), that has been enhanced by JASCO. RAM was developed at the US Naval Research Laboratory has been extensively benchmarked and is widely used as a reference model in the underwater acoustics community.

3. Results

The modeled received level (RL) of the broadband noise in the water column generated by the vibration sheet pile driving is illustrated in Figure 2 and Figure 3, which show the sound pressure level (SPL) in dB re 1 µPa in areas of different color as a function of the horizontal distance from the source (range) and the depth of the receiver. Each of the figures is for a different azimuthal direction away from the source location (measured in degrees, clockwise from geographic true north).

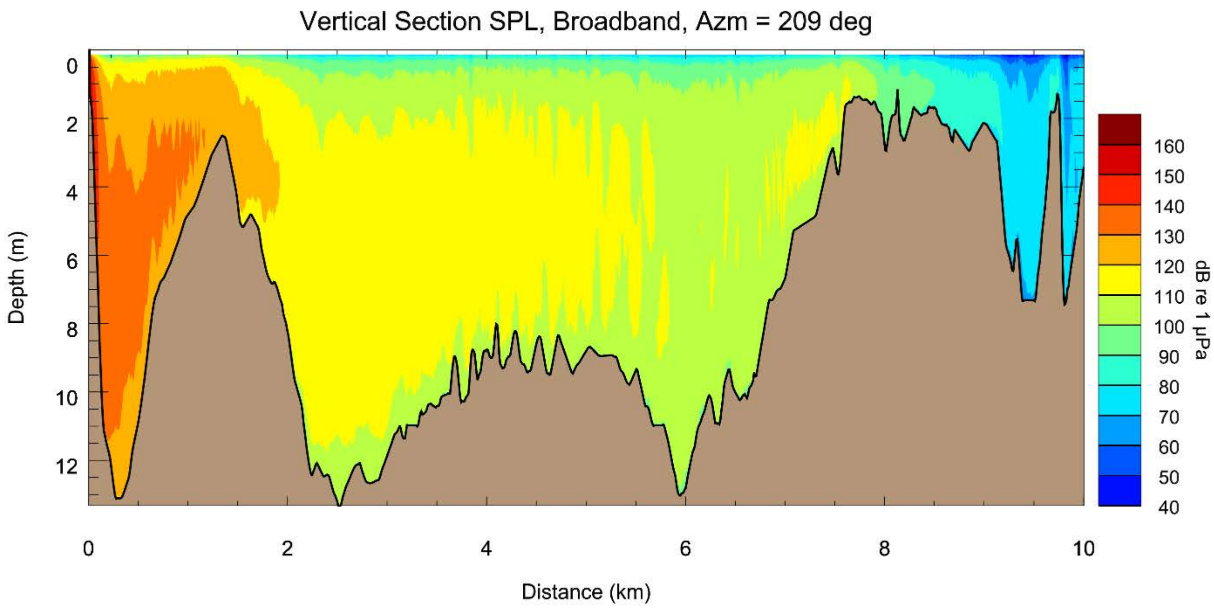

Figure 2. Broadband SPL versus horizontal range from the source and depth below the MHW tidal level for the 209° azimuth.

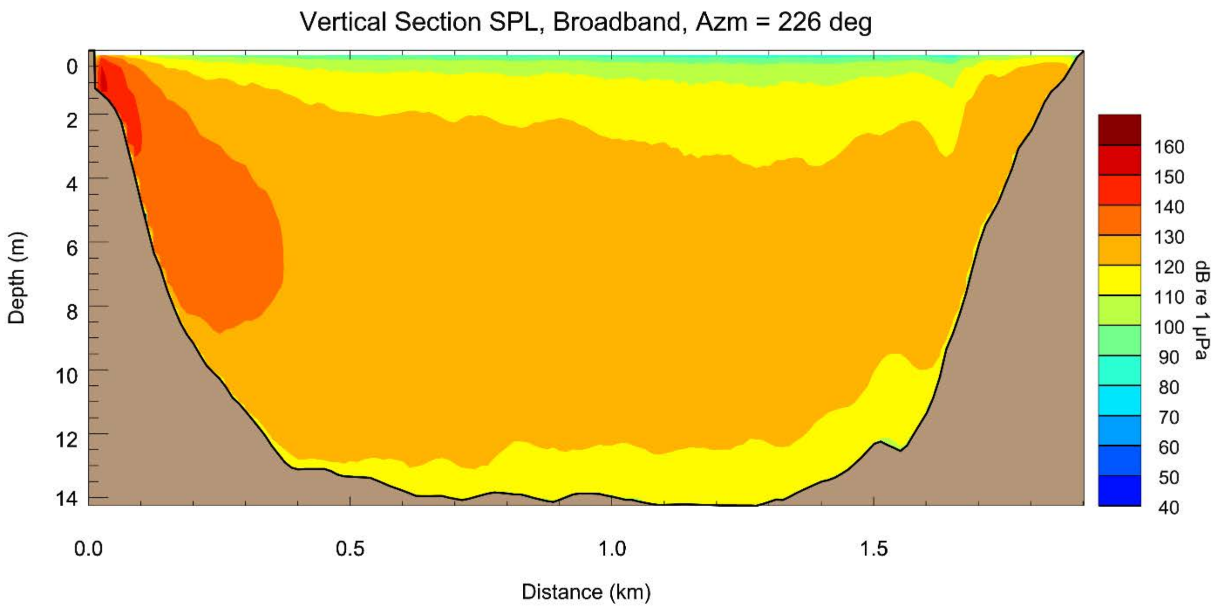

Figure 3. Broadband SPL versus horizontal range from the source and depth below the MHW tidal level for the 226° azimuth.

The 209° azimuthal direction illustrates the longest possible underwater range of noise propagation from the source location, as other directions are blocked at shorter ranges by shoals or the shoreline. The 226° azimuthal direction illustrates the highest underwater RL, at longer ranges, due to the greater water depth in that direction before shoaling is encountered.

The maximum modelled RL (over depth) as a function of range is illustrated in Figure 4 and Figure 5 for the same two azimuthal directions as the previous figures. Inspection of the 1/3-octave band RL shows that highest levels are at frequencies around 1000 Hz (Figure 6).

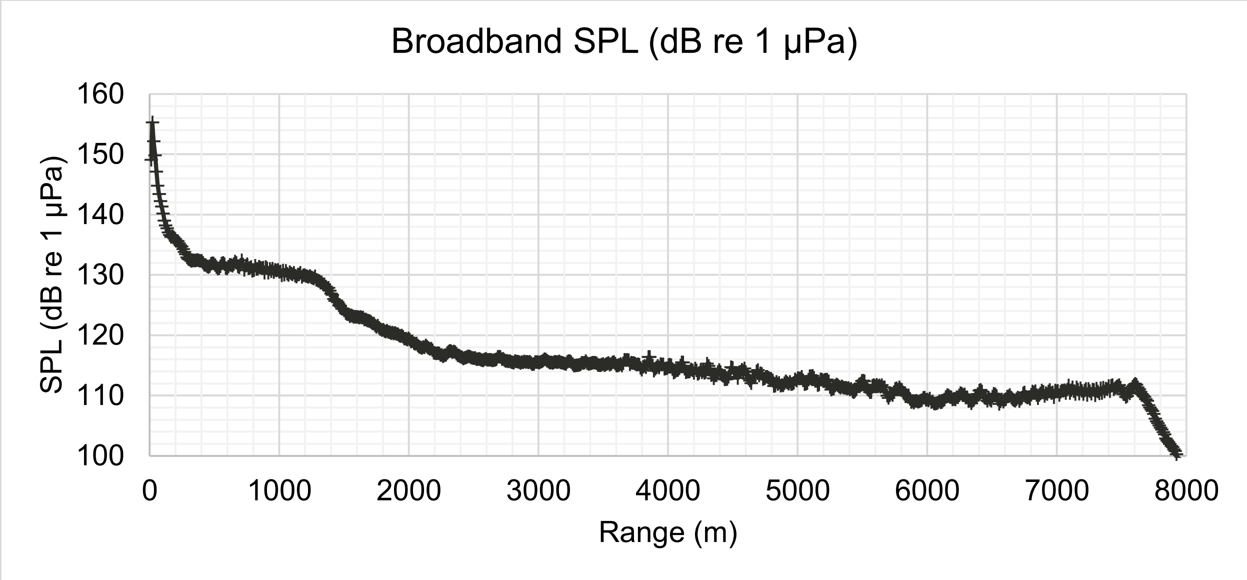

Figure 4. Maximum-over-depth broadband RL versus horizontal range from the source for the 209° azimuth.

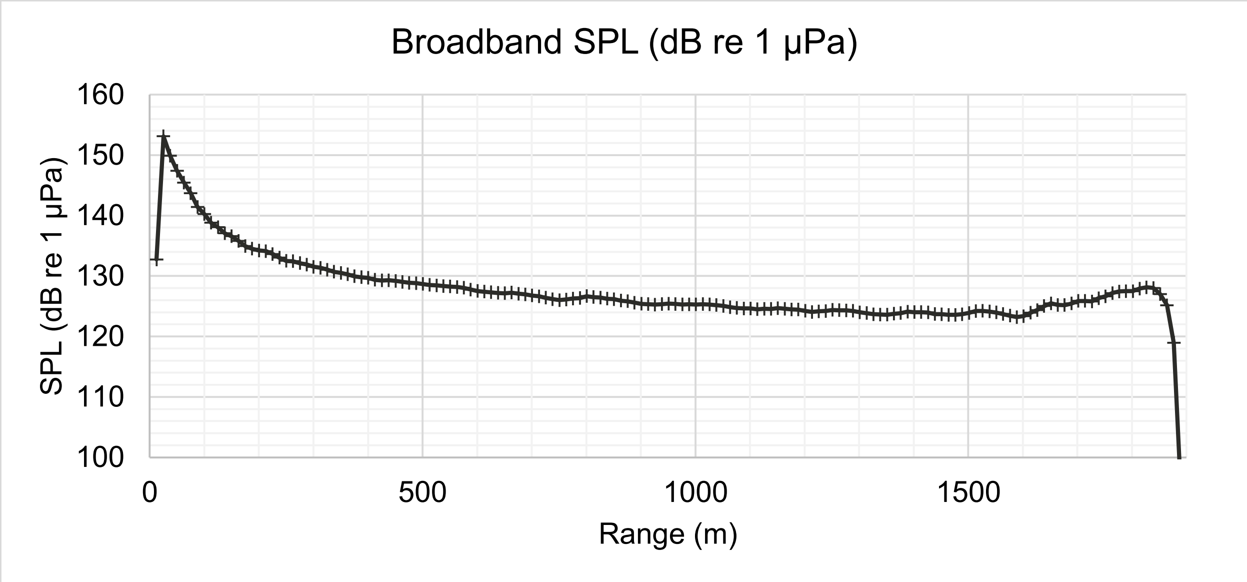

Figure 5. Maximum-over-depth broadband RL versus horizontal range from the source for the 226° azimuth.

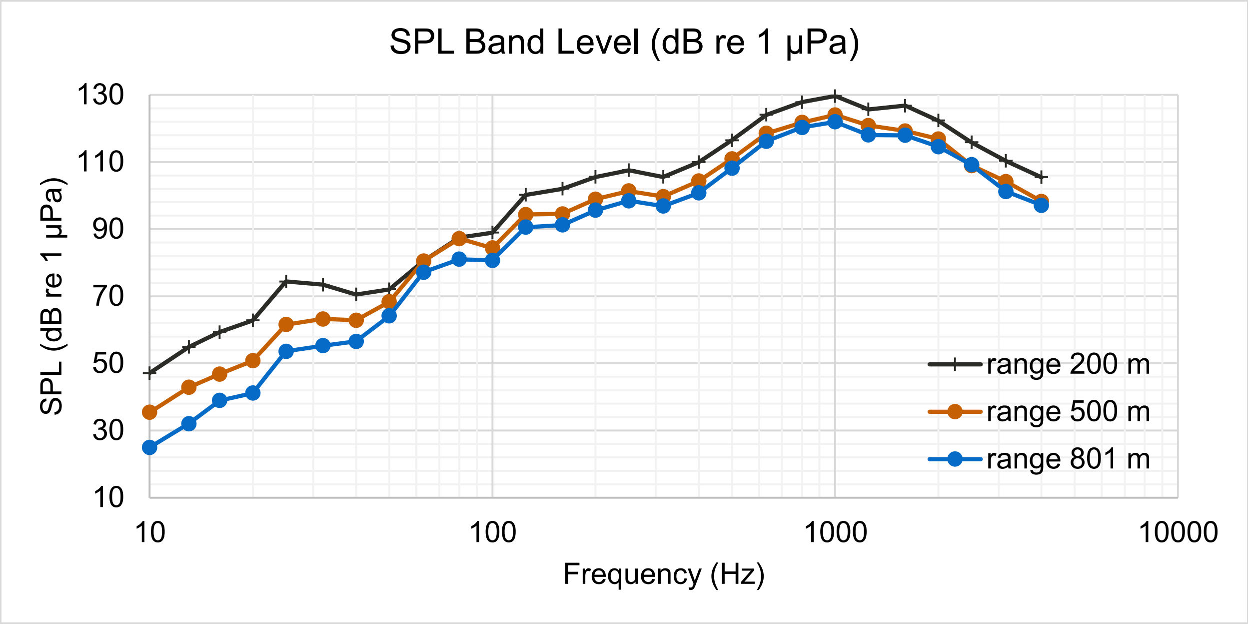

Figure 6. Maximum-over-depth SPL versus frequency in 1/3-octave bands, at three different distances, for the 226° azimuth.

4. Summary

Table 3 shows the maximum distance to the 120 dB re 1 µPa threshold along the two modelling transects considered in the current study. These results show that the highest noise levels from sheet piling at the MOF are to be found where the sound is able to propagate away from the source in deeper water for the furthest distance, before being attenuated by bottom loss in shallower water.

Table 3. Maximum modeled distance to the 120 dB re 1 µPa threshold along two azimuths.

Azimuth (° CW from North)	Maximum range to 120 dB re 1 µPa (m)
209	1914
226	1870

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Glossary

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise one octave. One-third-octave-bands become wider with increasing frequency. Also see octave.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

broadband sound level
The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.

compressional wave
A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

digital elevation model (DEM)
A sampled array of elevations (and bathymetric depths in water) for a number of geographical positions at regularly spaced horizontal intervals (i.e., on a horizontal grid).

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

geoacoustic
Relating to the acoustic properties of the seabed.

hertz (Hz)
A unit of frequency defined as one cycle per second.

mbsf
Meters below sea floor

mean high water (MHW)
The arithmetic mean of all the high water heights observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

mean lower low water (MLLW)
The arithmetic mean of the lower of the two low water heights of each tidal day, observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

NCEI
National Centers for Environmental Information (formerly the National Geophysical Data Center).

NGDC
National Geophysical Data Center.

NOAA
National Oceanic and Atmospheric Administration.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

received level
The sound level measured at a receiver.

rms
root-mean-square.

shear wave
A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 μPa) and the unit for SPL is dB re 1 μPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2/p_0^2\right) = 20\log_{10}\left(p/p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound level measured in the far-field and scaled back to a standard reference distance of 1 meter from the acoustic center of the source. Unit: dB re 1 μPa @ 1 m (sound pressure level) or dB re 1 $\mu Pa^2 \cdot s$ (sound exposure level).

APPENDIX C
JASCO Applied Sciences
Technical memorandum on impact pile driving

Jordan Cove LNG - Underwater Noise Impact Assessment

Jordan Cove Impact Pile Driving Underwater Noise Modeling

Technical Memorandum

Submitted to:
William Gorham, Ph.D.
AECOM Environment
Contract: 86019

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Disclaimer:

The results presented herein are relevant within the specific context described in this report. They could be misinterpreted if not considered in the light of all the information contained in this report. Accordingly, if information from this report is used in documents released to the public or to regulatory bodies, such documents must clearly cite the original report, which shall be made readily available to the recipients in integral and unedited form.

Contents

Figures

Tables

1. Introduction

This technical memorandum presents results from an underwater noise modeling study undertaken by JASCO on behalf of AECOM to support a Marine Mammal Protection Act Incidental Harassment Authorization application. The planned noise-generating activity is impact hammer pile driving that will be conducted as part of the construction of a Materials Off-loading Facility (MOF) at the proposed Jordon Cove LNG Terminal at Coos Bay, Oregon. The modeling presented in this technical memorandum is based on draft engineering plans for the Jordan Cove facility and is intended to provide a screening-level assessment of potential underwater noise from the construction of 36-inch diameter bollard pipes at the MOF.

The construction plans call for the bollard pipes to be installed in the dry, at a setback distance of 12 feet (ft) (3.65 meters (m)) from the sheet pile wall of the MOF. The purpose of the present study is to model underwater noise that would be transmitted from the pipe piles, through the sediment and sheet pile wall, and into the water, during impact pile driving. Noise from impact pile driving may have the potential to negatively impact nearby marine mammals in Coos Bay. The impacts of underwater noise generated by impact pile driving at the MOF is expected to be mainly limited to seals, eared seals (sea lions), and harbor porpoises that may be foraging near or transiting past the construction site, though other species of marine mammals may occasionally be present.

A hydrographic chart of Coos Bay is shown in Figure 1, with the location of the proposed pipe piles and the two transects used for underwater noise modeling in this study.

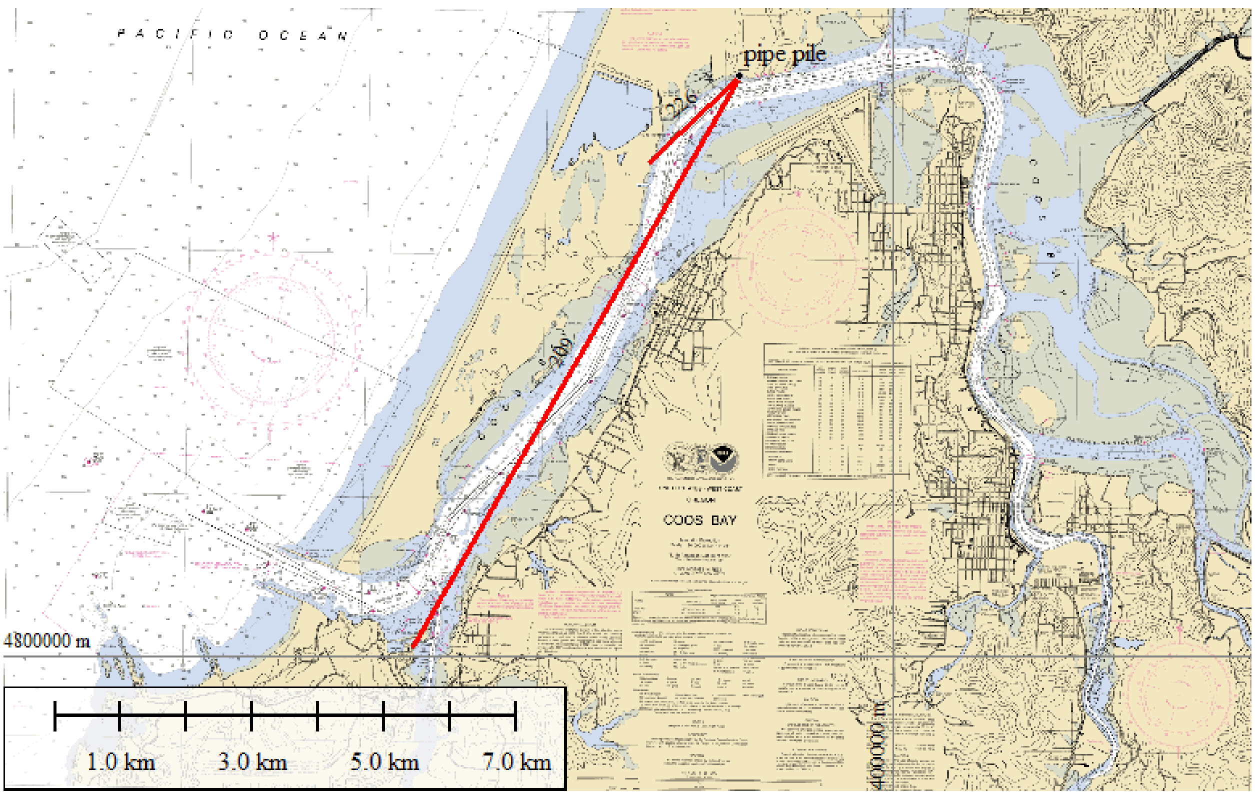

Figure 1. Annotated hydrographic chart of Coos Bay showing the location of the proposed pipe pile driving (black dot) and the underwater noise modeling transects (red lines). An expanded distance scale is also provided.

2. Methods

A full-wave numerical sound propagation model was used to simulate the transmission of impact pile driving noise through water-saturated soils into water. Source levels for impact pile driving were calculated using a thin-shell structural vibration model for cylindrical piles. For modeling the sound propagation, JASCO collected environmental data describing the bathymetry, water sound speed, and seabed geoacoustics in Coos Bay. The environmental data and source levels were input to underwater noise modelling software to estimate the underwater noise received levels (RL) that would be present in the water near the pile driving.

M-weighting was applied for multiple hearing groups, including low-frequency cetaceans, mid-frequency cetaceans, high-frequency cetaceans, phocid pinnipeds in water, and otariid pinnipeds in water, to weight the importance of received sound levels according to marine mammal hearing sensitivity, in accordance with the 2016 NOAA Technical Guidance (NMFS 2016).

2.1. Bathymetry

A bathymetry grid for the acoustic propagation model was constructed based on two datasets:

- U.S. Coastal Relief Model digital elevation model (DEM) with a 3-arc-second resolution ([NGDC] National Geophysical Data Center 2017)
- Coos Bay hydrographic chart, no. 18587, at 1:20,000 scale, from the National Oceanic and Atmospheric Administration (NOAA) Coast Survey, National Ocean Service. (Coast Survey 2017).

The DEM downloaded from the NOAA National Centers for Environmental Information (NCEI) website provided only positive elevation values inland of the Pacific Ocean coastline. To accurately represent the bathymetry of the Coos Bay channel, 16433 spot bathymetry values were sampled from the NOAA Bathymetric Chart. These spot bathymetric readings are relative to Mean Lower Low Water (MLLW), while the DEM is relative to the mean high water (MHW) tidal level. Based on the tide information published on the Coos Bay hydrographic chart, an adjustment of 6 ft was made to the spot bathymetry samples from the chart before incorporating them into the revised DEM with a 9-meter horizontal grid spacing. The underwater acoustic noise modeling was carried-out on the basis of a tidal water level equal to the MHW.

Bathymetry was manually edited to have 12 ft (3.7 m) of land before water starts. For the scenario with dredged bathymetry, water depths were uniformly 45 ft (13.7 m) from the toe of the sheet pile out to the shipping channel.

2.2. Sound Speed Profile

A uniform sound speed of 1500 meters per second (m/s) was assumed for the entire water column. This is a common laboratory reference value for speed of sound in sea-water. Since the water depth in this modeling area is very shallow (less than 46 ft (14 m)), and located in an estuary, it is reasonable to assume that this water column is well mixed and the speed of sound is uniform with depth.

2.3. Geoacoustics

In shallow water environments where there is increased interaction with the sea-floor, the properties of the substrate have a large influence over the sound propagation. Information on the composition of the soils at the measurement site was not available at the time of writing, therefore the geoacoustic model used in this work is based on estimated values that are thought to be typical for this environment, consisting of soft silty sand sediments of undetermined depth. The required parameters for modeling sound propagation are the density (ρ), compressional-wave speed, (c_p), shear-wave speed (c_s), compressional-wave attenuation (α_p), and shear-wave attenuation (α_s). A geoacoustic profile, Table 1, has been constructed to represent these geological conditions.

Table 1. Geoacoustic properties as a function of depth, in meters below the seafloor (mbsf). Within an indicated depth range, the parameter varies linearly within the stated range.

Depth (mbsf)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation **(dB/λ)**	S-wave speed (m/s)	S-wave attenuation **(dB/λ)**
0–50	Silty sand	1.83	1680–1730	0.5	250	0.1
> 50			1730			

2.4. Source Level

Draft engineering designs describe the individual pipe piles for bollard construction: 60 ft long, 36 in diameter, and embedded to a maximum penetration depth of 55 ft. The construction plan calls for the piles to be driven using a Demag D80-23 diesel impact hammer. A forcing function for the hammer was modelled using GRLWEAP 2010 (GRLWEAP, Pile Dynamics 2010) assuming that driving was carried out using the maximum recommended hammer energy (Figure 2). The forcing function was computed assuming direct contact between the hammer and the piles (i.e. no cushion material).

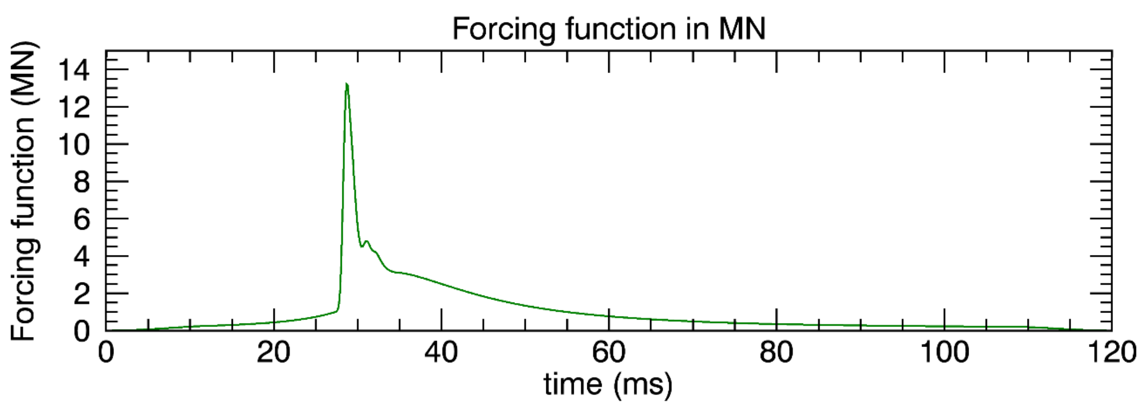

Figure 2. Force (meganewtons (MN)) at the pile tip generated by a Demag D80-23 diesel impact hammer as predicted by GRLWEAP 2010.

A structural acoustic model of pile vibration and near-field sound radiation (MacGillivray 2014) was used to predict the vibration of the struck pile (Figure 3). The sound radiating from the pile itself was simulated using a vertical array of discrete point sources to accurately characterise vertical directivity effects in the near-field zone. An extrapolation method (Zykov et al. 2016) was used to extend the modelled source levels up to 4 kHz, by applying a −2 dB per 1/3-octave-band roll-off coefficient to the source levels starting at 800 Hz.

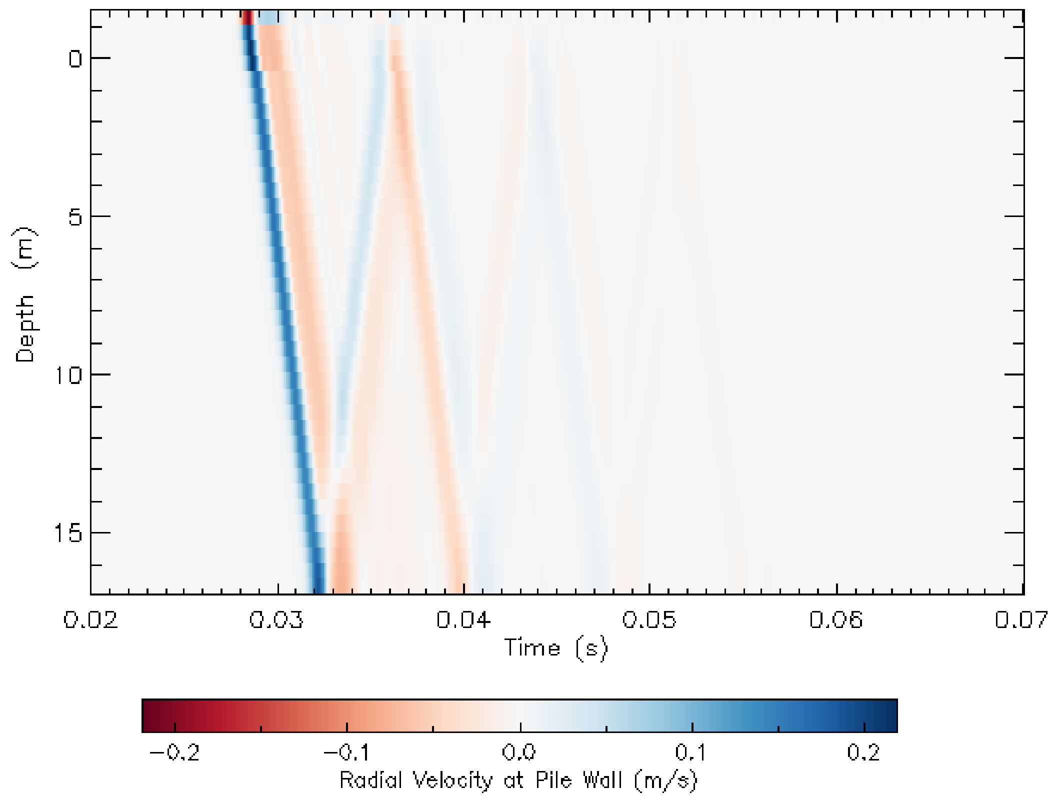

Figure 3. Radial vibration of the pile wall as predicted by the structural acoustic model.

2.5. Underwater Sound Propagation Model

For impulsive sounds from impact pile driving, time-domain representations of the pressure waves generated in the water are required to calculate sound pressure level (SPL), sound exposure level (SEL), and peak pressure level. For this study, synthetic pressure waveforms were computed using FWRAM, which is a time-domain acoustic propagation model. FWRAM computes synthetic pressure waveforms versus range and depth for range-varying marine acoustic environments, accounting for bathymetry, water sound speed profile, and seabed geoacoustics. FWRAM computes pressure waveforms via Fourier synthesis of the modelled acoustic transfer function in closely spaced frequency bands. FWRAM employs the array starter method to accurately model sound propagation from a spatially distributed source (MacGillivray and Chapman 2012).

2.6. Transmission Loss Through Sheet Pile Wall

Frequency-dependent attenuation through the sheet pile wall at the MOF was calculated according a plane wave transmission model (Jensen et al. 2011) from soil through a 0.5 inch steel layer. The frequency-dependent transmission loss (Figure 4) was applied to calculated source pressures of the pipe pile to simulate the attenuation of the pile driving noise due to the sheet pile wall.

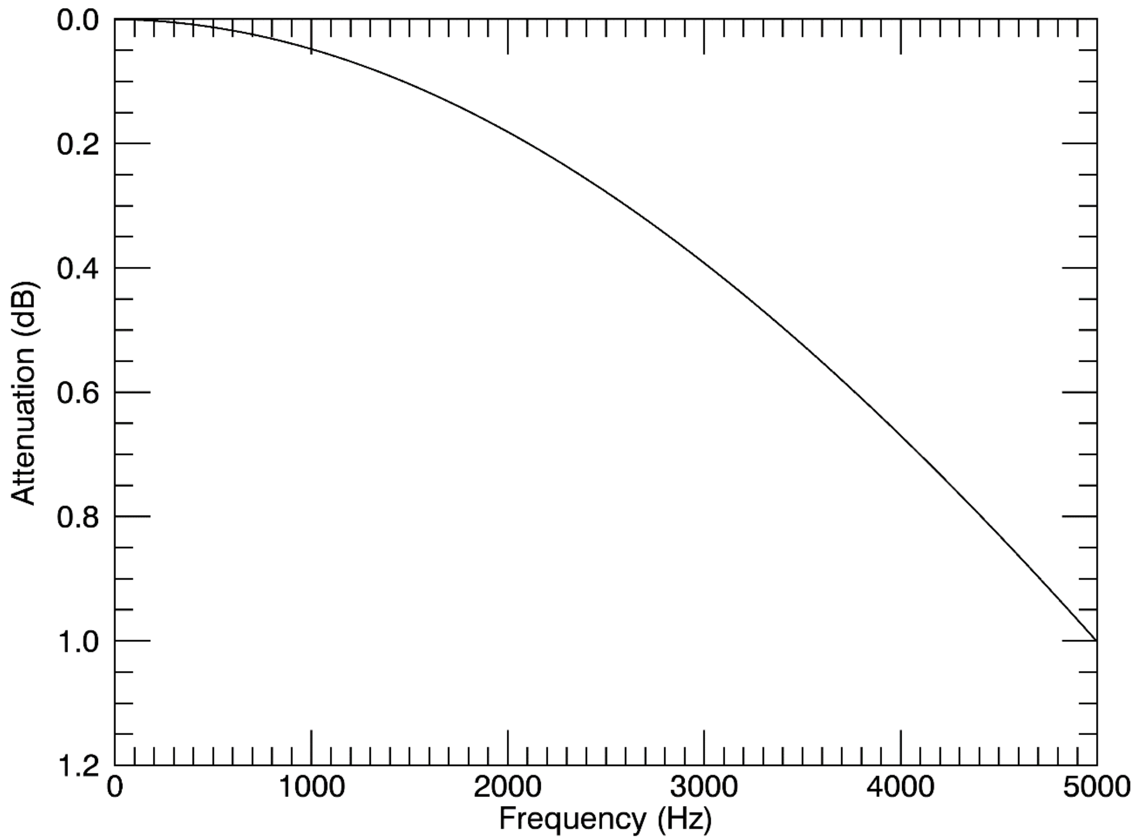

Figure 4. Calculated sound attenuation of the sheet pile wall versus frequency.

2.7. Marine Mammal Frequency Weighting Functions

In 2015, a U.S. Navy technical report recommended new auditory weighting functions for marine mammals (Finneran 2016). The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The report proposed five functional hearing groups for marine mammals in water: low-, mid-, and high-frequency cetaceans, phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year and were adopted in NOAA's technical guidance that assesses noise impacts on marine mammals (NMFS 2016). Figure 5 shows the recommended frequency-weighting curves.

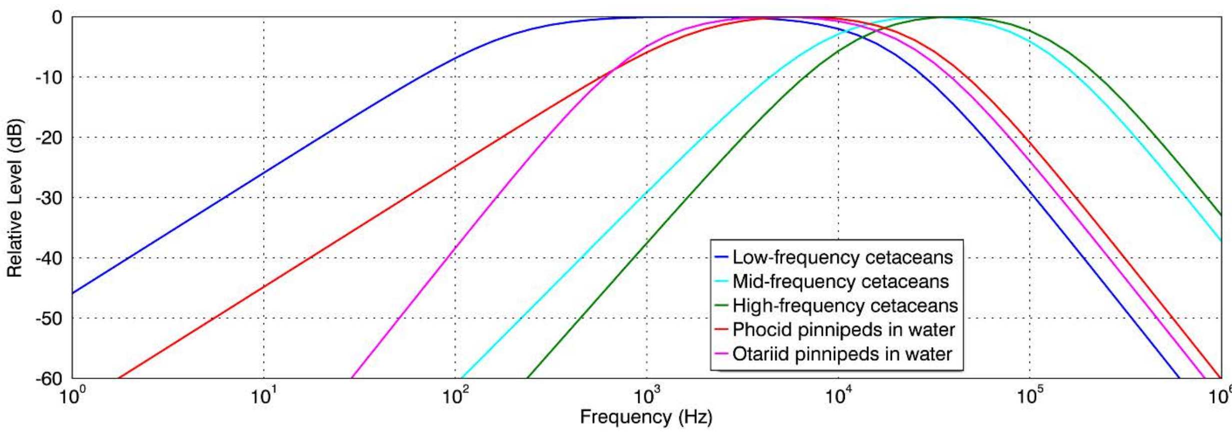

Figure 5. Auditory weighting functions for functional marine mammal hearing groups as recommended by NOAA (2016).

3. Results

The modeled received levels (RL) of the broadband noise in the water column generated by the impact pipe pile driving are illustrated in Figure 7 and Figure 7, which show unweighted, per-pulse SEL (dB re 1 µPa²s) as a function of the horizontal distance from the source and the depth of the receiver. Each of the figures is for a different azimuthal direction away from the source location (measured in degrees, clockwise from geographic true north).

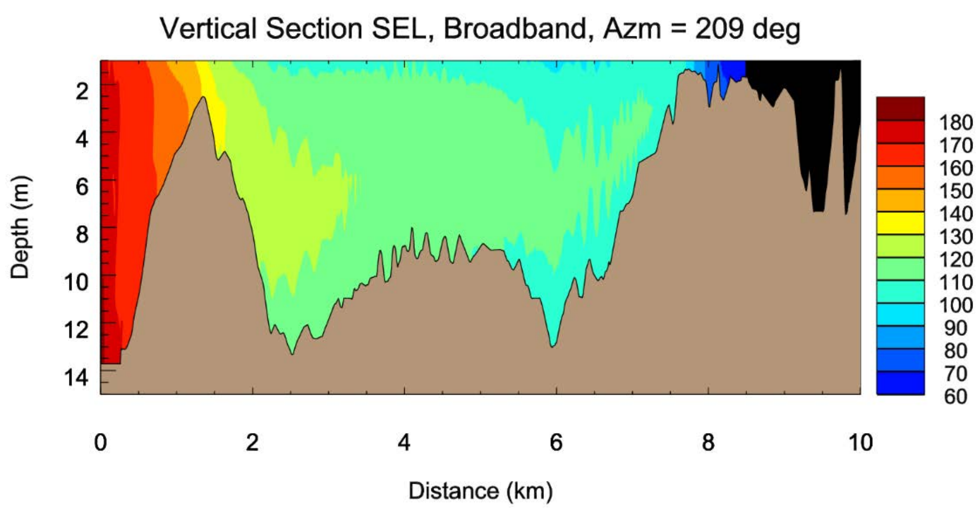

Figure 6. Per-pulse SEL (unweighted) versus horizontal range from the source and depth below the MHW tidal level for the 209° azimuth.

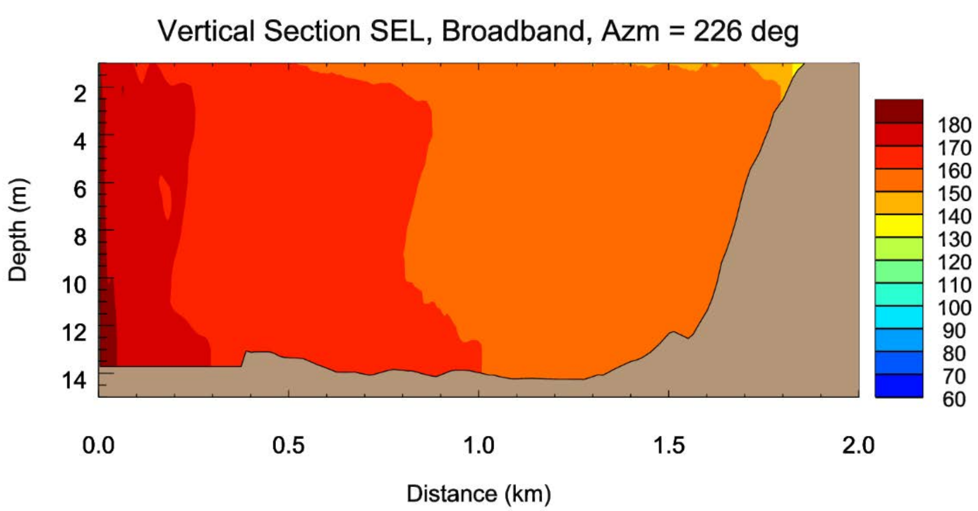

Figure 7. Per-pulse SEL (unweighted) versus horizontal range from the source and depth below the MHW tidal level for the 226° azimuth.

The 209° azimuthal direction illustrates the longest possible underwater range of noise propagation from the source, as other directions are blocked at shorter ranges by shoals or the shoreline. The 226° azimuthal direction illustrates the highest underwater RL, at longer ranges, due to the greater water depth in that direction before shoaling is encountered.

The maximum modelled RL (over depth) as a function of range is illustrated in Figure 8 and Figure 9 for the same two azimuthal directions as the previous figures. Inspection of the 1/3-octave band RL shows that highest levels are at frequencies around 300 to 500 Hz (Figure 10). These frequencies are within the hearing ranges of all marine mammal hearing groups, although killer whales (mid-frequency cetaceans) and harbor porpoises (high-frequency cetaceans) would not hear these frequencies as well as seals (phocid pinnipeds) and sea lions (otariid pinnipeds) (NMFS 2016).

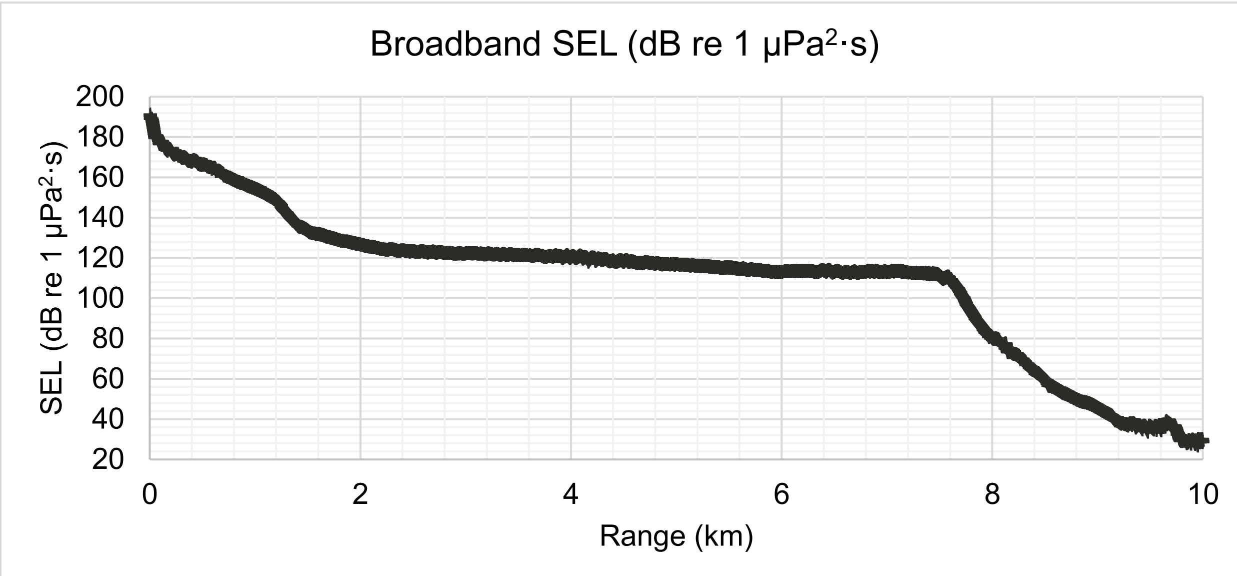

Figure 8. Maximum-over-depth per-pulse SEL (unweighted) versus horizontal range from the source for the 209° azimuth.

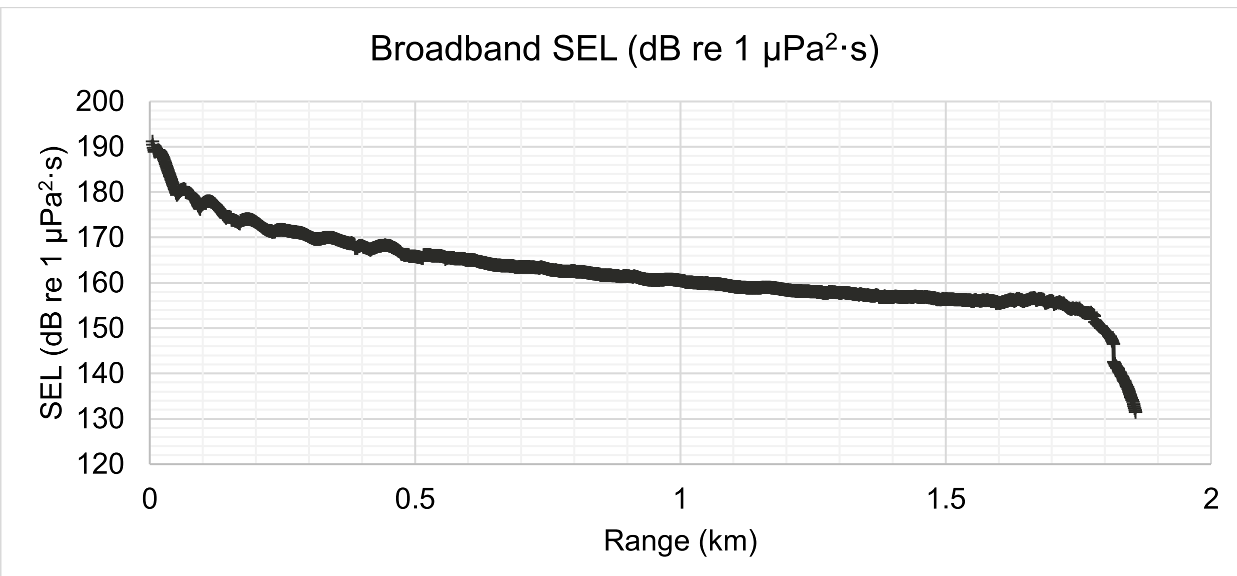

Figure 9. Maximum-over-depth per-pulse SEL (unweighted) versus horizontal range from the source for the 226° azimuth.

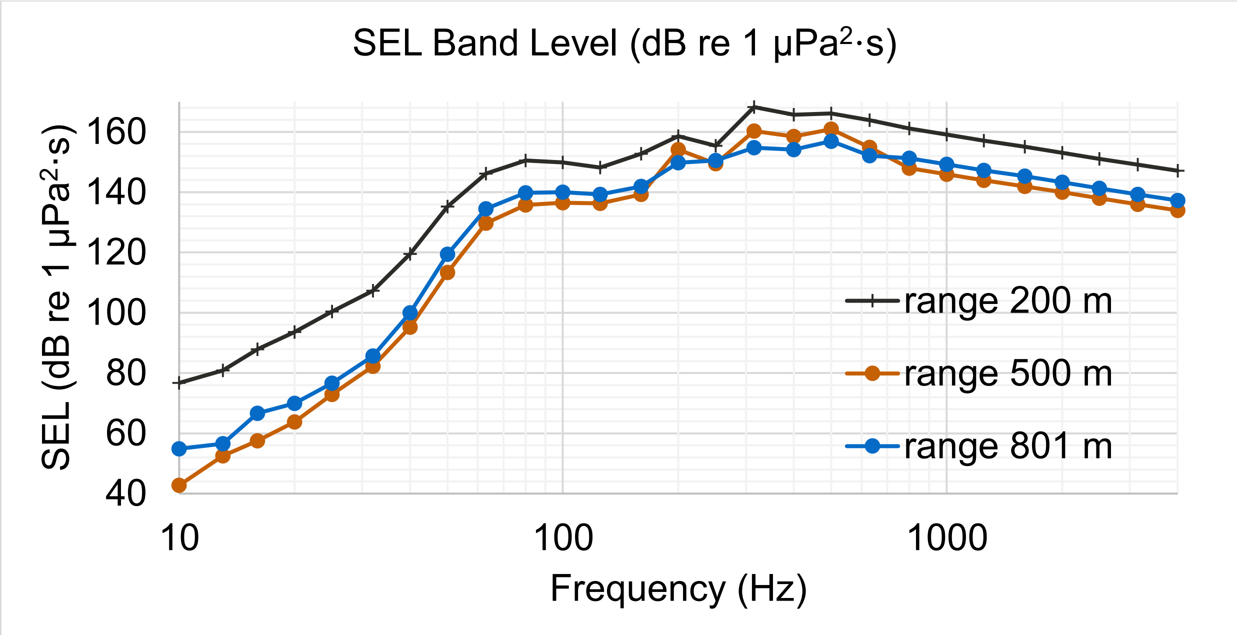

Figure 10. Maximum-over-depth per-pulse SEL versus frequency in 1/3-octave bands, at three different ranges, for the 226° azimuth.

4. Summary

NMFS criteria (NMFS 2016) define a 160 dB re 1 µPa SPL (rms) behavioral threshold for marine mammals for impulsive sound sources. Table 2 shows the maximum distance to 160 dB re 1 µPa SPL along the two modelled transects considered in the current study. The results show that bathymetry plays a strong role in sound propagation conditions in Coos Bay. Received sound levels along the 209° azimuth decrease at a greater rate within 1.8 km of the source than the received levels along the 226° azimuth. Table 3 and Table 4 show the maximum ranges to the Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) criteria along the two modeling transects. Because cumulative SEL depends on the total number of hammer strikes over a 24-hour period, distances were calculated for three different possible conditions: 100 strikes, 1000 strikes, and 10000 strikes. Assuming a blow rate of 40 strikes/second, these correspond to 2.5 minutes, 25 minutes, and 250 minutes of continuous pile driving during a 24-hour period.

Table 2. Maximum modeled distance to 160 dB re 1 µPa threshold along two azimuths.

Azimuth (° from North)	Maximum range to 160 dB re 1 µPa (m)
209	1299
226	1817

Table 3 Maximum range from the pipe pile to modelled peak pressure level TTS and PTS thresholds based on the NOAA Technical Guidance (NMFS 2016) A dash indicates that the threshold was not reached.

Hearing group	Peak SPL (dB re 1 µPa)			
	PTS Threshold	Range (m)	TTS Threshold	Range (m)
Low-frequency cetaceans	219	20	213	35
Mid-frequency cetaceans	230	-	224	-
High-frequency cetaceans	202	199	196	337
Phocid pinnipeds in water	218	21	212	43
Otariid pinnipeds in water	232	-	226	-

Table 4. Maximum range from the pipe pile to modelled 24h SEL thresholds based on the NOAA Technical Guidance (NMFS 2016).

Hearing Group	Weighted SEL_{24h} (dB re 1 µPa²·s)			
	PTS Threshold	Range (m)	TTS Threshold	Range (m)
100 strikes (2.5 minutes)				
Low-frequency cetaceans	183	669	168	1806
Mid-frequency cetaceans	185	613	170	1796
High-frequency cetaceans	155	1849	140	4223
Phocid pinnipeds in water	185	605	170	1795
Otariid pinnipeds in water	203	40	188	455
1000 strikes (25 minutes)				
Low-frequency cetaceans	183	1758	168	1835
Mid-frequency cetaceans	185	1726	170	1830
High-frequency cetaceans	155	2160	140	7592
Phocid pinnipeds in water	185	1726	170	1829
Otariid pinnipeds in water	203	204	188	1253
10000 strikes (250 minutes)				
Low-frequency cetaceans	183	1817	168	1860
Mid-frequency cetaceans	185	1817	170	1860
High-frequency cetaceans	155	5549	140	7732
Phocid pinnipeds in water	185	1817	170	1860
Otariid pinnipeds in water	203	750	188	1811

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Glossary

1/3-octave-band
Non-overlapping passbands that are one-third of an octave wide (where an octave is a doubling of frequency). Three adjacent 1/3-octave-bands comprise one octave. One-third-octave-bands become wider with increasing frequency. Also see octave.

attenuation
The gradual loss of acoustic energy from absorption and scattering as sound propagates through a medium.

azimuth
A horizontal angle relative to a reference direction, which is often magnetic north or the direction of travel. In navigation it is also called bearing.

broadband sound level
The total sound pressure level measured over a specified frequency range. If the frequency range is unspecified, it refers to the entire measured frequency range.

compressional wave
A mechanical vibration wave in which the direction of particle motion is parallel to the direction of propagation. Also called primary wave or P-wave.

decibel (dB)
One-tenth of a bel. Unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power (ANSI S1.1-1994 R2004).

digital elevation model (DEM)
A sampled array of elevations (and bathymetric depths in water) for a number of geographical positions at regularly spaced horizontal intervals (i.e., on a horizontal grid).

frequency
The rate of oscillation of a periodic function measured in cycles-per-unit-time. The reciprocal of the period. Unit: hertz (Hz). Symbol: *f*. 1 Hz is equal to 1 cycle per second.

geoacoustic
Relating to the acoustic properties of the seabed.

hertz (Hz)
A unit of frequency defined as one cycle per second.

mbsf
Meters below sea floor

mean high water (MHW)
The arithmetic mean of all the high water heights observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

mean lower low water (MLLW)
The arithmetic mean of the lower of the two low water heights of each tidal day, observed over a period of several years. In the United States this period spans 19 years and is referred to as the National Tidal Datum Epoch.

NCEI
National Centers for Environmental Information (formerly the National Geophysical Data Center).

NGDC
National Geophysical Data Center.

NOAA
National Oceanic and Atmospheric Administration.

octave
The interval between a sound and another sound with double or half the frequency. For example, one octave above 200 Hz is 400 Hz, and one octave below 200 Hz is 100 Hz.

parabolic equation method
A computationally-efficient solution to the acoustic wave equation that is used to model transmission loss. The parabolic equation approximation omits effects of back-scattered sound, simplifying the computation of transmission loss. The effect of back-scattered sound is negligible for most ocean-acoustic propagation problems.

point source
A source that radiates sound as if from a single point (ANSI S1.1-1994 R2004).

pressure, acoustic
The deviation from the ambient hydrostatic pressure caused by a sound wave. Also called overpressure. Unit: pascal (Pa). Symbol: *p*.

received level
The sound level measured at a receiver.

rms
root-mean-square.

shear wave
A mechanical vibration wave in which the direction of particle motion is perpendicular to the direction of propagation. Also called secondary wave or S-wave. Shear waves propagate only in solid media, such as sediments or rock. Shear waves in the seabed can be converted to compressional waves in water at the water-seabed interface.

sound
A time-varying pressure disturbance generated by mechanical vibration waves travelling through a fluid medium such as air or water.

sound pressure level (SPL)
The decibel ratio of the time-mean-square sound pressure, in a stated frequency band, to the square of the reference sound pressure (ANSI S1.1-1994 R2004).

For sound in water, the reference sound pressure is one micropascal (p_0 = 1 μPa) and the unit for SPL is dB re 1 μPa:

$$\mathrm{SPL} = 10\log_{10}\left(p^2 / p_0^2\right) = 20\log_{10}\left(p / p_0\right)$$

Unless otherwise stated, SPL refers to the root-mean-square sound pressure level. See also 90% sound pressure level and fast-average sound pressure level. Non-rectangular time window functions may be applied during calculation of the rms value, in which case the SPL unit should identify the window type.

sound speed profile
The speed of sound in the water column as a function of depth below the water surface.

source level (SL)
The sound level measured in the far-field and scaled back to a standard reference distance of 1 meter from the acoustic center of the source. Unit: dB re 1 µPa @ 1 m (sound pressure level) or dB re 1 $\mu Pa^2 \cdot s$ (sound exposure level).

October 28, 2019

Jordan Cove LNG LLC **J1-CTC-LET-KBJ-JCL-00088-19**
5615 Kirby Dr.
Suite 500
Houston, Texas 77005

Attention: Mr. Chris Haddon
Project Director

Subject: Concrete Batch Plant

References:

1. Boxcar Hill Concrete Batch Plant; JC-150-CIV-MAP-KBJ-02804-01, Rev A.
2. Example Concrete Batch Plant; J1-000CNS-SKT-03000-00, Rev A.
3. Fugitive Dust Control Plan; J1-000-CNS-PLN-KBJ-50003-00, Rev 0.

Dear Mr. Haddon,

KBJ has reviewed the findings of the Coos County Planning Department's September 23, 2019 Staff Report for the request for concurrent Land Use Application by Jordan Cove Energy Project L.P. for the Liquefied Natural Gas Terminal. To address the Coos County standards for compatibility of the temporary concrete batch plant, KBJ has reviewed the definition and has developed the following general description of the proposed support facility.

KBJ intends to construct a concrete batch plant to supply concrete for the Jordan Cove Energy Project. The plant will provide concrete supply for the construction of LNG Terminal and related facilities. The concrete needed is approximately 130,000 cubic yards. Local aggregate sources have been investigated and have been found to have deficiencies that preclude their use for concrete. Regional sourcing for the availability of on-spec aggregate has been confirmed. This plant will only be utilized to supply concrete to the JCEP and not offer concrete to the general public. The plant will be capable of producing approximately 200 cubic yards of concrete per hour, which is appropriate for the planned concrete needs for the project. KBJ has based these plans on the capabilities of current local red-i-mix concrete vendors as well as the impact on the local community concrete truck traffic on area roads if one of the local vendors was used to supply all of the concrete for the project.

The current plan for the batch plant is to be located on an approximately 5-acre parcel of land at Boxcar Hill. This will include the batch plant, aggregate storage, plant support equipment parking, and an office facility for batch plant operations. The plant layout has not been finalized, but early conceptual layouts have shown that the batch plant will use approximately 80,000 sq. feet of the approximately 5-acre (217,800 SF) area. The final layout will consider the safe traffic flow of concrete trucks and batch plant equipment, as well as proximity to property lines to keep batch plant operations away from neighboring properties. The batch plant will be located inside the property line and further set back behind a construction security fence. Attachment 1 contains an illustration of the proposed batch plant's location at Boxcar Hill.

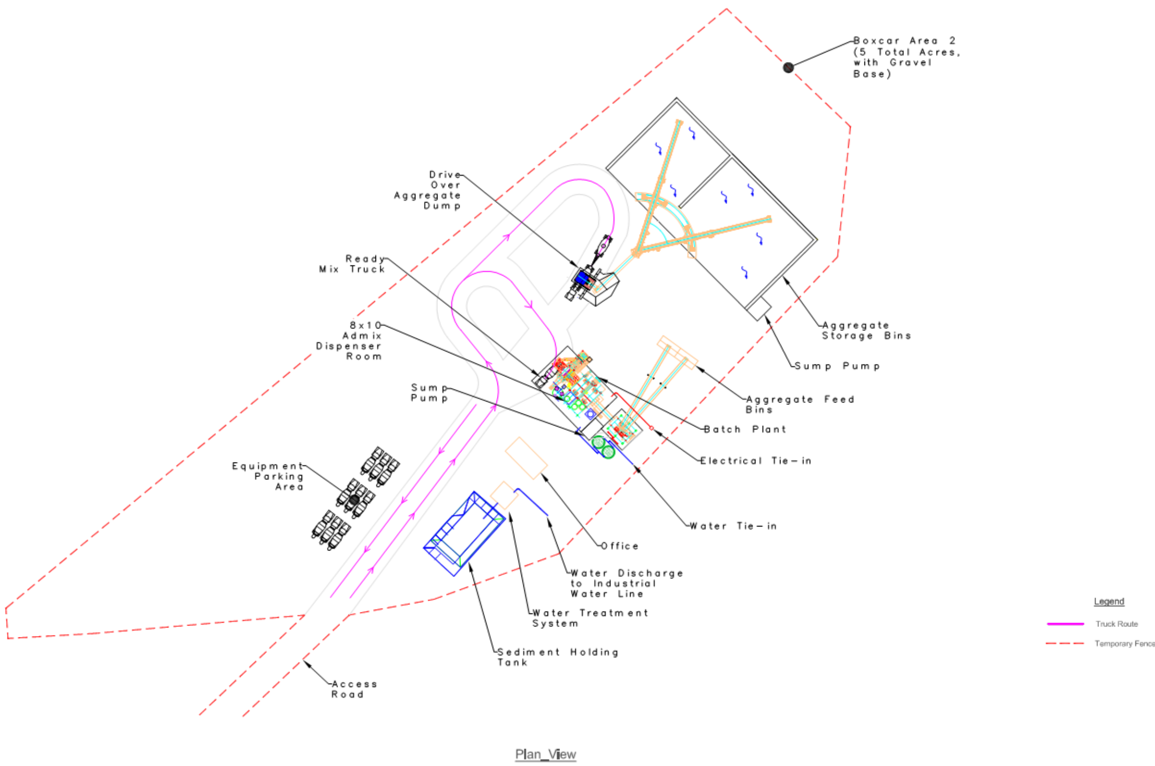
It is expected that the batch plant will be in operation for 30-36 months. Typical batch plant operations will be from 6:00 AM – 6:00 PM Monday through Friday. There may be some extended work hours for batch plant operations to support large concrete pours on the project. During plant operations the area will be well lit to provide a safe work environment for plant personnel. This lighting will be reduced when the plant is not in operations to levels that are appropriate for security purposes. Upon completion of the construction project, the temporary concrete batch plant will be decommissioned and removed from Boxcar Hill.

The concrete batch plant will be comprised of several pieces of equipment that are used in the batching process. The major pieces of equipment will include a batching hopper, material conveyors to transport aggregate materials into the hopper and cement silos along with their associated dust control equipment. This equipment will generally be less than 16' tall with the tallest element being the cement silos which could be as tall as approximately 60 feet. An example picture of this equipment has been included as Figure 1. Figure 2 illustrates a conceptual batch plant layout. It is anticipated that power to operate the batch plant will come from a permanent electrical connection to eliminate the need for portable generators to power the facility. Auxiliary equipment will include air compressors and mobile equipment such as front-end loaders, dump trucks, and fork lifts.

KBJ or their subcontractors will be responsible for attaining all required permits to erect and operate the concrete batch plant. It is anticipated that the plant will acquire an applicable air permit, a 1200-A permit, and develop a stormwater management plan, and a site-specific fugitive dust plan (reference for terminal site has been included). The batch plant will also have a water treatment system to address any waste water generated by plant operations. A separate wash out area will be managed to be used by concrete trucks washing up to contain all concrete wastes. Concrete batch plants do not typically generate significant plumes of steam or smoke as part of their standard operations and thus, impacts to local visibility are not expected. Additionally, Oregon exempts construction noise which would include noise generated from the proposed concrete batch plant.

Figure 1 - Example of a typical concrete batch plant

Conceptual Batch Plant Layout



Sincerely,
KBJ JOINT VENTURE

Craig Ratcliffe | JV Project Director

A Kiewit, Black & Veatch and JGC Joint Venture

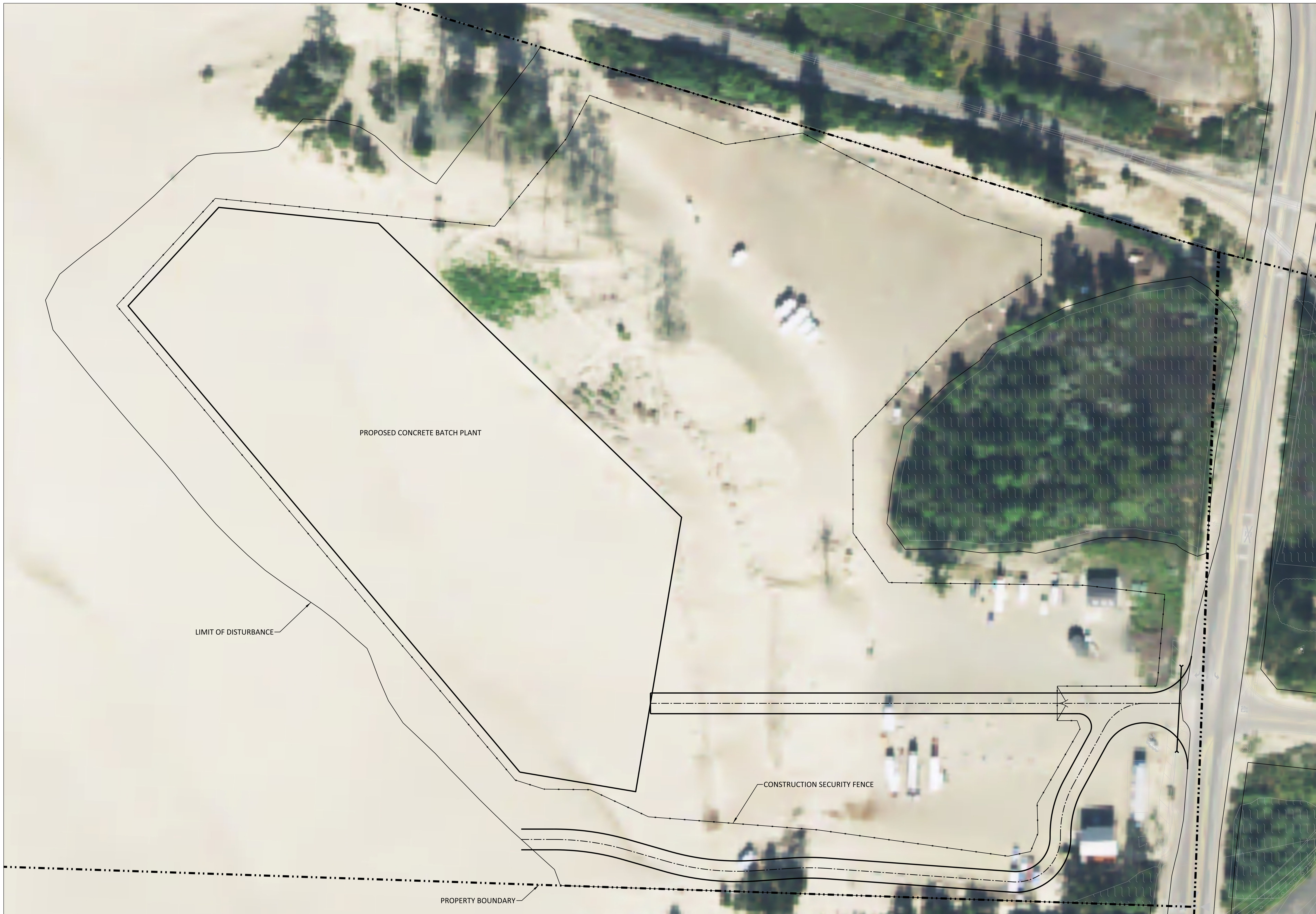
cc: Tony Diocee, Chris Haddon, Mick Rowlands, Brett Baker, Koji Shimeno, Cyndi Hanson, Mike Fitzgerald, Amanda Barkley

Attachment 1

NOTES

1. COORDINATES ARE BASED ON THE OREGON STATE PLANE SYSTEM, SOUTH ZONE 3602, NAD 83 INTERNATIONAL FEET. ALL COORDINATES, BEARINGS, AND DISTANCES SHOWN ARE GRID.

2. ELEVATIONS ARE BASED ON THE NAVD 88 DATUM.



60' 30' 0 60' 120'

1"=60'

JORDAN COVE LNG

Jordan Cove LNG℠
A Pembina Company

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A	28-OCT-19	ISSUED FOR REVIEW	CAF	CAF		MKA	KJL	A	28-OCT-19	ISSUED FOR REVIEW	CAF	CAF		MKA	KJL

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF

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JORDAN COVE LNG PROJECT

BOXCAR HILL
CONCRETE BATCH PLANT

PROJECT: 189980-0000-DS2804 DRAWING NUMBER REV A

JCLNG NUMBER: J1-150-CIV-MAP-KBJ-02804-01 REV A

APPLICANT-PREPARED

DRAFT

BIOLOGICAL ASSESSMENT

and

ESSENTIAL FISH HABITAT ASSESSMENT

for the

Jordan Cove Energy and Pacific Connector Gas Pipeline Project

Jordan Cove Energy Project, L.P.	Docket Nos. CP17-495-000
Pacific Connector Gas Pipeline Project, LP	CP17-494-000

Revised September 2018

EXECUTIVE SUMMARY

This applicant-prepared Draft Biological Assessment (APDBA) and Essential Fish Habitat (EFH) Assessment has been prepared for submission to the Federal Energy Regulatory Commission (FERC or Commission) to assist FERC in meeting its obligations under Section 7 of the Endangered Species Act of 1973 (ESA) and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) by Jordan Cove Energy Project, LP (JCEP) and Pacific Connector Pipeline, LP (PCGP) (JCEP and PCGP are together referred to as "Applicants").

In September 2017, JCEP filed an application with the FERC under Section 3 of the Natural Gas Act, 15 U.S.C. §717b(a) (NGA), in Docket No. CP17-495-000, seeking to site, construct and operate a LNG export terminal on the North Spit of Coos Bay, in Coos County, Oregon (LNG Terminal). Under Section 7 of the NGA, PCGP also filed an application with the FERC in September 2017, in Docket No. CP17-494-000, seeking a Certificate of Public Convenience and Necessity (Certificate) to construct and operate a 229-mile-long, 36-inch-diameter, pipeline from interconnections with the existing Ruby pipeline and Gas Transmission Northwest pipeline near Malin, Oregon (Pipeline) to supply the LNG Terminal with natural gas. The proposed Pipeline would cross through portions of Klamath, Jackson, Douglas, and Coos Counties, Oregon. The LNG Terminal and the Pipeline are collectively referred to as the "Project."

Section 7 of the ESA, 16 U.S.C. §§1531 et. seq. requires federal agencies to consult with the United States Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS), as applicable, to assure that any project authorized, funded, or conducted by a federal agency does not "jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined...to be critical." If, upon review of existing data, or data provided by the applicant, one (or both) of the Services find that any federally listed species or critical habitats may be affected by a proposed project, the lead federal agency is required to prepare a biological assessment (BA) to identify the nature and extent of the effects on these species and their habitats, and to recommend measures that would avoid, reduce, or mitigate impacts on habitats and/or species. FERC is the lead federal agency for this Project.

The Magnuson-Stevens Fishery Conservation and Management Act, as amended, 16 U.S.C. §§1361 et.seq. (MSA) established procedures designed to identify, conserve, and enhance essential fish habitat (EFH) for those species regulated under a federal fisheries management plan. The MSA requires federal agencies to consult with the NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH, 16 U.S.C. §305(b)(2); 50 C.F.R. §600.920. The applicable regulations encourage consolidation of environmental review procedures to reduce duplication and improve efficiency, 50 C.F.R. §600.920(f). For this Project, the EFH Assessment has been incorporated into the APDBA, 50 C.F.R. § 600.920(e)(3).

Under the NGA, the FERC is the federal agency responsible for authorizing the siting, construction, and operation of onshore LNG terminals, as well as allowing the interstate transportation of natural gas. The FERC is also the lead federal agency for compliance with the

NEPA, in accordance with the Energy Policy Act of 2005 and inter-agency agreements.[1] On behalf of the cooperating agencies, the FERC is also the lead federal agency responsible for complying with the ESA and the MSA for the Project. The federal agencies cooperating with the FERC in the production of this BA and EFH Assessment include the United States Department of Agriculture, Forest Service (Forest Service), the United States Department of the Interior, Bureau of Land Management (BLM) and Bureau of Reclamation (Reclamation), United States Army Corps of Engineers (COE), the United States Environmental Protection Agency (EPA), the United States Coast Guard (Coast Guard), the United States Department of Energy (DOE), and the United States Department of Transportation (DOT).

PROPOSED ACTION

The Project will be located in southern Oregon. The main components of the Project include:

- The LNG Terminal and associated facilities in Coos County, Oregon; and
- The Pipeline which will cross portions of Klamath, Jackson, Douglas, and Coos County, Oregon, and associated facilities.

The Project description is provided in section 2.0, and terminology in this document is defined as follows:

- "LNG Terminal site" refers to the terminal site footprint and "LNG Terminal project" refers to the terminal and associated components.
- "Pipeline" refers to the centerline or linear facility and "Pipeline project" refers to the construction right-of-way, temporary extra work areas (TEWAs), uncleared storage areas (UCSAs), aboveground facilities, contractor and pipe storage yards, quarries and rock source disposal sites, permanent and temporary access roads (PARs and TARs, respectively), existing access roads (EARs), communication facilities, 30-foot maintenance/operation corridor, and 50-foot permanent easement.
- "in the vicinity of the Pipeline project" or in the "Pipeline project area" describes the area where impacts to fish, wildlife, and vegetation (plants) could occur outside of the Pipeline project footprint. In many instances, these terms are used generally, since the extent (or distance from the Pipeline project) of impact beyond the Pipeline project varies by fish, wildlife, and vegetation (plant) species, Pipeline project activity, habitat and site characteristics (i.e., waterbody or vegetation). Similarly, discussion of area of surveys (i.e., distance from the Pipeline project) conducted for the Pipeline varies depending on wildlife and plant species targeted, landowner (federal or non-federal), and expected impact (i.e., proposed blasting and/or helicopter use). Specific distances for survey

[1] See the May 2002 *Interagency Agreement on Early Coordination of Required Environmental and Historic Preservation Reviews Conducted in Conjunction With the Issuance of Authorizations to Construct and Operate Interstate Natural Gas Pipelines Certificated by the Federal Energy Regulatory Commission*, signed by the FERC, Advisory Council on Historic Preservation, Council on Environmental Quality, EPA, Department of the Army, USDA, Department of Commerce, DOE, USDI, and DOT; and the February 2004 *Interagency Agreement Among the Federal Energy Regulatory Commission, United States Coast Guard, and Research and Special Programs Administration for the Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities*.

efforts and construction and operation impacts are discussed specifically in the individual species' sections below. See the discussion of the Action Area for purposes of Section 7 consultation below.

The Project is a market-driven response to the burgeoning and abundant natural gas supply in the US Rocky Mountain and Western Canadian markets, and the growth of international demand, particularly in Asia. The overall Project purpose and need is to construct a natural gas liquefaction and deep-water export terminal capable of receiving and loading ocean-going LNG carriers, in order to export natural gas derived from a point near the intersections of the Gas Transmission Northwest and Ruby Pipeline systems. JCEP intends to liquefy about 7.8 million tons per annum (mtpa) of LNG, which can be loaded onto LNG carriers, using a feed of about 1.2 billion cubic feet per day (Bcf/d) of natural gas. PCGP's new pipeline is designed to transport an everage of 1,200,000 dekatherms per day (dth/d) of natural gas obtained at proposed interconnections with the existing Gas Transmission Northwest LLC and Ruby Pipeline LLC systems near Malin, Oregon to be delivered to the LNG Terminal at Coos Bay.

The LNG Terminal would turn natural gas into its liquid form via cooling to about -260 degrees Fahrenheit (^{o}F), and in doing so, it would reduce in volume to approximately 1/600th of its original volume, making it easier and more efficient to transport. The LNG Terminal, related facilities, temporary construction sites, and other sites/actions associated with LNG Terminal construction are collectively referred to as the "JCEP Project Area." The JCEP Project Area is made up of the following project components:

- LNG Carrier Transit Route – the waterway for LNG carrier marine traffic for the Project extends from the outer limits of the Outer Continental Shelf approximately 12 nautical miles (nmi) off the coast of Oregon, and 7.5 nmi up the existing Coos Bay Federal Navigation Channel (FNC) to the LNG Terminal.
- LNG Terminal Site – the site includes the Ingram Yard, Access and Utility Corridor, and South Dunes site. These components are referenced throughout the document but are not described in greater detail. See JCEP's Resource Report 1 for additional information.
- Marine Slip – a permanent facility on Ingram Yard adjacent to the access channel. LNG carriers would enter the slip via the access channel, be loaded with LNG, and leave for export. The slip would include an LNG carrier loading berth and LNG loading facilities, a tug berth, and an emergency lay berth to safely moor a temporarily disabled LNG carrier.
- Access Channel – the access channel would be dredged north of the FNC to provide LNG carriers with access from the FNC to the slip.
- Pile Dike Rock Apron – a permanent rock apron located immediately west of the access channel to protect Pile Dike 7.3
- Material Offloading Facility (MOF) – a permanent facility east of the slip where fill would be placed and approximately 450 feet of dock face would be constructed for the mooring of a variety of vessel types to offload materials for construction and maintenance of the LNG Terminal. Dredging would occur to access the MOF.
- Temporary Materials Barge Berth (TMBB) – an offloading facility that would be

constructed on an existing berm west of the MOF to facilitate early construction activities, and would be removed when the access channel is dredged and the berm related to the slip construction is removed.

- Navigation Reliability Improvements – four permanent dredge areas adjacent to the FNC that would allow for navigation efficiency and reliability for vessel transit under a broader weather window.
- Trans Pacific Parkway and U.S. Highway 101 (US-101) Intersection Widening – the asymmetrical widening of Trans Pacific Parkway to the north and US-101 to the west to provide safe ingress/egress for construction traffic, by creating a left-turn lane from Trans Pacific Parkway onto northbound US-101 and a right-turn lane from US-101 onto Trans Pacific Parkway.
- APCO Site – APCO Site 1 (east) and APCO Site 2 (west) would be used as upland dredge disposal sites for the Project.
- Kentuck Project site – approximately 100-acre proposed wetland mitigation and habitat restoration site associated with the LNG Terminal and the Pipeline.
- Eelgrass Mitigation site – approximately 9.3-acre proposed mitigation site for unavoidable eelgrass impacts associated with dredging of the access channel.
- Upland Wildlife Habitat Mitigation Sites – proposed wildlife habitat mitigation sites (Lagoon, Panhandle, and North Bank) associated with the LNG Terminal.

PCGP proposes to construct and operate a pipeline that will extend approximately 229 miles[2], starting from an interconnection with the existing interstate pipeline systems of Ruby Pipeline LLC (Ruby) and Gas Transmission Northwest LLC (GTN) near Malin in Klamath County, Oregon, and extending to the LNG Terminal in Coos County, Oregon. The Pipeline would be 36 inches in diameter and is designed to transport up to 1,200,000 dekatherms per day (Dth/d) of natural gas at a maximum allowable operating pressure of 1,600 pounds per square inch gage.

PCGP's proposed jurisdictional natural gas facilities would include the following: aboveground facilities required for the Pipeline:

- the 62,200 horsepower Klamath Compressor Station at the eastern beginning of the pipeline at milepost (MP) 228.8. Within the compressor station tract would be the Klamath-Beaver and Klamath-Eagle receipt meter stations, at the interconnections with Ruby and GTN;
- the Jordan Cove Meter Station station would be at MP 0.00 at the interconnection with the LNG Terminal;
- 17 mainline block valves (MLV) located within the pipeline right-of-way or co-located

[2] Total pipeline length is 229.09 miles. However, PCGP retained its original design mileposting and accounted for realignments using equations. Therefore, although the gas would flow east to west, the mileposting is reversed, with the Klamath Compressor Station at MP 228.8 and the Jordan Cove delivery meter station at MP 0.00.

at aboveground facilities;

- 5 pig[3] launchers and receivers co-located within aboveground facilities; and
- 15 communication towers also co-located with existing or proposed facilities.

The Pipeline would traverse agricultural lands, sage and juniper woodlands ecozone of the Klamath Basin, over the Southern Cascades conifer forest and oak woodlands and conifer forest ecozones of the Klamath Mountains, through Camas Valley and Douglas-fir forests of the Coastal Range, and terminate in the Coastal lowlands.

The standard construction right-of-way would be about 95 feet wide. When crossing wetlands and certain riparian areas, the construction right-of-way may be reduced to 75 feet wide. Approximately 2,582 acres would be required for the construction right-of-way. The permanent easement would be 50 feet wide. There would be a number of ancillary use areas associated with construction of the Pipeline. PCGP proposes to use:

- 1,603 temporary extra work spaces, totaling about 922.6 additional acres;
- 320 uncleared storage areas totaling 676 acres would be used during construction,
- 20 rock source and disposal sites, totaling about 41.2 acres (an additional 20 sites, identified for rock source/disposal, are included in the temporary extra work areas, totaling 44.8 acres).
- 36 pipe storage and contractor yards, totaling about 674.2 acres.
- 670 miles of existing roads would be used to access the pipeline right-of-way during construction. PCGP would have to make improvements to portions of 27 of those existing roads, disturbing about 22.5 acres.
- build 10 new temporary access roads, totaling 3.8 acres, and permanently maintain 15 new access roads for operation of the pipeline, covering about 2.2 acres.

This APDBA and EFH Assessment considers impacts on federally listed and proposed species from the construction and operation of the FERC jurisdictional and inter-related and interdependent, non-jurisdictional facilities.

ACTION AREA

The action area includes all areas that would be affected directly or indirectly by the proposed action and not just the immediate area involved in the action. Because the proposed action potentially can affect such a variety of species inhabiting diverse habitats within marine, estuarine, riverine, and various terrestrial locations, there are multiple components of the action area that have been defined as species' analysis areas, the areas where individual or groups of listed species could be affected by the proposed action. Species' analysis areas are described in detail in each species' environmental baselines and figures of the analysis areas are provided, where appropriate. For some species there may be more than one analysis area if the listed

[3] A pig is an internal pipeline cleaning and inspection tool.

species utilizes multiple habitats in diverse locations. Analysis areas and associated species include:

- the marine analysis area is a fan shape beginning at the entrance to Coos Bay extending approximately 12-13 nautical miles (nm) off the coast of Oregon to the edge of the Outer Continental Shelf (OCS). The northern border of the fan extends from the North Jetty to the point located at the edge of the OCS near 43°, 28' 39", -124°33'34", and the southern border extends from the South Jetty to point located at the edge of the OCS near 43°24'49", -124°35'8". The analysis area is approximately 33.1 square miles. The marine analysis area applies to all listed marine mammals, short-tailed albatross, MAMU, green sturgeon, eulachon, coho salmon (Oregon Coast Evolutionary Significant Unit (ESU) and in the Southern Oregon/Northern California Coast (SONCC) ESU), and listed sea turtles;
- the gray wolf analysis area is based on the Area of Known Wolf Activity initially designated for OR-7, and applies only to the gray wolf;
- the estuarine analysis area (see figure 3.3.3-3) which encompasses all estuarine waters (and substrates) that are within the estuary between the North Jetty and South Jetty at the Coos Head entrance to the Upper Coos Bay. The estuarine analysis area is approximately 15 square miles. The estuarine analysis area applies to MAMU, green sturgeon, eulachon, and coho salmon (Oregon Coast ESU);
- the LNG terminal analysis area extends for 1.5 miles beyond the perimeter of the LNG Terminal Site (see figure 3.3.2-2) to include project components on the North Spit and APCO Site, which historically provided western snowy plover nesting habitat;
- terrestrial nesting analysis area extends inland along the Pipeline route to include MAMU Inland Zone 1 – MPs 0.00 to 53.76 - and MAMU Inland Zone 2 – MPs 53.76 to 75.40 (see figure 3.3.3-2). and applies only to MAMU;
- provincial analysis area is located within four Physiographic Provinces: Oregon Coast Range, Oregon Klamath Mountains, West Oregon Cascades, and East Oregon Cascades (see figure 3.3.4-1), and applies only to NSO;
- the riverine analysis area encompasses 5th field (watershed-level) hydrological unit codes (HUCs) and reflects an estimate of the average downstream extent that suspended sediment from any stream crossing generated by the Pipeline could equal ambient conditions within the 5th field watershed crossed. Several riverine analysis areas that are in specific geographic locations each in the respective ranges of coho salmon in the Oregon Coast ESU and in the Southern Oregon/Northern Californis Coast (SONCC) ESU, listed suckers, and Oregon spotted frogs; and
- botanical analysis areas extend to 30 meters (98 feet) each side of the Pipeline project on lands that have potential habitat for listed plant species, except vernal pool-associated species (fairy shrimp and two listed plants) where the area extends out 250 feet.

COORDINATION AND ORGANIZATION

The Applicants conferred with various federal agencies, including the FWS, NMFS, COE, EPA, DOE, Coast Guard, Forest Service, BLM, and Reclamation, as well as state resource agencies, including the Oregon Department of Environmental Quality, Oregon Department of State Lands, Oregon Department of Fish and Wildlife, Oregon Department of Forestry, Oregon Department of

Agriculture, Oregon Department of Water Resources, and the Oregon Department of Land Conservation and Development.

The presentation of the analysis in this APDBA and EFH Assessment is organized by key activities associated with construction and operation of the Project. Structural and functional elements of the Project were grouped into three major components: 1) LNG carrier traffic within marine analysis area; 2) LNG Terminal facilities; and 3) Pipeline and associated natural gas facilities. Section 3.0 discusses the potential effects on ESA listed and proposed species and critical habitat associated with each of these major components and includes our determination of effect for each species and designated or proposed critical habitat (where present in the action area). Section 4.0 discusses potential effects on EFH under the MSA.

SUMMARY OF EFFECTS DETERMINATIONS

Endangered Species Act

The FWS and NMFS were consulted to identify the federally listed and proposed species and critical habitat with the potential to occur in the action area. A total of 31 species, Evolutionarily Significant Units, and Distinct Population Segments that are federally listed as endangered or threatened have the potential to occur in the action area. Of these, critical habitat has been designated or proposed in the action area for 13 species. The findings regarding the potential effects of the Project on listed and proposed species and habitat are based on the best scientific and commercial data available.

Based on the documentation and analytical results contained herein that the Project may affect, but is not likely to adversely affect 20 species and/or their designated critical habitat, including eight whales (designated critical habitat not affected for two whale species), one land mammal, two birds, four sea turtles, one amphibian, one fish (designated critical habitat not affected), and three plants (designated critical habitat not likely to be adversely affected for one species and not affected for another species).

The Project may affect, and is likely to adversely affect 11 species, including two birds and their designated critical habitat, five fish and designated critical habitat for three of the fish species/populations, one invertebrate (designated critical habitat not likely to be affected), and three plants (designated critical habitat not affected for one of the plant species). These determinations as well as a summary of the justification for the determinations are provided in table ES-1.

TABLE ES-1

Determinations of Effect for Federally Listed and Proposed Endangered and Threatened Species Potentially Occurring In the Project Area

Listed Species	Determination of Effect a/ Species	Determination of Effect a/ Critical Habitat	Justification
Mammals			
Blue whale *Balaenoptera musculus*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable and could exceed NMFS interim noise exposure criteria for Level B non-pulse noise, but would be temporary and not likely to cause significant injury.
Fin whale *Balaenoptera physalus*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable and could exceed NMFS interim noise exposure criteria for Level B non-pulse noise, but would be temporary and not likely to cause significant injury.
Killer whale (Eastern Northern Pacific Southern Resident Stock) *Orcinus orca*	NLAA	NE	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable and could exceed NMFS interim noise exposure criteria for Level B non-pulse noise, but would be temporary and not likely to cause significant injury.
Humpback whale *Megaptera novaeangliae*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Ship noise would be detectable and could exceed NMFS interim noise exposure criteria for Level B non-pulse noise, but would be temporary and not likely to cause significant injury.
Sei whale *Balaenoptera borealis*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Sei whales are not expected to occur in marine analysis ares andcarrier noise would be detectable but would not exceed NMFS interim noise exposure criteria.
Sperm whale *Physeter macrocephalus*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable and could exceed NMFS interim noise exposure criteria for Level B non-pulse noise, but would be temporary and not likely to cause significant injury.
North Pacific right whale *Eubalaena japonica*	NLAA	NE	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. North Pacific Right Whales are not expected to occur in marine analysis ares and carrier noise would be detectable but would not exceed NMFS interim noise exposure criteria.
Gray whale (Western North Pacific Stock) *Eschrichtius robustus*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Gray Whales are not expected to occur in marine analysis ares and carrier noise would be detectable but would not exceed NMFS interim noise exposure criteria.

TABLE ES-1

Determinations of Effect for Federally Listed and Proposed Endangered and Threatened Species Potentially Occurring In the Project Area

Listed Species	Determination of Effect a/		Justification
	Species	Critical Habitat	
Gray wolf (Western Washington, Western Oregon, Northern California) *Canis lupus*	NLAA	N/A	The Pipeline route would be in the vicinity of the Rogue pack and additional estimated wolf use near Keno. Construction noise and human presence could affect wolf movements and behavior, but noises are not likely to be substantially different from the noise produced by existing recreation, hunting, and logging land uses that wolves have been shown to tolerate and are insignificant. One known den site is > 6 miles from the Pipeline.
Birds			
Short-tailed albatross *Phoebastria albatraus*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable.
Western snowy plover (Pacific Coast Population) *Charadrius alexandrinus nivosus*	NLAA	NLAA	Active nesting areas on the North Spit used by Western snowy plover are approximately 1.0 miles from the LNG Terminal, and critical habitat is 2.6 miles from the LNG Terminal. At these distances, construction noise at nesting areas and critical habitat would not be above ambient levels and is insignificant.
Marbled murrelet *Brachyramphus marmoratus*	LAA	LAA	Construction of the Pipeline would result in modification of suitable habitat, and could adversely affect the species and critical habitat.
Northern spotted owl *Strix occidentalis caurina*	LAA	LAA	Construction of the Pipeline would result in modification of suitable habitat, and could adversely affect the species and critical habitat.
Herpetofauna			
Green turtle *Chelonia mydas*	NLAA	NE	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable but would be temporary and should not adversely impair hearing of the species and is insignificant.
Leatherback turtle *Dermochelys coriacea*	NLAA	NLAA	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable but would temporary, and should not impair hearing of the species and is insignificant.
Olive Ridley turtle *Lepidochelys olivacea*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable but would be temporary and should not impair hearing of the species.
Loggerhead turtle *Caretta caretta*	NLAA	N/A	LNG carrier marine traffic would be traveling at slow speeds (10 knots or less as detailed in the Ship Strike Avoidance Measures for Whales) making the potential for ship-strike extremely low and discountable. Carrier noise would be detectable but would be temporary and should not impair hearing of the species.

TABLE ES-1

Determinations of Effect for Federally Listed and Proposed Endangered and Threatened Species Potentially Occurring In the Project Area

Listed Species	Determination of Effect a/ Species	Determination of Effect a/ Critical Habitat	Justification
Oregon spotted frog *Rana pretiosa*	NLAA	NLAA	The Pipeline construction across Spencer Creek may affect Oregon spotted frogs, because the crossing site is 6,400 feet upstream from occupied habitat. However, tffects to Oregon spotted frogs and critical habitat in Spencer Creek downstream of Buck Lake was judged to be insignificant and discountable because the right-of-way and Spencer Creek are separated by Clover Creek Road and are not hydrologically connected, and the nearest hydrostatic discharge site is approximately 2.4 miles (straight line) from occupied habitat and BMPs would prevent any potential adverse effects to designated critical habitat from sedimentation.
Fish			
Green sturgeon (Southern Distinct Population Segment) *Acipenser medirostris*	LAA	LAA	Short-term increase in noise associated with land based pile driving at the MOF and in-water pile driving at various temporary construction activities throughout the bay may create disturbance and physical injury. Exposure to suspended sediment during Pipeline construction could affect sturgeon and designated critical habitat. Slip Access Channel and Navigation Reliability Improvements dredging could reduce food supply for rearing fish in localized areas in Coos Bay Critical habitat would be adversely affected by reduction in food sources from dredging in Coos Bay for construction of the LNG Terminal.
Eulachon (Southern Distinct Population Segment) *Thaleichthys pacificus*	NLAA	NE	While some eulachon adults may be present in Coos Bay during dredging, mitigation measures would reduce turbidity from the actions so that any adverse effects from increased turbidity would be insignificant. No critical habitat coincides with the estuarine analysis area of the analysis area, so critical habitat would not be affected.
Coho salmon (Southern Oregon/Northern California Coast Evolutionarily Significant Unit) *Oncorhynchus kisutch*	LAA	LAA	Juvenile rearing stages would suffer stress and possibly mortality from elevated turbidity at Pipeline stream crossings, from fish salvage operations, and from in-stream blasting. Adult spawning success may also suffer from short-term elevated sediment from Pipeline stream crossings. Designated critical habitat would be adversely affected by reduced large woody debris (LWD) supply and riparian habitat loss and impedance of fish movement during instream construction. Critical habitat could be adversely affected by increased turbidity during construction.

TABLE ES-1

Determinations of Effect for Federally Listed and Proposed Endangered and Threatened Species Potentially Occurring In the Project Area

Listed Species	Determination of Effect a/ Species	Critical Habitat	Justification
Coho salmon (Oregon Coast Evolutionarily Significant Unit) *Oncorhynchus kisutch*	LAA	LAA	Short-term increase in noise associated with land-based pile driving at the MOF and in-water pile driving at various temporary construction activities throughout the bay may create disturbance and physical injury. Juvenile loss from entrainment during LNG carrier water intake in Coos Bay may occur. Slip, access channel and Navigational Reliability Improvements dredging could reduce food supply for fish in localized areas in Coos Bay and entrain juveniles but is not likely to contribute to significant adverse effects due to there being a small and localized area impacted. Juvenile rearing stages would suffer stress and possibly mortality from elevated turbidity at Pipeline stream crossings, from fish salvage operations, and from in-stream blasting. Adult spawning success may also suffer from short-term elevated sediment from pipeline stream crossings. Designated critical habitat could be adversely affected by reduced LWD supply and riparian habitat loss and impedance of fish movement during instream construction. Critical habitat could be adversely affectedby increased turbidity during construction.
Lost River sucker *Deltistes luxatus*	LAA	NLAA	Juvenile or adult fish may be adversely affected at Pipeline construction across several ditches/canals and the Lost River and may suffer mortality from fish salvage operations. Designated critical habitat would not be adversely affected as the use of horizontal direction drill (HDD) would avoid critical habitat in the Klamath River.
Shortnose sucker *Chasmistes brevirostris*	LAA	NLAA	Juvenile or adult fish may be adversely affected at Pipeline construction across several ditches/canals and the Lost River and may suffer mortality from fish salvage operations. Designated critical habitat would not be adversely affected as the use of HDD would avoid critical habitat in the stream.
Invertebrates			
Vernal pool fairy shrimp *Branchinecta lynchi*	LAA	NLAA	Direct or indirect impacts to vernal pool fairy shrimp may result from Pipeline construction within or adjacent to nine potentially suitable vernal pools identified between MPs 145.34 to 145.40 if species is present. Impacts to critical habitat are insignificant and discountable because an existing road separates the proposed pipeyward from critical habitat
Plants			
Applegate's milk-vetch *Astragalus applegatei*	LAA	N/A	Potential suitable habitat occurs along the Pipeline route, but comprehensive surveys have not been conducted in all potential habitat due to landowner denial. Indirect impacts to Applegate's milkvetch plants and habitat may occur if the plants or habitat are identified within 30 meters of either side of the Pipeline project. To the extent present, adverse impacts may occur as a result of land disturbing activities.
Gentner's fritillary *Fritillaria gentneri*	LAA	N/A	Not all potential suitable habitat crossed by the Pipeline was surveyed due to landowner access denial. Gentner's fritillary does not flower every year, and has been documented to not flower for several years; therefore, it is possible that this plant is present in the construction right-of-way even though it was not identified during the two years of surveys conducted for this flower. *Fritillaria sp*. leaves were documented within and adjacent to the Pipeline right-of-way and without flowers, it is nearly impossible to determine if those leaves belong to Gentner's fritillary or another *Fritillaria* species, which is not listed. To the extent present, adverse impacts may occur as a result of land-disturbing activities.

TABLE ES-1

Determinations of Effect for Federally Listed and Proposed Endangered and Threatened Species Potentially Occurring In the Project Area

Listed Species	Determination of Effect a/ Species	Critical Habitat	Justification
Large-flowered woolly meadowfoam *Limnanthes pumila ssp. grandiflora*	NLAA	NLAA	Surveys of potentially suitable habitat at proposed pipe storage yards in Jackson County and along the proposed Pipeline did not document large-flowered meadowfoam plants. Applicant would avoid using portions of proposed pipe storage yards with high-quality vernal pool habitat and/or identified plants. Effects to suitable habitat by the Pipeline would be insignificant. Construction of the Pipeline is not expected to adversely affect designated critical habitat subunit RV6C. Existing features (i.e., paved Agate Road) and proposed conservation measures would provide sufficient protection from adjacent development and weed sources such that any impacts would be insignificant and discountable.
Cook's lomatium *Lomatium cookii*	NLAA	NE	Surveyed suitable habitat at proposed pipe storage yards in Jackson County and along the proposed Pipeline did not document the presence of Cook's lomatium. Unsurveyed habitat is low quality vernal pool habitat located over 0.25 mile from known sites with no apparent hydrologic connectivity. The nearest critical habitat subunit RV6A is more than 0.5 miles from the Pipeline and therefore will not be affected by the proposed action.
Kincaid's lupine *Lupinus sulphureus var. kincaidii*	LAA	NE	Surface disturbance and excavation would occur within potentially suitable habitats, which may contain un-identified plants. Indirect impacts are expected to documented or unidentified plants outside of the construction right-of-way and along proposed access roads. All potential suitable habitat has not been surveyed due to landowner access denial. Designated Kincaid's lupine critical habitat does not occur in the action area.
Rough popcornflower *Plagiobothrys hirtus*	NLAA	N/A	Surveys for the Pipeline have not documented rough popcornflower, where survey permission has been granted. Surveys in potentially suitable habitat identified within Winchester pipe storage yard or within potential habitat identified within the botanical analysis area along the right-of-way would occur prior to ground disturbing activities; if plants are identified, conservation measures developed to avoid or minimize potential impacts to identified plants would be applied. As a result, any impacts would be insignificant and discountable.

a/ LAA –May affect, likely to adversely affect.
N/A – Not applicable (critical habitat has not been designated or proposed).
NE – No effect.
NLAA – May affect, not likely to adversely affect.

Magnuson-Stevens Fishery Conservation and Management Act (MSA)

The Pacific Fishery Management Council (PFMC) has developed four Fishery Management Plans (FMPs) that address Essential Fish Habitat (EFH) for managed species in the Project action area. The four fisheries managed by the PFMC contain highly migratory species, coastal pelagic species, groundfish, and Pacific Coast salmon.

EFH has been defined by the PFMC out to the limits of the United States Exclusive Economic Zone (EEZ). Marine traffic associated with construction and operation of the LNG Terminal may affect EFH beyond the marine analysis area (that is, beyond the limits of the OCS out to the limits of the EEZ). For example, vessel traffic would generate localized noise, and impacts on water quality may occur due to discharge of ballast water, intake and discharge of cooling water, or accidental spills of pollutants at sea. However, Coos Bay and the waters offshore out to the limits of the EEZ currently provide deepwater access for maritime commerce, and support high levels of deep draft vessel traffic. Any impacts due to the incremental increase in marine vessel traffic during construction and operation of the Project would not have a significant adverse effect on EFH outside of the marine analysis area of the Project action area. As a result, the analysis of potential adverse effects to EFH coincides with the Project action area under the ESA, and the EFH Assessment has been incorporated into the APDBA. 50 CFR § 600.920(e)(3).

The MSA defines EFH as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. Within the marine, estuarine and riverine analysis areas, EFH has been designated for two salmonid species, five pelagic species, 70 groundfish species, and over a dozen highly migratory species as described in Section 4.0. . According to the PFMC, all habitats accessible to these managed species, including spawning and incubation, juvenile rearing, juvenile migration corridors, and adult migration corridors, are considered EFH. Highly migratory species defined by the PFMC include tunas (three species), sharks (five species), and billfish/swordfish (one species). Based on the documentation and analytical results contained herein, the Project would have no adverse effect on EFH for highly migratory species, but may adversely affect EFH within the Project action area for coastal pelagic species, groundfish, and Pacific Coast salmon. These determinations as well as a summary of the justification for the determinations are provided in table ES-2.

TABLE ES-2

Determinations of Effect for Essential Fish Habitat

Fishery	**Analysis Area**			**Determination of Effect a/**	**Justification**
	Marine/EEZ	**Estuarine**	**Riverine**		
Highly Migratory Species	X	–	–	NAE	Discharges at sea, including any accidental spills of fuel or lubricants would not significantly diminish water quality within the marine analysis area. Vessel traffic noise would be detectable but would not exceed interim noise exposure criteria. Any impacts due to the incremental increase in marine vessel traffic would not have a significant adverse effect on EFH.
Coastal Pelagic Species	X	X	–	MAA	Loss of estuarine eelgrass habitat during dredging for LNG Terminal would adversely affect EFH for coastal pelagic species. Short-term loss of benthic food resources would also result from dredging of the slip, access channel and NRI areas; however, deep subtidal habitat is not a limited habitat type within Coos Bay and the effects would be minimal. Small juvenile and larval stages of fish could be entrained or impinged and suffer mortality from the cooling water intakes of LNG carriers while at berth; but a significant loss is unlikely.

TABLE ES-2

Determinations of Effect for Essential Fish Habitat

Fishery	Analysis Area: Marine/EEZ	Analysis Area: Estuarine	Analysis Area: Riverine	Determination of Effect a/	Justification
Groundfish	X	X	–	MAA	A localized loss of estuarine eelgrass habitat during dredging for LNG terminal access channel could adversely affect EFH for groundfish. Short-term loss of benthic food resources would also result from dredging of the slip, access channel and NRI areas. As described for coastal pelagic species EFH, these habitat types are not limited within Coos Bay and therefore the effects would be minimal. Over the long-term, eggs, larval, and small juvenile life stages of fish occupying waters near the LNG carriers at the terminal could be entrained or impinged, and suffer mortality by cooling water intakes but a substantive loss is unlikely.
Pacific Coast Salmon	X	X	X	MAA	Short-term increase in noise associated with land based pile driving at the MOF and in-water pile driving at various temporary construction activities throughout the bay may create disturbance and physical injury. Pipeline stream crossings could impact substrates and water quality over the short term, and LWD supply over the long term. Juvenile coho or Chinook salmon entrapped in isolated areas at pipeline stream crossings, as well as removal from stream crossing areas, would result in minor fish mortalities..

a/ – = Not applicable.
NAE = No adverse effect.
MAA = May adversely affect.

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1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

In September 2017, Jordan Cove Energy Project L.P. (JCEP) filed an application with the Federal Energy Regulatory Commission (FERC or Commission), under Section 3 of the Natural Gas Act, 15 United States Code (U.S.C.) §717b(a) (NGA), in Docket No. CP17-495-000, seeking to site, construct and operate a liquefied natural gas (LNG) export terminal on the North Spit of Coos Bay, in Coos County, Oregon (LNG Terminal). Simultaneously, under Section 7 of the NGA, Pacific Connector Gas Pipeline LP (PCGP) also filed an application with the FERC, in Docket No. CP17-494-000, seeking a Certificate of Public Convenience and Necessity (Certificate) to construct and operate a 229-mile-long, 36-inch-diameter, pipeline from interconnections with the existing Ruby pipeline and Gas Transmission Northwest pipeline near Malin, Oregon (Pipeline) to supply the LNG Terminal with natural gas. The proposed Pipeline would cross through portions of Klamath, Jackson, Douglas, and Coos Counties, Oregon. In this applicant-prepared draft biological assessment (APDBA), JCEP and PCGP are collectively referred to as “Applicants;” while the LNG Terminal and Pipeline are collectively referred to as the “Project.”

Section 7 of the Endangered Species Act (ESA), 16 U.S.C. §§1531 et. seq., requires federal agencies to consult with the United States Fish and Wildlife Service (FWS) or the National Marine Fisheries Service (NMFS), as applicable, to assure that any project authorized, funded, or conducted by a federal agency does not “jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined...to be critical.” If, upon review of existing data, or data provided by the applicant, one (or both) of the Services find that any federally listed species or critical habitats may be affected by a proposed project, the lead federal agency is required to prepare a biological assessment (BA) to identify the nature and extent of the effects on these species and habitats, and to recommend measures that would avoid, reduce, or mitigate impacts on habitats and/or species. FERC is the lead federal agency for this Project.

The Magnuson-Stevens Fishery Conservation and Management Act, as amended, 16 U.S.C. §§1361 et.seq. (MSA) established procedures designed to identify, conserve, and enhance essential fish habitat (EFH) for those species regulated under a federal fisheries management plan. The MSA requires federal agencies to consult with the NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH, 16 U.S.C. §305(b)(2); 50 C.F.R. §600.920. The applicable regulations encourage consolidation of environmental review procedures to reduce duplication and improve efficiency, 50 C.F.R. §600.920(f). For this Project, the EFH Assessment has been incorporated into the APDBA, 50 C.F.R. §600.920(e)(3).

Under the NGA, the FERC is the federal agency responsible for authorizing the siting, construction, and operation of onshore LNG terminals, as well as allowing the interstate transportation of natural gas. The FERC is also the lead federal agency for compliance with the

NEPA, in accordance with the Energy Policy Act of 2005 and inter-agency agreements.[1] On behalf of the cooperating agencies, the FERC is also the lead federal agency responsible for complying with the ESA and the MSA for the Project. The following federal agencies have agreed to be cooperating agencies under the applicable regulations - U.S. Department of Agriculture (USDA) Forest Service (Forest Service), U.S. Department of the Army Corps of Engineers (Corps), National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), U.S. Department of Homeland Security Coast Guard (Coast Guard), U.S. Department of the Interior Bureau of Land Management (BLM) and Bureau of Reclamation (Reclamation), and the U.S. Department of Transportation (DOT). A complete analysis of the potential impacts associated with the Project will be provided by FERC in its draft environmental impact statement (DEIS) which FERC will issue as a separate document.

In January 2018, PCGP submitted a Right-of-Way Grant application, under the Mineral Leasing Act, 30 U.S.C. §§181 et seq. to the BLM, Forest Service, and Reclamation. The Pipeline route would cross National Forest System (NFS) lands within the Umpqua, Rogue River, and Winema National Forests, and portions of the BLM's Coos Bay, Roseburg, Medford, and Lakeview Districts, and land and features within the Klamath Project managed by Reclamation.

The Applicants conferred with various federal agencies, including the FWS and NMFS, and the Corps, DOE, Coast Guard, Forest Service, BLM, and Reclamation, and state resource agencies, including the Oregon Department of Environmental Quality (ODEQ), Oregon Department of State Lands (ODSL), Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Forestry (ODF), Oregon Department of Agriculture (ODA), Oregon Department of Water Resources (ODWR), and the Oregon Department of Land Conservation and Development (ODLCD). This APDBA is being provided to FERC to assist in its preparation of a BA with which to enter into formal consultations with FWS and NMFS under the applicable provisions of the ESA.

1.1 PROPOSED ACTION

The Project will be located in southern Oregon. The main components of the Project include:

- The LNG Terminal and associated facilities in Coos County, Oregon; and
- The Pipeline which will cross portions of Klamath, Jackson, Douglas, and Coos County, Oregon, and associated facilities.

The Project description is provided in section 2.0, and terminology in this document is defined as follows:

[1] See the May 2002 *Interagency Agreement on Early Coordination of Required Environmental and Historic Preservation Reviews Conducted in Conjunction With the Issuance of Authorizations to Construct and Operate Interstate Natural Gas Pipelines Certificated by the Federal Energy Regulatory Commission*, signed by the FERC, Advisory Council on Historic Preservation, Council on Environmental Quality, EPA, Department of the Army, USDA, Department of Commerce, DOE, USDI, and DOT; and the February 2004 *Interagency Agreement Among the Federal Energy Regulatory Commission, United States Coast Guard, and Research and Special Programs Administration for the Safety and Security Review of Waterfront Import/Export Liquefied Natural Gas Facilities*.

- “LNG Terminal site” refers to the terminal site footprint and “LNG Terminal project” refers to the terminal and associated components.

- “Pipeline” refers to the centerline or linear facility and “Pipeline project” refers to the construction right-of-way, temporary extra work areas (TEWAs), uncleared storage areas (UCSAs), aboveground facilities, contractor and pipe storage yards, quarries and rock source disposal sites, permanent and temporary access roads (PARs and TARs, respectively), existing access roads (EARs), communication facilities, 30-foot maintenance/operation corridor, and 50-foot permanent easement.

- “in the vicinity of the Pipeline project” or in the “Pipeline project area” describes the area where impacts to fish, wildlife, and vegetation (plants) could occur outside of the Pipeline project footprint. In many instances, these terms are used generally, since the extent (or distance from the Pipeline project) of impact beyond the Pipeline project varies by fish, wildlife, and vegetation (plant) species, Pipeline project activity, habitat and site characteristics (i.e., waterbody or vegetation). Similarly, discussion of area of surveys (i.e., distance from the Pipeline project) conducted for the Pipeline varies depending on wildlife and plant species targeted, landowner (federal or non-federal), and expected impact (i.e., proposed blasting and/or helicopter use). Specific distances for survey efforts and construction and operation impacts are discussed specifically in the indivudal species’ sections below.

1.2 ACTION AREA

The action area includes all areas that would be affected directly or indirectly by the proposed action and not just the immediate area involved in the action. Because the proposed action potentially can affect such a variety of species inhabiting diverse habitats within marine, estuarine, riverine, and various terrestrial locations, there are multiple components of the action area that have been defined as species’ analysis areas, the areas where individual or groups of listed species could be affected by the proposed action. Species’ analysis areas are described in detail in each species’ environmental baselines and figures of the analysis areas are provided, where appropriate. For some species there may be more than one analysis area if the listed species utilizes multiple habitats in diverse locations. Analysis areas and associated species include:

- the marine analysis area is a fan shape beginning at the entrance to Coos Bay extending approximately 12-13 nautical miles (nm) off the coast of Oregon to the edge of the Outer Continental Shelf (OCS). The northern border of the fan extends from the North Jetty to the point located at the edge of the OCS near 43°, 28’ 39”, -124°33’34”,and the southern border extends from the South Jetty to point located at the edge of the OCS near 43°24’49”, -124°35’8”. The analysis area is approximately 33.1 square miles. The marine analysis area applies to all listed marine mammals, short-tailed albatross, MAMU, green sturgeon, eulachon, coho salmon (Oregon Coast Evolutionary Significant Unit (ESU) and in the Southern Oregon/Northern California Coast (SONCC) ESU), and listed sea turtles;
- the gray wolf analysis area is based on the Area of Known Wolf Activity initially designated for OR-7, and applies only to the gray wolf;

- the estuarine analysis area (see figure 3.3.3-3) which encompasses all estuarine waters (and substrates) that are within the estuary between the North Jetty and South Jetty at the Coos Head entrance to the Upper Coos Bay. The estuarine analysis area is approximately 15 square miles. The estuarine analysis area applies to MAMU, green sturgeon, eulachon, and coho salmon (Oregon Coast ESU);
- the LNG terminal analysis area extends for 1.5 miles beyond the perimeter of the LNG Terminal Site (see figure 3.3.2-2) to include project components on the North Spit and Al Pierce Company (APCO) Site, which historically provided western snowy plover nesting habitat;
- terrestrial nesting analysis area extends inland along the Pipeline route to include MAMU Inland Zone 1 – MPs 0.00 to 53.76 - and MAMU Inland Zone 2 – MPs 53.76 to 75.40 (see figure 3.3.3-2). and applies only to MAMU;
- provincial analysis area is located within four Physiographic Provinces (Burns 1998): Oregon Coast Range, Oregon Klamath Mountains, West Oregon Cascades, and East Oregon Cascades (see figure 3.3.4-1), and applies only to NSO;
- the riverine analysis area encompasses 5^{th} field (watershed-level) hydrological unit codes (HUCs) (USGS 2018) and reflects an estimate of the average downstream extent that suspended sediment from any stream crossing generated by the Pipeline could equal ambient conditions within the 5^{th} field watershed crossed. Several riverine analysis areas that are in specific geographic locations each in the respective ranges of coho salmon in the Oregon Coast ESU and in the Southern Oregon/Northern Californis Coast (SONCC) ESU, listed suckers, and Oregon spotted frogs; and
- botanical analysis areas extend to 30 meters (98 feet) each side of the Pipeline project on lands that have potential habitat for listed plant species, except vernal pool-associated species (fairy shrimp and two listed plants) where the area extends out 250 feet.

1.3 ESA CONSULTATION BACKGROUND

1.3.1 Species Lists

Thirty-one federally listed and proposed endangered and threatened species may occur in the proposed project area that were identified by the FWS (2018a and b; FERC 2013) and NMFS (Wheeler 2006a and 2006b; NMFS 2009a, 2018a) and updates from agencies' websites. Table 1.4.1-1 summarizes these species, including critical habitat where designated and availability of recovery plans, and the general component of the Project where they may occur.

TABLE 1.4.1-1

Listed and Proposed Species that May Be Present within the Project Area

Listed Species	Federal Status a/	General Area of Potential Occurrence	Critical Habitat within the Project Area	Recovery Plan Drafted	Effects Determination Species b/	Effects Determination Critical Habitat b/
Mammals						
Blue whale *Balaenoptera musculus*	E	Oregon Coast	None Designated	Yes	NLAA	N/A
Fin whale *Balaenoptera physalus*	E	Oregon Coast	None Designated	Yes	NLAA	N/A
Killer whale (Eastern Northern Pacific Southern Resident Stock) *Orcinus orca*	E-CH	Oregon Coast	Not in Action Area	Yes	NLAA	NE
Humpback whale *Megaptera novaeangliae*	E	Oregon Coast	None Designated	Yes	NLAA	N/A
Sei whale *Balaenoptera borealis*	E	Oregon Coast	None Designated	Yes	NLAA	N/A
Sperm whale *Physeter macrocephalus*	E	Oregon Coast	None Designated	Yes	NLAA	N/A
North Pacific right whale *Eubalaena japonica*	E-CH	Oregon Coast	Not in Action Area	Yes	NLAA	NE
Gray whale (Western North Pacific Stock) *Eschrichtius robustus*	E	Oregon Coast	None Designated	No	NLAA	N/A
Gray wolf *Canis lupus*	E	Douglas County Jackson County Klamath County	None Designated	None Applicable	NLAA	N/A
Birds						
Short-tailed albatross *Phoebastria albatraus*	E	Oregon Coast	None Designated	Yes	NLAA	N/A
Western snowy plover (Pacific Coast Population) *Charadrius alexandrinus nivosus*	T-CH	Coos County	Yes – Unit OR-10, Coos Bay North Spit	Yes	NLAA	NLAA
Marbled murrelet *Brachyramphus marmoratus*	T-CH	Coos County Douglas County	Yes – CHU OR-06-d	Yes	LAA	LAA
Northern spotted owl *Strix occidentalis caurina*	T-CH	Coos County Douglas County Jackson County Klamath County	Yes – CHU OCR-6 (in Unit 2 Oregon Coast Range), KLW-1 (in Unit 9 Klamath West), KLE-1, KLE-2, KLE-3, KLE-4, KLE-5 (in Unit 10 Klamath East), ECS-1 (in Unit 8 East Cascades)	Yes	LAA	LAA
Herpetofauna						
Green turtle *Chelonia mydas*	T-CH	Oregon Coast	Not in Action Area	Yes	NLAA	NE
Leatherback turtle *Dermochelys coriacea*	E-CH	Oregon Coast	Yes-Pacific Ocean north of Cape Blanco, south of Cape Flattery	Yes	NLAA	NLAA
Olive Ridley turtle	T	Oregon Coast	None Designated	Yes	NLAA	N/A

TABLE 1.4.1-1

Listed and Proposed Species that May Be Present within the Project Area

Listed Species	Federal Status a/	General Area of Potential Occurrence	Critical Habitat within the Project Area	Recovery Plan Drafted	Effects Determination Species b/	Effects Determination Critical Habitat b/
Lepidochelys olivacea						
Loggerhead turtle *Caretta caretta*	T	Oregon Coast	None Designated	Yes	NLAA	N/A
Oregon spotted frog *Rana pretiosa*	T -CH	Buck Lake, Klamath County	Yes - Buck Lake, Klamath County	No	NLAA	NLAA
Fish						
Green sturgeon (Southern Distinct Population Segment) *Acipenser medirostris*	T-CH	Oregon Coast Coos Bay estuary and tributary rivers to Head of Tide	Yes - Coos Bay estuary, tributary rivers to Head of Tide, and Pacific Ocean to 60 fathoms	No	LAA	LAA
Eulachon (Southern Distinct Population Segment) *Thaleichthys pacificus*	T-CH	Coos Bay, Oregon Coast	Not in Action Area	Yes	NLAA	NE
Coho salmon (Southern Oregon/Northern California Coast Evolutionarily Significant Unit) *Oncorhynchus kisutch*	T-CH	Rogue River	Yes – Upper Rogue HU (17100307)	Yes	LAA	LAA
Coho salmon (Oregon Coast Evolutionarily Significant Unit) *Oncorhynchus kisutch*	T-CH	Coos Bay, and the Coos, Coquille, and South Umpqua, Rivers	Yes – South Umpqua Subbasin (HU 17100302), Coquille Subbasin (HU 17100305), – Coos Subbasin including the Coos Bay Estuary (HU 17100304)	Yes	LAA	LAA
Lost River sucker *Deltistes luxatus*	E-CH	Klamath River Lost River	Yes – Unit 1, Klamath County	Yes	LAA	NLAA
Shortnose sucker *Chasmistes brevirostris*	E-CH	Klamath River Lost River	Yes – Unit 1, Klamath County	Yes	LAA	NLAA
Invertebrates						
Vernal pool fairy shrimp *Branchinecta lynchi*	T-CH	Jackson County	Yes – Eagle Point and Sams Valley quadrangles – CHUs VERFS 3A and 3B	Yes	LAA	NLAA
Plants						
Applegate's milk-vetch *Astragalus applegatei*	E	Klamath County	None Designated	Yes	LAA	N/A
Gentner's fritillary *Fritillaria gentneri*	E	Jackson County	None Designated	Yes	LAA	N/A
Large-flowered woolly meadowfoam *Limnanthes pumila ssp. grandiflora*	E-CH	Jackson County	Yes- Units Rogue Valley-6 and Rogue Valley-8	Yes	NLAA	NLAA
Cook's lomatium *Lomatium cookii*	E-CH	Jackson County	Not in Action Area	Yes	NLAA	NE
Kincaid's lupine *Lupinus sulphureus var. kincaidii*	T-CH	Douglas County	Not in Action Area	Yes	LAA	NE
Rough popcornflower *Plagiobothrys hirtus*	E	Douglas County	None Designated	Yes	NLAA	N/A

a/ Status Key: E = Endangered, T = Threatened, , CH = Critical Habitat.
b/ Effects Determination: N/A – Not applicable (critical habitat has not been designated or proposed; NE = No Effect, NLAA= Not Likely to Adversely Affect, LAA = Likely to Adversely Affect

In addition, there are six listed species that occur within Oregon but for which the proposed action would have no effect. Those species include the Contiguous United States Distinct Population Segment (DPS) of Canada lynx, Coterminous United States Population of bull trout – Klamath River DPS, yellow-billed cuckoo – Western DPS, streaked horned lark, slender orcutt grass, and the western lily. In addition, the North American wolverine occurs in Oregon and has been proposed for listing as threatened under ESA. Brief synopses of the rationales to exclude these species from consideration in this APDBA are provided in section 3.1.2.

1.3.2 Information Sources

Information on listed and proposed species' distributions, habitat requirements, and potential occurrence in the Action Area as set forth in section 1.3 was gathered from many sources: 1) published scientific literature; 2) agencies' published and unpublished reports; 3) agencies' unpublished raw and/or compiled data; 4) agencies' geo-spatial databases, which document species observations; 5) on-site surveys for species and habitats (as modified during agency review); and 6) personal communications with agency personnel knowledgeable about species' ecological status in the Project area and vicinity. During the previous NEPA process, the Applicants and FERC representatives met with the Interagency Task Force, which included representatives of the FWS and NMFS, as well as Forest Service, BLM, ODLCD, Oregon Department of Energy (ODE), ODSL, Corps, ODFW, EPA, and ODEQ, to obtain specific input, guidance, and technical approach reviews. Agencies participating in the Interagency Task Force reviewed information provided by the Applicants. A subgroup of the task force, the ESA Consultation Subgroup, was established to develop habitat layers, determine extent of analyses, and provide guidance for avoidance and minimization measures for ESA species. To the extent this information remained relevant to the Project, it has been included in this APDBA. Due to changed circumstances, both regulatory and factual, certain portions of the previous information are no longer applicable to the Project and updates have been included.

Existing vegetation within the Pipeline project area was classified using several reference/data sources: 1) wetland delineation surveys conducted between 2006 and 2017; 2) county-based 2016 aerial photography; 3) BLM Forest Operations Inventory (FOI) digital geographic information system (GIS) coverage (BLM 2016c); 4) digital GIS data coverage and vegetation categories described by the Oregon Gap Analysis Project (Oregon Gap – Kagan et al. 1999); and 5) current wildlife-habitat types described and delineated by the Northwest Habitat Institute in 1999 (Kiilsgaard and Garrett 1999). Vegetation cover types within at least 100 meters of the Pipeline project were digitized with GIS from 2016 aerial photography and delineated based on the predominant vegetation physiognomy (*e.g.*, trees, shrubs, herbaceous vegetation) and the dominant species present.

Fisheries (ESA-listed species and species with EFH) information was gathered from many sources: 1) NMFS (Wheeler 2006a, 2006b, 2018b; NMFS 2017a, 2018a,b,c); 2) FWS (FWS 2017a); 3) ODFW Natural Resources Information Management Program (ODFW 2017a), which documents observations of species in the project area; 4) species' population and distribution information available online at StreamNet (StreamNet 2012); and 5) published scientific literature and agency reports. Information on other listed species was gathered from: 1) *Wildlife-Habitat Relationships in Oregon and Washington* (Johnson and O'Neil 2001), which provides relationships between specific habitats and the wildlife species that may occur in the Pipeline project area; 2) ORBIC (2017a), GeoBOB (BLM 2017), and Natural Resource

Information System (Forest Service 2017) databases; FWS GIS database and NSO demographic database; 3) National Biological Breeding Bird Survey routes and Audubon Christmas Bird Counts; 4) published scientific literature and agency reports; and 5) other state and federal databases and literature available online. Field surveys (described below) were conducted prior to formation of the Interagency Task Force, but survey results and survey protocols have been reviewed by members of a Species Survey Subgroup.

1.3.3 Species Surveys

Existing vegetation cover types within the LNG Terminal project were determined from field surveys conducted by consultants to JCEP, including wetland delineations (Stuntzner Enginering and Forestry 2005; SHN Consulting Engineers and Geologists, Inc. – SHN 2013a) that have been approved by the COE and ODSL, and botanical surveys (SHN 2006, 2013b). There is no suitable habitat for listed wildlife or plant species within the LNG Terminal project.

JCEP also had consultants conduct biological investigations for wildlife and fish at the LNG Terminal and related areas in 2005, 2006, and 2012 (LBJ Enterprises 2006; Alice Berg & Associates 2006; SHN 2013c), as well as a biological sampling program in Coos Bay in 2010 (Shanks et al. 2011). Terrestrial wildlife surveys conducted for the Project documented 11 mammal species. The most common marine mammal in the Coos Bay near the LNG Terminal project would be the harbor seal. Surveys at the LNG Terminal noted 151 avian species. Sampling by the University of Oregon Institute for Marine Biology for zooplankton in Coos Bay near the LNG Terminal access channel found sculpin, gunnels, sand lance, English sole, and surf smelt, in addition to ghost shrimp and several crab species. The results of Applicant's biological surveys relevant to federally listed or proposed species are presented in section 3.0 of this APDBA.

PCGP had Siskiyou BioSurvey, LLC (SBS) conduct botanical and biological surveys for the action area for terrestrial sensitive species between 2007 and 2017. Based on literature reviews, 108 species of mammals and 281 bird species may be present in habitats that coincide with the action area for the Pipeline. PCGP had targeted biological surveys conducted for NSO, MAMU, great gray owl, red tree vole, and northern goshawk, as well as terrestrial and aquatic mollusks. Botanical surveys were targeted for ESA-listed and State-listed vascular plant species; Survey and Manage vascular, lichen, bryophyte, and fungi species; vascular, lichen, and bryophyte species on the Oregon BLM Special Status Strategic or Sensitive Plant Lists; and vascular, lichen, and bryophyte species on Forest Service Region 6 Sensitive and Strategic Plant Lists. The results of these surveys were summarized in PCGP's Resource Report 3.

The most common native freshwater mussels present in the waterbodies crossed by the Pipeline route belong to the genus *Anadonta*. Typical warmwater fish species in waterbodies crossed by the pipeline include black and white crappie, and brown bullhead, which are not native to the region. Coolwater fish present in the project area include both non-native and native species. Some important non-native species include smallmouth bass and yellow perch. Native coolwater species include the Lost River sucker, shortnose sucker, Klamath largescale sucker, blue chub, and Umpqua chub. Resident rainbow and redband trout are the most common resident coldwater game species along the route. Eight species of anadromous fish are known in the Pipeline area: Chinook salmon, coho salmon, chum salmon, steelhead, coastal cutthroat trout, Pacific lamprey, river lamprey, and green sturgeon. Section 3 of this APDBA discusses federally listed fish, plants, and animals in more detail.

1.4 MAGNUSON-STEVENS ACT CONSULTATION

The Sustainable Fisheries Act of 1996 amended the MSA and requires federal agencies, in part, to consult with the NMFS about activities that may adversely affect EFH (NMFS 1997a). The MSA established guidelines for Regional Fishery Management Councils to identify and describe EFH in Fishery Management Plans (FMPs) to responsibly manage exploited fish and invertebrate species in federal waters. The Pacific Fishery Management Council (PFMC) has developed four FMPs that address EFH for managed species in the Project area (PFMC 1998, 1999, 2004). The four fisheries managed by the PFMC are highly migratory species, coastal pelagic species, groundfish, and Pacific Coast salmon.

This APDBA and EFH Assessment provides information to NMFS on potential effects to EFH, pursuant to Section 305(b) of the MSA. The MSA describes EFH as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (NMFS 1997a). Within the Project action area, EFH has been designated for two salmonids (Chinook and coho), five pelagic species (northern anchovy, Pacific sardine, Pacific mackerel, jack mackerel, and market squid), and 70 groundfish species. All habitat accessible to these managed species, including spawning and incubation, juvenile rearing, juvenile migration corridors, and adult migration corridors, is considered EFH (PFMC 1999). Highly migratory species defined by the PFMC include tunas (five species), sharks (five species), billfish/swordfish (two species), and the dorado (also called dolphinfish or mahi-mahi).

2.0 PROPOSED ACTION

2.1 PROJECT COMPONENTS

As stated above, the Project is comprised of two parts, the LNG Terminal and the Pipeline. A more detailed description of the Project is provided in the FERC certificate applications. Below is a description of the components and construction activities which may potentially impact listed species or critical habitat associated with the LNG Terminal project (see section 2.1.1) and the Pipeline (see section 2.1.2).

2.1.1 LNG Terminal and Associated Facilities

The LNG Terminal would be located on the bay side of the North Spit of Coos Bay in southwest Oregon and would be designed to receive a maximum of 1,200,000 dekatherms per day (dth/d) of natural gas and produce a maximum of 7.8 million tons per annum (mtpa) of LNG for export. The LNG Terminal would turn natural gas into its liquid form via cooling to about -260 degrees Fahrenheit (F), and in doing so, it would reduce in volume to approximately 1/600th of its original volume, making it easier and more efficient to transport. The LNG Terminal, related facilities, temporary construction sites, and other sites/actions associated with LNG Terminal construction are collectively referred to as the "LNG Terminal project." The general location of the proposed LNG Terminal project is shown on figure 2.1.1-1. The main operational components of the LNG Terminal are shown in appendix B, figure 6.1-2. The LNG Terminal project is made up of the following components:

- LNG Carrier Transit Route – the waterway for LNG carrier marine traffic for the Project extends from the outer limits of the Outer Continental Shelf, 12 nautical miles (nmi) off the coast of Oregon, and 7.5 nmi up the existing Coos Bay Federal Navigation Channel (FNC) to the LNG Terminal.

- LNG Terminal Site – the site includes the Ingram Yard, Access and Utility Corridor, and South Dunes site. These components are referenced throughout the document but are not described in greater detail. See JCEP's Resource Report 1 for additional information.

    - Ingram Yard – the portion of the LNG Terminal site that would house permanent LNG Terminal facilities including LNG tanks and liquefaction equipment, and temporary facilities such as the Temporary Materials Barge Berth (TMBB).

    - Access and Utility Corridor – an approximately 1-mile-long corridor connecting Ingram Yard and the South Dunes site that would provide temporary construction and permanent access roads and facilities, and would include the Fire Department, underground utilities, and gas feed to the LNG Terminal.

    - South Dunes – the portion of the LNG Terminal site that would house temporary construction and permanent facilities, including a Workforce Housing Facility, metering station, administrative building, and the Southwest Oregon Regional Safety Center (SORSC), which would provide emergency response services for the facility and the southern Oregon region.

- Marine Slip – a permanent facility on Ingram Yard adjacent to the access channel. LNG carriers would enter the slip via the access channel, be loaded with LNG, and leave for export. The slip would include an LNG carrier loading berth and LNG loading facilities, a tug berth, and a lay berth to safely moor a temporarily disabled LNG carrier.

- Access Channel – the access channel would be dredged north of the FNC to provide LNG carriers with access from the FNC to the slip.

- Pile Dike Rock Apron – a permanent rock apron would be constructed west of the access channel to increase resiliency and protect the existing Pile Dike 7.3.

- Material Offloading Facility (MOF) – a permanent facility east of the slip where fill would be placed and approximately 450 feet of dock face would be constructed for the mooring of a variety of vessel types to offload materials for construction and maintenance of the LNG Terminal. Dredging would occur to access the MOF.

- Temporary Materials Barge Berth (TMBB) – An offloading facility that would be constructed on an existing berm west of the MOF to facilitate early construction activities, and would be removed when the access channel is dredged and the berm related to the slip construction is removed.

- Navigation Reliability Improvements – four permanent dredge areas adjacent to the FNC that would allow for navigation efficiency and reliability for vessel transit under a broader weather window.

- Meteorological Station – a permanent facility consisting of a tower located on the west side of the lagoon on the North Spit, used to measure wind speed, direction, and other weather data to provide weather information to the LNG Terminal and to support ship navigation.

- Industrial Wastewater Line (IWWP) and Water Line Relocation – an industrial wastewater line and water line, which would be permanently relocated in the vicinity of Trans Pacific Parkway.

- Trans Pacific Parkway and U.S. Highway 101 (US-101) Intersection Widening – the asymmetrical widening of Trans Pacific Parkway to the north and US-101 to the west to provide safe ingress/egress for construction traffic, by creating a left-turn lane from Trans Pacific Parkway onto northbound US-101 and a right-turn lane from US-101 onto Trans Pacific Parkway.

- APCO Site – APCO Site 1 (east) and APCO Site 2 (west) would be used as upland dredge disposal sites for the Project.

- Temporary Construction Sites – additional construction staging and temporary laydown of equipment would occur during LNG Terminal construction at Boxcar Hill, the Port Laydown site, and APCO Site 1. Additional construction staging, equipment laydown, and dredge materials disposal would occur at the Roseburg site, which is a portion of the adjoining Roseburg Forest Products (RFP) property leased by JCEP. Off-site park and ride lots would be developed as temporary facilities at Pony Village in North Bend and Myrtlewood Factory & RV Park north of North Bend.

- Kentuck Project site – approximately 100-acre proposed wetland mitigation and habitat restoration site associated with the LNG Terminal project and the Pipeline project.

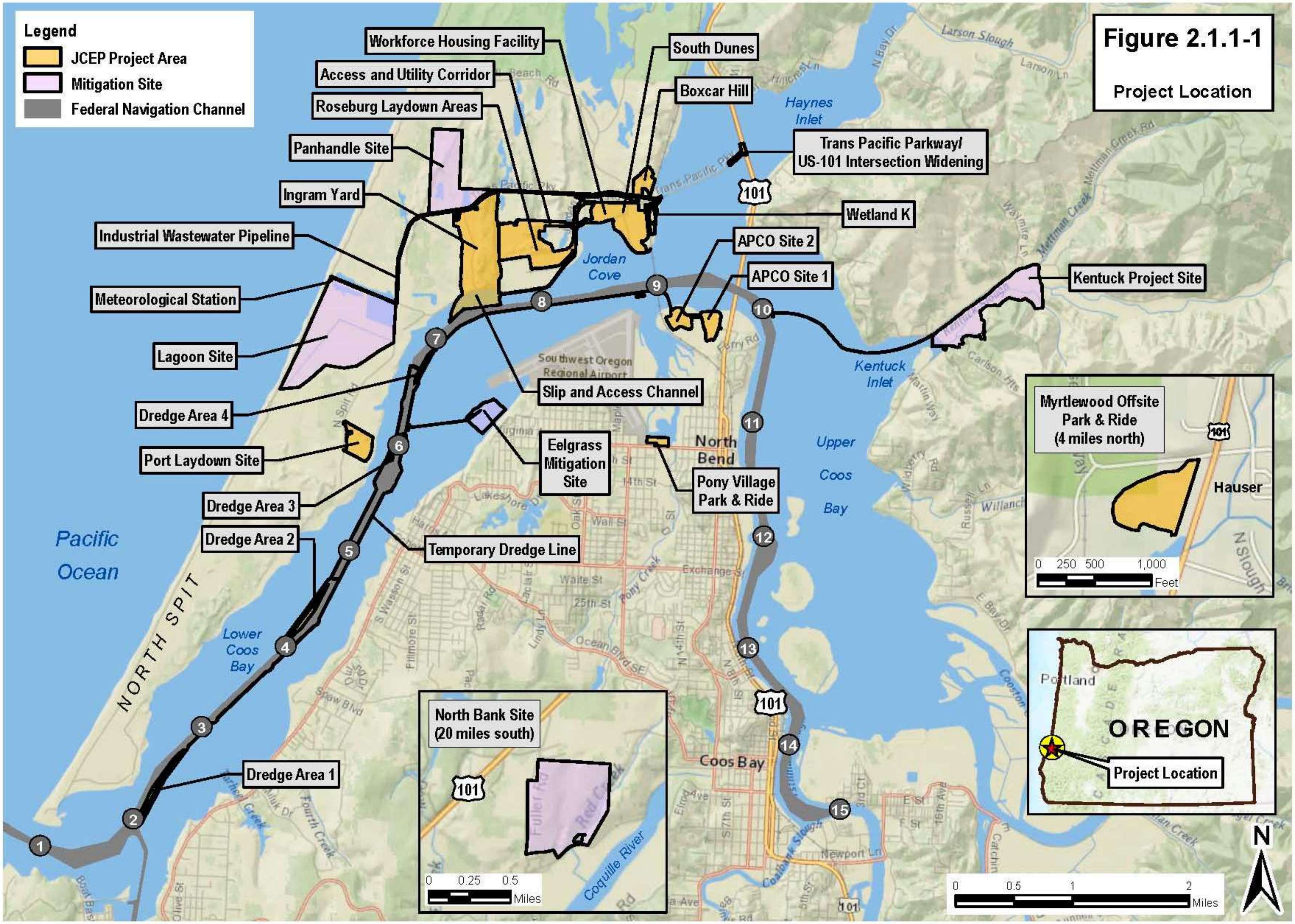


Figure 2.1.1-1
Project Location
Legend
JCEP Project Area
Mitigation Site
Federal Navigation Channel
Workforce Housing Facility
Access and Utility Corridor
Roseburg Laydown Areas
Panhandle Site
Ingram Yard
Industrial Wastewater Pipeline
Meteorological Station
Lagoon Site
Dredge Area 4
Port Laydown Site
Dredge Area 3
Dredge Area 2
Dredge Area 1
Temporary Dredge Line
Slip and Access Channel
Eelgrass Mitigation Site
Pony Village Park & Ride
South Dunes
Boxcar Hill
Trans Pacific Parkway/ US-101 Intersection Widening
Wetland K
APCO Site 2
APCO Site 1
Kentuck Project Site
Myrtlewood Offsite Park & Ride (4 miles north)
Hauser
North Bank Site (20 miles south)
Project Location
OREGON
Portland
Pacific Ocean
NORTH SPIT
Lower Coos Bay
Upper Coos Bay
Jordan Cove
Haynes Inlet
Kentuck Inlet
North Bend
Coos Bay
Southwest Oregon Regional Airport
Coquille River
Miles
Feet
N

- Eelgrass Mitigation site – approximately 9.3-acre proposed mitigation site for unavoidable eelgrass impacts associated with dredging of the access channel.
- Upland Wildlife Habitat Mitigation Sites – proposed wildlife habitat mitigation sites (Lagoon, Panhandle, and North Bank) associated with the LNG Terminal project.
- Meteorological Data Buoys – JCEP would install five meteorological ocean data collection buoys to aid navigation by measuring wind speed and direction, current speed and direction, and tide height in real time. It is anticipated that three buoys would be installed in place of currently existing buoys but may replace existing moorings and anchors using conventional construction methods. The buoys would be located in the Pacific Ocean near the bay entrance, and within Coos Bay along the LNG carrier route. Two new data collection buoys would be located near the access channel.

2.1.1.1 LNG Terminal Project Component Description

The marine facilities at the LNG Terminal would include an access channel, marine slip, LNG carrier berth, a lay berth, the MOF, and a tug berth. The LNG Terminal would include a single-use marine slip dedicated to supporting LNG exports. The east side of the slip would be utilized for the LNG carrier-loading berth and LNG loading facilities. Berths for tugboats and security vessels would be located on the north side of the slip. A lay berth would be provided on the west side of the slip to allow for berthing of a temporarily disabled LNG carrier in an emergency. This berth would have no product loading facility, but it would comply with and be designed to meet all of the safety and security standards of the Oil Companies International Marine Forum (OCIMF) and the Coast Guard. The MOF would be constructed outside of the slip to deliver construction and maintenance components of the LNG Terminal that are too large or heavy to be delivered by road or rail.

LNG Carrier Transit Route

The Coast Guard defines the waterway for LNG carrier marine traffic for this Project as extending from the outer limits of the outer continential shelf, 12 nmi off the coast of Oregon, and 7.5 nmi up the existing FNC to the LNG Terminal. For the analysis in this APDBA and EFH Assessment specific to species covered by the ESA and the MSA, impacts from LNG carrier marine traffic along the transit route includes the estuarine and marine analysis areas (see figure 2.1.1-2).

An LNG carrier traffic study conducted by Moffatt & Nichol International (Moffatt & Nichol 2008a) concluded that the additional LNG carrier traffic associated with the LNG Terminal can be accommodated in the existing Oregon International Port of Coos Bay (Port) and the FNC. The ship traffic conditions in the Port that existed when the LNG carrier traffic study was conducted have not changed. JCEP had a consultant conduct a carrier simulation study which showed that LNG carriers up to 148,000 cubic meters (m^3) in capacity could safely transit up the existing Coos Bay FNC under high tide conditions.[2] JCEP plans to excavate four submerged areas lying adjacent to the FNC (the Navigation Reliability Improvements). These minor enhancements would allow for transit of LNG carriers of similar overall dimensions to those

[2] Moffatt and Nichol, Jordan Cove LNG Terminal Coos Bay, Oregon, 148,000 m^3 Class LNG Carrier Transit and Maneuvering Simulations, March 17-20, 2008.

listed in the July 1, 2008 Coast Guard Waterway Suitability Report, but under a broader weather window. This allows for greater navigational efficiency and reliability to enable JCEP to export the full capacity of the optimized design production of 7.8 mtpa from the LNG Terminal. The proposed channel enhancements are discussed further under Navigation Reliability Improvements below.

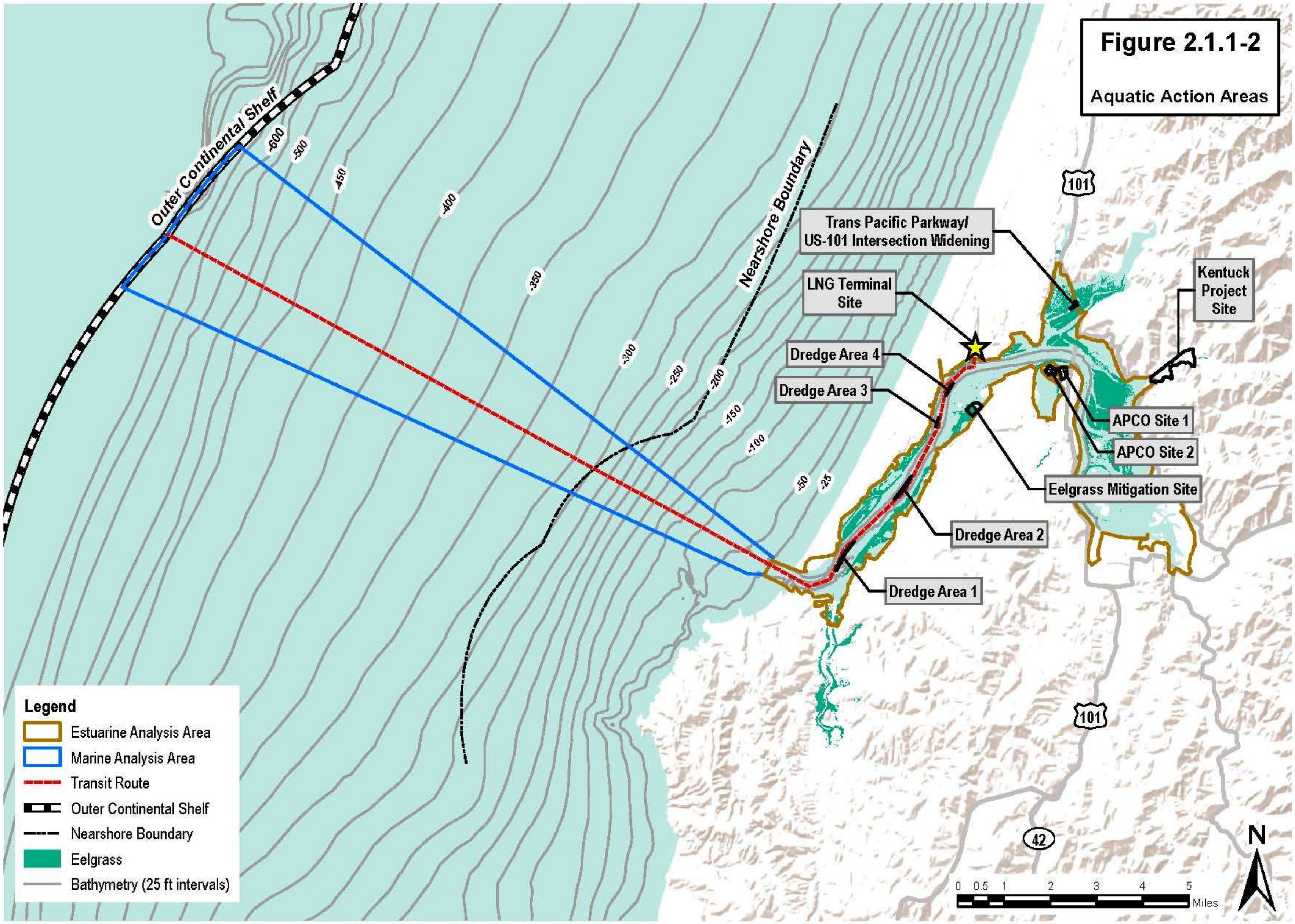


Figure 2.1.1-2
Aquatic Action Areas
Outer Continental Shelf
Nearshore Boundary
-600
-500
-450
-400
-350
-300
-250
-200
-150
-100
-50
-25
101
Trans Pacific Parkway/
US-101 Intersection Widening
LNG Terminal
Site
Kentuck
Project
Site
Dredge Area 4
Dredge Area 3
Dredge Area 2
Dredge Area 1
APCO Site 1
APCO Site 2
Eelgrass Mitigation Site
42
Legend
Estuarine Analysis Area
Marine Analysis Area
Transit Route
Outer Continental Shelf
Nearshore Boundary
Eelgrass
Bathymetry (25 ft intervals)
0 0.5 1 2 3 4 5
Miles
N

The Coast Guard issued a new LOR and an LOR Analysis for the LNG Terminal in May 2018. The Coast Guard again limited the size of LNG carriers that could transit in the waterway to LNG carriers of approximately 950 feet length, 150 feet beam, and loaded draft of 40 feet (nominal 148,000 m^3). Depending upon the approved LNG containment system type, carriers with these approximate dimensions may range in LNG cargo capacity from 135,000 m^3 to 170,000 m^3.

The LNG Terminal could generate a maximum of 120 LNG carrier calls per year, although the average is expected to be between 110 and 120 LNG carriers per year. The actual number of LNG carriers per year would be dependent on the capacity of the LNG carriers calling on the LNG Terminal and the actual output of the LNG Terminal.

A professional Coos Bay pilot (Pilot) would board an incoming LNG carrier at about 5 nmi outside of the channel entrance.

Three 80-metric-ton bollard pull boats and two sheriff's escort boats would accompany the LNG carrier upon entering the breakwater. After passing the jetties and the southern tip of the North Spit, the LNG carrier would travel approximately 1.8 nmi and begin its turn to the north at a speed of approximately 4 to 5 knots. Transiting a distance of 1.6 nmi up the Coos Bay Range, the speed of an LNG carrier in this area would be determined by steerage and wind conditions, but would be about 4 to 5 knots. The LNG carrier would travel in a northerly direction a distance of 2.1 nmi when traversing the Empire Range and the Lower Jarvis Range. The speed of an LNG carrier in this area would be between about 4 to 5 knots.

After the Lower Jarvis Range, the LNG carrier would travel 0.8 nmi to reach the northernmost point in its transit, at the beginning of the access channel to the LNG Terminal. The vessel would be slowed and turned at the direction of the pilot. With tug assistance, the LNG carrier would back into the terminal berth.

Loaded LNG carriers, with a deeper draft, would transit through Coos Bay as close to 'slack high tide' as possible to maximize their under keel clearance at an average speed of between 4 and 6 knots. Arriving LNG carriers in ballast condition can transit at either high tide or low tide slack water conditions due to their shallower draft. Transits will be initially during daylight hours until the Pilots, Tug boat Masters and LNG Carrier Masters gain sufficient experience in navigating the channel, which is estimated to be a couple of months, after which the LNG Carrier transits will be conducted 24/7 (day or night) whenever the correct environmental conditions exist. The total average LNG carrier port time is estimated to be approximately 36 hours, assuming there are no delays caused by natural environmental conditions. This estimate includes the 1.5 hours transit time from the Pilot boarding to arrival at the LNG loading berth to the Pilot drop-off at departure, time of mooring, unmooring and cast off, the bulk LNG loading time of approximately 15 hours (using the 12,000 m^3/hr loading rate), and the 8 hours of time waiting for the next available high tide cycle needed for safe departure and transit of the FNC.

<u>Characteristics of the Waterway Within Coos Bay</u>

The following summarizes the characteristics of the portion of the waterway within Coos Bay (See JCEP Resource Report 2 - Water Use and Quality and Resource Report 3 - Fish, Wildlife, and Vegetation for a detailed description of the waterway and its associated habitats). Coos Bay is an inland estuary, meaning that it is a semi-enclosed body of water that empties into the

Pacific Ocean. As an estuary, Coos Bay is a transition zone where upland fresh water meets ocean salt water, and supports both marine adapted and riverine species. The surface area of Coos Bay covers about 12,380 acres measured at mean high water. The estuary is part of the U.S. Geological Survey (USGS)-designated watershed, Coos Bay (USGS Hydrologic Unit Code [HUC]:17100304; EPA 2012). The watershed drains an area of approximately 739 square miles of Oregon's southern coastal range, within the larger South Coast Watershed Basin (ODEQ 2012). Coos Bay is fed by about 30 tributaries, including the Coos River, Millicoma River, Catching Slough, Isthmus Slough, Pony Slough, South Slough, North Slough, Kentuck Slough, and Haynes Inlet. At its mouth, the estimated average annual discharge is 2.2 million acre-feet of water (Roye 1979).

The existing FNC in Coos Bay would be used as part of the waterway for LNG carriers transiting to the LNG Terminal. The FNC is included in the Coos Bay Estuary Management Plan (CBEMP) and is zoned Deep-Draft Navigation Channel (37-foot authorized draft). The FNC is bounded by the North Spit on the west and north, and the mainland to the south and east. Along the mainland bounding the FNC are the communities of Charleston and Barview, and the cities of Coos Bay and North Bend.

The Coos Bay FNC extends from the mouth of Coos Bay to the city of Coos Bay docks at about Channel Mile (CM) 15.1. The entrance to Coos Bay is located between two jetties that are about 2,100 feet apart and that extend about 3,000 feet from the shore. There is a bar in the Entrance Range with a depth of 37 feet, which establishes the minimum depth of the FNC. The most favorable time for crossing the bar is on the end of the flood tide. The channel width at the entrance mark is 1,500 feet, reducing to 700 feet at CM 0. From CM 1 to the LNG Terminal (at about CM 7.5) the authorized channel width is 300 feet. The FNC is maintained by the Corps.

Marine Slip

The new marine slip would be constructed by excavating an existing upland area consisting of about 16.4 acres of forest and about 20.3 acres of grasses or brush. The majority of the marine slip would be excavated from existing uplands owned by JCEP. Part of the marine slip would be constructed within state waters of Coos Bay to the Mean Lower Low Water (MLLW) line, for which the Port has obtained an easement from the ODSL.

The slip would be bounded on the east and west sides by sheetpile walls, creating a vertical face to support mooring structures. The northern side of the slip would be sloped to meet the existing bottom contours at an angle of 3 feet horizontal to one foot vertical (3:1). The inside dimensions at the toe of the slope of the slip would measure a minimum of 800 feet between the vertical sheetpile walls along the east/west axis, and approximately 1,500 feet and 1,200 feet along the western and eastern boundaries, respectively. The slip would have a minimum depth of -45 feet below MLLW (North American Vertical Datum of 1988 - NAVD88) to ensure minimum under-keel clearance is achieved for the safe maneuvering and berthing of loaded LNG carriers. Appendix B, figure 6.1-2, shows a plot plan of the marine slip. The slip is sized to provide the flexibility needed to safely maneuver an LNG carrier from the access channel into the slip when another LNG carrier is already berthed on the east or west sides, and for tugs to move a temporarily disabled LNG vessel away from the loading berth on the east side of the slip to the lay berth on the west side of the slip if necessary.

LNG Carrier Berths

The marine facilities would include two LNG carrier berths, a lay berth and a product loading berth. Each berth consists of a number of elements: the sheetpile wall, mooring structures, and breasting structures. In general, the LNG product loading berth would be about 1,280 feet long between the centers of the end mooring structures, and 312 feet long from the center of the northernmost breasting structure to the center of the southernmost breasting structure. Appendix B, figure 6.1-2, shows a plan view of the LNG carrier berth.

Sheet Pile Walls. The physical berth would be constructed of steel sheet piles to support surface structures (i.e., the loading area) or provide the foundation for the breasting and mooring structures. Under the loading facility, the wall would extend from the bottom of the slip at elevation -45.97 (minimum) to approximate elevation +34.5 NAVD88. This face would extend north and south to capture the outermost breasting structures and then turn to the east, creating a setback wall for the remainder of the slip.

Mooring Structures. Mooring structures would be provided at both the product loading berth and the lay berth for the safe breasting, berthing, and mooring of the LNG carriers docked at either berth. Six mooring structures (three on each side of the LNG berth centerline) would be used to secure the LNG carrier at both the LNG loading berth and the lay berth. The structures would be behind the sheetpile wall, set back approximately 145 feet from the face of each berth. These structures would have concrete platforms founded on steel pilings and would each have remote release mooring hooks with capstans, as well as all required equipment and instrumentation for safe mooring operations.

Breasting Structures. There would be four breasting structures located adjacent to the product loading facility (PLF); two would be located north of the PLF and two to the south. Like the mooring structures, each breasting structure would have a concrete platform founded on steel pilings and would have remote release mooring hooks with capstans, as well as all required equipment and instrumentation for safe mooring operations. Each breasting structure would also support a fender assembly sized to absorb and distribute berthing and mooring loads for the full range of LNG carriers that the LNG berth is designed for, thus preventing damage to the LNG carriers or the LNG berth. The fender system would allow the carriers to be moored a safe distance off the vertical face of the sheetpile wall. The lay berth would have four breasting structures with fenders and capstans spaced equally about the mid-ship. There would be additional breasting fender structures - two to the north and two to the south of the main breasting structures, for a total of eight. The exact number, type, and location of the breasting structures for the lay berth would be defined during detailed design to meet OCIMF requirements for non-parallel vessel approach and the full range of vessel sizes.

Product Loading Facility. The PLF would utilize a pile-supported concrete slab that provides structural support to the marine loading arms, terminal gangway, and other ancillary equipment. The PLF is designed to support a number of elements that facilitate the safe transfer of LNG product between the LNG facility and the LNG carriers.

The PLF would be constructed on top of the sheetpile wall at approximate elevation +34.5, and would be about 130 feet long and 86 feet wide. The foundation would be reinforced concrete supported by steel pilings.

The transfer equipment would consist of four marine loading arms and ancillary equipment. There would be two dedicated liquid loading arms, one hybrid arm, and one ship vapor return arm to meet the design loading rate of 12,000 cubic meters per hour (m^3/h). The hybrid arm would be designed for dual service and would be capable of transferring LNG to the LNG carriers or returning vapor from the LNG carriers to the boil-off gas (BOG) vapor management system. During normal operation, the hybrid arm would be used in liquid service along with the two liquid arms, and the vapor return arm would be used to return vapor to the BOG vapor management system.

The loading arms are designed with swivel joints to provide the required range of movement between the LNG carrier and the shore connections. Each arm would be fitted with a hydraulically interlocked double-ball valve and powered emergency release coupling to isolate the arm and the LNG carrier in the event of an emergency condition in which rapid disconnection of the connected arms is required. Each arm would be fully balanced in the empty condition by a counterweight system and maneuvered by hydraulic cylinder drives. A mezzanine-type elevated steel platform would be installed for maintenance of the triple-swivel assembly of the arms.

LNG spill containment would be accomplished by a concrete curbed and sloped area that would contain any LNG spillage, and allow the spill to safely flow away from the loading area through the LNG spill collection trench to the marine area LNG impoundment basin.

Additional structures at the LNG loading berth would include an LNG carrier gangway, area lighting facilities, aids to navigation, firewater monitors, and a dry chemical firefighting system.

Lay Berth

A lay berth on the west side of the slip would be provided with facilities to safely moor a temporarily disabled LNG carrier. Berthing facilities would be supported by the west side sheetpile wall with a top-of-wall elevation of approximately +20 feet (NAVD88). The lay berth would have pile-supported breasting structures with fenders extending above the vertical sheetpile and mooring structures on the land side of the sheet pile. A grated platform with a gangway would be placed behind the berthing breasting structures to allow for safe access and egress from the disabled LNG carrier at berth. Support infrastructure would include an access road down from the area of the tug berth building, duct bank with cabling for powering the mooring hooks and capstans, and limited lighting of the ship access area.

Along the western property line, but on the Project side of the Henderson Property buffer zone, a tsunami flow control wall would be constructed. The flow control wall would be of sufficient height and strength to prevent overtopping into the Henderson Property and would limit the drag due to the tsunami current loads on LNG carriers within the marine slip. The wall height would be approximately 34.5 feet and would be determined in accordance with the design tsunami criteria. The wall would run from the southwest side of the LNG tank impoundment area down to the entrance to the slip.

Tug Berth

The tug berth at the north side of the marine slip would accommodate four tugboats, as well as two sheriff's boats and six other visitor boats with similar characteristics as the sheriff's boats. For design purposes, the tugs are assumed to be 80-metric-ton bollard pull boats approximately

100 feet long with a beam of 40 feet. The basis for the sheriff's boat is the Willard Coast Guard Long Range Interceptor. The tug dock would generally be about 425 feet long and 18 feet wide; in addition, there would be 360 feet of 8-foot-wide floats for mooring and accessing the security vessels.

The tug dock would be composed of precast concrete box beams and a concrete topping slab supported by steel piles. The security vessel floating dock is made from 8 foot wide precast concrete sections with a polystyrene (or equal) core anchored by steel pile. The security boat dock would support two separate boat houses (canopies), roughly 35 feet by 50 feet. The canopies are composed of structural steel frame and sheet metal roof. The tug dock would be accessible from land by a pile-founded trestle, thus allowing vehicle and pedestrian access for service and support of operations. The access ramp connecting the dock to shore is roughly 110 feet to the face of sheet pile wall and is the same width and construction as the dock. An onshore tug operations building would provide storage, meeting, and sanitary facilities for the crews of the tug and security boats. Approximately 170 steel or concrete piles would be driven to support the tug boat dock complex and boat houses. No treated timber piles will be used to construct the tug dock. The pile would be installed before the removal of the berm separating the slip from the bay.

Access Channel

Access to the marine slip would be via a newly constructed access channel that would connect the slip to the FNC at approximate CM 7.3 at the beginning of the confluence between the Jarvis Turn and the Upper Jarvis Range A. The access channel and intertidal portion of the slip fall within zoning districts 5 and 6 – Development Aquatic (5-DA and 6-DA). The purpose of the 6-DA zone is to provide areas for navigation and other water-dependent uses. The access channel would flare from the narrowest portion at the mouth of the slip, with a minimum width of 800 feet, to the intersection with the FNC, with an approximate width of 2,200 feet. The proposed access channel would allow for the safe transit of vessels between the berth and the FNC, and allow the safe turning of vessels during an inbound transit so that the LNG carrier can be backed into the slip and berthed bow out, according to industry best practice requirements.

The access channel would cover approximately 22 acres below the Highest Measured Tide (HMT) elevation of 10.26 feet (NAVD 88). The walls of the access channel would be sloped to meet the existing bottom contours at an angle of approximately 3 feet horizontal to 1 foot vertical (3:1). The marine slip and access channel would have a minimum depth of -45 feet below MLLW (-45.97 feet NAVD 88) to ensure minimum underkeel clearance is achieved for the safe maneuvering and berthing of loaded LNG carriers. An allowance over and above the minimum depth would be made for advanced maintenance dredge and incidental overdredge, in accordance with industry best practices. Dredging of the access channel would affect about 15 acres of currently existing deep subtidal area below -15.3 feet below MLLW.

Pile Dike Rock Apron

During early coordination with the USACE Northwest Division, Portland District (NWP) Section 408 Project Development Team, the need was raised to protect Pile Dike 7.3 located immediately west of the access channel. A rock apron has been proposed to arrest slope migration, or equilibration, before it can progress to a condition that could potentially negatively impact Pile Dike 7.3. The preliminary design involves a 50-foot-wide by 3-foot-thick by approximately 1,100-foot long rock apron set back approximately 20 feet from the top (slope catch point) of the access channel side slope. The proposed rock size is a well graded 6-inch to 22-inch angular stone with a median size of 14-inches. This median stone size and gradation is sufficient to protect against potential stone displacement due to anticipated wave action or currents in the project area. In the area of the existing Pile Dike 7.3 rock apron, the proposed design adds additional rock to proactively maintain the current function and longevity of the pile dike. The proposed design also includes an approximately 100 foot long extension of the slip's sheetpile bulkhead at the northwest corner of the access channel to minimize slope cut-back at this location. Total required rock volume is approximately 6,500 cubic yards.

Material Off-Loading Facility (MOF)

The MOF would be constructed to deliver components of the LNG Terminal that are too large or heavy to be delivered by road or rail. The MOF would cover about 3 acres on the southeast side of the slip, adjacent to the RFP property (see appendix B, attachment D.1, Material Offloading Facility). This area includes about 1.43 acres of intertidal habitat, 0.07 acre of shallow subtidal habitat, and 1.3 acres of upland habitat, of which 0.4 acre is forested dune.

The MOF would be constructed using the same sheetpile wall system as the LNG loading berth and the lay berth. The top of the MOF would be at elevation approximately +13.0 feet (NAVD88), and the bottom of the exposed wall would be at the access channel elevation. The MOF would provide approximately 450 feet of dock face for the mooring and unloading of a variety of vessel types.

During construction of the LNG Terminal, in addition to receiving equipment and large modules (upwards of 6,000 short tons) by break-bulk cargo carriers, roll-on/roll-off cargo carriers, and barges, the MOF would allow other bulk materials to be delivered by sea to minimize impacts on the local road network. After construction, the MOF would be retained as a permanent feature of the LNG Terminal to support maintenance and replacement for large equipment components that are too large to be transported by rail and road.

Temporary Materials Barge Berth (TMBB)

The MOF construction cannot be completed during a single in-water work window and as such, to take advantage of marine deliveries as early as possible in the Project, a TMBB would be constructed on the existing shoreline within the access channel footprint (see appendix B, attachment D.2, Temporary Materials Barge Berth). The TMBB would be removed when the berm in which it sits is excavated. The TMBB would be utilized until the MOF is able to receive materials.

Construction of the TMBB would result in fewer trucks trips to the site, thus reducing Project-related road traffic. The TMBB would be an excavated slot in the shoreline that would be removed before the dredging of the slip and access channel. The TMBB would be constructed during the first available in-water work window that occurs after the initiation of overall construction activities. It would accommodate ocean-going barges that are from 100 to 250 feet in length. The barges would be berthed with one end pushed approximately 60 feet into the excavated shoreline slot. The excavated floor of the berth would be approximately 65 feet wide and extend 500 feet into the access channel footprint from the back of the berth. Use of the TMBB may be restricted during low tides if required to prevent grounding of a barge.

The construction sequence for the TMBB would be as follows: An excavator and 40-ton articulated trucks would cut soil from the shoreline area near the face of the west side of the slip. The crews would cut a notch large enough to receive and moor the end of an ocean-going barge. The excavators would cut down to an elevation of -12.97 feet NAVD88 (-12 feet MLLW) and create a channel to deeper water. The excavator would mine material as it works away from the channel, passing excavated material back to the trucks for upland disposal. A crane would be used to install six mooring piles: two in the end of the berth and two on each of the berth sides. The mooring piles would be 24 inches in diameter or less. The piles would be driven using a vibratory hammer until resistance is met, and then would be set with an impact hammer. These piles would be removed during the berm excavation.

Navigation Reliability Improvements

The Navigation Reliability Improvements would take place entirely within deep subtidal habitat at four locations adjacent to the FNC. The dredge areas are named Dredge Areas 1, 2, 3, and 4 and would be located adjacent to the FNC roughly between CM 2 to CM 7, in order from Dredge Area 1 to Dredge Area 4, as depicted in figure 2.1.1-1 and detailed in appendix B, attachment D.3, Navigation Reliability Improvements.

- Dredge Area 1 – Coos Bay Inside Range channel and right turn to Coos Bay Range: Excavation at this site would reduce the constriction to vessel passage at the inbound entrance to Coos Bay Inside Range for any ship making the 95-degree turn from the Entrance Range through the Entrance Turn and Range. JCEP proposes to widen the Coos Bay Inside Range channel from the current 300 feet to 450 feet, thereby making it easier for all vessels transiting the area to make this turn. In addition, the total corner cutoff on the Coos Bay Range side would be lengthened from the current 850 feet to about 1,400 feet from the turn's apex.

- Dredge Area 2 – Turn from Coos Bay Range to Empire Range channels: The current corner cutoff distance from the apex of this turn is about 500 feet, making it difficult for vessels to begin turning sufficiently early to be able to make the turn and be properly positioned in the center of the next channel range. JCEP proposes to widen the turn area from the Coos Bay Range to the Empire Range from the current 400 feet to 600 feet at the apex of the turn, and lengthen the total corner cutoff area from the current 1,000 feet to about 3,500 feet.

- Dredge Area 3 – Turn from the Empire Range to Lower Jarvis Range channels: JCEP proposes to add a corner cut on the west side in this area that would be about 1,150 feet, thereby providing additional room for vessels to make this turn.

- Dredge Area 4 – Turn from Lower Jarvis Range to Jarvis Turn Range channels: JCEP proposes to widen the turn area here from the current 500 feet to 600 feet at the apex of the turn, and lengthen to total corner cutoff area of the turn from the current 1,125 feet to about 1,750 feet, thereby allowing vessels to begin their turn in this area earlier.

Meteorological Station

A Meteorological Station would be located on the west side of the lagoon on the North Spit. The Meteorological Station would be a permanent facility consisting of a tower used to measure wind speed and direction, and other weather data to provide weather information to the LNG Terminal facility and to support ship navigation. The station would be mounted on an approximately 30- to 40-foot-high lattice tower, with a 30-foot-by-30-foot triangular or square footprint.

Industrial Wastewater Line (IWWP) and Water Line Relocation

Portions of the existing IWWP would be relocated or abandoned in place in order to construct the LNG Terminal. Currently, the IWWP carries water from the two existing bio-solids ponds to the existing ocean outfall via the site of the Lagoon that is southwest of the proposed LNG Terminal. Occasionally the water passing through the IWWP is supplemented by water purchased from the Coos Bay-North Bend Water Board (CBNBWB) to maintain permitted pH levels in the Lagoon system and ensure the ocean outfall remains open. The IWWP would be relocated to an easement along Trans Pacific Parkway to connect the Lagoon site to both Ingram Yard and the South Dunes site. Several connections would be made to the relocated IWWP to serve LNG Terminal construction and LNG Terminal, SORSC, and Fire Department operation.

Portions of existing CBNBWB potable water and raw water pipelines would be relocated to easements along the Trans Pacific Parkway or abandoned in place in order to construct the LNG Terminal. In addition, an interconnect to an existing CBNBWB potable water pipeline would be used for all normal operational water needs in the LNG Terminal, SORSC, and the Fire Department, as well as most construction water needs. The tie-point to the 12-inch-diameter potable water pipeline would be located near the northwest corner of the LNG Terminal, along the south side of the Trans Pacific Parkway. A connection to an existing CBNBWB 8-inch-diameter raw water pipeline would also be used for construction water, including LNG tank hydrotesting. The raw water pipeline tap, to be located near the northwest corner of the LNG Terminal on the north side of the Trans Pacific Parkway, would remain connected after construction; however, there are no normal operational uses anticipated for this raw water supply.

Trans Pacific Parkway/US-101 Intersection Widening

Traffic surveys and studies of projected construction traffic have determined that the intersection of US-101 and Trans Pacific Parkway would need to be improved. These improvements would involve widening Trans Pacific Parkway on the north side to provide a left-turn lane onto northbound US-101 to mitigate the traffic impacts that would result from construction of the LNG Terminal (see appendix B, attachment D.5, Trans Pacific Parkway/US 101 Intersection). The existing travel lanes are 11 feet wide, with less than 1 foot between the edge of the pavement and the fog line; most areas have a wide gravel shoulder. The proposed improvements would provide a wider turning radius from southbound US-101 onto Trans Pacific Parkway, two 12-foot travel lanes, a 14-foot left-turn lane, 6-foot shoulders with guardrail, and a 2-foot gravel shoulder on the north side of the guardrail. The existing gravel shoulder on the south side of the parkway would remain as currently configured. See JCEP Resource Report 5 for more information regarding the Transportation Impact Analysis.

Embankment widening on the north side of the causeway at Trans Pacific Parkway/US-101 would extend for approximately 650 feet and would be constructed on a grid of untreated timber piling driven in the soft bay mud. No treated timbers would be used. To drive the pile grid, the contractor would construct a work access bridge as pile driving is progressed parallel to Trans Pacific Parkway. The grid of piling would then be capped with riprap embankment, providing a foundation to widen the roadway to the north. Construction would be isolated from Coos Bay with a temporary sheetpile work isolation containment system and turbidity curtain. These measures to isolate the work area would minimize fill impacts.

APCO Sites

APCO Site 1 and APCO Site 2 consist of two relatively level sandy fill pads that are currently vacant, separated by a tidal mudflat, and surrounded by estuarine wetlands. APCO Sites 1 and 2 would be used as upland dredge disposal sites for the LNG Terminal Project (see appendix B, attachment D.6, APCO Dredge Disposal Site). Disposal of dredge material at APCO Sites 1 and 2 would require the "on-shoring" of the temporary dredge material pipeline discussed under the Navigation Reliability Improvements for hydraulically and mechanically dredged material, as detailed in Section 2.1.1.2 Construction Methods, in order to provide for direct pumping to the sites. If material needs to be offloaded from a barge/scow, a deck barge would also need to be moored adjacent to APCO Sites 1 and 2 using temporary piles or spuds, to provide an offloading facility for dredged materials that would be mechanically offloaded.

Hydraulically dredged (or offloaded) material would be transported via pipeline as described under the Navigation Reliability Improvements, and would be discharged directly within the containment berms at both APCO Sites 1 and 2, if deemed feasible. The pipeline would likely be placed on a cradle supported by piles or other support system where it would cross eelgrass habitat along the northern shoreline of APCO Sites 1 and 2. Decant water would be discharged to Coos Bay and/or Pony Slough via a controlled outlet.

Alternatively, dredge material could be mechanically offloaded from the barge moored adjacent to APCO Site 2. Mechanical offloading reduces the amount of water discharged onto the site, allowing direct placement of the material without an explicit need for containment berms. Details regarding the disposal, decanting, and processing of dredge materials to APCO Sites 1 and 2 are provided in the LNG Terminal Project's Dredged Material Management Plan (DMMP see Resource Report 7/Appendix N.7).

Management of dredge material at APCO Sites 1 and 2 would require the construction of a permanent bridge connecting the two sites to provide access from APCO Site 1 to APCO Site 2 for heavy earth-moving equipment. The permanent bridge would be a single-lane single-span bridge approximately 200 feet long and approximately 40.5 feet wide, and would include two concrete abutments on pile-supported footings with material-stabilized earth walls that extend landward. The bridge would completely span the intertidal wetland separating the sites, and the material-stabilized earth walls extending from the abutments would eliminate the need for fill material to extend below the HMT or wetlands.

Construction of the permanent access bridge between the two sites would begin with construction of a temporary work bridge to the north of the location of the permanent bridge that would provide access for construction of the permanent structure. The temporary work bridge would be approximately 30 feet wide and 280 feet long, and would have seven 40-foot spans. It is likely that the temporary work bridge would use three steel piles per bent, and have a steel frame and a steel or concrete bridge deck. The steel plate girders for the bridge would be assembled and installed on-site. Precast deck panels would be installed between each of the four steel girders, and a cast-in-place concrete deck would be poured over the steel girders and deck. All water that comes in contact with green concrete during pouring of the concrete bridge deck would be pumped into tanks for disposal at an approved off-site location. The work bridge pile would have temporary impacts to intertidal habitat. An impact hammer would most likely be used to construct the temporary work bridge and therefore is likely to generate acoustic impacts.

A total of 0.63 mcy of dredged material would be placed at the APCO Sites from capital dredging related to the Eelgrass Mitigation Site and the Navigation Reliability Improvement sites.

Temporary Construction Sites

Temporary facilities and construction laydown areas would be required during construction of the LNG Terminal to house construction offices, crafts lunchrooms, warehousing, equipment maintenance, and laydown of materials after delivery to the site. These facilities have been located to maximize use of land owned by JCEP within the overall site boundary and minimize the impact on wetland environments through use of brownfield land, which is suitably zoned for industrial purposes, at the Roseburg site, Boxcar Hill site, Port Laydown site, and APCO Site. A concrete batch plant would be situated on the north side of the Trans-Pacific Parkway on the Boxcar Hill site (see figure 2.1.1-1).

Kentuck Project Site

The Kentuck Project is a roughly 100-acre wetland mitigation and coho salmon habitat rehabilitation project located on the western shore of Coos Bay at the mouth of the Kentuck Slough. Construction activities at the Kentuck Project include earthwork and civil infrastructure improvements to re-establish a tidal connection to roughly 90 acres and roughly 10 acres of freshwater flooplain reconnection at this former golf course site that more closely approximates conditions at the site prior to the creation of the golf course (see appendix O – Compensatory Wetland Mitigation Plan).

Kentuck Slough has subsided approximately 2 to 3 feet from its historical profile as a result of diking and drainage; therefore, earthwork activities would include importing of dredge materials from other areas of the LNG Terminal project to raise the subgrade to a profile conducive to establishing appropriate estuarine habitat and some freshwater habitats. Historical drainage patterns would be re-established to the extent practical given the site constraints.

Infrastructure improvements would include:

- Constructing a new bridge in East Bay Drive to allow tidal exchange between Kentuck Inlet and the Kentuck Project;
- Improving the existing dike separating the site from Kentuck Slough;
- Constructing a new muted tidal regulator (i.e., a "fish-friendly" tidegate) in the upper portion of the Kentuck Project to redirect a portion of Kentuck Slough flows into the Kentuck Project site;
- Raising the profile of East Bay Drive and approximately 2,100 lineal feet of Golf Course Lane to be above the zone of tidal influence;
- Installing stormwater treatment facilities for new impervious surfaces along East Bay Drive and Golf Course Lane;

- Constructing a fish-friendly culvert or other structure within Golf Course Lane to allow passage into the drainage above the former golf course irrigation sump pond;
- Constructing a temporary unloading facility, including a hydraulic unloader on a deck barge, mooring/fleeting barges, booster pump(s), and a dredge material transport pipeline; and
- Constructing a boardwalk path upland, on the southern boundary of the site.

JCEP will continue to coordinate with ODFW and NMFS as the bridge, muted tidal regulator tidegate, and culvert designs progress to review compliance with both agencies' fish passage criteria.

Eelgrass Mitigation Site

The Eelgrass Mitigation site is approximately 9.3 acres in size and is located approximately 500 feet southeast of the offshore end of the North Bend Municipal Airport runway and about 200 feet off the opposite North Bend shoreline (see appendix O – Compensatory Wetland Mitigation Plan). The area of Coos Bay surrounding the Eelgrass Mitigation site and extending west to the FNC is composed of lower intertidal mudflat and shallow subtidal habitat(s), including eelgrass beds. Construction of the Eelgrass Mitigation site would involve lowering the bottom grade within an unvegetated sand/mudflat bordered by eelgrass. This elevated area (mound) is currently not supporting eelgrass because of its elevation. Most of this area is currently between elevations +1.0 and +2.5 MLLW (+0.00 and + 1.50 NAVD88) and would be lowered to an elevation of approximately -1.5 MLLW (-2.5 NAVD88).

Upland Wildlife Habitat Mitigation Sites

JCEP has worked closely with ODFW to identify three sites that will be used to provide upland wildlife habitat mitigation as recommended by ODFW. The Panhandle Site is approximately 133 acres located north of Trans Pacific Parkway The Lagoon Site is approximately 320 acres and is located adjacent to the Meteorological StationThe North Bank Site is approximately 156 acres located on the north bank of the Coquille River adjacent to the Bandon Marsh National Wildlife Refuge.

The proposed ecological uplift at these sites focuses on improving and preserving current habitat. For example, the proposed ecological uplift at the Lagoon Site would bury overhead powerlines that run from Trans Pacific Parkway to a small building just behind the foredune, removing potential western snowy plover predatory species perching habitat. .

Meteorological Ocean Data Collection Buoys

Meteorological ocean data collection buoys would be installed to measure wind speed and direction, current speed and direction, and tide height in real time. Three buoys would be located in the Pacific Ocean near the bay entrance, and within Coos Bay along the LNG carrier route. JCEP has identified a need to provide two new buoys within the vicinity of the access channel for the LNG carrier berth. The updated buoys would be identified in coordination with the National Oceanic and Atmospheric Administration (NOAA) and the Coast Guard, and permitted through applicable agencies. For the purposes of this APDBA, it was assumed that the buoy anchoring system would need to be replaced at existing buoy locations. Removal of the existing anchor and installation of new industry standard anchoring systems would result in temporary disturbance to the channel bed, resulting in localized turbidity. JCEP has initiated discussions with NOAA to install Physical Oceanographic Real-Time System (PORTS) sensors on three existing Coast Guard ATON buoys with the PORTS sensors being attached to the existing USCG buoys and anchor systems. The PORTS will be managed, installed, and the system will be operated by NOAA. NOAA will initiate any regulatory approvals required for the addition of PORTS sensors on the three Coast Guard ATON buoys.

2.1.1.2 Construction Methods

Timing of Construction Activities

Construction of the LNG Terminal and slip is expected to take approximately five years. To meet an in-service date of the second half of 2024, construction activities are expected to begin in the first half of 2020. The general construction schedule is described below by anticipated year an activity would occur with in-water work noted where applicable. Because the in-water work window occurs from October to February, the construction activity is shown in the year construction begins. The in-water work window a construction activity is anticipated to occur may vary as construction proceeds.

During 2020, JCEP would conduct the following activities:

- Begin final engineering design;
- Procure all major equipment;
- Mobilize to the site and set up erosion and sediment controls;
- Clear and grub the site;
- Start ground improvements;
- Start cut and fill activities;
- Construct TMBB (In-water work);
- Start MOF construction by placing clean fill in the bay (In-water work);
- Start Trans Pacific Parkway/US-101 Intersection Widening (In-water work);
- Start Eelgrass Mitigation (In-water work);
- Start Navigation Reliability Improvements (In-water work); and
- Start APCO access bridge and install work bridge (In-water work).
- Begin Kentuck Project (In-water work).

During 2021, the following activities would be conducted:

- Begin module fabrication;
- Complete ground improvements;
- Continue cut and fill activities;
- Continue MOF construction;
- Begin marine slip construction – sheet pile, pipe pile, and excavation/dredging behind the berm
- Transport excavated/ hydraulically dredged materials to Ingram Yard, the Roseburg site, the South Dunes site;
- Begin piling for process areas;
- Begin concrete work for LNG Storage Tanks;
- Begin concrete foundations for process areas;

- Begin plate work for LNG Storage Tanks;
- Begin work on site Buildings;
- Begin Workforce Housing Facility;
- Complete Trans Pacific Parkway/US-101 Intersection Widening;
- Commence excavating in front of the MOF;
- Dredge access channel (In-water work);
- Begin Pile Dike Rock Apron construction;
- Continue Navigation Reliability Improvements if not completed (In-water work);
- Complete APCO access bridge and remove work bridge (In-water work); and
- Continue Kentuck Project including installation of dredge off-loading facilities (In-water work).

During 2022, the following activities would be conducted:

- Continue Module fabrication;
- Complete and open Workforce Housing Facility;
- Complete cut and fill activities;
- Complete MOF, install fender pile (In-water work) and begin receiving major equipment;
- Complete marine slip and remove berm to connect slip to the bay (In-water work);
- Deliver dredge material to Kentuck Project (In-water work);
- Continue Navigation Reliability Improvements if not completed (In-water work)
- Begin berthing facilities;
- Complete piling for process areas;
- Complete concrete foundations for process areas;
- Continue work on site Buildings;
- Continue LNG Tank construction;
- Begin mechanical equipment installation;
- Receive and install Pipe Rack and initial Major Equipment Modules; and
- Begin BOP pipe and electrical work.

During 2023, the following activities would be conducted:

- Continue Kentuck Project;
- Complete Navigation Reliability Improvements (In-water work);
- Complete final engineering design;
- Complete Module fabrication;
- Complete berm removal and slope protection (In-water work);
- Install meteorological ocean data collection buoys (In-water work)
- Complete berthing facilities;
- Receive and install remaining Major Equipment Modules;
- Complete site Buildings and turnover essential portions;
- Continue LNG Tank construction;
- Complete mechanical equipment installation;
- Complete BOP pipe and electrical installation; and

- Begin Pre-Commissioning and Commissioning.

During 2024, the following activities would be conducted:

- Complete Kentuck Project, connect site to Coos Bay and Kentuck Creek (In-water work)
- Install final site finishes;
- Complete LNG Storage Tank construction;
- Commission and Cool Down LNG Storage Tanks;
- Complete Commissioning;
- Staged start-up and commencement of operations;
- Ship first LNG Cargo;
- Performance Testing;
- Plant Turnover; and
- Clean and demob site.

During 2025, the following activities would be conducted:

- Decommission and remove Workforce Housing Facility; and
- Clean and demob site.

Dredging and Shore Protection

For the capital dredging, about 5.7 million cubic yards (mcy) of material would be removed to create the slip basin and access channel. Of this, about 1.4 mcy would be dry excavated and about 4.3 mcy would be wet dredged. It is proposed that excavated and dredged material be distributed between Ingram Yard, the Roseburg site, the South Dunes site, and the Kentuck Project site.

During the “fresh water” construction phase of the slip about 2.2 mcy of material would be dredged in the pocket behind a temporary construction berm. During the “salt water” construction phase of the slip, about 0.7 mcy (slip and berm) of material would be dredged during removal of the temporary construction berm and finish dredging of the marine slip, of which about 0.3 mcy may be used for the Kentuck Project. It is also possible that the 0.3 mcy required to facilitate the Kentuck Project could be sourced from the salt water dredge taken from the access channel between the FNC and the proposed LNG Terminal marine slip. A total of about 1.4 mcy of material would be dredged from the bay during construction of the access channel.

The northern slip face would be armored after the slip is dredged but before the earthen barrier berm is removed. The barrier berm would remain unarmored, because it would be removed during the later stages of slip construction.

The estimated excavated and dredged material volumes and their proposed placement location are summarized in table 2.1.1-1 and further discussed in subsequent sections below.

To minimize the impacts on aquatic resources in Coos Bay, reduce the total period of estuary turbidity, and extend the time available for construction, a multi-phase approach was developed for construction of the slip and access channel. The basic concept is to maintain a natural physical barrier between the slip and Coos Bay. Therefore, construction of the slip could take place year-round without working in the waters of Coos Bay. The first phase would be the dry excavation of the upper level of the upland portion of the proposed marine berth, above the underground water table. The second phase, known as the "fresh water" phase, would be the dredging of the lower level of the upland portion of the marine slip, below the underground water table. The third phase, known as the "salt water" phase, would include the removal of the berm, and the dredging of the far southern portion of the slip and the entire access channel (including the area around the MOF) in the bay.

TABLE 2.1.1-1

Estimated Excavated and Dredged Material Volumes

Construction Phase	Volume (mcy)	Disposition Sites
Upland Excavation	1.4	Ingram Yard, Access and Utility Corridor, South Dunes
Fresh Water Dredge	2.2	Ingram Yard, Access and Utility Corridor, South Dunes, Roseburg site
Salt Water Dredge	0.2	Ingram Yard, Access and Utilitiy Corridor, South Dunes, Roseburg site
Upland Excavation	0.03	Ingram Yard, Access and Utility Corridor, South Dunes
Salt Water Dredge	0.5	Ingram Yard, Access and Utility Corridor, South Dunes, Kentuck
Upland Excavation	0.004	Ingram Yard, Access and Utility Corridor, South Dunes, Roseburg site
Salt Water Dredge	1.4	Ingram Yard, Access and Utility Corridor, South Dunes, Roseburg site
Salt Water Dredge	0.7	APCO Site 1 / APCO Site 2

Marine Construction Equipment

A variety of marine equipment would be used in the course of dredging and placing slope protection. There are two types of dredging operations that use different equipment: clamshell and cutter-suction. The following describes the equipment that would be used; exact details would be finalized during detailed design and may be impacted by market availability.

The apron excavation, berm removal, pile dike rock apron, and slope protection would be completed with a derrick barge that has an approximate capacity of 180 tons. The derrick barge would use anchors for station keeping. The barge would be supported by dredge tender for positioning and a crew boat. The crane would have both standard and flat-bottom eco-buckets for digging operations and a rock box for placing slope protection. Spoils would be placed on one of three flat deck barges with approximately 15,000 square feet of deck space. A tugboat of nominal capacity 1,500 horsepower (hp) would shuttle the spoil barges to the MOF, where the dredge spoils would be transferred to trucks for placement on the LNG Terminal site. For the material being delivered to the Kentuck Project, the same tug would deliver the deck barges for unloading and return the empties.

The dredging of the slip would be completed using a barge-mounted cutter-suction dredge of nominal capacity 3,000 hp. The dredge would be delivered by ocean-going barge to the channel, then partially disassembled and pulled over the berm into the slip area. The dredge would pump the dredge spoils to fill areas on the LNG Terminal site. The dredge would be serviced by a dredge tender and a crew boat.

Before the berm is removed, slope protection within the slip area would be installed using land-based cranes and a crawler craned mounted on a flexi float barge within the slip. A crawler crane would use a rock box to pick slope protection materials off the bank and place the material, working from the toe of slope up. This crane may also be used to service concrete work and equipment installation throughout the slip.

Other marine equipment could include boats for survey, personnel movement, and the shuttling of supplies. A variety of tugboats might also be called upon from the local area that would vary in size and role, depending on availability.

Navigation Reliability Improvement Dredging Means and Methods

Two methods of dredging could be used: mechanical dredging via clamshell or excavator, and hydraulic cutter-suction dredging. Mechanical dredging via clamshell or excavator would involve placement into a scow or hopper barge for transit to a temporary dredge offloading area and hydraulic pumping to disposal sites. Hydraulic cutter-suction dredging could involve pumping material via temporary dredge lines directly to a scow or barge for offloading at disposal sites, or pumping the material via temporary dredge lines directly to disposal sites. The total volume of capital dredged material from these excavations is approximately 590,000 cubic yards (cy). Dredged material may be distributed between APCO 1 and APCO 2 upland disposal sites, or placed entirely at APCO 2, if it is feasible.

Dredging would take place in deep subtidal habitat, which also provides habitat for benthic organisms such as worms, crustaceans, and mollusks. These activities would temporarily impact the macroinvertebrates that live within the substrate in these areas and move, rest, find shelter, and feed on the substrate and organic material. Additionally, the fish species that utilize these habitats could be temporarily affected. Dredging would result in increased turbidity within the estuarine analysis area. The restriction of construction activities to the in-water work window of October 1 through February 15, when salmonid species abundance is lower, would reduce the likelihood of impacts to these species.

Dredging would require a temporary dredge line to be placed on the bottom, running along the outer limits of the FNC, to connect the first deepening location to APCO Site 2. Navigation markers would be used where the dredge line temporarily crosses the FNC for Dredge Areas 2 and 3. There are two viable alternatives for placement of the dredge line at these two dredge locations. Option one is to use a floating line that connects the hydraulic cutter suction head dredge across the FNC and connecting to the submerged pipeline on the east side of the channel at each of these two dredge areas. The line must be floated at this location because the FNC is not deep enough to place a submerged pipeline and still maintain the required navigational underkeel clearance to the top of a submerged pipeline. The floating section of dredge line would need to be broken to allow passage of deep draft vessels restricted to the FNC. The dredge line would be flushed prior to breaking the line to minimize the release of turbid water. An alternate option is to place a submerged material pipeline along the west side of the FNC to transport the dredge material from Dedge Areas 2 and 3 and cross the FNC near Dredge Area 4 at approximately RM 6.7, where the FNC is naturally deep enough to maintain adequate clearance to a submerged pipeline. Material from Dredge Areas 1 and 4 that are located on the east side of the FNC can be managed without impact to deep draft vessels. The pipeline would also be elevated at fixed locations to feed booster pumps. The booster pumps would be located on barges, which would be moored on the eastern side of the FNC using temporary piles and/or spuds, and which would be used to move the dredge slurry toward APCO Sites 1 and 2 for disposal.

If dredged material is offloaded from a barge/scow, a temporary dredge offload facility would need to be constructed to hydraulically transfer dredge material to APCO Site 2. The hydraulic unloader would operate from a deck barge up to 40 feet by 100 feet in size. Two flat deck mooring/fleeting barges (measuring 40± feet by 160± feet) would be moored adjacent to the unloader barge. Approximately 16 temporary piles and/or spuds that would be 24 inches in diameter will be used to moor the barges, depending on actual equipment and configuration.

Indirect impacts resulting from the runoff of decant water at the APCO Site are not anticipated. The perimeter dike would be sized appropriately to allow for the settling of dredged material, and for evaporation and dewatering. During the drying phase, finer sediments would be allowed to consolidate, settle, and dewater. Water would evaporate or percolate into the ground. Weirs would also be used to enable surface water to exit the site via a culvert and would be designed with sufficient retention times to ensure that adequate sediment settling has occurred before discharge. Adequate settling before discharge would prevent turbid water from being released into the bay.

Maintenance materials would be disposed of in the upland dredge disposal sites located on the APCO Site 1 and APCO Site 2, and management of the dredge areas would be the responsibility of JCEP.

Construction of Sheetpile Wall

The sheetpile system would serve as a retaining wall for the shoreline on the east and west sides. The east side would support the LNG carrier loading facility and associated berthing and mooring facilities. The sheetpile system would be designed to support the dead loads of the soils and structures, and the live loads of the LNG carrier at berth and LNG transfer equipment, and also would be designed to meet the seismic criteria for the facility and water-imposed loads. The west side would provide a lay berth, and the sheetpile system would be designed to support the dead loads of the soils and structures and the live loads of the LNG carrier at berth.

The sheetpile wall system consists of face sheet piles for retaining the soils as well as tail-walls for anchorage of the retaining wall. All sheet piles and tail-walls would be driven from the land while the slip construction activities are isolated from Coos Bay.

Slip Construction

To minimize the impacts of construction of the marine facilities on fisheries, reduce the total period of estuary turbidity, and extend the time available for construction, a two-phase construction methodology would be used to construct the slip. The basic concept of the two-phase construction methodology is to excavate (either wet or dry) the majority of the slip area and construct the structures while maintaining a natural physical barrier between the excavated/dredged slip and the water of Coos Bay (see appendix B, attachment D.2, Temporary Materials Barge Berth). This methodology would be accomplished by retaining a natural earthen berm to provide a physical partition between the water of Coos Bay and the fresh water construction activities for the marine facilities. This construction methodology would allow year-round work on the northern portion of the slip without being in contact with or causing an impact to the waters of Coos Bay. The remaining open water work would include excavation of the access channel (including the area around the MOF), excavation/dredging of the berm area, and installation of the MOF fender piles. This work would be constructed during periods when fisheries considerations allow in-water work, which is between October 1 and February 15.

Dry Excavation

The existing natural ground surface is at an elevation of approximately +20 feet NAVD88. The water table across the slip occurs at an elevation of approximately +10 feet NAVD88. All excavated material above an elevation of approximately +10 feet NAVD88 would be removed by conventional earthmoving equipment such as excavators, scrapers, bulldozers, and front-end loaders. A berm would be maintained as a barrier to the bay during this construction phase. The permanent north slope would be of 2.5 horizontal to 1 vertical (2.5:1). The same slope would be maintained on the slip side of the temporary berm to preserve the integrity of the berm during excavation and dredging, as shown in appendix B, attachment D.2, Temporary Materials Barge Berth. Excavation during this step would remove only material that is essential for creating the slip and constructing upland structures. Contouring of the slip perimeter above +10 feet NAVD 88 would be performed during this step.

The volume of material to be excavated and dredged from the slip, including the berm, is 4.3 mcy, as shown in table 2.1.1-1. The material would be placed on the LNG Terminal site, which includes Ingram Yard, the Access and Utility Corridor, the South Dunes site, and the Roseburg site.

Excavated material would be hauled by trucks to upland areas of the LNG Terminal site. The excavated material truck haul route would go to the north of the slip through Ingram Yard and then follow the route of the Access and Utility Corridor to the South Dunes site. The route would not cross the Trans Pacific Parkway at any time, and the only potential conflict would be with chip truck traffic to the RFP wood chip facility, which would be mitigated by construction of a traffic overpass. The excavated material truck haul route would be on JCEP- or RFP-owned land.

Slip Dredging

Excavators would be used to remove material down to elevation 0.0 feet NAVD88 to build the dredge launch pad. The channel would be roughly 300 foot by 200 foot and be 10 feet deep. The launch pond preferably would be located near the slip perimeter and road access. The material would be moved to the upland disposal sites by trucks, as described in the previous section.

The dredge barge would be delivered by ocean-going barge to the channel, then pulled over the berm to facilitate hydraulic dredging of the slip. All of the material to be excavated that is located at or below the level of the water table would be removed by means of hydraulic dredging and transported to the Roseburg site. Based on scheduling efforts during detailed design, placement may be required at the South Dunes site; however, no off-site disposal is anticipated.

A hydraulic transport pipeline would connect the dredge or dredges to the disposal areas, and a decant water return pipeline would return the water to the slip area or purpose-built decant basin. The hydraulic dredges, which are capable of transporting a slurry of 30 percent solids by weight at a flow rate of 6,000 gallons per minute (gpm) or greater, would create an ever-increasing dredge prism that would, in the end, create the fully defined slip within the confines of the berm. The hydraulic dredges are capable of dredging to the final slip depth.

The slurry pipeline used for hydraulic transportation of excavated materials going to South Dunes (including the decant water return line) would follow the shoreline of the RFP property until the point where it follows the route of the future Access and Utility Corridor. Slurry lines going to the Roseburg site would be routed through Ingram Yard to the Access and Utility Corridor, and then turn south into the RFP property. The pipes would run along the ground and be braced as necessary. In the area of the RFP chip ship berth, the pipeline would be placed on the riprap along the shoreline, so that it does not affect the docking and loading of the chip ships. The pipeline would be able to span any affected wetlands or waterbodies without the need to place any structures in the wetlands or waterbodies. The pipelines are high density polyethylene) that are fusion welded together, which will greatly reduce the likehood of a rupture. Any mechanical joints would be located to avoid discharge to wetlands and waters.

The slurry pipeline and decant water return pipelines would be made of 18- to 20-inch-diameter fused polypropylene (seamless) pipe. The decant water return pipeline would be placed along, and directly adjacent to, the slurry pipeline (no spacing between the two pipelines). The decant water pipeline would be used to convey the decanted water from the settling areas back to the dredge pond. When the hydraulic transport has been completed, the pipelines would be drained, flushed with clean water, and cut apart only in those areas where any residual material in the pipeline could not potentially be released into the bay, wetlands, or other waterbodies. The pipeline would be removed by the contractor and taken off-site for reuse, recycling, or disposal in a permitted landfill. Because the pipelines would be on existing developed surfaces (grassed, paved, graveled, and riprap area of the RFP property) and areas to be developed for the LNG Terminal Project (Access and Utility Corridor), post-construction restoration would include reseeding of grassed areas that were disturbed by the location of the pipelines on the grassed area.

Access Channel Dredging

The volume of material to be dredged from the access channel is 1.4 mcy, as shown in Table 2.1.1-1. The material may be placed on Ingram Yard, the Access and Utility Corridor, the Roseburg site, and the South Dunes site. This portion of work is open to Coos Bay and therefore would be performed during the annual in-water work window, which is from October 1 to February 15.

The access channel dredging would utilize a barge-mounted crane with clamshell bucket and material barges. The channel dredging would occur during the second available in-water work window. The operation would start at the MOF in order to facilitate the relaxation of the sheets, and would continue until all material between the berm and the FNC is removed. It is expected that dredging would occur around the clock to finish in the available time frame.

Material would be loaded into material barges from the clamshell. When full, the barges would be towed to shore and the material would be transferred to trucks for placement at the available upland sites as determined by the final schedule.

Driving of Piling for Marine Structures for the LNG Terminal and Tug Dock

All of the marine piling for the tug dock would be driven concurrent with dredging of the slip and, as such, piles would be driven prior to connection of the slip to Coos Bay. Land-based mobile cranes with pile-driving equipment would be located in the slip excavation as it approaches the top of pile elevation. All piles required for the LNG loading foundation and all mooring and berthing structures for the LNG and lay berths are behind the sheetpile walls and would be driven on dry land. One hundred sixty eight 30-inch-diameter piles would be used for the mooring dolphins and one hundred sixty eight piles would be needed for the breasting dolphins. In addition, thirty-five 48-inch-diameter piles would be used to support the loading platform above the LNG carrier berth. The tugboat dock would require 109 (24-inch-diameter) pile and 62 (20-inch) fender piles.

Slope Armoring

The northern slip face would be armored from the toe to above the water line using rock, a cement based riprap, or other appropriate measures to protect the slope from scour and erosion (see JCEP Resource Report 6 – Geological Resources). The armor would be placed with a combination of land-based and barge-mounted equipment. Currently the east side (LNG Berth), west side (Emeregency Lay Berth), and MOF are proposed to be vertical steel sheetpile wall, which in part provide an active scour protection system. Scour protection will be evaluated further during final design to determine if slope armoring or pile embedment would prevent undermining of the sheetpile wall. It is anticipated that pile embedment would prevent undermining, however, additional rock, cement based riprap, or other appropriate measures may be specified to provide scour protection along the sheetpile walls. The south slip face created by the berm would also remain unarmored, because it would be removed to create the final configuration of the slip and the access channel.

The sequence for pile driving, slope dressing, and armoring could vary depending upon the means and methods chosen by the contractor performing the work.

Above the waterline, alternative scour (and wind/rain erosion) protection systems for less frequent events would be provided using any number of potential techniques, including concrete cellular mattresses, grout-injected geotextile fabric mattresses (fabriform), and/or geotextile-reinforced vegetative planting.

Connection of Slip to Coos Bay

Details of each of the steps involved during connection of the slip to the Coos Bay are outlined below.

Breaching and Removing the Berm

Once all of the fresh water construction is complete, work would begin on breaching and removing the berm (500,000 cy) and completing the remaining area of the slip. This work would be in-water work and occur during the October 1 to February 15 window. Dredging might be conducted from both the Coos Bay side and the slip side to reduce the duration of the breaching and removal activity. Material would be removed by hydraulic dredge or clam-shell dredge. A portion of the material (approximately 300,000 cy) may be transported to the Kentuck Project to be used as fill. The remainder would be placed at the South Dunes site. The temporary piles used at the TMBB would be removed at this time as well.

Final Contouring and Slope Armoring

Removing the berm would open the slip to Coos Bay. Additional dredging to contour the access channel would complete the construction dredging activities. Armoring of the remaining unarmored slip side slopes would be completed. Although not anticipated at this time, any additional in-water structures required to complete the slip and associated in-water structures then would be installed. In-water work would be performed during the allowable construction window between October 1 and February 15.

Pile Dike Rock Apron

The proposed pile dike rock apron would likely be placed within the same in-water work window as dredging/construction of the access channel side slope but may occur the following in-water work window. Construction of the rock apron following dredging of the access channel would allow for much or all the apron rock to be placed from floating equipment, such as a material barge for the rock and a barge mounted crane for placement. If the contractor's equipment could not provide the reach necessary to place all rock from a floating platform some work may occur using wide track/lower ground pressure equipment working in the intertidal zone. Land-based equipment would work in the dry or during low tide to the extent feasible. If site constraints require equipment to work in shallow water conditions, measure would be installed as needed to minimize turbidity. At the end of Pile Dike 7.3, the new rock apron will be placed directly over the visible apron rock in a careful manner so the new rock apron will not extend towards the access channel beyond the end line of the existing visible rock. Construction is anticipated to take approximately one in-water work window if all material is placed from floating equipment.

Meteorological Ocean Data Collection Buoys

Removal of the existing anchor and installation of new industry standard anchoring systems would result in temporary disturbance to the channel bed, resulting in localized turbidity of a short duration. If required, replacement of the anchoring system would occur during the in-water work window to minimize any potential impacts. Aquatic organisms in Coos Bay are adapted to and exposed to periods of high to moderate turbidity during the winter months due to existing conditions. Therefore, impacts to marine species from replacement of the anchoring systems for the three existing buoys and installation of the two new buoys are expected to be insignificant and discountable due to the limited area affected and the timing of construction that would coincide with periods of naturally higher turbidity.

Restoration

Following the excavation activities, all areas within the LNG Terminal Project footprint, including exposed slopes, would be protected from erosion and stabilized with an erosion protection system and/or an approved seed mixture specified as being capable of surviving in highly permeable, xeric regimes; binding loose sand; and withstanding burial and deflation from aeolian processes (for more information, see JCEP Resource Report 7 – Soils).

The slurry and decant water return pipelines would be removed as described above. Any areas that are disturbed by the haul truck or pipeline routes that do not become part of the Access and Utility Corridor would be restored to pre-construction conditions.

The route of the slurry/decant water return pipelines on the developed RFP property would not require restoration, because the pipelines would be placed on areas that are surfaced with gravel, concrete, or riprap. If there are any areas of the route where ground disturbance occurs, these areas would be returned to pre-construction conditions.

LNG Carrier Loading Facilities

The LNG carrier loading facilities would be constructed once the installation of the eastern sheetpile wall system is complete. All of the loading facilities would be on the shore side of the slip, with no facilities located in the water of the slip. The platform with the loading arms (inclusive of the loading and vapor return arms) would be installed on a concrete pad located at the edge of the slip. The foundation of the pad would contain a number of piles to provide a stable foundation for the loading arm platform. Separate piles, typically steel pipe piles, would be driven for the breasting and mooring structure platforms. The loading arm platform would be constructed on columns raised from the concrete pad and accessed through stairways. The LNG transfer piping would be located over LNG troughs that would contain any spills and divert the LNG to a containment basin.

The LNG carrier loading facilities would be constructed using land-based equipment to install the required structural elements for the loading platform and mooring structures. Installation of berth piping and equipment, and hookup and commissioning of the loading system and utilities would follow.

Driving of In-water Piles for Marine and Temporary Facilities

The exception to the installation of all piles "in the dry" is associated with the installation of the TMBB berthing and mooring piles, MOF fenders, the Temporary Dredge Line and Temporary Dredge Transfer Line support cradle pile, the temporary work bridge piles for the APCO Site access bridge and Trans Pacific Parkway/ US 101 Intersection Widening, and the temporary piles for the Temporary Dredge Off-loading Area at the Kentuck Project and APCO Site 2, and the Temporary Dredge Loading Area at the Eelgrass Mitigation site, which could require steel piles to be installed in open water of the bay. Untreated timber piles would be installed within a sheetpile cofferdam at the Trans Pacific Parkway/US-101 Intersection Widening to provide subgrade stabilization. All piles installed in open water of the bay would be 24 inches in diameter or smaller to minimize acoustic impacts. A vibratory hammer would likely be used to install the steel piles for these actions; however, an impact hammer might be needed if the piles cannot be installed to design depth with vibration alone. Construction activities would occur during the in-water work window (approved by ODFW), when sensitive life stages of listed fish are less abundant in the bay, which would further minimize the potential for adverse impacts.

Construction of Upland Facilities at the LNG Terminal

All facilities would be constructed in accordance with applicable regulations, including 33 C.F.R. Part 127, 49 C.F.R. Part 193, National Fire Protection Association (NFPA) Standard 59A, and 49 C.F.R Part 192. JCEP would construct its LNG Terminal facilities in accordance with its project-specific *Upland Erosion Control, Revegetation, and Maintenance Plan* (JCEP's "Plan) and *Wetland and Waterbody Construction and Mitigation Procedures* (JCEP's Procedures). JCEP has adopted the FERC's Plan and Procedures (May 2013 versions), as modified for the LNG Terminal Project, into JCEP's Plan and Procedures; therefore, there are no differences between JCEP's and FERC's Plan and Procedures. In addition, JCEP prepared Construction-phase and Operation-phase Spill Prevention, Control, and Countermeasure Plans (SPCCPs), which are included as Appendices F.2 and G. 2 in JCEP Resource Report 2 – Water Use and Quality. JCEP Resource Report 2 – Water Use and Quality also contains further information regarding the Erosion and Sediment Control Plan (ESCP) and SPCCP.

Preliminary Activities

During construction, equipment and material would be brought to the LNG Terminal site by road, rail, and marine transport. The kinds of materials and the mode of delivery to the site would depend on the origin, size, and weight of the material. It is anticipated that the larger and heavier pieces of equipment would arrive by barge or ship. Heavy equipment haul roads would be constructed from the MOF to the LNG Terminal process or laydown areas. The existing rail line to the North Spit has been acquired by the Port and is now called the Coos Bay Rail Link. Upon assumption of ownership of the line in 2010, the Port undertook an extensive repair program that placed portions of the line back in service in stages. The entire 134-mile-long line was declared fully operational in April 2013. Therefore, the railroad is available to transport equipment and materials to the LNG Terminal site.

JCEP estimated there would be an average of about 140 heavy vehicle trips to and from the LNG Terminal site per day. It is assumed that the use of an on-site concrete batch plant would reduce the potential number of delivery trips to the terminal.

JCEP further envisions that some bulk materials, such as insulation, could be shipped in standardized containers. Fabrication shops would be used to fabricate pipe spool pieces and other prefabricated units of equipment and skid-mounted process equipment modules, and would be delivered to the site in accordance with the construction schedule. Where practical, skid-mounted equipment would be used to minimize the pieces that must be delivered and installed at the site.

Construction of Terminal Facilities

Construction site preparation would require clearing, filling, and grading of the LNG Terminal site to an approximate elevation of +27 feet for the base of the LNG storage tank area and approximately +46 feet for the liquefaction process areas. The water-dependent facilities would typically be at an elevation of 34.5 feet.

Approximately 5.7 mcy of material would be removed to create the slip basin and access channel. Of this, about 1.4 mcy would be dry excavation and about 4.3 mcy would be wet dredged. The material is planned to be distributed between Ingram Yard, the Roseburg site, and the South Dunes site. Approximately 0.3 mcy may be used for the Kentuck Project. The material would be used to raise the elevation of the South Dunes site and the Access and Utility Corridor to approximately +46 feet to +70 feet. The dry-excavated material would be transported by truck to the designated location. The excavated material truck haul route would go north of the slip through the LNG Terminal site, and then follow the route of the Access and Utility Corridor to the South Dunes site. The excavated material truck haul route would be on

JCEP–owned land and would not cross the Trans Pacific Parkway. A temporary traffic overpass would be constructed to segregate traffic travelling to and from the RFP property from the LNG Terminal site construction equipment.

The wet dredged material would be conveyed by slurry pipelines laid on the surface across the RFP property, as described in section 2.1.1.2 above under "Slip Dredging." Dredge spoils would be contained within berms constructed of dry material in the spoil areas. The containment areas and berms would be sized to accommodate the dredged material delivery method and the project schedule. For dredged material delivered by truck, the wet material would be allowed to dry the disposal area. Dredged material from the cutter-suction dredge would be suspended in water and pumped to the containment area. At a low point within the containment area, a vertical riser would be installed that would allow decant water to escape the spoil area via a pipe, to be collected and pumped back to the slip via a decant return line. The dredge discharge pipe would be relocated frequently to allow for the even distribution of dredge spoils and the collection and removal of decant water.

Temporary erosion control devices, such as ditches, sediment fences, and silt traps, would be installed as necessary, in accordance with JCEP's Erosion and Sediment Control Plan (ESCP). The subsurface conditions at the site require soil improvement before any structures can be built for the LNG Terminal facilities. These conditions include the presence of peat, clay, buried driftwood, and liquefiable soil, which could cause excessive settlement and stability concerns or issues associated with liquefiable soils should a seismic event occur. Potential soil improvement methods include: soil densification using vibro-compaction or sand compaction piles, and excavation or soil mixing where organic materials are located (see JCEP Resource Report 6 – Geological Resources for more detailed information). Individual excavations would then be made for equipment foundations. Following completion of foundations, the site would be brought up to final grade. Final grading and surfacing would consist of gravel-surfaced areas, asphalt-surfaced areas, concrete-paved surfaces, anchored reinforced vegetation system, and vegetated areas utilizing salvaged topsoil and mulch.

The foundations for all equipment and structures, including the LNG storage tanks, process equipment, and pipe racks, would use either a shallow or a deep foundation system. Typically, shallow isolated or raft foundations would be used unless the design requires the use of deep foundations. A number of piling solutions would be utilized on the LNG Terminal Project, and would include driven pile and drilled pier systems. Typically, conventional pipe pile, sheet pile, or drilled piles would be used where required for earth retaining structures and deep foundations. It is anticipated that soil improvements would be sufficient to provide the bearing capacity for typical design loads.

Construction of the LNG storage tanks will be the most time-consuming element in the development of the LNG Terminal. General steps taken during construction of each LNG storage tank would include installation of the foundation, seismic isolators, and tank bottom slab, construction of the outer concrete container wall, installation of the bottom carbon steel vapor liner and floor insulation, construction of the steel dome roof and suspended deck, installation of the 9 percent nickel steel inner tank, installation of the internal tank accessories (pump columns, instrumentation, and piping), installation of external tank accessories, installation of insulation, and installation of LNG pumps. Following a successful inner container hydrotest (see following discussion), the tank will be washed down and cleaned. After installation of the LNG pumps, the tank will be closed and purged with nitrogen to a positive gauge pressure. Final insulation will be installed in the annulus between the inner and outer tank an above the inner roof. At this point in the construction process, the tank will be ready for cooldown with LNG.

For the hydrotesting of the LNG storage tanks, water would be supplied from the existing CBNBWB raw water line. The raw water line can supply 4 million gallons per day (mgd). It would take approximately ten days to fill the first tank with the 28 million gallons required for the hydrotest. If the construction sequence allows, the two tanks would be hydrotested with the same water by transferring the water at the conclusion of the hydrotesting of one tank to the other tank. The total duration of the hydrotest of the first tank from start of filling to emptying is expected to be approximately 34 days, with the second tank taking approximately three weeks. The existing 12-inch CBNBWB water line has the necessary pressure and capacity to deliver 20 million gallons over a two-week period during the low-demand period (September through May) and a three-week period during the peak demand period (Memorial Day through Labor Day). No biocides or chemicals would be added to the hydrostatic test water.

Water used in hydrotesting would be locally discharged, following testing and ODEQ approval, to the stormwater system for infiltration or discharged to the IWWP according to the applicable the National Pollutant Discharge Elimination System (NPDES) permit requirements. The rate of discharge is expected to be approximately 2.9 mgd for the bulk pumping operation, with substantially lower rates being achieved when removing the final amounts of water from the tank bottom. The IWWP connects to a previously existing, permitted ocean discharge.

Construction of foundations for buildings and installation of major mechanical equipment would occur once LNG storage tank construction is underway. Large equipment items would be set on their foundations upon delivery. After the pipe racks are completed, work would commence on the installation of the process and utility piping. The installation of mechanical equipment would be followed by electrical and instrumentation installation. Once the piping is completed and tested, piping insulation would be installed. As the construction of the process portion of the LNG Terminal progresses, work would commence on the precommissioning activities, so that these activities can be completed concurrently with the completion of the LNG storage tanks and be ready for nitrogen purging.

Construction Workers and Vehicle Traffic

Construction of the LNG Terminal would require 4,527 full-time equivalent jobs over the 53-month construction period. Construction is expected to employ 1,996 workers in the peak month and 1,023 workers in an average month. See JCEP Resource Report 5 – Socioeconomics for more detailed information.

Construction workers commuting to the job site could have impacts on terrestrial wildlife, specifically with regards to vehicle strikes on individual animals (ranging from slow-moving reptiles such as turtles to big game such as deer). The number of vehicles used for commuting to the LNG Terminal, and measures to mitigate construction traffic, are discussed in JCEP's Transportation Impact Analysis (see supplemental information to JCEP Resource Report 5 - Socioeconomics). Off-site park and ride lots would be developed as temporary facilities at Pony Village in North Bend and Myrtlewood Factory & RV Park north of North Bend.

Trash and Predators

During construction and operation, trash and food waste could attract corvids and other predators (such as crows, rats, and raccoons) that represent a threat to other species. Covered, animal-resistant receptacles would be provided in eating and break areas, parking lots, and at appropriate locations around the LNG Terminal site. During construction, the site would be policed on a daily basis to remove any food or other debris left by construction workers. During operation, the facility and grounds would be regularly inspected to ensure that no garbage is allowed to accumulate. Structures within the LNG Terminal site would be monitored to discourage their occupation or use by avian predator species.

Removal of Vegetation

Combined, the LNG Terminal and operational facilities would cover about 200 acres. Original vegetation would be cleared by construction activities and replaced with industrial facilities. The removal of upland vegetation would affect habitat for terrestrial species. During construction, it is anticipated that most mobile wildlife would leave the LNG Terminal project and relocate to similar undisturbed adjacent habitat. Site areas that are disturbed by site preparation, clearing, and construction of the LNG Terminal and related facilities would be stabilized by applying Best Management Practices (BMPs) for temporary sediment and erosion control measures until construction is complete, unless covered by equipment, gravel, or other covering. Site areas that would be disturbed only by temporary construction activities would be restored in consultation with landowners, and to the extent possible, using non-invasive native plant species to stabilize the sites and to prevent erosion of disturbed areas. If there are any areas that are disturbed by the excavated material haul truck road, the heavy haul route, or the hydraulic slurry/decant water return pipelines that do not become part of the Access and Utility Corridor for the LNG Terminal, they would be restored to preconstruction conditions.

JCEP proposes to implement various measures to avoid, minimize, and in some instances mitigate, impacts on migratory birds that may nest within the LNG Terminal project. If the construction schedule allows, all vegetation clearing at the LNG Terminal site would be conducted before March 1 or after August 31 to ensure that most nesting birds have fledged. If construction activities must occur during the nesting season, JCEP would conduct focused preconstruction surveys to determine whether there are active migratory bird nests present. If active nests are encountered within the limits of the survey, construction activities would be halted in the immediate vicinity until a qualified biologist has determined that the individuals have fledged or that the nest has failed from natural causes. Before allowing construction to proceed, JCEP would develop a Migratory Bird Conservation Plan in consultation with the FWS.

Temporary Construction Facilities Stormwater

Construction laydown areas would be surfaced to a large extent with larger, open-graded aggregate that would allow infiltration; therefore, stormwater from these areas would be self-contained and would infiltrate without the need for outfalls. Impervious surface would not be added at the Pony Village and Myrtlewood Offsite Park & Rides for the LNG Terminal project. Stormwater treatment for temporary facilities is described further in JCEP Resource Report 2 – Water Use and Quality (Storm Water Management Plan appendix), and the ESCP in an appendix to JCEP Resource Report 7 – Soils.

2.1.1.3 Impacts on Aquatic Resources Related to Construction

This section provides a general overview of the potential construction related impacts on aquatic resources. Species specific impact analysis is included in section 3.0 Species Accounts, Critical Habitat, Project Effects and Determinations of Effect and in section 4.0 Essential Fish Habitat.

Construction of the LNG Terminal marine facilities, including the access channel, slip, and berths, can cause impacts on aquatic resources in Coos Bay, including invertebrates, fish, and marine mammals. Although it is anticipated that most mobile aquatic species, such as seals, adult crabs, shrimp, and fish, could move away from the area during construction operations, some smaller juveniles and larvae could be entrained during dredging so that direct mortality or injury could occur. Impacts may also occur to aquatic organisms as a result of the removal of substrata during creation of the access channel, and due to dredging turbidity and construction noise, particularly the driving of piles, and are briefly mentioned below. More details about LNG Terminal construction and impacts on water resources and aquatic species can be found in Resource Reports 2 and 3.

Removal of Substrata

The access channel between the existing FNC and the LNG Terminalslip would be created by the salt water dredging of about 1.4 mcy of material. Dredging of the access channel and the portion of the slip in Coos Bay would affect approximately 17.6 acres of currently existing deep subtidal habitat, about 10.1 acres of intertital habitat, 4.0 acres of shallow subtidal habitat, and 2.0 acres of eelgrass.

The dredging operation to create the access channel would change physical conditions of the bay bottom in this area, locally altering the bathymetry and potentially altering the morphology and water currents. The current deep subtidal habitat at -15 feet would be taken to about -45 feet. A JCEP consultant conducted studies of the potential impact of the creation of the access channel and slip on shoreline erosion and sediment transport. Analysis of two models for wave measurement found that creation of the access channel would not change wave heights in the bay that could cause erosion along the shoreline. Likewise, an analysis of a model for sediment transfer showed that, for all design conditions, creation of the access channel would not change existing patterns of rates of bottom erosion or deposition of sediment deposits (CHE 2011).

An additional study conducted by Moffatt & Nichol analyzing the potential impact of the access channel, slip, and Navigation Reliability Improvements on shoreline erosion and sediment transport found that dredging associated with these project components would not change wave heights in the bay that could cause erosion along the shoreline. Likewise, the Moffatt & Nichol study corroborated the results of the CHE (2011) study that indicated dredging would not dramatically change existing patterns or rates of bottom erosion or sediment deposition (Moffatt & Nichol 2017b).

A comprehensive sediment sampling and analysis plan (SAP) was completed in October 2006 in order to evaluate the grain size distribution and total volatile solids composition of sediments in the proposed dredge prism for the terminal access channel (SHN 2007). The testing that was conducted to determine whether the sediments meet Dredge Material Evaluation Framework (DMEF) guidelines, relative to Lower Columbia River Management Area, for in-water disposal. Since results of the study revealed that all samples were primarily composed of medium to fine grain sand and had a very low percentage of total volatile solids, no further chemical testing was required, and the sediments were considered suitable for in-water disposal per DMEF guidelines. Furthermore, the results indicate the sediment character should not result in significant increases in bioavailability of contaminants to fish and fish food organisms within the analysis area. Based on the results of the sediment sampling, there is little to no risk of contamination as a result of dredging the access channel.

Sediment evaluations conducted by the USACE in 2004 for the Coos Bay channel maintenance and improvement dredging along the FNC revealed only low levels of sediment contaminants, all below their respective DMEF screening levels. In 2011 and 2016, JCEP conducted geotechnical investigations at the Navigation Reliability Improvements sites to support the JCEP's DMMP. Analysis of the physical character of sediments at the Navigation Reliability Improvements sites determined that sediment composition consisted of sand, silty sand, sandstone, and siltstone. This is similar to sediments collected from the adjacent FNC and from within the footprint of the proposed LNG Terminal access channel. These sediments were generally described as coarse-grained with high sand content, which the Portland Sediment Evaluation Team (PSET) previously determined suitable for unconfined aquatic disposal. Due to their proximity to previous sampling locations in the FNC and access channel, sediments to be dredged from the Navigation Reliability Improvements sites will have a similar chemical character. Therefore, they will also have a low likelihood of potential contaminants and be suitable for unconfined aquatic disposal.

JCEP's dredging for the access channel would remove benthic organisms (e.g., worms, mollusks, echinoderms, and crustaceans) from the bay bottom. Aquatic species in Coos Bay produce pelagic larvae. Species found in waters deeper than 30 feet tend to spawn in the winter months, with larvae recruited into benthic bottom habitats in the early spring and summer. Between 2009 and 2011, JCEP had the University of Oregon Institute of Marine Biology conduct samplings in the bay near the access channel to characterize the zooplankton, larvae, and juvenile fish that occupy this area. The study noted benthic species taken in samples (Shanks et al. 2011). Juvenile *Anthopleura artemesia* (a burrowing sea anemone) were found mostly from late summer through early winter. Cumaceans (a benthic crustacean) were most abundant in samples taken in fall and winter on rising tides, and on falling tides in spring and summer. Porcelain crab larvae were present year-round, mostly found on rising tide samples. Pea crab zoea were abundant in samples taken in the fall, spring, and summer. Mytilid (mussel) juveniles were uncommon only in the early summer. *Clinocardium* spp. (cockels) were present during the entire year. Juvenile bivalves were most abundant in late winter and spring. Juvenile gastropods were least abundant in spring and early summer samples.

Creation of the access channel would be a short-term impact, lasting not more than six months, and should not have population-level effects on benthic organisms in Coos Bay. It has been reported that benthic communities on mud substrates in Coos Bay, when disturbed by dredging, recovered to pre-dredging conditions after about one month (Newell et al. 1998). Therefore, removal of benthic species from the bottom of the access channel is not anticipated to have significant adverse impacts on the aquatic environment of the bay.

In addition, because the shallow tidal habitats would be converted to deeper-water habitat than what is currently there, some long-term reduction in benthic production would occur. Some of this net loss would be offset by added annual benthic production from the newly formed 38-acre slip habitat, even though it would likely be of poor quality, because this area was originally an upland. An increase in organic matter production to the Coos Bay system is expected from JCEP's proposed eelgrass and wetland mitigation sites.

Removal of Eelgrass

About 2.0 acres of eelgrass would be removed by creation of the access channel and the portion of the slip in Coos Bay, which is less than 0.6 percent of the estimated total area where eelgrass was detected in lower Coos Bay. Submerged grass meadows provide cover and food for a large number of organisms, including burrowing, bottom-dwelling invertebrates; diatoms and algae; fish that lay eggs on their leaves; tiny crustaceans and fish that hide and feed among the blades; and larger fish, crabs, and wading birds that forage in the meadows at various tides. Eelgrass provides shelter for a variety of fish and may lower predation, allowing more opportunity for foraging. Eelgrass mapping surveys conducted between 2005 and 2014 detected more than 1,400 acres of low- and high-density eelgrass communities throughout upper and lower Coos Bay (EPA 2005; David Evans and Associates, Inc. [DEA] 2007 and 2010; Ellis Ecological Services 2007 and 2013). The largest and most contiguous beds of submerged grasses are located in both the lower and upper bay, in the North and South sloughs, and in Haynes Inlet. Habitat mapping documented intertidal and subtidal aquatic beds, including submerged aquatic vegetation composed of eelgrass, in Jordan Cove and across the bay from the site of the proposed LNG Terminal in and near the mouth of Pony Slough, and adjacent to the APCO Site. Based on aerial photo interpretation and eelgrass surveys, the distribution and spatial extent of submerged aquatic vegetation within the area to be dredged for the slip is patchy and sparse. Because of the low density and narrow extent of distribution of submerged aquatic vegetation in this area, habitat value is expected to be lower than the more extensive and contiguous submerged aquatic vegetation beds located elsewhere in Coos Bay. JCEP would mitigate for the removal of eelgrass at the access channel by planting a minimum of approximately 6.03 acres of new eelgrass beds at the Eelgrass Mitigation site located south of the Southwest Oregon Regional Airport in Coos Bay (see appendix O – Compensatory Wetland Mitigation Plan).

Temporary impacts to eelgrass could occur where the Temporary Dredge Line and Dredge Transfer Line cross eelgrass habitat adjacent to the APCO Site 2, Kentuck Project site, and Eelgrass Mitigation site. To minimize impacts, the dredge lines would be placed on pile-supported cradles at the narrowest point of the eelgrass beds. Temporary impacts would occur where the piles are driven into the seabed to support the cradle.

Turbidity Caused by Dredging

A large quantity of suspended sediment can reduce light penetration, which in turn reduces primary production of both pelagic and benthic algae and grasses. Increased sediment can affect feeding of benthic and pelagic filter feeding organisms (Brehmer 1965; Parr et al. 1998), and the settling of the suspended particles can cause local burial, affect egg attachment, and modify benthic substrate. High enough levels can have direct adverse effects to fish ranging from avoidance to direct mortality.

JCEP intends to use either a hydraulic cutterhead suction dredge or a clamshell dredge to create the access channel. A study by Moffatt & Nichol (2006) modeled total suspended sediment (TSS) and turbidity for dredging based on the United States Army Corps of Engineers (USACE) DREDGE model and the two dimensional numerical model Mike21. For hydraulic dredging at a current of 1.0 meters per second (m/s) or 1.9 knots, the TSS at the elevation of the cutterhead would be approximately 250 mg/l. This dissipated to about 14 mg/l at about 60 meters (200 feet) from the dredge location based on a current of 1.0 meter/second (3.3 feet per second [ft/sec]). For mechanical dredging using an open clamshell dredge at a current of 1.0 m/s, TSS at a line source extending between the bottom and water surface would be about 700 mg/l. This dissipated rapidly to less than 50 mg/l at distance of 200 meters (about 660 feet) from the dredge site.

Within Coos Bay, ambient turbidity levels (generated by stream flows into the estuary, waves, and ship traffic) have been assessed based on several studies. As described in a report by Moffatt & Nichol (2006), the average concentration of TSS measured near the proposed LNG terminal site was 14 mg/l with a range of 0-25 mg/l. This report also references a longer record of Coos Bay background turbidity data reported by NOAA for the period of April 2002 to December 2004 at the Charleston Bridge station located closer to the bay entrance than the LNG terminal site. Based on results from this study, the average summer and winter TSS levels at the Charleston Bridge station were 10.1 and 27.3 mg/l, respectively, which are equivalent to 5.8 and 12.2 NTUs. Substantially higher values, betweem 100 and 500 mg/l, were measured during individual sampling events.

More recently, hourly turbidity readings taken at the North Spit-BLM boat ramp gauge were compiled between August 2013 and January 2015. Preliminary data processing was first conducted to remove high turbidity measurements occurring for extended periods of time, as these typically occurred when dredging activities were ongoing. In addition, based on an empirical relationship developed for nine streams in the Pacific Northwest, turbidity values expressed in nephalometric turbidity units (NTUs) were converted to TSS in mg/L. Based on these data, the average natural turbidity level was calculated to be 40 mg/L at the North Spit-BLM boat ramp gauge (Moffatt & Nichol 2016).

Moffatt & Nichol (2017c) concluded that dredging associated with the slip, access channel, MOF, and Navigation Reliability Improvements would cause elevated turbidity levels. Increased turbidity would be short term and relatively localized; however, with turbidity plumes extending up to about 3,350 feet from the dredge footprint (based on either cutter suction or clamshell dredging) for the Navigation Reliability Improvement sites; up to between 750 and 780 feet from the dredge footprint (based on either cutter suction or clamshell dredging) for the access channel and MOF; and up to about 350 feet from the dredge footprint when using clamshell dredge equipment at the slip. Since turbidity associated with dredging at the Eelgrass Mitigation Site would be generally limited to the local area of excavation, there would be no significant dispersal of suspended sediment. The highest turbidity levels in all cases would occur at the dredge location. Dredging would be limited to the approved in-water work window. As a result, turbidity caused by dredging should not have significant adverse impacts on aquatic species in Coos Bay.

Dredging methods used by the contractor would be performance based which allows flexibility in conducting dredge operations while requiring compliance with water quality standards to control generation of turbidity and suspended sediment. A preliminary Turbidity Monitoring and Management Plan (TMMP) will be prepared during final design. The TMMP will be subsequently finalized after the selected contractor confirms the means and methods of dredge operations. The primary goal of the TMMP will be to manage proposed dredging operations for the Project consistent with DEQ water quality standards and permit requirements. Provisions of the DEQ-approved TMMP will be followed during all dredging activities. In order to minimize turbidity during dredging, environmental controls will be implemented whenever possible. Such controls may include use of a cutter suction dredge or closed clamshell bucket to minimize turbidity generation at the dredging site.

Construction Noise

Airborne and underwater noise would be generated during construction of the LNG Terminal and associated facilities.

Airborne Construction Noise

Construction noise levels for the LNG Terminal are expected to be similar to typical commercial programs, which average from 47 to 57 A-weighted decibels (dBA) at 2,000 feet (Hoover & Keith Inc. [H&K] 1994). The most noticeable construction noise at the LNG Terminal would be from driving the piles for the berthing structures and the temporary construction facilities.

Piling installation activities at the LNG Terminal would take place between July 2020 and July 2022 over two 10-hour shifts per day, six days per week (i.e., not on Sundays or major holidays). Up to 14 concurrent diesel impact pile hammers would be used during construction of the facility to drive approximately 3,600 pipe piles in the plant facility area. Up to six vibratory hammers would be in use to install roughly 11,800 sheet piles. The noise of pile driving was estimated to be 88 dBA 20 feet away, with an L_{nd} of 49.6 dBA at the nearest noise-sensitive area (NSA) in the city of North Bend, about 1.3 miles south of the LNG Terminal Based on the distance of construction from western snowy plover critical habitat (2.6 miles) and potential nesting sites (1 mile) on the North Spit, acoustic disturbances from the proposed action are not expected to affect this species.

Underwater Construction Noise

On the basis of the noise levels predicted based on studies (Deveau and MacGillivray 2017; O'Neill and MacGillivray 2017), and with reference to Popper et al. (2014), there is a high likelihood of behavioral responses for fish in the vicinity of vibratory piling. More severe impacts (mortality or injury) to fish due to underwater noise from vibratory piling behind the soil berm are not expected. When piling occurs in water using an impact hammer, there is potential for fish mortality, injury or behavioral response if fish are present during pile driving.

As discussed above, the following project components would require the installation of piles in Coos Bay: TMBB berthing and mooring piles, MOF fenders, the Temporary Dredge Line and Temporary Dredge Transfer Line support cradle pile, the temporary work bridge piles for the APCO Site access bridge and Trans Pacific Parkway/US-101 Intersection Widening, the temporary piles for the temporary dredge off-loading area at the Kentuck Project and APCO Site 2, and Temporary Dredge Loading Area at the Eelgrass Mitigation site. All piles installed in open water of the bay would be 24 inches in diameter or smaller to minimize acoustic impacts. A vibratory hammer would likely be used to install the steel piles for these actions; however, an impact hammer might be needed if the piles cannot be installed to design depth with vibration alone. An impact hammer would most likely be used to construct the temporary work bridges for the APCO Site access bridge and Trans Pacific Parkway/US-101 Intersection Widening and therefore is likely to generate acoustic impacts. If sound levels are determined to exceed NMFS

Level A regulatory thresholds for marine mammals or guidelines for listed salmonids, sound attenuation measures would be used in accordance with NMFS guidelines to minimize potential effects to fish and marine mammals from higher-intensity sound waves in the water column. Construction activities would occur during the ODFW-approved in-water work window, when sensitive life stages of listed fish are less abundant in the bay, which would further minimize the potential for adverse impacts. Approximately 1,150 untreated timber piles would be installed within a sheetpile cofferdam at the Trans Pacific Parkway/US-101 Intersection Widening to provide subgrade stabilization. The untreated wood piles are approximately 30 feet long and have a 14-inch diameter at the top. The sheetpile cofferdam would likely be installed with a vibratory hammer. If an impact hammer is used, the sheetpile cofferdam would be installed when the work area is not tidally inundated.

Underwater noise may be generated by driving piles on land (dry piles) since some noise propagates through ground and sediments (especially through harder substrates such as rock and clay) and may transfer to the water column somewhere else (known as sound flanking). The propagation of underwater construction noise from the "dry" land based impact pile driving associated with the MOF was modeled in several reports prepared by JASCO Applied Sciences (O'Neill and MacGillivray 2017; Wladichuk et al. 2017; Wladichuk et al. 2018). Wladichuk et al. (2018) modeled potential impacts of land-based pipe pile driving on fish using both current guidelines (FHWG 2008) and new proposed guidelines (Popper et al. 2014). This study found that injury to fish from peak sound pressure levels (206 dB in current guidelines) would occur up to 37 meters from the face of the MOF. Also, this study predicted that injury to both small (less than 2 grams) and large (greater than or equal to 2 grams) fish from cumulative sound exposure levels (183 and 187 dB respectively under current guidelines) would occur up to 1,723 meters from the shoreline. Section 3.5 describes the potential effects and Figure 3.5.1-2 shows the modeled extent of this potential zone of injury in the analysis area from land-based pile driving at the MOF face.

Existing information suggests that fish are unlikely to be adversely affected by airborne noise levels. It is expected that the threshold for disturbance to pinnipeds would be airborne noise greater than 100 decibels (dB) root mean squared. JCEP estimated that sound levels greater than 65 dB would extend less than 0.25 mile from pile-driving operations. Therefore, it is unlikely that sound levels of 100 dB root mean squared or greater in air would be experienced within 300 feet of the piles at the LNG Terminal site There would be underwater noise associated with dredging activities in Coos Bay, which may generate sound pressure levels that could elicit responses in aquatic organisms. However, sound pressure levels in the range of 112 to 160 dB would probably not be great enough to cause physiological damage to aquatic species (Richardson 1995; Hastings and Popper 2005; Fisheries Hydroacoustic Working Group 2008).

Construction of Kentuck Project and Eelgrass Mitigation

JCEP would undertake a number of measures designed to mitigate the potential construction and operation impacts on fisheries and aquatic resources, as described in this APDBA. In addition, restoration activities at the Kentuck Project and at the Eelgrass Mitigation site would offset the permanent loss of intertidal, subtidal, salt marsh, and eelgrass habitat resulting from construction of the slip and access channel. During operation of the LNG Terminal, mitigation measures would be incorporated at the LNG Terminal site to minimize the potential for discharge of pollutants or hazardous materials into the bay. Additional mitigation procedures would be implemented to ensure that LNG carriers do not adversely impact marine organisms either through direct mortality or through the introduction of exotic marine species.

There would be short-term localized impacts to aquatic resources to construct the Kentuck Project and Eelgrass Mitigation. Kentuck Project construction activities include transporting dredged material into the site, earthwork, and civil infrastructure improvements to re-establish a connection with Kentuck Inlet and Coos Bay. Dredged material is currently proposed to be unloaded and hydraulically transported into the site through a Temporary Dredge Transfer Line from a Temporary Dredge Off-Loading Area located as close as possible to the site in a minimum 20 feet of water depth. The off-loading area could include a hydraulic unloader on a deck barge, mooring/fleeting barges, and booster pump(s). The hydraulic unloader would operate from a deck barge up to 40 feet by 100 feet in size. Two flat deck mooring/fleeting barges (measuring 40± feet by 160± feet) would be moored adjacent to the unloader barge. Approximately 16 temporary piles and/or spuds 24 inches in diameter would be used to moor the barges, depending on actual equipment and configuration. Intake water for offloading operations may be drawn through self-cleaning fish screens sized to minimize fish entrapment. Infrastructure improvements include: constructing a new bridge in East Bay Drive to allow tidal exchange between Kentuck Inlet and the Kentuck Project; improving the existing dike separating the site from Kentuck Slough; constructing a new muted tidal regulator (i.e., a “fish-friendly” tidegate) in the upper portion of the Kentuck Project to redirect a portion of Kentuck Slough flows into the Kentuck Project; and raising the profile of East Bay Drive and approximately 1,900 lineal feet of Golf Course Lane to be above the zone of tidal influence. A fish-friendly culvert or other structure would be constructed within Golf Course Lane to allow passage into the drainage above the former golf course irrigation sump pond. The earthwork and the majority of the infrastructure construction activities would be isolated from Kentuck Slough, Kentuck Inlet, and Coos Bay. Construction of the East Bay Drive bridge and muted tidal regulator would require in-water work and isolation measures. There would be a short-term increase in turbidity into Kentuck Inlet and Coos Bay when the connection is re-established to the bay and while the site equilibrates.

As part of the Eelgrass Mitigation, a shallow-water hydraulic dredge is proposed to be used to lower areas that are currently too shallow to support eelgrass. A Temporary Dredge Line would connect the dredge and Temporary Dredge Loading Area, which would be located as close to the site as possible in a minimum 20 foot of water depth. The loading area is proposed to include deck barge, transport barges/scows, and tugboats. As noted above, the number of temporary mooring pile and/or spuds would depend on equipment and configuration. The containment system on the scows and/or barges will minimize the release of turbid decant water back into the bay. If determined feasible, silt curtains at the dredge site also could be deployed to limit the dispersion of turbid waters to the local embayment as the bathymetry is modified to make it more suitable for eelgrass transplants the following year. Construction would occur during the ODFW in-water work window. Construction of the mitigation site would likely result in direct mortality of marine organisms and would temporarily elevate turbidity levels from dredging, as discussed in JCEP Resource Report 3 – Fish, Wildlife, and Vegetation, Section 3.1.4.1, Direct Mortality of Marine Organisms, and Section 3.1.4.3, Sedimentation and Turbidity Levels. The resulting habitat increase from the Eelgrass Mitigation site would provide benefits to the fish and marine organisms that utilize this habitat overall by increasing the natural cover and forage production in Coos Bay.

2.1.1.4 Impacts on Aquatic Resources Related to Operations

This section provides a general overview of the potential operation related impacts on aquatic resources. Species specific impact analysis is included in section 3.0 Species Accounts, Critical Habitat, Project Effects and Determinations of Effect and in section 4.0 Essential Fish Habitat.

Operation of the marine facilities at the LNG Terminal could affect water quality and aquatic species in several ways. Tugboats and LNG carriers could stir up bottom sediments during docking operations in the access channel and slip. While an LNG carrier is at dock, it would release ballast water while taking on cargo that could affect the salinity and dissolved oxygen levels in the slip, or introduce invasive non-native species. In addition, the recirculation of water for engine cooling while an LNG carrier is at dock could affect the temperature of the water in the slip. Also, water intake might result in impingement or entrainment of aquatic species.

LNG Carrier Transit in the Channel – Operations

LNG carrier transits in the FNC could cause shoreline erosion that might result in adding sedimentation and increasing turbidity in the bay. Likewise, LNG carriers, tugboats, and escort boats could have propeller wash that could stir up bottom sediments. Erosion, sedimentation, and turbity could adversely effect water quality and impact aquatic species in Coos Bay. Vessel wake waves could also result in fish strandings along the shoreline. These potential impacts are discussed below. JCEP conducted studies that show that LNG carriers are not likely to cause major shoreline erosion, that propeller wash would not result in major bottom erosion and turbidity, and that vessels traveling at slow speeds would not produce waves large enough to strand fish. More details about the studies these conclusions are based on may be found in appendix I.2 of JCEP's Resource Report 2.

Shoreline Erosion

The potential for LNG carrier traffic in the waterway to cause shoreline erosion was evaluated. If there was significant shoreline erosion along the navigation channel, this could result in a rise in sedimentation and turbidity in Coos Bay, which could have an effect on aquatic resources.

The possible impacts on the shoreline along the navigation channel from the pressure fields generated by passing deep-draft cargo ships and LNG vessels were analyzed at selected areas of interest along the route, namely, Pigeon Point, Clam Island, and the airport. A complete description of the modeling was attached as appendix I.2 in Resource Report 2 of JCEP's September 2017 application to the FERC (CHE 2011). The results of the analysis indicate that hydrodynamic effects from pressure field velocities along the shoreline caused by deep-draft cargo ships currently using the Port would exceed the pressure field velocities that may be generated by future LNG vessels. In short, LNG vessels transiting the waterway to and from the LNG Terminal would not cause serious shoreline erosion.

CHE (2011) also studied the potential impacts on the shoreline caused by wakes of LNG vessels in the waterway by comparing swash sediment transport for Post-Project Conditions relative to Existing Conditions. The results show that the increase in swash sediment transport from combined inbound and outbound LNG vessel marine traffic would not exceed six percent at Pigeon Point, eight percent at Clam Island, and five percent at the airport sensitive shorelines. The estimated increase in swash sediment transport due to the LNG carrier traffic is a small fraction of the swash sediment transport due to the natural wind-wave conditions. This means that waves generated by LNG vessels transiting in the waterway to and from the LNG Terminal would not be much larger than waves caused by natural wind, and would not result in significantly more sedimentation than existing conditions.

A vessel wake impacts study by Moffatt & Nichol (2017d) modeled wake impacts from three types of vessel (tug, bulk carrier, and LNG carrier), using a range of vessel sizes and speeds, and reached generally similar conclusions to those discussed above for the CHE (2011) report. Moffatt & Nichol (2017d) concluded that the LNG Terminal project will not result in significant increases in shoreline effects due to larger vessels transiting the channel, and that wave heights at the shoreline would be lower relative to existing conditions. The Moffatt & Nichol (2017d) study also found that wakes generated by outbound tugs traveling alone at a maximum speed of 10 knots could generate shoreline waves ranging from 0.6-0.8 feet in height which would be at the low end of the locally generated wind wave heights that range from 0.5 to 3 feet. Such wave heights generated by the tugs would only expose shorelines to waves a fraction of the time and at the low end of the range of those caused by locally generated wind waves (Moffatt & Nichol 2017d).

Propeller Wash

The possible impacts on the bottom of the navigation channel from propeller wash (propwash) due to LNG vessels transiting to and from the LNG Terminal was investigated by CHE (2011) using a model called "JETWASH." The turbulent force that might be experienced at the channel bottom and suspension of bottom sediment by the LNG vessel motion and propwash would be additional to the turbulence and sediment suspension caused by the deep-draft cargo ships that currently navigate the channel. Displacement of bottom material by fluid forces without replacement by deposition is defined as bottom scour. Propwash of tugs moving with the LNG vessel was not included in this analysis because the tugboats would operate at low power, and the tugboat's propeller diameter is less than a third the diameter of the LNG vessel's propeller. Further, the vertical distance between the tugboat propeller tip and the bottom is so large (about 35 feet) that tugboat effects on the channel bottom in this operation would be unsubstantial.

Bottom sediment may be disturbed by flow created by the hull passing over the bottom. The potential exists for sediment suspended from the bottom of the navigation channel to be dispersed in the flow laterally outside the channel limits to the areas that may have habitat value. Suspended material falling back to the bottom within the navigation channel limits may be disturbed or dredged at some future time. The relative amount dispersed beyond the navigation channel limits, compared to that returning to the bottom within the channel, is a measure of the physical impact by propwash on the channel bottom.

The potential increase in bottom scour was analyzed by comparing the effects of a 148,000 m^3 capacity LNG vessel with the effects caused by a typical deep-draft cargo ship that currently transit the navigation channel. The comparison of vessel effects is based on vessel propwash bottom sediment scour, suspension, and dispersal by each of the two vessel types, along with their respective proportions of re-deposition of sediment outside the limits of the 300-foot-wide navigation channel.

Analysis of propwash modeling results showed that no bottom scour outside of the navigation channel boundaries would occur during passage of the LNG vessel. The modeling results also showed that a greater level of turbulence, and thus suspended sediment dispersion, would occur in the transit of a typical bulk carrier than with an LNG vessel. Near bottom velocity created by passage of the bulk carrier is greater than that of the LNG vessel for the design conditions of tide level and vessel speed and draft. It is expected that propwash from LNG vessels, tugboats, and escort boats in the Coos Bay navigation channel would not result in major erosion of the bottom and sides of the channel, nor cause turbulence or increased suspended sediments that could significantly affect aquatic species.

Fish Stranding

Fish stranding can occur when fish become caught in a vessel's wake and are deposited on shore by the wave generated by the vessel wake. Stranding typically results in mortality unless another wave carries the fish back into the water. A series of interlinked factors act together to produce stranding during vessel traffic and may include water surface elevations, with low tides more likely to result in strandings than high tide; beach slope, with strandings more likely on low gradients than high; wake characteristics influenced by vessel size, hull form, depth underwater (draught), and speed; and biological factors, such as numbers of small fish present near the shoreline and whether fish are strong swimmers or not.

Ship wakes produced by deep-draft vessels traveling at speeds greater than the estimates for LNG vessel speeds have been observed to cause occasional stranding of juvenile salmon (Pearson et al. 2006); however, no strandings were observed as a result of vessels traveling at speeds under nine knots (10.4 miles per hour [mph]). The hull geometry of the LNG carriers is such that bow wakes are minimized, especially at the slower speeds of four to six knots that would occur during most of the transit route through Coos Bay. Therefore, the LNG vessels would be traveling at speeds less than that observed to cause stranding. In models and research conducted by JCEP (Moffatt & Nichol 2008b), wave heights produced by LNG vessel traffic would not exceed that of normal conditions in Coos Bay and overall waves would contribute to a small portion of the total waves that occur in the bay. This conclusion is supported by the results of vessel wake impacts modeling performed by Moffatt & Nichol in 2017 (Moffatt & Nichol 2017d). In addition, LNG vessels would be arriving and leaving at slack high tide, which is a period when gently sloping beaches are mostly covered and less likely dewatered from waves. Considering that LNG vessel marine traffic would enter and leave at slack high tide, have low vessel speeds, and wave height would be in normal range, it appears unlikely that the LNG Terminal Project would contribute to fish stranding within Coos Bay.

Marine Facilities Operations

LNG vessels, tug boats, and escort boats could have propeller wash that may stir up bottom sediments. Erosion, sedimentation, and turbity could adversely effect water quality, and impact aquatic species in Coos Bay. The LNG Terminal would be visited by about 120 LNG carriers per year. JCEP conducted studies that show that LNG vessels are not likely to cause major shoreline erosion (Moffatt & Nichol 2017d), that propeller wash would not result in major bottom erosion and turbidity (Moffatt & Nichol 2017e), and that vessels traveling at slow speeds would not produce waves large enough to strand fish (Moffatt & Nichol 2017d). More details about the studies these conclusions are based on may be found in the FERC certificate application.

Propeller Wash within the Marine Slip

Tugboats docking LNG vessels at the LNG Terminal may cause erosion on the slopes and bottom of the access channel and slip, due to propeller wash (propwash). Three tugboats may apply up to 75 percent of their available power for up to 60 seconds while pushing an LNG vessel backwards into the slip. It is assumed that docking would occur at a tide elevation not lower than 4 feet above MLLW. Tugboats are assumed to have 6,500 rated hp, powered by twin azimuth drives. Using the JETWASH model, it was determined that the location of maximum near-bottom velocity of 2.0 feet per second (ft/sec) is on the slip bottom, about 30 feet from the toe of the side slope. The west slope of the slip would not be subject to propwash erosion if the size of material present on the bottom and on the side slope is larger than medium sand. In this case, propwash would have no scouring effect on the armored material placed on the side slope. Analysis indicated that bottom surface sediments may be eroded during design extreme events; however, materials larger than the 96 percent finer size would not be suspended. Using a conservative approach, maximum depth of scour was estimated to be less than 2 inches at a propwash velocity of 2.16 ft/sec. This is not expected to be a significant impact on bottom stability or water quality, as mobilized materials would not be distributed far from where the scour occurs (CHE 2011).

The propwash analysis work by CHE (2011) was based on only tugs used for the berthing and unberthing of an LNG vessel. Therefore, Moffatt & Nichol (2017e) analyzed potential impacts of propwash from vessels and tugs on shoaling and scour in the Access Channel and MOF areas. The primary exposure of the Slip, Access Channel, and MOF to propwash is during berthing and unberthing of vessels calling at the LNG Terminal. Additionally, the Access Channel, Slip, and the MOF are exposed to propwash during vessel arrivals and departures.

In order to calculate the velocity fields created by vessel and tug propellers, the guidance in the Permanent International Association of Navigation Congress (PIANC 2015) was adopted. PIANC provides several methods to estimate the velocity field associated with propeller wash. Moffatt & Nichol (2017e) chose a method that considers the effect of restricted jet propagation for lateral quay walls, which is applicable to the Slip and Access Channel in the area of the MOF. Analysis of propwash modeling based on the use of ship engines and tug assist for berthing and unberthing estimated bottom velocities that were significantly larger during unberthing when main vessel engines were in operation. The largest bottom velocities (13.6 ft/sec) were estimated to occur on the eastern side of the Access Channel and Slip near the MOF. Estimated scour depths were up to nearly 0.5 feet due to propeller wash in the Access Channel and the Slip near the eastern side of the Access Channel and the slip if no slope protection is installed. However, as discussed above in section 2.1.1.2 Slope Armoring, slope armoring or pile embedment would be designed to minimize scour. During berthing, the largest bottom velocities (5.4 ft/sec) are expected to be near the western slope (Moffatt & Nichol 2017e). Propwash erosion is not anticipated along the western sheetpile wall (Lay Berth) and no additional slope protection is planned beyond the sheetpile wall.

Ballast Water Releases

An LNG vessel at dock at the LNG Terminal would release ballast water while taking on cargo. It is estimated that a 148,000 m^3 capacity vessel would release about 9.2 million gallons of ballast water, at a rate of approximately 20,250 gpm. Ballast water would be discharged into the slip through sea chests located on the hull of the vessel about -33 feet below the water line or about 12 feet from the bottom.

LNG carriers would take on ballast water from the open ocean at least 200 miles offshore. While ballast water would have a physio-chemical composition very similar to waters in Coos Bay, a potentially notable difference between ocean water and bay water may be observed relative to salinity. Ocean seawater on average has a salinity of about 35 parts per thousand (ppt). This means that every liter of seawater has approximately 35 grams of dissolved salts. Coos Bay is an inland estuary, where salty seawater mixes with inflows of upland fresh water, with the transition zone between CM 8 and 9, near the LNG Terminal (Roye 1979). Salinity in the bay varies with tides, season, and water levels. When measured over a three year period (1960-1963) at the US-101 bridge (CM 10), salinity ranged from 4 to 35 ppt (McAlister and Blanton 1963). Using more recent measurements near the LNG Terminal (CM 7.5) between August 2009 and December 2010, Shanks et al. (2011) found salinity levels varied between 15 and 35 ppt.

Another physio-chemical water quality parameter that may be influenced by the introduction of ballast water is the dissolved oxygen level. Dissolved oxygen levels are a critical component for the respiration of aquatic marine organisms. Among many other factors, dissolved oxygen levels in water can be influenced by water temperature, water depth, phytoplankton, wind, and current. Typical water column profiles indicate a decrease in dissolved oxygen with an increase in depth. Roye (1979) indicated that below CM 13, dissolved oxygen levels in Coos Bay are rarely below the ODEQ standard of 6 mg/l.

Water within the ballast tanks of a ship could have suppressed dissolved oxygen levels. While ballast water is not expected to be anoxic (i.e., lacking all oxygen), it would be lower than levels would likely be at the surface of the slip. This is because the water is contained in the ballast of the ship without exposure to sunlight or mixing from wind, waves, and currents. In addition, ambient waters near the bottom of the slip will naturally have lower dissolved oxygen levels than waters near the surface although they will be subject to mixing caused by tidal currents, LNG carriers, and tug traffic while berthing and unberthing at the terminal.

Because the slip will be located adjacent to the Coos Bay federal navigation channel, tidal mixing will tend to affect any localized temporary changes in dissolved oxygen levels in the Slip that may result from ballast water exchanges of the LNG carriers. Also, and perhaps more significantly, propeller wash from tugs and LNG carriers traveling within the slip will generate water velocities up to 13.2 feet/sec near the bottom causing substantial mixing of local waters (Moffatt & Nichol 2017e). Therefore, potential impacts on local marine species from the exchange of open ocean ballast water with potentially suppressed dissolved oxygen levels in the slip are expected to be discountable. Discharge of ballast water at the LNG terminal also will be subject to Oregon Administrative Rule 340-041-0016 to assure compliance with dissolved oxygen standards.

Water temperatures and pH are not likely to be altered as a result of introducing ballast water. Because ballast water is stored in the ship's hull below the waterline, water temperatures are not expected to deviate much from ambient temperatures of the surrounding seawater. The pH of the ballast water (reflective of open ocean conditions) may be slightly higher as compared to that of freshwater estuaries. However, this slight variation is not expected to have any impacts on marine organisms.

The release of ballast water from an LNG vessel at dock at the LNG Terminal would probably not have significant adverse effects on aquatic species in the bay due to slight changes in salinity, dissolved oxygen, and water temperature. This is because of the larger volume of water in the slip, and tidal mixing. The slip, exclusive of the access channel, would create approximately 50 million cubic feet of additional water volume from land that is currently upland, that could contain 374 million gallons of water. Roye (1979) indicated that the average annual discharge of fresh water from Coos Bay was 2.2 million acre-feet. Shanks et al. (2011) estimated that 122.5 million m^3 of water passes by the LNG Terminal in the bay during one complete high and low tidal cycle. Tidal ranges have been measured between 3.3 and 7.9 feet, with tidal currents between 3.4 ft/sec to 8.4 ft/sec; and flushing would be greatest during the spring rainy season. The discharge of 9.2 million gallons of ballast water from a 148,000 m^3 capacity LNG vessel would represent 2.4 percent of the volume of the slip, and an infinitesimal percent in comparison to the total volume of water in Coos Bay which exceeds 1.6 million acre-feet.

An environmental concern associated with the release of ballast water by LNG vessels at the LNG Terminal is the risk of introducing exotic non-native species from foreign ocean waters into the Coos Bay estuary ecosystem. The transfer of water from port to port could result in aquatic biological invasions. While some of the larger macro-organisms that may be collected during ballast water intake will often die, some of the smaller planktonic organisms could survive. Invasive species threaten to outcompete and exclude native species, resulting in a decline in biodiversity. The ballast water discharged by LNG vessels at the LNG Terminal would be from the ocean exchange occurring at least 200 miles offshore; not from a distant foreign port. The FERC would have no authority over LNG vessels, which would be owned and operated by independent third parties. However, JCEP would have agreements with the LNG vessel operators. The LNG vessel operators would have to follow federal laws and regulations regarding the prevention of invasive species through the release of ballast water, including the National Invasive Species Act, Nonindigenous Aquatic Nuisance Prevention and Control Act, National Aquatic Invasive Species Act, National Ballast Water Management Program, Shipboard Technology Evaluation Program, and Navigation and Vessel Inspection Circular 07-04, Change 1. In 2013, EPA developed specific measures for ballast water treatment, under the Vessel General Permit requirements of the NPDES permitting program under Section 402 of the CWA, to reduce the chance of releasing invasive organisms in U.S. waters.

Engine Cooling Water Recirculation

LNG carriers would need to recirculate water while loading LNG at the berth. The amount of cooling water to be recirculated is a function of the ships' propulsion systems. A steam propulsion LNG vessel typical cooling water flow rates while at the berth are expected to be approximately 11,000 m^3/hr) (2.9 million gallons per hour or 48,430 gpm). For a 148,000 m^3 ship, cooling water flows would total approximately 69.7 million gallons during the 24-hour loading of LNG cargo. If a dual fuel diesel electric propulsion system (160,000 – 170,000 m^3 ship) were used, the typical cooling water flow rates are expected to be approximately 3,200 m^3/hr (845,376 gallons per hour or approximately 14,000 gpm) for a total amount of approximately 22 million gallons of cooling water recirculated to the slip over a 26-hour loading cycle of LNG cargo . Initial estimates are that 40% of the LNG vessels loading at the terminal would be steam propulsion and 60% would be dual fuel diesel electric propulsion. Over time, the trend is anticipated to shift to a greater number of dual fuel diesel electric propulsion LNG vessels, thereby reducing the total cooling water intake per vessel call in the future. Once the

LNG fleet has been identified, cooling water flow rates and the amount of water required can be further addressed. Generally, the total water intake would occur over a 24-hour period during each loading period, about 110 to 120 times per year.

A typical LNG vessel has an upper and a lower sea chest on each side of the hull, to allow for the intake and release of ballast and engine cooling water. The lower unit is just above the keel of the ship, approximately 15 to 20 feet above the channel bottom. A sea chest is approximately 3.5 to 4.2 square meters (37.7 to 45.2 square feet) covered by a screen with 4.5 millimeter (mm; 0.18 inch) bars, spaced every 24 mm (0.94 inch). Additional finer mesh screens are located internally on the vessels to prevent larger items from entering the system. These screens would not meet NMFS (1997a) screening criteria for juvenile salmonids. It is likely that some marine organisms that are small enough to pass through the screens covering the sea chests would be drawn in with the cooling water and would be lost from the population in the slip (see section 3.5.4.3 Entrainment of Food Organisms).

LNG vessels at berth at the LNG Terminal have the potential to both warm the temperature of the marine slip while discharging engine cooling water, and to cool the temperature of the marine slip while loading LNG cargo. Water temperatures in Coos Bay have seasonal and diurnal fluctuations influenced by fresh water inflow and tidal currents. Roye (1979) indicated that bay temperatures at CM 8 ranged between about 50 and 65 degrees Fahrenheit (°F), while Shanks at al. (2011), near the same location, recently recorded bay water temperatures varying between 6 and 17 degrees Celsius (°C; 42.8 to 62.6°F), with lows in the winter and highs in summer. Moderate to large temperature increases have the potential to reduce fish and invertebrate growth, reproductive success, and if high enough can cause mortality. Studies have shown that water temperatures over about 24°C (75.2°F) would be considered lethal in the short term (a few days) for salmonids (WDOE 2002).

When an LNG vessel at the LNG Terminal puts water back into the slip after using the water to cool its engines, that released water would be slightly warmer than the temperature of the original slip water. Modeling conducted by JCEP estimated that the discharged engine cooling water would not exceed 0.3°C (0.54°F) above the ambient water temperature in the slip at a distance of 50 feet from the sea chests. Based on the volume of the slip at 4.8 mcy (3.7 million m^3 or 977.4 million gallons), the average water increase for the total slip volume during one day when an LNG vessel is at dock would range from 0.03 to 0.06°F The results of the CHE (2011) modeling were supplemented in 2017 (Moffatt & Nichol) with additional thermal plume modeling to investigate the extent of the regulatory mixing zone (RMZ) where cooling water discharge will be greater than 0.3 °C above ambient (Moffatt & Nichol 2017g). The RMZ used in the temperature plume modeling is defined as the three-dimensional extent where water quality standards may be exceeded as long as acutely toxic conditions are prevented and fish habitat and other uses are protected. This modeling analyzed LNG carriers with capacity of 148,000 m^3 and 170,000 m^3. It also modeled cooling water discharges of 10 to nearly 21 degrees C into various ambient temperatures ranging from 8 to 18 degrees C and under constant and stratified salinity conditions.

In summary, this latest modeling showed that the largest RMZ was associated with steam-driven carriers and extended up to 79.2 feet and 22.1 feet in longitudinal and transverse directions respectively, with a vertical rise of 12.1 feet under peak summer temperature conditions. Dual fuel diesel-electric driven carriers had a substantially smaller RMZ that extended up to 36.5 feet and less than 7 feet in longitudinal and transverse directions, respectively, with a vertical rise of up to 1.3 feet. In the future, LNG vessels will trend more to Dual Fuel Diesel Electric propulsion systems thereby reducing the total cooling water intake per vessel call (Moffatt & Nichol 2017g). It is unlikely that the water temperature of the slip would be greatly increased from the release of engine cooling water, therefore, no significant adverse impacts on aquatic species in the bay are anticipated.

Upland Facilities Operations and Maintenance

There are multiple ways in which the operation of the LNG Terminal facilities could have impacts on species. The accidental leakage or spills of hazardous materials or fluids into soils or waterbodies could expose species to those hazardous materials. Stormwater runoff could cause erosion or contain hazardous fluids. Erosion might result in increased sedimentation or turbidity, and hazardous fluids running off-site into waterbodies could affect aquatic species. Terminal lighting could affect the behavior of aquatic species in the slip. However, as discussed below, JCEP would implement measures to prevent, reduce, or mitigate impacts on species from operation of the LNG Terminal.

Leaks or Spills

The most likely source of hazardous liquids that may spill or leak during operation of the LNG Terminal that would have the potential to contaminate soils or surface water, include oil, gasoline, fuel, lubricants, or coolant from equipment or facilities. Because of the design of the LNG Terminal, it is highly unlikely that there would be a spill or release of LNG. Within the LNG Terminal would be a system of curbs, drains, and basin that would collect LNG if any spilled or leaked. JCEP prepared a draft Emergency Response Plan (as discussed in JCEP Resource Report 13) for the operational phase of the LNG Terminal that is intended to minimize the potential for accidental releases of hazardous materials and to establish proper protocol concerning minimization, containment, remediation, and reporting of any releases that might occur. If LNG spilled or leaked, it would turn to vapor when exposed to the warmer atmosphere, and these vapors would rise because they are lighter than air. LNG is not soluble and would not mix with or contaminate water or soils.

To minimize or reduce the impacts of spills or leaks associated with fuel storage, equipment refueling, equipment maintenance, or facilities operations, JCEP prepared an Operation-phase SPCCP to describe the preventive measures that would be implemented to avoid spills and leaks, as well as the mitigation measures utilized to minimize potential effects should a spill or leak occur. JCEP Resource Report 2 – Water Use and Quality contains further information regarding the SPCCP.

Stormwater Runoff

LNG Terminal. A stormwater management plan has been prepared to address stormwater system design, which will require approval from ODEQ (see Storm Water Management Plan in an appendix to JCEP Resource Report 2 – Water Use and Quality). Impervious surfaces associated with the LNG Terminal site include concrete at operational laydown areas, vehicle offloading areas, secondary containment areas, and working areas for operational maintenance. General surfacing in other areas where operational maintenance access would potentially be required would be dense-graded aggregate. In the areas of the Administration building and the SORSC building, finished surfacing would be asphalt for the parking lots and concrete for the helipad. The gas metering station would be surfaced with dense-graded aggregate. Runoff would be separated into either the stormwater system or the oily waste system. Stormwater with a high potential to encounter oil and grease pollution would be contained via curbs or other means and routed to an oil/water separator prior to disposal through the IWWP according to the applicable NPDES permit requirements. For areas of the site where stormwater has a low potential to encounter oil and grease pollution, the first flush of stormwater would be treated on-site by either infiltration facilities, flow-through type cartridge filter devices, or vegetated filter strips. Infiltration facilities would provide treatment for the majority of the stormwater falling on the site and would be treated to meet applicable regulatory discharge criteria. The infiltration facilities would be designed to capture and infiltrate all stormwater for 100 percent of the 2-year, 24-hour storm. Overflows from the infiltration facilities would be routed to pipe outfalls in the slip and Coos Bay. For some locations that are not feasible to infiltrate, stormwater would be routed to cartridge filter devices, where the treated effluent would be discharged to Coos Bay. Other locations will flow through filter strips. Stormwater from access roads to the site would flow through filter strips or swales for treatment before being discharged to natural grade.

Industrial wastewater would be conveyed to the existing IWWP ocean outfall, pursuant to the NPDES permit issued by ODEQ. Stormwater collection and treatment facilities would be designed in consultation with NMFS and the ODEQ. Stormwater discharges are regulated under Section 402 of the Clean Water Act and by Oregon Administrative Rules that describe policies, criteria, and standards for the protection of water quality and designated beneficial uses including those that assure suitable habitats are maintained for aquatic and other wildlife species. Discharges to the ocean from this stormwater outfall will be monitored to assure compliance with these requirements.

Trans Pacific Parkway/US-101 Intersection Widening. Stormwater generated as a result of new impervious area at the Trans Pacific Parkway/US-101 Intersection Widening would be collected and conveyed to treatment facilities to provide treatment for 100 percent of the 2-year storm event. Drainage curbs would be installed near the edge of pavement along the northwest side of the roadway. These drainage curbs would collect and convey flow from the road crown to water quality treatment facilities consisting of cartridge filtration systems. The proposed flow through cartridge filter type devices, will be designed and installed to meet applicable regulatory criteria, for example, criteria established by the Washington Department of Ecology and Oregon Department of Transportation standards for water quality treatment. The water quality facilities would provide treatment for the design flow volume and bypass higher flows before discharging the runoff into Coos Bay.

Kentuck Project Site. Roadway improvements associated with the Kentuck Project, which include elevating and repaving of East Bay Drive and Golf Course Lane, would result in the addition of new impervious area. The stormwater facilities at the Kentuck Project site would be designed to provide treatment for 100 percent of the 2-year storm event wherever feasible.

East Bay Drive would sheet flow stormwater runoff to roadside drainage curbs. Once along the curb, water would flow toward the low point of the roadway. Water quality treatment facilities would be installed to capture and treat the runoff. The water quality facilities would treat water and bypass higher design flows before discharging the runoff onto riprap road base adjacent to the receiving waters in Kentuck Inlet.

Along most of Golf Course Lane, surface water ditches and flow-through bio-infiltration conveyance systems are proposed. In these areas, collected flow that does not fully infiltrate into the underlying well-draining soils would be conveyed to an outfall into the Kentuck Slough. At the north end of Golf Course Road, runoff would be collected in drainage curbs and conveyed to flow-through water quality treatment systems before discharging to Kentuck Slough.

Lighting

Only lighting required for operation and maintenance, safety, and security, and meeting Federal Aviation Administration requirements would be used on the LNG storage tanks. Lighting would be localized to minimize off-site effects. When an LNG carrier is not in the berth, the lighting around the slip would be reduced to that required for security. The lighting levels would be based on American Petroleum Institute (API) standards. Lighting around equipment and facilities where routine maintenance activities could occur on a 24-hour basis would range from 1 to 20 foot-candles. General process area lighting would be kept to a minimum, on the order of 2 foot-candles. The lighting along the Access and Utility Corridor would be 0.4 foot-candle. Perimeter security would be on the order of 1.3 foot-candles, using evenly spaced 400-watt floodlights. As a point of reference, 20 foot-candles is close to the indoor lighting in a typical home, 2 foot-candles is typical of that found in a store parking lot, and 0.4 foot-candle is typical of residential street lighting.

The use of low-intensity lighting would minimize adverse effects on wildlife. Before construction of the LNG Terminal, JCEP would develop its final lighting plan in consultation with appropriate resource agencies, and it would include measures that would reduce impacts on wildlife.

Localized changes in light regime have been shown to affect the behavior of fish species in a variety of ways (Simenstad et al. 1999; Valdimarsson et al. 1997; Tabor et al. 2004; Nightingale and Simenstad 2001). Disorientation may cause delays in migration, while avoidance responses may cause diversion of migratory routes into deeper, less protected waters. In some cases, increased light may attract both predators and potential prey species.

Nighttime construction is likely to occur in the estuarine analysis area for in-water work activities such as dredging or placing revetment, as well as on-water activities such as receiving deliveries at the TMBB or MOF. Construction lighting would be designed, installed, and operated at a level that allows construction work to be completed safely and effectively while minimizing glare to surrounding areas. Construction lighting would be directed only to the surface waters of Coos Bay when necessary, in order to minimize impacts to aquatic organisms. Lighting for in-water work would be limited to the area around each vessel and the area of the in-water work. For example, during dredging, the area under the crane boom for clamshell dredging or derrick arm for cutter-suction dredging would be lit. Lighting is anticipated to be a mix of fluorescent and sodium fixtures around the vessels (dredge, barges, tugs, and support vessels) with larger sodium or halogen lights shining on the work area (i.e., the water) under the crane boom or derrick of the suction dredge. Lighting for on-water work, such as barge or ship unloading, would be limited to the vessels and adjacent landing areas. Final marine construction lighting requirements would be developed in consultation with appropriate resource agencies, and it would include measures that would reduce impacts on aquatic resources.

When an LNG carrier is not at the berth, the lighting would be reduced to that required for safety and security. It would be focused upon the structures and not be in proximity to the water so that it would serve as an attractant or deterrent to fish species. When an LNG carrier is at the berth, it would physically block the lighting on the berth from the slip waters and, due to its proximity to the slip wall, would block the fish from getting too close to the lighting on the berth. Lighting used at the LNG Terminal would be similar to that already in place at other Coos Bay facilities.

Lighting on the tug dock would be low-intensity lighting for safety that would provide sufficient light for personnel movements on the trestle out to the tug berth and for movement on the berth itself. There is no intention to provide lighting near the water line or high-intensity lighting that would be associated with activities other than the simple berthing of the tugs at this location. The reduced lighting levels near the water would reduce or eliminate any behavioral effects to fish at the LNG Terminal site. The final details of the lighting arrangement would be determined in consultation with NMFS, USCG, and with other resource agencies to reduce these potential adverse effects.

Strikes on Standing Structures within the LNG Terminal

During operation, bats and birds would be at risk of colliding with LNG Terminal facilities. The top of the dome of each LNG storage tank would be about 219 feet above grade Some of the facilities would be lit at night, which could attract bats and birds. There is some evidence that high-intensity continuous anti-collision lights on structures may result in an increased number of bird strikes, especially at night or during fog and overcast conditions. The number of strikes can apparently be reduced by strobing or blinking the anti-collision lights. The LNG storage tanks would not be illuminated with high-intensity lighting. The intensity and number of lights would be limited to what is required for security and operations.

Terminal Operational Noise

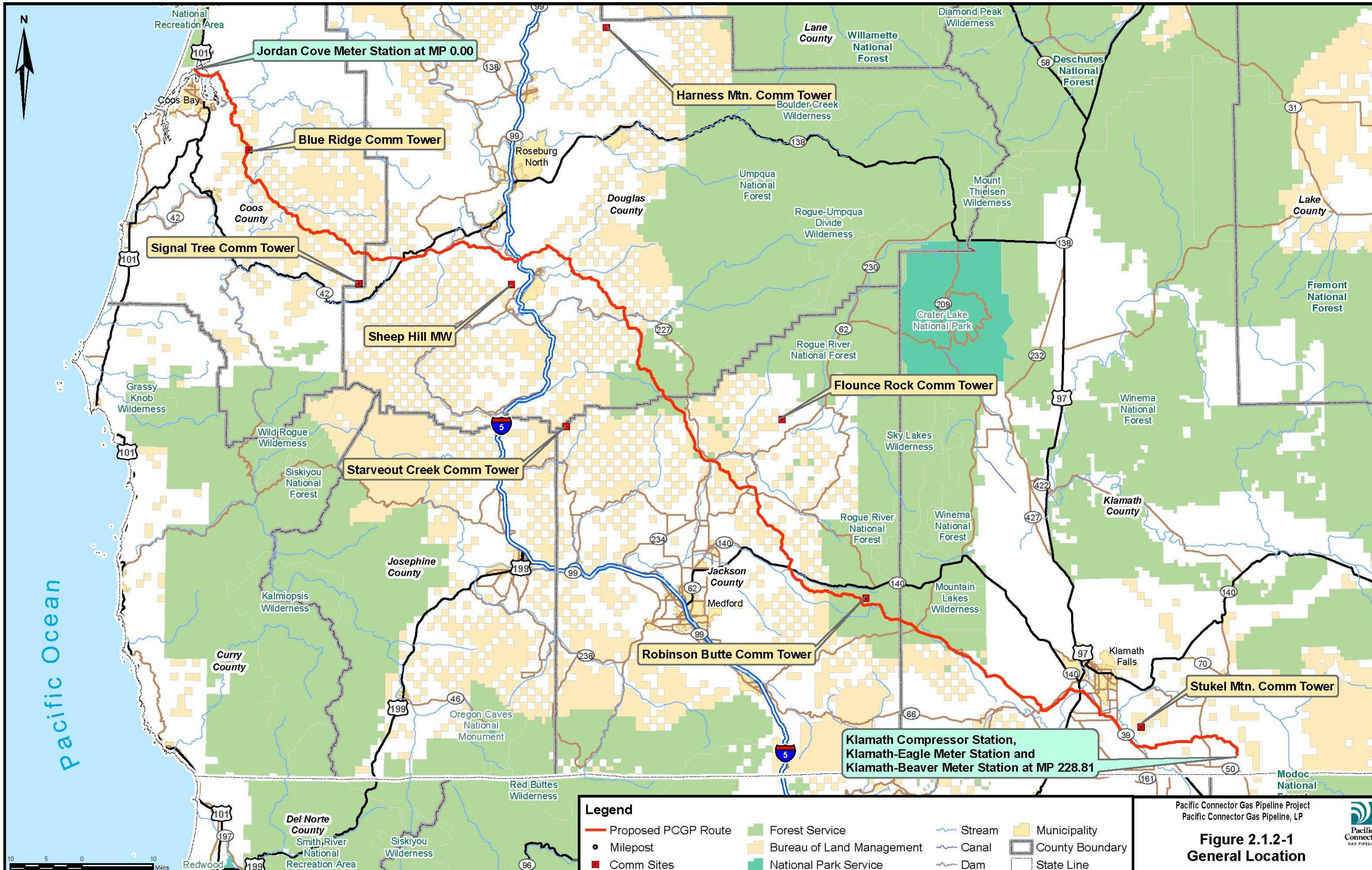
The predicted operational noise from the LNG Terminal would have an equivalent sound level (L_{eq}) of 45 decibels on an A-weighted scale (dBA) and day-night sound level (L_{dn}) of 51 dBA when measured about 1.3 miles away. This compares to current ambient L_{dn} noise levels of about 47.4 to 51.6 dBA in the city of North Bend, just southwest of the airport (see JCEP Resource Report 9). Because there is existing noise generated by other industrial facilities on the North Spit, and noise from the LNG Terminal would be less than the FERC standard of 55 dBA at NSAs, the operational noise from the LNG Terminal would not significantly affect any listed species.

2.1.2 Pipeline and Associated Facilities

PCGP proposes to construct and operate a pipeline that will extend approximately 229 miles[3], starting from an interconnection with the existing interstate pipeline systems of Ruby Pipeline LLC (Ruby) and Gas Transmission Northwest LLC (GTN) near Malin in Klamath County, Oregon, and extending to the LNG Terminal in Coos County, Oregon (see figure 2.1.2-1 and appendix A). The Pipeline would be 36 inches in diameter and is designed to transport up to

[3] Total pipeline length is 229.09 miles. However, PCGP retained its original design mileposting and accounted for realignments using equations. Therefore, although the gas would flow east to west, the mileposting is reversed, with the Klamath Compressor Station at MP 228.8 and the Jordan Cove delivery meter station at MP 0.00.

1,200,000 dth/d of natural gas at a maximum allowable operating pressure of 1,600 pounds per square inch gage (psig).


Jordan Cove Meter Station at MP 0.00
Harness Mtn. Comm Tower
Blue Ridge Comm Tower
Signal Tree Comm Tower
Sheep Hill MW
Starveout Creek Comm Tower
Flounce Rock Comm Tower
Robinson Butte Comm Tower
Stukel Mtn. Comm Tower
Klamath Compressor Station,
Klamath-Eagle Meter Station and
Klamath-Beaver Meter Station at MP 228.81
Pacific Ocean
Coos Bay
Coos County
Douglas County
Lane County
Lake County
Klamath County
Jackson County
Josephine County
Curry County
Del Norte County
Roseburg North
Medford
Klamath Falls
Willamette National Forest
Umpqua National Forest
Rogue River National Forest
Siskiyou National Forest
Winema National Forest
Fremont National Forest
Deschutes National Forest
Modoc National Forest
Crater Lake National Park
Oregon Caves National Monument
Legend
Proposed PCGP Route
Milepost
Comm Sites
Forest Service
Bureau of Land Management
National Park Service
Stream
Canal
Dam
Municipality
County Boundary
State Line
Pacific Connector Gas Pipeline Project
Pacific Connector Gas Pipeline, LP
Figure 2.1.2-1
General Location

Aboveground facilities required for the Pipeline would include the 62,200 horsepower Klamath Compressor Station at the eastern beginning of the pipeline at milepost (MP) 228.8. Within the compressor station tract would be the Klamath-Beaver and Klamath-Eagle receipt meter stations, at the interconnections with Ruby and GTN, and the JCEP delivery station would be at MP 0.00R at the interconnection with the LNG Terminal. In addition, there would be 17 main line block valves (MLV) located within the pipeline right-of-way or co-located at aboveground facilities; 5 pig[4] launchers and receivers co-located within aboveground facilities; and 15 communication towers also co-located with existing or proposed facilities. Further detail is provided on all of these facilities, below.

The Pipeline route would traverse across the basin and range sage and juniper woodlands ecozone of the Klamath Basin, over the Southern Cascades conifer forest and oak woodlands and conifer forest ecozones of the Klamath Mountains, through Camas Valley and Douglas-fir forests of the Coastal Range, and terminate in the Coastal lowlands.

The Pipeline would cross 46.8 miles within Coos County, between MPs 0.0 and 45.7; 64.9 miles in Douglas County between MPs 45.7 and 110.1; 56 miles within Jackson County between MPs 110.1 and 166.4; and 61.4 miles within Klamath County between MPs 166.4 and 228.8. In Coos County, the Pipeline would cross lands zoned predominantly Forest and Exclusive Farm Use, as well as some Rural Residential. In Douglas County, the Pipeline would cross lands zoned predominantly Timberland Resource, Farm Forest, and Exclusive Farm Use, and to a lesser extent Farm Forest Agriculture and Woodlot and Rural Residential. In Jackson County, the Pipeline would cross lands zoned predominantly Forest Resource and a substantial length of Exclusive Farm Use. In Klamath County, the Pipeline would cross primarily lands zoned for Forest and Exclusive Farm Use, but also some Residential and Heavy Industrial. PCGP has obtained or will obtain local permits allowing for the Pipeline, including conditional use permits and land use compatibility statements from the affected counties.

The Pipeline would cross a combined total of about 142.2 miles of forest, include deciduous forest, evergreen forest, mixed forest (containing both deciduous and evergreen trees), clearcut forest, and regenerating forest. About 26.6 miles of agricultural lands would be crossed, including cropland and pasture. The Pipeline would cross about 34.0 miles of range, including herbaceous (grassy) rangelands, shrub and brush rangelands, and mixed (both grassy and brush) rangelands.

The standard construction right-of-way would be about 95 feet wide. When crossing wetlands and certain riparian areas, the construction right-of-way may be reduced to 75 feet wide. Approximately 2,582 acres would be required for the construction right-of-way for the pipeline. The permanent easement would be 50 feet wide.

There would be a number of ancillary use areas associated with construction of the Pipeline. PCGP proposes to use 1,603 temporary extra work spaces, totaling about 922.6 additional acres. In addition, about 320 uncleared storage areas would be used during construction, totaling another 676 acres. There would be 20 rock source and disposal sites, totaling about 41.2 acres (an additional 20 sites, identified for rock source/disposal, are included in the temporary extra

[4] A pig is an internal pipeline cleaning and inspection tool.

work areas, totaling 44.8 acres). PCGP would use 36 pipe storage and contractor yards, totaling about 674.2 acres. Approximately 670 miles of existing roads would be used to access the pipeline right-of-way during construction. PCGP would have to make improvements to portions of 27 of those existing roads, disturbing about 22.5 acres. PCGP would need to build 10 new temporary access roads, totaling 3.8 acres, and permanently maintain 15 new access roads for operation of the pipeline, covering about 2.2 acres. Details about TEWAs can be found in PCGP's RR 1.

2.1.2.1 Pipeline Routing Considerations

The Pipeline route was developed with consideration of the construction requirements for a large-diameter, high-pressure natural gas transmission pipeline. The Pipeline will commence near the interconnections with Ruby and GTN within the proposed Klamath Compressor Station, and end at the LNG Terminal. Routing considerations and explorations of alternatives are set out in PCGP's RR 10. For about 97.7 miles (almost 43 percent of the route) the Pipeline would be situated adjacent to existing rights-of-way, including powerlines, other pipelines, and roads. The Pipeline was routed around major urban centers. To the extent possible, PCGP attempted keep the route on top of ridges, to reduce side-hill construction, and minimize the crossing of stream valleys. Adverse geological hazards, such as potential landslide areas were avoided, where possible. PCGP also sought to reduce potential impacts on sensitive resources, such as minimizing crossings of old-growth forest and habitat for federally listed species. For the most part, the Pipeline route avoids crossing national parks and monuments, wildlife refuges, federally designated wild and scenic rivers, and wilderness areas.

Aboveground Facilities

Proposed aboveground facilities that would be associated with the Pipeline include meter stations, mainline valves, pig launchers/receivers, and one compressor station. Aboveground facilities are listed in table 2.1.2-1 and described below. Aboveground facility locations are shown on the maps in appendix A.

<u>Jordan Cove Meter Station</u>

Natural gas would be delivered to the proposed LNG Terminal via the Jordan Cove Meter Station located at MP 0.0 (see appendix A) of the Pipeline in Coos County. The meter station would be located on JCEP property adjacent to the LNG Terminal. This industrial land was the former location of the Weyerhaeuser linerboard mill. Construction and operation of the meter station would affect 1.7 acres. There are no waterbodies or wetlands at the meter station location.

The meter station would be graveled and enclosed by a 7-foot high chain-link fence. Existing power and phone service for gas control communication equipment is available. A pig receiver and mainline block valve would be located within the meter station facility. Access to the site would be from a road provided by the LNG Terminal. A building would be installed to house the gas chromatographs, moisture analyzer, communications equipment, and flow computer. A canopy would also be installed to cover the control valves and ultrasonic meters. A communications antenna would be installed to provide a link with the gas control monitoring system, and the antenna would be installed on a new 140-foot tall steel tower. The tower would stand without support of guy wires. Lighting at the meter station would be down-shielded to keep light within the boundaries of the site, which would minimize attracting nocturnally flying bats or birds to the vicinity of the tower.

TABLE 2.1.2-1

Summary of Disturbance Associated with Aboveground Facilities

Facility [1]	**MP**	**Acres Disturbed [2]**	**Land Use**	**Land Ownership**
Jordan Cove MS, BVA #1, and Receiver[4,5]	0.00	1.72	Industrial	Private
BVA #2 (Boone Creek Road)	15.07	0.09	Mixed Forest Land, Transportation	Private
BVA #3 (Myrtle Point Sitkum Road)	29.50	0.09	Cropland Pasture	Private
ABVA #4 (Deep Creek Spur)[5]	48.58	0.09	Mixed Forest Land	BLM
BVA #5 (South of Olalla Creek)	59.58	0.09	Cropland Pasture	Private
BVA #6, Launcher/Receiver [5]	71.46	0.49	Herbaceous Rangeland	Private
BVA #7 (Pack Saddle Road)	80.03	0.09	Mixed Forest Land	BLM
BVA #8 (Hwy 227)	94.66	0.09	Mixed Rangeland	Private
BVA #9 (BLM Road 33-2-12/Dead Horse Creek)	113.66	0.09	Evergreen Forest Land, Clearcut Forest Land	Private
ABVA #10 (Shady Cove)[5]	122.18	0.09	Mixed Rangeland	Private
ABVA #11, Launcher/Receiver (Butte Falls)[5]	132.46	0.27	Mixed Rangeland	Private
BVA #12 (Heppsie Mtn Quarry Spur)	150.70	0.09	Shrub and Brush Rangeland	BLM
BVA #13 (Clover Creek Road)	169.48	0.09	Regenerating Evergreen Forest	Private
BVA #14 and Launcher/Receiver Site	187.43	0.44	Regenerating Evergreen Forest Land, Shrub and Brush Rangeland	Private
ABVA #15 (Klamath River)[5]	196.53	0.09	Cropland Pasture	Private
ABVA #16 (Hill Road)[5]	211.58	0.09	Cropland Pasture	Private
Klamath Compressor Station, Klamath-Beaver and Klamath-Eagle Meter Stations, BVA #17, Launcher & Communications Tower [5]	228.81	21.40	Shrub and Brush Rangeland	Private
Total		**25.40**		
Blue Ridge Communication Site – Coos County [6]	~ 20	0.23		BLM
Signal Tree Communication Site – Coos County [6]	~45.0	0.23		BLM
Sheep Hill Communication Site – Douglas County [6]	~70	0.23		Private
Harness Mountain Communication Site – Douglas County [7]	~75	0.00	Transportation, Communications, and Utilities/Commercial	Private
Starvout Communication Site – Jackson County [6]	~115	0.23		Private
Flounce Rock Communication Site – Jackson County [6]	~123.0	0.23		BLM
Robinson Butte Communication Site – Jackson County [6]	~159.0	0.23		Forest Service
Stukel Mountain Communication Site – Klamath County [6]	~209	0.23		BLM
	Total	**1.61**		
	Grand Total	**27.01**		

TABLE 2.1.2-1 Summary of Disturbance Associated with Aboveground Facilities				
Facility [1]	**MP**	**Acres Disturbed [2]**	**Land Use**	**Land Ownership**

[1] BVAs denoted as ABVA are automated valves and will include a 40-foot tall communication tower.
[2] Temporary construction disturbance associated with the aboveground facilities is included within the Pipeline construction right-of-way, and is not double counted in total Pipeline disturbance estimates.
[3] The 17 mainline block valves will be located within areas disturbed by the construction right-of way or within associated aboveground facility footprints (*i.e.*, meter stations and the compressor station); however, the permanent operation acres provided will remain as permanent disturbance associated with these graded, graveled and fenced facilities.
[4] The Jordan Cove Meter Station will be located entirely within the proposed LNG Terminal.
[5] Communication facilities are included in the disturbed areas associated with the meter station, block valves and compressor station.
[6] Communication facilities will utilize existing towers and equipment buildings, where space is available for lease, with no associated disturbance. If construction of new facilities is required, PCGP will obtain an approximate 100 x 100 foot (0.23 acre) area in the immediate area of the existing communication tower facilities.
[7] The Harness Mountain Communication Tower is an existing communication facility, where no new disturbance is required.

Klamath Compressor Station and Meter Stations

The Klamath-Eagle and Klamath-Beaver meter stations would be located within the 21-acre tract for the Klamath Compressor Station at MP 228.8 (see appendix A). The tract is used for hay and pasture, and includes sagebrush steppe vegetation. No wetlands or waterbodies are within this tract.

The compressor station is located approximately 1.75 miles northeast of Malin, Oregon. The location is accessed on the south from Malin Loop Road and on the west from Morelock Road. The site is located adjacent to the existing GTN Malin/Tuscarora Meter Station and Ruby Turquoise Flats Meter Station. The compressor station would also include a pig launcher for the pipeline.

The Klamath-Eagle Meter Station would serve as the interconnect with Ruby, and the Klamath-Beaver Meter Station would serve as the interconnect with GTN.

The Pipeline would require approximately 62,200 International Organization for Standardization (ISO) hp of new compression (with one additional standby unit of 31,100 ISO hp) provided at the new Klamath Compressor Station. The compressor station would consist of turbine-driven centrifugal compressor units.

The new compression units would be installed in a new Class 1 Division 2 rated compressor building. Other facilities would include an inlet filter/separator, lube oil cooler, inlet air silencer/cleaner, exhaust system, and gas coolers. The compressor building would include skid-mounted fuel gas conditioning, measuring, and regulation equipment. Related suction and discharge headers and piping would be installed between the pipeline and the compressor units. Other buildings inside the station would include a new control room/ancillary equipment building and unit valve skid buildings. The ancillary equipment building would include an air compressor system, hot water boiler, and back-up generator. A high-pressure vent system with a silencer would be installed to allow the station to be blown down. Near where the pipeline leaves the station boundaries, aboveground pig launcher/receiver equipment and a mainline block valve would be installed.

There would be a small office in one of the buildings with phone and computer access. The station would also be used as a maintenance base for operation of the pipeline facilities. The station would not be manned 24 hours per day, but would have emergency pipe, spare parts, portable equipment such as blow-down silencers, and small hand tools stored on site. The facility would be equipped with outside lighting to support night work activities; however, these lights would only be utilized when operations personnel are working at the station. During operations, nighttime work or maintenance activities would generally not be scheduled; therefore, these lights would only be used periodically and possibly for short periods during the winter when daylight hours are shorter.

The 21-acre site would be secured by a 7-foot-high, chain-link fence. To minimize visual intrusions, the security fence around the perimeter of the station would be installed with screening slats and landscaping along appropriate sides of the station to reduce potential visual effects to area residences. Areas inside the fenced area subject to operating or maintenance traffic would have a covering of paving, concrete, crushed rock or gravel.

The nearest existing NSA is a farm residence (NSA #6) located about 1,500 feet southeast of the proposed compressor building location (subsequent to the 2012 noise survey, PCGP acquired NSAs #1 and #2). An additional NSA (NSA #7) would potentially be located 1,230 feet north of the compressor station location. This NSA location is based on a building permit for a new residence filed with the local zoning board. Estimated noise from operation of the Klamath Compressor Station would have an L_{dn} of 50.9 dBA at NSA #6, and range between 46.7 and 50.5 dBA at the four other closest NSA, which would not exceed FERC's standard of 55 dBA. Noise below that level should have no significant adverse impacts on wildlife in the vicinity of the station.

<u>Gas Control Communications</u>

PCGP would need a total of 15 radio communication towers to link the Pipeline with the company's communication systems (see table 2.1.2-2. Two new communication towers would be erected at the Jordan Cove Meter Station and the Klamath Compressor Station. The towers would be 140 feet high.

TABLE 2.1.2-2

Location of Proposed and Existing Gas Control Communication Towers

	Location							Tower Height (feet)	Land Ownership
Site Name	Latitude			Longitude			County		
Proposed New Towers within Proposed Aboveground Facility Sites									
Jordan Cove Meter Station	43	25	58.1	124	14	27.8	Coos	140	Private
ABVA #4 (Deep Creek Spur)	43	3	2.6	123	42.	57.01	Douglas	40	BLM
ABVA #10 (Shady Cove)	42	38	43.8	122	49	3.4	Jackson	40	Private
ABVA #11, Launcher/Receiver (Butte Falls)	42	34	40.4	122	40	49.7	Jackson	40	Private
ABVA #15 (Klamath River)	42	9	33	121	50	37.4	Klamath	40	Private
ABVA #16 (Hill Road)	42	3	25.5	121	38	43.9	Klamath	40	Private
Klamath Compressor and Meter Stations, BVA #17, Launcher	42	2	1.4	121	22	23.9	Klamath	140	Private
Existing Communication Tower Site									
Harness Mountain	43	31	27.4	123	5	39.2	Douglas	150	Private
Existing Communication Tower Sites (space to be leased or new tower installed)									

TABLE 2.1.2-2

Location of Proposed and Existing Gas Control Communication Towers

Site Name	Location							Tower Height (feet)	Land Ownership
	Latitude			Longitude			County		
Blue Ridge [1]	43	16	16	124	5	9	Coos	170	BLM
SignalTree(Kenyon Mtn.)[1]	43	0	7.4	123	46	44.3	Coos	120	BLM
Sheep Hill MW[1]	43	0	7.5	123	21	19.3	Douglas	125	Private
Starvout Communication[1]	42	42	50.3	123	12	10.4	Jackson	115	Private
Flounce Rock[1]	42	43	40.4	122	36	33.1	Jackson	120	BLM
Robinson Butte[1]	42	21	51.4	122	22	54.1	Jackson	125	Forest Service
Stukel Mountain[1]	42	5	46.0	121	38	1.0	Klamath	100	BLM

[1] New towers and equipment buildings may be necessary at these locations if lease space is unavailable at the time of construction.

PCGP intends to lease space on an existing 150-foot-high tower at Harness Mountain in Douglas County. At the Blue Ridge and Signal Tree sites, PCGPintends to lease space on the existing American towers, which are 170 feet and 120 feet tall, respectively. PCGP would also lease space on existing towers operated by other entities at the Sheep Hill MW site (125 feet high) in Douglas County, and Starvout Creek site (115 feet high) in Jackson County. New communication towers may need to be erected near existing facilities at Flounce Rock and Robinson Butte in Jackson County, and Stukel Mountain in Klamath County. The new towers at Flounce Rock and Robinson Butte would be 120 and 125 feet high, respectively, while the new tower at Stukel Mountain would be 100 feet tall. No waterbodies or wetlands would be affected at any of the communication sites.

If leased space is not available on existing facilities and construction of new facilities is required, PCGP would seek to obtain an approximate 100-foot by 100-foot (0.23-acre) area for each of the new facility installations in the immediate vicinity of the existing communication tower facilities. The new towers and communication buildings would be enclosed within a 50-foot by 50-foot (0.06-acre) fenced footprint located within the larger 100-foot by 100-foot area. In the case of Robinson Butte, within the Rogue River National Forest, the Forest Service may require the modification of the current special use permit in order to allow the addition of new communication equipment. For use of the Robinson Butte communication site, PCGP would only require light utility four-wheel drive vehicles to travel 2.2 miles on Forest Service Road 3730 from Big Elk Road (paved) to access the tower. A cable and winch system would be used to hoist the microwave antenna communication systems from the vehicle to the tower. No maintenance and/or improvements are expected along Forest Service Road 3730 because only light utility vehicles are required to access the site. The Robinson Butte communication tower is located within NSO designated critical habitat (Unit KLE-4). Currently known NSO sites are farther than one-quarter mile from activity associated with this communication tower. Also, no suitable habitat for listed plants occurs along this road or at the communications site.

Launchers/Receivers and Mainline Block Valves

MLVs would be located along the Pipeline according to DOT's spacing requirements (C.F.R. §192.179). There would be a total of 17 MLVs along the proposed route, of which 2 would be co-located at the meter and compressor stations. Each MLV would occupy a site 50 x 75 feet (0.09 acre) and would be enclosed by a 7-foot-high chain-link fence. Each MLV would require a permanent access road, and PCGP has attempted to locate final placement of block valves adjacent to existing roads to minimize the length of new permanent access roads. PCGP would paint the aboveground piping in the block valve locations green unless otherwise dictated by permit conditions. Locations of mainline block valves are depicted on the USGS quad-based general location maps in appendix A.

Pigs, or remotely operated pipe inspection and cleaning tools, would be used to inspect and maintain the inside of the pipeline. Pig launchers/receivers would be located at each end of the pipeline (Jordan Cove Meter Station and Klamath Compressor Station). Due to battery and data storage limitations, there would also be a pig launcher and receiver co-located with MLVs #6 at MP 71.5, #11 at MP 132.5 and #14 at MP 187.4. At these locations, the block valve and pig launcher/receiver assembly sites would be 95 by 200 feet (0.44 acre); however, MLV #11 would be 0.27 acre to avoid adjacent wetlands. Pigging facilities would be located inside the fenced areas at all locations.

Launchers/receivers and mainline block valves would be located within the permanent pipeline easement or within the footprints of the aboveground facilities, which have been discussed above. Areas of existing wildlife habitats associated with each block valve are included in the discussion of the construction right-of-way.

2.1.2.2 Land Requirements – Pipeline

Construction of the Pipeline would require acquisition of temporary construction rights-of-way, TEWAs, and permanent easements which are described in this section. Table 2.1.2-3 summarizes the construction and operation land requirements. Table 2.1.2-4 lists acres of wildlife habitat affected by construction of the PCGP facilities.

TABLE 2.1.2-3

Total Pipeline Project Land Requirements for Construction and Operation

Pipeline Component	Length (miles) or Number of Sites	Land Affected During Construction (acres)	Land Affected During Operation (acres)
Pipeline Facilities	229.09*	2,582.04	1,373.66[1] / 820.60[2]
Temporary Extra Work Areas[3]	1,603	922.64	(44.80)[8]
Uncleared Storage Areas	320	676.44	0.00
Quarries & Disposal Sites	20	41.18	(41.18) [7]
Contractor and Pipe Storage Yards	36	674.17	0.00
Existing Roads Needing Improvements in Limited Locations[4]	32 Improvements (27 Roads)	22.52	(22.70)[9]
Temporary Access Roads	10	3.80	0.00
Permanent Access Roads	15	2.16[5]	2.16[5]
Aboveground Facilities	17	27.01[6]	27.01[7]
	Total	**4,951.96**	**1,402.83[7, 9]**

* Because of changes in the centerline and associated MP equations, the ending MP no longer represents the actual centerline length.
[1] New permanent easement is 50-feet on private and federal lands.
[2] Acreage affected by the 30-foot corridor where brush control would be performed during operation of the pipeline.
[3] TEWAs are shown on the Environmental Alignment Sheets
[4] Includes those existing roads requiring widening in specific locations; does not include limbing/brush clearing or blading/grading for potholes.
[5] Portions of the PARs are within the construction right-of-way and permanent easement.
[6] Construction impacts associated with the aboveground facilities are included in the construction impacts for the Pipeline facilities except the 8 potential communication tower sites and the Klamath Compressor Station, which are included here (1.61 acres and 21.4 acres, respectively).

[7] Portions of the operational impacts of the aboveground facilities are included within the permanent easement acreage.
[8] Represents TEWAs, existing quarries, and rock source and disposal sites provided in appendix G that may be used as permanent storage areas. The acreages are not included in the overall operational total because the storage areas will not be used during operation of the Pipeline.
[9] Although the improvements will not be reclaimed, these road improvements are not needed for operations, and the acres are not included in the total operational acreage.

TABLE 2.1.2-4

Disturbance to Habitats (acres) from Construction of the Pipeline Project

General Habitat Type	Mapped Habitat Category Type	Forest Stand by Age	Pipeline Facilities: Construction Right-of-Way	Temporary Extra Work Areas	Uncleared Storage Areas	Rock Source/ Disposal	Access Roads (TARs/PARs/ Improvements)[4]	Pipe Yards	Aboveground Facilities - Klamath Compressor Station[5]	Subtotals: Subtotal Late Successional – Old Growth	Subtotal Mid-Seral	Subtotal Clearcut or Regenerating	Subtotal by Habitat Type	Percent of Total Habitat
Forest-Woodland	Westside Lowland Conifer - Hardwood Forest	L-O [1]	113.53	25.63	89.91									
		M-S [2]	264.47	67.62	122.60	0.98	0.20	0.09		229.07	455.96	612.15	***1,297.19***	26.2%
		C-R [3]	323.29	129.54	154.39	4.90	0.03							
	Montane Mixed Conifer Forest	L-O [1]	15.66	0.69	6.14									
		M-S [2]	9.20	0.46	4.49					22.49	14.15	77.53	***114.17***	2.3%
		C-R [3]	45.01	16.73	15.79									
	Southwest Oregon Mixed Conifer-Hardwood Forest	L-O [1]	251.54	41.29	111.74	1.49	0.24							
		M-S [2]	108.69	36.36	33.88	0.04	0.07			406.31	179.03	354.29	***939.62***	19.0%
		C-R [3]	210.59	60.97	82.37		0.35							
	Ponderosa Pine Forest and Woodlands	L-O [1]	50.92	15.86	6.00									
		M-S [2]	50.88	8.89	0.64	0.04				72.78	60.45	86.97	***220.20***	4.5%
		C-R [3]	63.05	15.97	6.99	0.96								
	Westside Oak and Dry Douglas-fir Forest and Woodlands	L-O [1]	26.67	8.97	3.91									
		M-S [2]	25.00	7.35	1.88		0.05			39.55	34.27	0.00	***73.82***	1.5%
		C-R [3]												
	Western Juniper and Mountain Mahogany Woodlands	L-O [1]	2.29	0.40										
		M-S [2]	48.68	7.63			0.12			2.69	56.43	45.64	***104.75***	2.1%
		C-R [3]	42.25	3.39			0.00							
Subtotal Forest-Woodland by Age Class		L-O [1]	***460.62***	***92.83***	***217.70***	***1.49***	***0.24***	***0.00***	***0.00***					
		M-S [2]	***506.91***	***128.30***	***163.49***	***1.06***	***0.43***	***0.09***	***0.00***	***772.89***	***800.29***	***1,176.57***	***2,749.75***	55.6%
		C-R [3]	***684.19***	***226.60***	***259.54***	***5.85***	***0.38***	***0.00***	***0.00***					

TABLE 2.1.2-4

Disturbance to Habitats (acres) from Construction of the Pipeline Project

General Habitat Type	Mapped Habitat Category Type	Forest Stand by Age	Pipeline Facilities							Subtotals			Subtotal by Habitat Type	Percent of Total Habitat
			Construction Right-of-Way	Temporary Extra Work Areas	Uncleared Storage Areas	Rock Source/ Disposal	Access Roads (TARs/PARs/ Improvements)[4]	Pipe Yards	Aboveground Facilities - Klamath Compressor Station [5]	Subtotal Late Successional – Old Growth	Subtotal Mid-Seral	Subtotal Clearcut or Regenerating		
Subtotal Forest-Woodland			**1,651.72**	**447.73**	**640.74**	**8.41**	**1.06**	**0.09**	**0.00**	**772.89**	**800.29**	**1,176.57**	**2,749.75**	***55.6%***
Percent of All Forest-Woodland			**60.1%**	**16.3%**	**23.3%**	**0.3%**	**0.0%**	**0.0%**	**0.0%**	***28.1%***	***29.1%***	***42.8%***		
Grasslands-Shrubland	Sagebrush Steppe		77.89	33.44			0.16		21.40				**132.89**	2.6%
	Shrublands		122.35	40.82	10.65		0.22						**174.04**	3.5%
	Westside Grasslands		132.42	86.80	5.86	0.34	1.86	148.28					**375.57**	7.6%
	Eastside Grasslands		50.56	8.47	0.00	1.40		122.26					**182.70**	3.7%
Subtotal Grasslands-Shrubland			**383.22**	**169.53**	**16.52**	**1.74**	**2.24**	**270.55**	**21.40**				**865.20**	**17.4%**
Wetland / Riparian	Westside Riparian-Wetlands/Eastside Riparian-Wetlands	L-O [1]								0.00	0.95	0.91	***1.86***	*0.0%*
		M-S [2]	0.77	0.18										
		C-R [3]	0.61	0.30										
		Shrub	1.20	0.19	0.03			0.40					**1.82**	0.0%
	Herbaceous Wetlands		64.23	45.49	0.02		0.07	0.73					**110.55**	2.2%
Subtotal Wetland / Riparian			**66.82**	**46.15**	**0.05**	**0.00**	**0.07**	**1.14**	**0.00**	**0.00**	**0.95**	**0.91**	**114.23**	**2.3%**
Agriculture	Agriculture, Pastures, and Mixed Environs		306.11	132.37	0.25	2.77	2.30	14.37					**458.17**	9.3%
Subtotal Agriculture			**306.11**	**132.37**	**0.25**	**2.77**	**2.30**	**14.37**	**0.00**				**458.17**	**9.3%**
Developed / Barren	Urban and Mixed Environs		22.28	54.37	0.07	26.12	0.10	336.25					**439.18**	8.9%
	Beaches		0.16	6.46									**6.61**	0.1%
	Roads		143.48	60.90	18.26	2.15	22.69	47.09	0.01				**294.57**	6.0%
Subtotal Developed / Barren			**165.91**	**121.73**	**18.32**	**28.27**	**22.79**	**383.34**	**0.01**				**740.37**	**15.0%**

TABLE 2.1.2-4

Disturbance to Habitats (acres) from Construction of the Pipeline Project

General Habitat Type	Mapped Habitat Category Type	Forest Stand by Age	Pipeline Facilities							Subtotals			Subtotal by Habitat Type	Percent of Total Habitat
			Construction Right-of-Way	**Temporary Extra Work Areas**	**Uncleared Storage Areas**	**Rock Source/ Disposal**	**Access Roads (TARs/PARs/ Improvements)[4]**	**Pipe Yards**	**Aboveground Facilities - Klamath Compressor Station [5]**	**Subtotal Late Successional – Old Growth**	**Subtotal Mid-Seral**	**Subtotal Clearcut or Regenerating**		
Open Water	Open Water - Lakes, Rivers, Streams		8.27	5.05	0.56		0.01	0.13					**14.01**	0.3%
	Bays and Estuaries			0.08				4.56					**4.63**	0.1%
Subtotal Open Water			**8.27**	**5.12**	**0.56**	**0.00**	**0.01**	**4.69**	**0.00**				**18.65**	0.4%
Subtotal Non-Forest			**930.32**	**474.91**	**35.71**	**32.78**	**27.41**	**674.08**	**21.40**	**0.00**	**0.95**	**0.91**	**2,196.60**	**44.4%**
Percent of All Non-Forest			***42.4%***	***21.7%***	***1.6%***	***1.5%***	***1.3%***	***30.7%***	***0.8%***	***0.0%***	***0.0%***	***0.0%***		
Pipeline Total			**2,582.04**	**922.64**	**676.44**	**41.18**	**28.47**	**674.17**	**21.40**	**772.89**	**801.24**	**1,177.49**	**4,946.35**	
Percent of Pipeline Facilities			***52.2%***	***18.7%***	***13.7%***	***0.8%***	***0.6%***	***13.6%***	***0.3%***	***15.6%***	***16.2%***	***23.8%***		

[1] The "Late Successional and Old-Growth" category (L-O) describes those forest areas with a majority of trees over 80 years of age. Forests with stands greater than 175 years are considered to have old-growth characteristics.
[2] The "Mid-Seral" category (M-S) describes those forest areas with a majority of trees over 40 years of age but less than 80 years of age.
[3] The "Grass-shrub-sapling or Regenerating Young Forest" category (C-R) describes those forest areas that are either clear-cut (tree age 0-5 years) or regenerating (tree age 5 to 40 years). Forest areas in this category are divided into forest vegetation types based on their potential to become those types of forests.
[4] Road improvements will affect approximately 22.52 acres along the margins of existing access roads; all acres of disturbance have been included in vegetation type "roads."
[5] Construction disturbance associated with aboveground facilities (4 acres: mainline block valves and meter station) are included in construction right-of-way and/or TEWA acres of disturbance. Approximately 1.61 acres associated with communication towers are not included in this table (previously disturbed sites).

Construction Right-of-Way

Temporary Construction Right-of-Way

PCGP proposes to utilize a standard 95-foot-wide temporary construction right-of-way. The temporary construction right-of-way would accommodate clearing and grading activities, storage of spoil materials, and provide a passing lane for equipment movement. The temporary construction right-of-way would be used as the primary transportation corridor, as the spread processes in a linear fashion installing the pipeline.

The temporary construction right-of-way would encompass about 2,582 acres. After construction, workspace outside of the 30-foot-wide maintenance easement would be restored to its original condition and use (although mature forest would take many years to be re-established). The restoration and revegetation of the temporary construction right-of-way would be done in accordance with PCGP's *Erosion Control and Revegetation Plan* (ECRP).[5] At wetland crossings and stream crossings, where feasible, the construction right-of-way would be reduced to 75 feet in width, to minimize impacts to these resources and be consistent with the FERC's *Procedures* (Section VI.A.3). On NFS and BLM lands where Riparian Reserves would be affected, up to a 100-foot riparian strip or to the edge of the existing riparian vegetation would be replanted adjacent to stream crossings.

Temporary Extra Work Areas

In addition to the 95-foot-wide construction right-of-way, TEWAs would also be required at numerous locations to provide additional work space during construction. The TEWAs are listed in appendix G. Generally, these TEWAs are required for (but not limited to) the following:

- steep slopes and side sloping areas to accommodate cuts and spoil storage requirements;
- bore pits and spoil storage at road and railroad crossings;
- spoil storage, staging, and construction of drag sections such as at wetland crossings, residential/industrial areas, and road crossings, etc.;
- waterbody and wetland crossings;
- pipe and equipment staging;
- additional spoil storage areas where the topography requires cut and fills or where side slopes are traversed;
- areas where tie-ins or factory bends require additional trench widths to allow workers to enter the trench and perform welds and to ensure Occupational Safety and Health Administration (OSHA) trench safety requirements;
- sharp angles or points of inflection (PIs) where additional area is required to account for the wide turning radius of stringing trucks (which would be greater than 100 feet in length);
- topsoil segregation areas to ensure topsoil and subsoils are not mixed;
- off right-of-way dewatering areas; and
- timber staging/decking.

[5] The ECRP was attached as appendix B.1 in Resource Report 1 of PCGP's September 2017 application to the FERC, and included as appendix I to PCGP's POD.

A total of about 923 acres of TEWAs would be disturbed during construction of the pipeline. All of these areas are considered temporary disturbance and would be restored upon completion of construction (see appendix F). All TEWAs that were forested prior to construction would be replanted with trees. TEWAs would be located more than 50 feet away from the edge of waterbodies and wetlands where possible, and PCGP has identified locations where site-specific conditions or other constraints prevent a 50-foot setback.

Uncleared Storage Areas

To minimize disturbance associated with the Pipeline, PCGP has specifically designated some temporary work areas as UCSAs rather than TEWAs (see appendix G). Unlike the TEWAs, the UCSAs would not be cleared of trees. These areas would be used to store forest slash, stumps, and dead and downed log materials removed from the construction right-of-way prior to construction; these materials would be scattered back across the right-of-way after construction. The amount of this type of material is expected to be large enough to hinder construction activities if it were stored within the construction right-of-way. The use of UCSAs rather than TEWAs would minimize forested habitat removal while still providing important work areas to facilitate construction.

In some locations, the UCSAs may be used to store spoil or to temporarily park equipment between the mature trees; however, storage and temporary parking of equipment/vehicles would not occur immediately adjacent to the tree so as to minimize impacts (soil compaction or tree damage). PCGP has prepared the *Leave Tree Protection Plan* (see appendix P to the Plan of Development [POD]) detailing how live trees would be protected within the UCSAs. In extremely steep and side sloping topography, the UCSAs may be required as a contingency location to contain rock that rolls beyond the construction limits. Along extremely steep and narrow ridgeline areas, logs, slash, and dead and downed material may be used as cribbing to contain excavated materials during construction (right-of-way grading and trenching activities). During restoration, some of the materials that are pulled out of the cribbing may roll beyond the construction limits. Where feasible, PCGP would retrieve materials that have rolled downhill using cables and chokers attached to standard on-site restoration equipment (i.e., bulldozers and trackhoes) to winch the material back to the right-of-way. There may be some cases where retrieval of the lost cribbing material may cause more harm to resources than allowing it to remain where it settled to naturally decompose. In these areas, it would be infeasible and impractical to retrieve all of the overcast materials because additional tree clearing and grading would be required to reach the materials.

PCGP has identified about 676 acres of UCSAs that would be used during construction. There are 115 UCSAs within riparian zones that are within 1 site potential tree height of 94 waterbodies. The UCSAs are considered temporary disturbance because they would not be cleared and the materials (i.e., slash, stumps and downed and dead material, etc.) stored within them would be removed during restoration activities, with the exception of unrecoverable materials on steep slopes as described above.

In many cases, the use of UCSAs would have impacts on the forest understory, but temporary reduction of understory shrub cover does not produce the effects of an "edge." After removal of the materials stored in the UCSAs, the understory would recover.

Contractor and Pipe Storage Yards

PCGP has identified 36 temporary pipe storage and contractor yards and rail ports (see table 2.1.2-5 and appendix A) that may be used during construction to offload and store pipe and stage contractor equipment. These sites are generally not along or immediately adjacent to the proposed Pipeline. The yards would also be used to stage equipment and store materials used during construction. Stored materials may include: construction mats, fencing materials, fuel and lubricants, stormwater control materials (straw bales, erosion control fabric, silt fence materials, etc.) and other materials. The yards would also be used for contractor office trailers and employee parking facilities. The yards that are available for use would be secured during the easement acquisition phase, which is anticipated to begin prior to construction. Figures of the proposed yards are provided in appendix I. The yards total about 674 acres.

In general, PCGP selected yard locations because they are existing industrial sites that have been previously graded and graveled, are proximate to the Pipeline project area, and can be accessed by railroad or roads. All of the currently identified sites are privately owned.

Of the 36 yards, 26 were surveyed for wetlands and access was denied to 10. No wetland features are present on 15 of the surveyed yards. Eleven yards contain wetland features or drainage ditches, which would be protected during construction. Because most of the yards are existing industrial facilities, they do not contain high quality wildlife habitat.

Rock Source and Disposal Sites

Permanent disposal sites may be required to handle excess rock, spoil, or drilling mud that are generated during construction. Prime disposal sites for these materials include existing rock/gravel quarries and pits near the pipeline route. Where existing quarries or pits are not available, PCGP has identified stable sites along the right-of-way as permanent disposal sites. PCGP has identified 20 rock source/disposal sites which total about 86 acres (see appendix G). Of these 20 rock source/disposal sites, 15 sites are existing quarries/gravel pits or abandoned quarries/gravel pits. It is not PCGP's intent to expand these sites beyond the existing or previously disturbed footprints.

Construction Access Roads

About 724 existing roads, totaling 670 miles, would be used for access to the Pipeline right-of-way during construction. Existing egress and ingress points to and from the construction right-of-way have been identified in the table in appendix J as well as on the USGS quad-based maps in appendix A. These points have been identified to allow for safe, efficient construction and movement of equipment and materials.

In some areas, it would be necessary to grade or widen existing roads (to allow large equipment a turning radius) to access the construction right-of-way. Minor improvements (i.e., filling potholes, grading to remove ruts, and/or limbing to remove overgrowth) may be needed in some areas to accommodate oversized and heavy construction equipment (see footnotes in appendix J). In general, roadway improvements would require a minimal amount of site disturbance and earthwork necessary to make the roads useable for access to the construction right-of-way. Widening access roads in the identified constricted locations is necessary to accommodate the potential for the stringing trucks to "walk" outside of the existing road footprint. In some circumstances, it may also be necessary for oncoming traffic to "pull out" of the existing road footprint for passing purposes.

TABLE 2.1.2-5

Contractor and Pipe Storage Yards that may be used during Construction of the Pipeline Project

Name	County	Size (acres)	Description
North Spit Dock Yard	Coos	4.79	Industrial dock with gravel/native surface lot
Menasha	Coos	36.93	Export log yard and dock with rail sidings
K-2	Coos	25.56	Export log yard and dock with rail sidings
Brunell	Coos	12.88	Vacant industrial lot and dock with rail siding
Millington 1	Coos	28.4	Log yard
Millington 2	Coos	5.66	Vacant industrial lot, connected to railroad
Coquille Yard	Coos	20.37	Old industrial mill site, vacant lot
Coquille Park	Coos	3.28	Sturdivant Park, adjacent to rail siding
Coquille Mill	Coos	4.37	Mill log, lumber, storage yard and parking lot, adjacent to rail siding
Coquille Sawmill Yard	Coos	7.46	Industrial lot/previous sawmill that was utilized as a contractor's yard
Winchester	Douglas	101.94	Undeveloped lots connected to rail yard, adjacent to interstate interchange
Green #1 Yard	Douglas	9.37	Vacant industrial lot, adjacent to rail siding
Green District Yard	Douglas	7.06	Vacant industrial lot/ log yard, gravel surface/ parking lot adjacent to railroad
Hult Chip Yard 2 (Pipe)	Douglas	13.30	Vacant industrial site; paved/gravel surface
Hult Chip Yard (Parking)	Douglas	2.66	Vacant industrial site; gravel surface
Hult Chip Yard 1 (Roll)	Douglas	8.91	Vacant industrial site; paved lot with rail siding
Roth	Douglas	3.79	Pasture, adjacent to rail siding, connects to project right-of-way
Weaver Highway 99	Douglas	6.37	Vacant undeveloped lot adjacent to Interstate interchange and close to railroad and sidings
Weaver Road Yard	Douglas	7.77	Vacant industrial log storage yard, adjacent to railroad
Riddle Main Street	Douglas	8.78	Vacant industrial lots including railroad siding
Riddle Pasture	Douglas	7.31	Vacant field adjacent to industrial sites and rail siding
Milo Yard 1	Douglas	5.27	Reclaimed quarry
Milo Yard 2	Douglas	10.32	Reclaimed quarry
Burrill Lumber	Jackson	61.44	Vacant lumber mill/log yard
Avenue F and 11th Street	Jackson	26.15	Industrial business and vacant graveled lot, adjacent to rail sidings
WC Short	Jackson	8.36	Rail siding and industrial yard
Rogue Aggregates	Jackson	38.90	Pasture/undeveloped land within active aggregate quarry and processing facility and undeveloped land includes rail siding
Collins Pacific Yard 1	Klamath	9.47	Active wood products plant – vacant gravel lot
Collins Pacific Yard 2	Klamath	5.41	Active wood products plant – vacant gravel lot
Klamath Falls Amuchastegui Building	Klamath	25.46	Existing commercial site and undeveloped industrial lots adjacent to rail siding
Klamath Falls Industrial Oil	Klamath	39.48	Undeveloped industrial lots adjacent highway, rail and rail sidings.
Klamath Falls Memorial Drive 2 / Bair	Klamath	65.53	Undeveloped industrial lots adjacent to rail siding
Klamath Falls Memorial Drive 1 Pipe Yard	Klamath	24.72	Vacant industrial mill site / lot, adjacent to railroad and sidings
Klamath Falls Cross Road East	Klamath	6.99	Farmland, adjacent to rail siding
Klamath Falls Cross Road West (Stukel) Rail siding	Klamath	9.93	Railroad siding
Merrill Oregon RR Siding	Klamath	9.78	Pasture adjacent to rail siding
	Total	**674.17**	

PCGP has estimated that 27 existing roads (32 locations) would need to be modified to handle construction traffic. These roads have been identified with footnotes in appendix J. PCGP has estimated that modifications of existing access roads may be required outside of the existing road bed, resulting in about 22.5 acres of disturbance.

During use of existing roads for construction, paved surfaces would be kept clear of large accumulations of mud and other debris. Dirt roads may be maintained by grading, or covered by gravel. Appropriate sediment and erosion control devices would be installed along dirt roads used during wet weather or the rainy season to contain potential impacts to the road surface.

Table 2 in appendix J lists access roads needing improvement that are within 100 feet of waterbodies. With implementation of the procedures in the ECRP (see appendix F), PCGP does not anticipate that improvement of these existing roads would have any significant impacts on nearby waterbodies, as erosion and sedimentation would be controlled and minimized. Therefore, there would be no adverse impacts from road improvements on federally listed aquatic species in those waterbodies.

New Temporary Access Roads

PCGP has identified 10 locations where it would be necessary to construct new TARs (see appendix A). Construction of the TARs would temporarily impact four acres. After installation of the pipeline, the TARs would be restored to their previous condition and land use. Table 2.1.2-6 lists all temporary and permanent access roads that are required for the Pipeline.

The potential increase in surface runoff from the Pipeline project's temporary or permanent access roads is expected to be insignificant. Most of the TARs would require minor grading to access the right-of-way from existing roads because they are located in pastures, along gentle terrain, or along existing two-track roads.

Only one of the TARs would be located within 100 feet of a wetland or waterbody (see table 2 in appendix J). Of the TARs to be constructed, three are within riparian zones of fish-bearing waterbodies and one of the three is on BLM lands within a designated Riparian Reserve (TAR-27.06 at Middle Creek). Appropriate BMPs outlined in PCGP's ECRP (see appendix F) would be utilized to ensure that potential surface runoff and potential sedimentation impacts on waterbodies and wetlands from use of these roads would be avoided or minimized.

Permanent Access Roads

PCGP would need to construct 15 new PARs for access to the right-of-way and aboveground facilities (see appendix A). These roads would provide access during operations and maintenance activities while the pipeline is in service. Most of the PARs would be located within PCGP's permanent easement. Construction of the PARs would permanently impact about 2.2 acres.

Most of the disturbance associated with these PARs would occur within disturbed areas associated with the pipeline's construction right-of-way or along existing two-track roads. Three of the permanent access roads would be located within riparian zones of three waterbodies, two of which are non-fish bearing. PCGP would ensure that the roads are appropriately stabilized using gravel and appropriate BMPs, as outlined in the ECRP (see appendix F), to minimize potential surface water runoff and to avoid potential sedimentation impacts. No waterbodies or Riparian Reserves on federal lands would be affected by PARs.

TABLE 2.1.2-6 Temporary and Permanent Access Roads for the Pipeline Project				
Access Road (TAR/PAR-MP)	**Dimension (feet)**	**Impact (acres)** [1]	**Jurisdiction**	**Purpose**
TAR-27.06	20x1,500	0.69	BLM – Coos Bay	Access to TEWA 27.05-W
TAR-29.92	16x2,249	1.03	Private	Access TEWA 29.87-N
TAR-88.69	20x416	0.19	Private	Access to TEWA 88.62-N
TAR-94.81	20x114	0.05	Private	Access to S. Umpqua River
TAR 101.70	25x1,517	0.69	Private/FS - Umpqua	Access to TEWA 101.63-W
TAR-141.10	25x471	0.44	Private	Access to TEWA-140.98
TAR 143.19	20x146	0.07	Private	Access to right-of-way
TAR 145.60	20x391	0.18	Private	Access to TEWA 145.58-N
TAR-208.72	20x281	0.13	Private	Access to TEWA-208.67-W
TAR-215.72	14x728	0.33	Private	Access from Taylor Road
	Total TAR	**3.80**		
PAR-15.07	25x258	0.15	Private	Access to BVA#2
PAR-29.48	25x85	0.04	Private	Access to BVA#3
PAR-48.58	25x222	0.13	BLM	Access to BVA#4
PAR-59.58	25x105	N/A* (0.07)	Private	Access to BVA#5 McNabb Creek Rd.
	25x90	0.04	Private	
PAR-71.46	25x692	0.84	Private	Access to BVA#6; Access to right-of-way
PAR-80.03	25x92	0.05	BLM	Access to BVA #7
PAR-94.66	25x501	0.29	Private	Access to BVA#8
PAR-113.66	25x73	0.04	Private	Access to BVA#9
PAR-122.18	25x181	0.10	Private	Access to BVA#10
PAR-132.46	25x271	0.16	Private	Access to BVA#11 Launcher/Receiver
PAR-150.70	25x282	0.16	BLM	Access to BVA#12
PAR-169.48	25x219	N/A* (0.13)	Private	Access to BVA#13
	25x123	0.06	Private	
PAR-187.46	25x377	N/A* (0.23)	Private	Access to BVA#14/ Launcher/Receiver Existing Unknown Rd.
	25x61	0.02	Private	
PAR-196.53	25x106	0.04	Private	Access to BVA#15
PAR-211.58	25x72	0.04	Private	Access to BVA#16
	Total PAR	**2.16**		
	Total TAR & PAR	**5.96**		

[1] All or portions of the PARs are located within the permanent Pipeline easement.
* Existing roads not included in area of impact (acreage represented in parentheses and not included in total).

2.1.2.3 Construction Methods and Potential Impacts – Pipeline

All pipeline facilities would be designed, constructed, tested, operated, and maintained to conform with DOT requirements found in 49 C.F.R. Part 192; FERC regulations at 18 C.F.R. §380.15; and other applicable federal and state regulations. PCGP would follow its ECRP while constructing the Pipeline and associated facilities. This plan was modeled on the FERC's *Plan* and *Procedures* (appendix C), with project-specific modifications, and other changes based on reviews by the BLM and Forest Service. During activities associated with constructing the Pipeline and associated facilities (survey, timber clearing, construction, and revegetation), PCGP would ensure that construction contracts include stipulations to ensure that all trash, food waste, debris, and other items attractive to corvids and other potential predators are picked up and removed from the project area on a daily basis. PCGP's environmental inspectors (EIs) and FERC's third-party Environmental Monitors would be responsible for overseeing that the construction contractor is adequately following these stipulations.

The Pipeline would be divided into seven or more construction spreads to allow for mainline construction in two construction seasons. Average numbers of personnel for the seven spreads would range between 137 and 610. It is estimated that there would be approximately 10 to 25 surveyors and 25 to 150 construction and EIs along the pipeline route during mainline construction. Construction of the Klamath Compressor Station would require between 25 and 100 workers, and the three proposed meter stations would require between 15 and 75 construction personnel.

Construction Spreads and Sequence

Standard pipeline construction proceeds in the manner of an outdoor assembly line composed of specific activities that make up the linear construction sequence. These operations collectively include survey and staking of the right-of-way, clearing and grading, trenching, pipe stringing and bending, welding and coating, lowering-in and backfilling, hydrostatic testing, right-of-way cleanup, and restoration. PCGP has determined that to efficiently construct the pipeline, construction would be divided into seven or more separate construction spreads. The construction spreads would include all construction/restoration activities within a specific milepost range along the pipeline.

Preliminary locations of construction spreads identified by PCGP include the following:

- Early Works – 0.0–7.34R
- Spread One – MPs 7.34R–29.54;
- Spread Two – MPs 29.54–51.58;
- Spread Three – MPs 51.58–71.37;
- Spread Four – MPs 71.37–94.75;
- Spread Five – MPs 94.75–132.52;
- Spread Six – MPs 132.52–162.40; and
- Spread Seven – MPs 162.40–228.81.

Surveying and Staking

Prior to the start of construction, the exterior right-of-way limits and the boundaries of TEWAs shown on the Environmental Alignment Sheets would be civil surveyed and clearly staked. Any pre-existing property line or survey monuments that occur within the construction right-of-way would be protected where possible, and if damage occurs during construction, these monuments would be replaced according to state and federal standards. Civil surveys on federal lands would be conducted in accordance with PCGP's *Right-of-Way Marking Plan* (included as appendix T to the POD). Civil survey is generally performed on foot or using all-terrain vehicles (ATVs) or off-highway vehicles (OHVs) from existing access points to the pipeline right-of-way. An EI would verify the limits of the staked right-of-way and TEWAs and these survey stakes would be maintained throughout construction. Approved access roads would be signed. Also signed would be sensitive environmental areas that would be off-limits to construction crews.

Clearing and Grading

During tree and brush clearing, all operations and tree falling would occur within the certificated construction limits. On lands supporting taller shrub-type vegetation cover (sagebrush communities), PCGP would clear the right-of-way by mowing or scalping off the tops of the shrubs with a motor-grader or a bulldozer. Hayfields and vegetation cover types such as grass, low shrubs, or other low-growth vegetation would not be cleared except in areas directly over the trench or where grading would be required. The cleared vegetation material would be stored on the edge of the right-of-way and spread back over disturbed areas during final restoration. PCGP has produced a *Right-of-Way Clearing Plan for Federal Lands* as appendix U to the POD. The general clearing procedures outlined in that plan would also apply to non-federal lands.

During clearing operations, existing fences crossed by the pipeline route would be cut and braced, and temporary gates installed to control livestock and limit public access to the right-of-way. Temporary erosion control devices would be installed at the end of clearing activities. Details about erosion control devices can be found in PCGP's project-specific ECRP, in the FERC's *Plan*, and the POD. Clearing in wetlands would be done in accordance with the FERC's *Procedures*.

Following clearing, the right-of-way would be graded where necessary to create a reasonably level working surface to allow safe passage of construction equipment and materials. During grading activities, topsoils would be separated from subsoils, and each would be stored in segregated piles within the construction right-of-way and TEWAs. The FERC's *Plan* requires topsoil segregation in residential areas, crop lands, pastures and hayfields, and in other areas as required by the landowner. The topsoil should be stripped either across the entire construction right-of-way, or over the trench line and soil storage areas. In wetlands, the FERC's *Procedures* require that the top foot of soil over the trench line be salvaged, except in areas of standing water or saturated soils. Where topsoil would be segregated on non-federal lands, PCGP has requested 10 additional feet of TEWA in addition to the 95-foot-wide construction right-of-way in uplands.

Timber Removal

Timber cruises would be conducted prior to vegetation clearing to determine timber volumes, values, and species composition within forested lands. PCGP would be required to retain qualified foresters and logging engineers to develop site-specific logging plans for each area to be logged. Merchantable timber would be removed and sold according to landowner stipulations. PCGP's ECRP (see appendix F to the POD) describes the BMPs that would be applied during timber clearing.

Clearing of forest is a two-step process: tree felling, followed by yarding. PCGP's *Clearing Plan* outlined 15 different scenarios that may be used to cut and remove timber from the right-of-way along the pipeline route, based on slope, stand density, and tree types.

The specific logging methods would not be determined until after a contractor has been selected through the bidding process for each construction spread. PCGP expects that the use of all logging methods may be necessary during clearing to efficiently remove timber from the right-of-way, depending on the site-specific geographic conditions. Timber cutting can be done by mechanical means (using tracked feller-buncher, saw, or shear) or by hand methods with a chainsaw. Alternative harvest equipment could include tracked crawler stroke-delimber and tracked crawler-chipper. Yarding can be done by cable or helicopter. Ground-based skidding and cable yarding would likely be the standard methods. Ground-based skidding would use tracked grapple and rubber-tired grapple equipment. Ground-based yarding could use shovel logging methods (with tracked feller-buncher, hydraulic grapple heel boom, or dangle-head processer).

In some isolated rugged topographic areas with poor access, helicopter logging may be utilized. Cable and helicopter logging methods would minimize the potential for soil compaction. Helicopter yarding is currently proposed for the following locations but would not be finalized until a contractor is selected for project construction:

Begin MP	End MP	Helicopter Staging
		TEWAs 6.49-W, 7.21-N, 7.44-W, 10.22-W, 13.79-W, 14.62-W, 15.75-W, 16.71-W, 18.05, 21.12-W, 23.99-N, 21.87-N
37.10	38.42	TEWAs 36.63-W, 36.97-W, 37.15-N, 38.32-W, 38.32-N, 38.90-W, 39.18-N
46.70R	47.20R	TEWAs 46.75-N, 47.53-N, 47.52-W
60.50	61.50	TEWAs 60.52-N, 60.54-W, 60.59-N, 60.87-W, 60.88-N, 61.43-N
77.80	79.90	TEWAs 77.72-N, 77.95-W, 78.99-W, 79.85-N
92.46	94.50	TEWAs 92.62, 92.62-N, 92.63-W, 93.01, 93.01-N, 94.56-W
95.10	97.05	TEWAs 95.39, 96.22-N, 96.23-W 97.02-N, 97.04-W
97.70	98.00	TEWAs 97.63, 97.79-N, 97.91-W
101.30	102.30	TEWAs 101.62-N, 101.75-N, 102.19-N
108.50	110.40	TEWAs 109.10-W, 110.34-W, 110.73 (Helicopter landing Peavine Quarry)
116.30	117.85	TEWAs 116.59-W, 117.67-N
123.30	125.15	TEWAs 123.53-W, 123.71-N, 124.30-N, 124.54-W, 124.71-W, 124.96-N

Prior to clearing operations, PCGP would flag existing snags in forested areas on the edges of the construction right-of-way or TEWAs, to protect those snags from removal during timber cutting, where feasible. These snags would be saved to benefit primary and secondary cavity-nesting birds, mammals, reptiles, and amphibians. During this process, other large-diameter trees on the edges of the construction right-of-way and TEWAs would also be flagged and saved as green recruitment or habitat trees, where possible. Some of these trees would be girdled to create snags to benefit wildlife. Snags and habitat trees would be retained if they do not pose a safety hazard to construction activities, as per the regulations outlined by OSHA.

Trees would be felled or sheared in a manner that would not impact adjacent forest or structures outside of the right-of-way. Trees would also be felled away from wetlands, waterbodies, and riparian reserves. PCGP would not remove stumps or root systems from wetlands, except along the trench line, unless necessary for safety reasons during construction. In upland forest, PCGP would also limit stump removal to the trench line and areas where grading would be necessary to create a level working surface. Any debris as a result of tree cutting that falls into a waterbody would be removed, if practical. Logs and slash would not be yarded across perennial streams unless fully suspended. Existing logs firmly embedded into the bed or banks of streams would not be disturbed, unless their removal is necessary for clearing the right-of-way, trenching, or fluming or other waterbody crossing methods. Any existing logs removed from waterbodies during installation of the pipeline would be returned during restoration (if occurring on federally-managed lands, approval would be obtained from the land-managing agency). Landings for clearing operations would not be located in wetlands or riparian reserves. Where feasible, logs yarded out of wetlands or riparian zones would be skidded with at least one end suspended from the ground so as to minimize soil disturbance. Any cut timber designated for in-stream or upland wildlife habitat enhancements would be stored at the edge of the right-of-way or in TEWAs for later use during restoration activities. Where large woody debris (LWD) is acquired for project in-stream habitat use, this material would only be obtained from the certified construction limits and would be collected outside riparian zones to maintain root structure within the riparian zone. An exception to this is where the LWD can be obtained from the trenchline or right-of-way cut areas where root systems would be removed during trench excavation or grading operations.

Trees to be cleared in forested areas along the pipeline route are typically considered too large to be taken whole for yarding. Therefore, trees would be cut, topped, limbed, and bucked on site where they have fallen. Generally, only the logs would be yarded to a landing for decking, loadout, and transport. The remainder of the wood debris from clearing (i.e., tree tops and limbs) would remain on the ground within the construction right-of-way where the trees were cut. During logging, tree tops and limbs would be broken or crushed creating a volume of small slash that would be impractical to remove from the right-of-way. Some of the slash on the ground would act as erosion control between the time the right-of-way is cleared and the pipeline is installed.

Danger trees are those trees at risk of falling on workers or vehicles and thus would need to be removed for safety reasons. A tree may be at risk of falling for a number of reasons including the tree's location and the presence of defects, insects, disease, work activities, and weather conditions. Such trees would be felled in advance of logging, pipeline construction, road construction/reconstruction, and road maintenance. Additionally, danger trees could be created from trees felled for the pipeline. This would occur if trees outside of approved construction areas are damage during felling of harvested timber. While this could result in growth loss, for which PCGP would compensate the land-management agency (or landowner on private lands) for any trees removed and any loss in timber productivity, the FERC requires that all operations be contained within the certificated work areas. Danger trees would be designated by qualified PCGP representatives, in accordance with OSHA standards and the Forest Service/BLM–published *Field Guide for Danger Tree Identification and Response* (Forest Service and BLM 2008). Danger trees would be directionally felled, when consistent with OSHA guidelines, away from the construction right-of-way if trees are to be left on the right-of-way, and towards the construction right-of-way if trees are to be removed. FERC compliance monitors in the field would review and approve as appropriate requests to remove danger trees outside the approved construction area.

Treatment of Forest Slash

Slash from timber clearing would be salvaged on or at the edge of the right-of-way and redistributed across the right-of-way during final cleanup and reclamation. Scattering the slash across the right-of-way would hinder OHV traffic on the right-of-way and would act as a natural mulch to minimize erosion (see appendix F).

Because more than one ton per acre of woody material (logs, slash, and chips) may be scattered across the right-of-way during final cleanup in many areas, PCGP requested a modification from Section IV.F.4.e. of the FERC's *Plan*. PCGP would utilize the fuel loading standards of the BLM and the Forest Service as the limit for the quantity of woody debris that would be distributed across the right-of-way to minimize fire hazard risks for this variance request. PCGP requested this modification because it would be impractical and infeasible to remove this material from the right-of-way and it is a typical silvicultural practice in the Pipeline project area (i.e., forest slash left in logged areas). Furthermore, it is expected that the woody slash material would not deplete soil nitrogen in the short term, during revegetation establishment, because the size of the woody material that would be scattered on the right-of-way would be large and would not readily decay in the short-term.

On NFS lands, the maximum amount of slash that would be scattered across the right-of-way would be 12 tons per acre (see table 2.1.2-7), and on BLM and private lands the maximum would be 15 tons per acre (table 2.1.2-8). In areas where the fuel loading exceeds these standards, PCGP would machine or hand pile and burn the excess material, depending on the site location, according to the requirement of the landowner. Burning would occur during the appropriate burning season and according to the conditions permitted by the BLM, the Forest Service, and the ODF. PCGP developed a Prescribed Burning Plan (see appendix R to the POD).

TABLE 2.1.2-7

Fuel Loading Specification by Size Class on NFS Lands

Size Class (diameter)	tons/acre
0 to 1/4 inch	< 1
1/4 to 3 inches	4 to 8
3 to 8 inches	7 to 12
Maximum Total Loading	12

TABLE 2.1.2-8.

Fuel Loading Specification by Size Class on BLM and Private Lands

Size Class (diameter)	tons/acre
0 to 1/4 inch	< 1 a/
1/4 to 8 inches	5 to 8 a/
>8 inches	10 to 15

a/ Adapted from Forest Service Fuel Loading Standards

Weeds and Forest Pathogens

Noxious weeds which are target species are listed as "Class T" by the ODA. Of the weeds documented within the pipeline area during botanical surveys conducted by PCGP, only spotted knapweed, rush skeletonweed, Dalmatian toadflax, tansy ragwort, and gorse were Class T weeds.

Invasive or noxious plants can negatively affect habitat by competing for resources such as water and light, changing the community composition, eliminating or reducing native plants, or changing the vegetation structure. The changes in community composition or vegetation structure can reduce native plant populations and can also negatively affect habitat for wildlife.

Pipeline construction can cause the spread or establishment of noxious weeds. Soil disturbance and/or removal of existing vegetation for pipeline or road construction can provide openings for invasive or noxious plants to establish or spread. Movement of equipment can also provide opportunities for seed transport into new areas. In general, habitats with more bare ground, such as grasslands, riparian areas, and relatively dry or open forests, are more susceptible to invasion than are dense, moist forests, high montane areas, and serpentine areas that have relatively closed canopy cover or have extreme climate or soils that are tolerated by fewer invasive plant species.

PCGP's ECRP includes measures to control noxious weeds, soil pests, and forest pathogens. In addition, PCGP developed an *Integrated Pest Management Plan,*[6] in consultation with the ODA (Butler 2006), BLM, and the Forest Service, to minimize the potential spread and infestation of weeds along the construction right-of-way. This plan includes surveys prior to construction to

[6] See appendix N to the POD.

determine the presence of noxious weeds; cleaning of construction equipment (in areas where weeds have been identified or when leaving these areas) to prevent the import and spread of weeds; and vegetation clearing and grading requirements in areas of noxious weeds. Additionally, disturbed areas would be replanted with appropriate seed mixes to prevent noxious weed germination. After construction, the right-of-way would be monitored and any noxious weed infestations would be controlled.

PCGP's *Integrated Pest Management Plan* also identifies BMPs and conservation measures that would be implemented to minimize the spread of forest pathogens and insects along the pipeline route. PCGP would identify/verify areas infested with forest pathogens during timber cruises prior to construction and implement minimization measures, including but not limited to cleaning equipment and vehicles upon entering/departing infested areas, applying sporax/borax on freshly cut stumps and wounds to reduce spread of root rot, and utilizing standard logging practices that minimize or prevent damage to standing trees adjacent to the Pipeline.

Forest Fragmentation and Edge Effects

The Pipeline route would cross about 142 miles of forest and 34 miles of shrubs and grasslands. Of the forested land crossed, about 39.3 miles would be late successional old growth, and 43.6 miles would be mid-seral. PCGP estimated that during clearing of the construction right-of-way, it would harvest about 1,189 acres of large mature trees over 40 years in age and approximately 911 acres of younger small to medium sized trees. During operation of the Pipeline, a 30-foot-wide corridor would be maintained in an herbaceous state, resulting in the permanent removal of about 517 acres of forest.

Fragmentation, or breaking up of contiguous areas of vegetation into smaller patches that become progressively smaller and isolated over time, has occurred and continues to occur within the areas crossed by the pipeline route. Because the Pipeline is linear, the created patch associated with the new edge would be narrow. Creation of edges by the Pipeline would affect seral stands differently. Forest edges play a crucial role in ecosystem interactions and landscape function, including the distribution of plants and animals, fire spread, vegetation structure, and wildlife habitat. Creation of forest edge adjacent to dense canopy would impact microclimate factors such as wind, humidity, and light, and can lead to a change in species composition within the adjacent forest or increase invasion by invasive species. Compared to the forest interior, areas near edges receive more direct solar radiation during the day, lose more long-wave radiation at night, have lower humidity, and receive less short-wave radiation. Increased solar radiation and wind can desiccate vegetation by increasing evapotranspiration, can affect which species survive along the edge (typically favoring shade intolerant species), and can impact soil characteristics.

Different species composition and abundance occurs in edge habitats (Forman and Gordon 1986) than within patch interiors, depending on species' tolerances for the variation in microclimatic parameters. Often present along the edge are higher levels of flower and fruit production, pollinator, and frugivore densities and seed dispersal. Some terrestrial amphibians have narrow temperature and moisture tolerances (Spotila 1972; Feder 1983). Loss of canopy cover and coarse woody debris can affect microclimatic conditions found advantageous by some amphibians. Some wildlife species use right-of-way corridors created by linear utilities. The herbaceous pipeline right-of-way would provide browse for ungulates, such as deer and elk.

Increased herbivore density provides a food source for predators (Forman 1995), so predator density can be increased along the edge.

Edge habitat created by the pipeline right-of-way is expected to have positive and negative impact on bird species. Expected positive effects are increased diversity and density of bird species, increased access to a variety of food resources, and increased ground cover favoring ground-nesting species (Rosenberg and Raphael 1986). Potential negative impacts include increased brood parasitism, increased nest depredation in grasslands, forests and edge habitats, and lower nesting success (Thomas and Toweill 1982; Burger et al. 1994; Vickery et al. 1994; Marini et al. 1995; Danielson et al. 1997; Brand and George 2000).

To minimize the effects of the Pipeline project on fragmentation and edge effects, PCGP would replant native shrubs and trees within the temporary construction right-of-way outside of the 30-foot-wide operational pipeline maintenance corridor right-of-way, per the requirements found in its ECRP (e.g., by revegetating the area, the hard edge along the fragment would be reduced, thereby minimizing the effects of fragmentation and edge effects).

Douglas-fir and western hemlock planted adjacent to edges of clearcut and/or early regenerating stands (assuming conifers from 1 to 10 feet tall at the time of construction) would modify edges with the seral stands from hard to soft to no edge as they grow. In 50 years, which is the operational life of the Pipeline, trees replanted in temporary workspaces outside of the 30-foot maintenance corridor would similarly modify edges of regenerating and mid-seral stands adjacent to the right-of-way, from hard to soft edge characteristics as tree heights increase. As the replanted trees grow, edge contrasts would decrease as would effects on forest interiors, because taller trees would reduce direct solar radiation and increase soil moisture and humidity along the edges of stand interiors (Chen et al. 1995; Heithecker and Halpern 2007).

During right-of-way restoration, PCGP would create habitat diversity features within the permanent right-of-way, such as rock and brush piles, that would provide habitat for a variety of wildlife species including mollusks, amphibians, and small mammals. Such features reduce fragmentation effects of abrupt edge characteristics by creating local irregularities. LWD placed within and/or across the right-of-way may eventually contribute to microsite diversification and provide corridors for some wildlife (e.g., terrestrial mollusks) to travel across an otherwise potential barrier. Such movements would be essential to avoid potential genetic isolation of relatively non-mobile species.

Trenching and Backfilling

A rotary trenching machine, rock trencher, track-mounted backhoe, or similar equipment would be used to excavate a trench for the pipeline. Spoil excavated during trenching would be temporarily stockpiled to one side of the right-of-way adjacent to the trench.

PCGP intends to exceed DOT requirements where possible, and bury its pipeline up to 36 inches deep in Class 1 areas with normal soils and 24 inches deep in Class 1 areas with consolidated rock. The trench may be deeper at stream crossings with scour concerns, or areas with geological hazards. PCGP committed to burying the pipeline below the estimated 100-year scour depth or into competent bedrock, whichever is shallower.

During trenching activities, in areas where shallow bedrock is encountered, PCGP would first attempt to utilize specialized excavation methods to reach the required pipeline design burial depth. These excavation methods may include ripping using hydraulic hammers or rock saws. However, if these methods prove to be ineffective or inefficient, blasting may be necessary to achieve the required trench depth.

After trenching is complete, the pipe sections would be strung along the trench, bent to fit the contour of the trench bottom, aligned, welded together, and placed on temporary supports along the edge of the trench. All welds would be visually and radiographically inspected and repaired, if necessary. Line pipe, normally mill-coated prior to stringing, would require field applied coating at the welded joints prior to final inspection. The entire pipeline coating would be inspected and tested to locate and repair any faults or voids. The pipe assembly would then be lowered into the trench by side-boom tractors, and the trench would be backfilled using a backfilling machine or bladed equipment. No foreign substance, including skids, welding rods, containers, brush, trees, or refuse of any kind, would be permitted in the backfill.

PCGP would install trench plugs (see Drawing 3430.34-X-0011 in the ERCP in appendix F) consistent with the requirements of the FERC's *Plan* (see Section V.B.1). Trench plugs would be installed at the base of slopes adjacent to wetlands and waterbodies and where needed to avoid draining of wetlands (springs). Trench plugs may be constructed from sandbags, foam, or bentonite. Topsoil would not be used to fill the bags. Trench plugs would be installed on slopes to minimize water flow down the trenchline to prevent potential subsurface erosion and to maximize stability.

<u>Blasting</u>

If blasting is required, all applicable federal, state, and local regulations would be observed and all necessary permits would be obtained. All blasting activities would be conducted by licensed blasting contractors in accordance with all applicable regulatory requirements. Table 2.1.2-9 lists areas with bedrock that may require blasting.

TABLE 2.1.2-9

Areas with Bedrock that May Require Blasting along the Pipeline Route

From MP	To MP	Blasting Potential	Material
0.00	19.65BR	None to Low	sediments, water, marine sedimentary rocks
19.65BR	19.90BR	Moderate	volcanic rocks
19.90BR	21.49BR	None	Sediments
21.49BR	21.55BR	Moderate	volcanic rocks
21.55BR	21.88BR	None	Sediments
21.88BR	21.96BR	Moderate	volcanic rocks
21.96BR	21.99BR	None	Sediments
21.99BR	22.12BR	Moderate	volcanic rocks
22.12BR	22.34BR	None	Sediments
22.34BR	23.60BR	Moderate	volcanic rocks
23.60BR	45.91	None to Low	marine sedimentary rocks, sediments
45.91	48.18	Moderate	marine sedimentary rocks (hard)
48.18	59.17	None to Low	marine sedimentary rocks, sediments, melange rocks with valley floor sediments, sediments
59.17	59.26	Moderate	melange rocks
59.26	59.38	None	Sediments
59.38	59.50	Moderate	melange rocks
59.50	59.94	None	Sediments
59.94	63.93	Moderate	melange rocks
63.93	63.98	None	Sediments

TABLE 2.1.2-9

Areas with Bedrock that May Require Blasting along the Pipeline Route

From MP	To MP	Blasting Potential	Material
63.98	65.58	Moderate	melange rocks
65.58	67.02	None	sediments, melange rocks
67.02	69.25	Moderate	melange rocks
69.25	70.36	None	melange rocks with valley floor sediments
70.36	71.14	Moderate	metamorphic rocks, sediments
71.14	71.33	High	Sediments
71.33	75.06	Moderate	metamorphic rocks
75.06	78.53	None to Low	marine sedimentary rocks, sediments
78.53	79.02	High	volcanic rocks, intrusive rocks
79.02	79.15	None	Sediments
79.15	81.12	High	intrusive rocks, volcanic rocks
81.12	81.57	None	Sediments
81.57	87.69	High	volcanic rocks, intrusive rocks
87.69	88.25	Low	marine sedimentary rocks
88.25	88.82	High	volcanic rocks, intrusive rocks
88.82	88.95	Low	marine sedimentary rocks
88.95	89.51	High	volcanic rocks
89.51	89.87	Moderate	marine sedimentary rocks
89.83	91.27	Low	marine sedimentary rocks
91.27	94.50	Moderate	marine sedimentary rocks, volcaniclastic rocks
94.50	95.28	None	Sediments
95.28	95.52	High	intrusive rocks
95.52	96.96	Low	marine sedimentary rocks
96.96	108.87	High	intrusive rocks, metamorphic rocks, melange rocks
108.87	109.43	None	Sediments
109.43	110.99	High	volcaniclastic rocks, volcanic rocks
110.99	113.28	Low	volcaniclastic rocks
113.28	113.64	High	volcaniclastic rocks, volcanic rocks
113.64	113.71	Low	volcaniclastic rocks
113.71	116.92	High	volcanic rocks, volcaniclastic rocks, intrusive rocs
116.92	118.19	Low	volcaniclastic rocks
118.19	119.53	High	volcanic rocks
119.53	119.62	Low	volcaniclastic rocks
119.62	119.83	High	volcanic rocks
119.83	120.22	Low	volcaniclastic rocks
120.22	120.40	High	volcanic rocks
120.40	121.68	Low	volcaniclastic rocks
121.68	122.10	High	volcanic rocks
122.10	122.39	Low	volcaniclastic rocks
122.39	122.59	High	volcanic rocks
122.59	123.10	None	Sediments
123.10	125.99	High	volcanic rocks
125.99	126.68	Low	volcaniclastic rocks
126.68	133.55	High	volcanic rocks
133.55	134.10	Low	volcaniclastic rocks
134.10	134.72	High	volcanic rocks
134.72	140.15	None to Low	volcaniclastic rocks, sediments
140.15	141.74	High	volcanic rocks
141.74	141.93	Low	volcaniclastic rocks
141.93	143.50	High	volcanic rocks
143.50	143.89	None to Low	volcaniclastic rocks, sediments
143.89	144.77	High	volcanic rocks
144.77	145.19	Low	volcaniclastic rocks
145.19	145.66	High	volcanic rocks
145.66	145.70	None	Sediments
145.70	146.78	High	volcanic rocks
146.78	146.97	Low	volcaniclastic rocks
146.97	148.23	High	volcanic rocks
148.23	148.26	Low	volcaniclastic rocks
148.26	148.34	High	volcanic rocks
148.34	148.40	Low	volcaniclastic rocks

TABLE 2.1.2-9 Areas with Bedrock that May Require Blasting along the Pipeline Route			
From MP	**To MP**	**Blasting Potential**	**Material**
148.40	172.04	High	volcanic rocks, vent and pyroclastic rocks
172.04	175.40	None	volcanic rocks with overlying thick soil
175.40	186.60	High	volcanic rocks
186.60	186.67	None	Sediments
186.67	190.78	High	volcanic rocks
190.78	212.57	None	terrestrial sedimentary rocks, sediments
212.57	214.75	Moderate	terrestrial sedimentary rocks
214.75	215.03	High	volcanic rocks
215.03	215.15	None	Sediments
215.15	215.61	High	volcanic rocks
215.61	216.44	None	Sediments
216.44	216.51	Moderate	terrestrial sedimentary rocks
216.51	217.05	High	volcanic rocks
217.05	217.50	Moderate	terrestrial sedimentary rocks
217.50	217.89	None	Sediments
217.89	218.49	Moderate	terrestrial sedimentary rocks
218.49	218.92	None	Sediments
218.92	218.93	Moderate	terrestrial sedimentary rocks
218.93	222.06	High	volcanic rocks, volcaniclastic rocks
222.06	222.52	Moderate	terrestrial sedimentary rocks
222.52	223.92	High	volcaniclastic rocks, volcanic rocks
223.92	224.85	Moderate	terrestrial sedimentary rocks
224.85	225.75	None	Sediments
225.75	226.95	Moderate	terrestrial sedimentary rocks
226.95	227.68	None	Sediments
227.68	228.81	High	volcanic rocks

Blasting in uplands during construction is not expected to generate noise levels in excess of 92 dBA, with appropriate mitigation measures applied. Under worst-case conditions, the distance for noise from blasting to attenuate to 92 dBA is 175 to 200 feet away from the pipeline trench (see PCGP's *Blasting and Helicopter Noise Analysis & Mitigation Plan*, appendix P to the POD).

Where blasting is required in streambeds, PCGP proposes to utilize the dam-and-pump crossing method so that blasting activities can be completed in the dry to avoid potential impacts to aquatic species during in-water blasting. If a dam-and-pump crossing method cannot be used and in-water blasting is required, PCGP would implement other techniques such as scare charges to temporarily clear aquatic organisms from the area. It is anticipated that the preparation of the rock for blasting (drilling shot holes) would cause enough disturbance to displace most aquatic organisms from the immediate vicinity of the blast. Immediately following blasting, equipment would remove any shot rock that could impede stream flow.

Construction Noise

The typical ambient sound level for forest habitats ranges from 25 dB to 44 dB. Sound levels from construction of the Pipelne are predicted to be 93 dBA L_{eq} at 50 feet, and would attenuate to 85 dBA L_{eq} and 72 dBA at 100 feet and 300 feet, respectively. Noise would diminish rapidly as the distance from the noise source increases. Distances at which noise would attenuate to ambient levels would depend on local conditions such as tree cover and density, topography, weather (humidity), and wind, all of which can alter background noise conditions. Consequently, short-term impacts on wildlife by construction noise would vary along the length of the pipeline route.

Double rotor helicopters may be used for timber clearing along a portion (15.4 miles) of the Pipeline route. This type of helicopter generates noise of about 92 dBA within 700 feet of its area of use. Mitigation to reduce helicopter noise would include operational restrictions such as maintaining a high altitude and keeping away from noise sensitive areas whenever possible.

Noise could potentially impact wildlife for a short duration during construction activities, including clearing and grading the right-of-way, and horizontal direction drill (HDD) operations. The average time a given point along the pipeline would be disturbed by construction noise is approximately 8 weeks. This would vary, as the speed at which crew would be able to work would be affected by terrain, construction methods, weather, and environmental windows. Noise would most likely displace wildlife some distance away from noise sources especially if wildlife species are nearby. Noise would move along the construction right-of-way in a linear fashion. Therefore, impacts to wildlife because of noise would be of short duration and spatially localized.

Raptors and other forest-dwelling bird species have demonstrated more adverse impacts to project-generated sound during nesting and breeding when levels substantially exceed ambient conditions existing prior to a project (i.e., by 20 to 25 dB experienced by the animal) and when the total sound level is very high and exceeds 90 dB. Such impact could potentially result in egg failure or reduced juvenile survival, malnutrition or starvation of the young, or reducing the growth or likelihood of survival of young. However, these effects may be minimal; Awbrey and Bowles (1990) found that raptors flushed from their nests while incubating did not leave the eggs exposed for more than 10 minutes and concluded that multiple, closely spaced disturbances would be required to cause lethal egg exposure. Some raptors, for example osprey, refuse to be flushed from their nest despite closely approaching helicopters (Poole 1989).

Hydrostatic Testing

After backfilling, the Pipeline would be hydrostatically tested in accordance with DOT regulations to ensure that the system is capable of operating at the maximum operating pressure. If a leak is identified during hydrostatic testing, the line would be repaired and retested until the specifications are achieved.

PCGP's *Hydrostatic Testing Plan* (see appendix U) includes measures to prevent the transfer of aquatic invasive species and disease. Water for hydrostatic testing would be obtained from commercial or municipal sources, private supply wells, or surface water right owners (see table 2.1.2-10). PCGP would negotiate water appropriations with private owners in the year prior to construction. If water for hydrostatic testing is acquired from surface water sources, PCGP would obtain all necessary appropriations and withdrawal permits, including permits through the ODWR. As required by ODFW, pumps used to withdraw surface water would be screened according to NMFS standards to prevent entrainment of aquatic species. With the possible exception of chlorine, used to kill aquatic diseases, PCGP does not intend to add chemicals to the hydrostatic test water.

The Pipeline would be tested in approximately 32 sections; each with varying lengths and water volume requirements (see table 2.1.2-11). During the test, it may be necessary to discharge water at each of the section breaks; however, PCGP would conserve water as much as practical and minimize discharge where feasible by cascading, or transferring, water between test sections.

TABLE 2.1.2-10

Potential Hydrostatic Source Locations

County	MP	Primary Source / *Alternate Source*		Owner	Estimated Withdrawal Requirement *(Longest Test Segment Volume plus pre-test water for HDD/Direct pipe [1])* (acre feet)	Test Section	Spread	ESA Species
South Coast Basin - Coos Bay Frontal Pacific Ocean (1710030403) - Fifth Field Watershed								
Coos	0.00	Coos Bay - North Bend Water Board (North Spit Pump House MP 0.00		Coos Bay - North Bend Water Board	1,938,000 (5.95)	1 -2	Early Works	N/A (municipal water)
	1.31	*Fire Hydrant at base of Hwy 101 MP 1.31*						
Coos	11.08R	Coos River		Oregon Department of Water Resources	2,825,000 (8.67)	3-6	1	In Coos River: • Southern DPS Green Sturgeon • Oregon Coast ESU Coho Salmon
South Coast Basin – E. F. Coquille River (1710030503) - Fifth Field Watershed								
Coos	*29.64*	*East Fork Coquille River*		*Oregon Department of Water Resources*		*3-6*	*1*	*In EF Coquille River: • Oregon Coast ESU Coho Salmon*
Coos	29.64	East Fork Coquille River		Oregon Department of Water Resources	2,458,000 (7.54)	7-10	2	In EF Coquille River: • Oregon Coast ESU Coho Salmon
South Coast Basin - M. F. Coquille River (1710030501) - Fifth Field Watershed								
Douglas	*50.28*	*Middle Fork Coquille River*		*Oregon Department of Water Resources*		*7-10*	*2*	*In MF Coquille River: • None*
Umpqua Basin - Olalla Creek-Lookingglass Creek (1710030212) - Fifth Field Watershed								
Douglas	*57.30 (TEWA 55.90)*	*Water Impoundment*	*Ben Irving Reservoir*	*Douglas County Public Works/ Looking Glass Olalla Water District/ Winston-Dillard Water District*		*11-12*	*3*	*In Ben Irving Reservoir/Berry Creek: • Oregon Coast ESU Coho Salmon*
Douglas	*58.79*	*Looking Glass Olalla Water District (Olalla Creek Crossing)*		*Looking Glass Olalla Water District*		*11-12*	*3*	*In Olalla Creek: • Oregon Coast ESU Coho Salmon*
Umpqua Basin - Clark Branch-South Umpqua River (1710030211) - Fifth Field Watershed								
Douglas	71.25	S. Umpqua River Crossing #1		Oregon Department of Water Resources	4,042,000 (12.40)	11-12	3	In S. Umpqua River: • Oregon Coast ESU Coho Salmon

TABLE 2.1.2-10

Potential Hydrostatic Source Locations

County	MP	Primary Source / *Alternate Source*	Owner	Estimated Withdrawal Requirement *(Longest Test Segment Volume plus pre-test water for HDD/Direct pipe [1])* (acre feet)	Test Section	Spread	ESA Species
Douglas	71.25	S. Umpqua River Crossing #1	Oregon Department of Water Resources	2,878,000 (8.83)	13-17	4	In S. Umpqua River: • Oregon Coast ESU Coho Salmon
Umpqua Basin - Days Creek-South Umpqua River (1710030205) - Fifth Field Watershed							
Douglas	*94.73*	*S. Umpqua River Crossing #2*	*Oregon Department of Water Resources*	*2,878,000 (8.83)*	*13-17*		*In S. Umpqua River: • Oregon Coast ESU Coho Salmon*
Douglas	94.73	S. Umpqua River Crossing #2	Oregon Department of Water Resources	2,535,000 (7.78)	18-20	5a	In S. Umpqua River: • Oregon Coast ESU Coho Salmon
Rogue Basin - Shady Cove-Rogue River (1710030707) - Fifth Field Watershed							
Jackson	122.80	Rogue River Crossing	Oregon Department of Water Resources	2,872,000 (8.81)	21-24	5b	In Rogue River: • SONCC ESU Coho Salmon
Rogue Basin - Little Butte Creek (1710030708) - Fifth Field Watershed							
Jackson	141.00	Star Lake	Frances Jensen – Star Ranch (JK-542.000RT)	3,060,000 (9.39)	25-27	6	In Star Lake: • None
Jackson	*133.38*	*Medford Aqueduct*	*Eagle Point Irrigation*		*25-27*		In Medford Aqueduct: • None
Klamath Basin -Lake Ewauna-Klamath River (1801020412)							
Klamath	199.20	Klamath River	Oregon Department of Water Resources	4,817,000 (14.78)	28-32	7	In Klamath River: • Lost River Sucker • Shortnose Sucker
Klamath Basin -Mills Creek–Lost River (1801020409)							
Klamath	*212.0*	*Lost River*	*Oregon Department of Water Resources*		*28-32*	*7*	In Lost River: • Lost River Sucker • Shortnose Sucker
			Total	**N/A [2]**			

[1] The volumes in the table represent the estimated withdrawal volume from a potential hydrostatic test source, and, in some cases, alternate sources are identified for the same test segment(s) because water withdrawals would be based on conditions at the time of construction.

[2] Totaling the potential withdrawal volumes is not applicable because, as stated in footnote #1, multiple (alternate) sources have been identified for the same test segments. Without cascading (not proposed), the physical volume for all individual test segments would be approximately 64.3 million gallons, or about 40.2 acre feet. With the use of cascading, which is proposed, the minimum test water volume to be withdrawn would be approximately 25,832,000 gallons or 79.28 acre feet across all sources, an approximate 43 percent reduction in water use. The actual volume will be within this range and is expected to be at the lower end of the range.

TABLE 2.1.2-11

Hydrostatic Test Water Discharge Locations within the Construction Right-of-Way

Test Segment	Oregon Plan Watershed Basin	HUC (10-digit) (Begin MP)	HUC (10-digit) (Ending MP)	Begin MP [1]	End MP	Section Length [2] (feet)	Volume [3,4] (gallons) (acre feet)	Potential Water Source (Primary Sources Are in Bold / Alternates are Un-Bolded)	Jurisdiction (Ending MP)	Milepost (MP) Waterbodies Closest to Dewatering Locations [5] (Reach Code)	Distance to Waterbodies [5] (feet)	End Latitude End Longitude
Spread - E.W.												
1	South Coast	Coos Bay Frontal Pacific Ocean 1710030403	Coos Bay Frontal Pacific Ocean 1710030403	0.00	1.31	6,917	366,000 (1.12)	MP 0.00 - North Spit Pump House (Coos Bay) **MP 1.31 - Fire Hydrant on West side of Hwy 101 Bridge**	Private	MP 0.00 Tributary to Coos Bay (17100304022002)	500	43.432966 Begin -124.238834 Begin
										MP 0.00 Coos Bay	850	
										MP 1.31 Coos Bay/ Coos River (17100304006491)	650	43.422047 End -124.221637 End
2	South Coast	Coos Bay Frontal Pacific Ocean 1710030403	Coos Bay Frontal Pacific Ocean 1710030403	1.31	8.35R	17,383	1,181,000 (3.62)		Private	MP 8.4 BR Tributary to Willanch Slough (17100304000413)	240	43.405267 -124.159758
										MP 8.4BR Willanch Slough (17100304001393)	480	
Spread 1												
3	South Coast	Coos Bay Frontal Pacific Ocean 1710030403	Coos Bay Frontal Pacific Ocean 1710030403	8.35R	11.04R	19,154	751,000 (2.30)	**MP 11.08R - Coos River** MP 29.64 - East Fork Coquille River	Private	MP 11.04BR Coos River (17100304000093)	350	43.375797 -124.141648
										MP 11.04BR Tributary to Coos River (17100304015694)	50	
4	South Coast	Coos Bay Frontal Pacific Ocean 1710030403	Coos Bay Frontal Pacific Ocean 1710030403	11.04R	19.62BR	45,302	2,395,000 [4] (7.35)		BLM-Coos	No Water Release at MP 19.62BR.		
5	South Coast	Coos Bay Frontal Pacific Ocean 1710030403	N.F. Coquille River 1710030504	19.62BR	23.95	21,701	1,147,000 (3.52)		Private	23.93 Tributaries to N. Fork Coquille (17100305012274, 17100305012275,)	300-800	43.209046 -124.061842
6	South Coast	N.F. Coquille River 1710030504	E. F. Coquille River 1710030503	23.95	29.54	48,101	2,543,000 (7.80)		Private	MP 29.54 East Fork Coquille River (17100305000286)	500	43.1561 -123.994802
Spread 2												
7	South Coast	E. F. Coquille River 1710030503	M. F. Coquille River 1710030501	29.54	37.15	40,181	2,215,000 (6.80)	**MP 29.64 - East Fork Coquille River** MP 50.28 - Middle Fork Coquille River	BLM-Coos	No Water Release at MP 37.15.		
8	South Coast	M. F. Coquille River 1710030501	M. F. Coquille River 1710030501	37.15	38.90	9,240	489,000 (1.50)		BLM-Coos	No Water Release at MP 38.90.		
9	South Coast	M. F. Coquille River 1710030501	M. F. Coquille River 1710030501	38.90	47.40	44,880	2,373,000 (7.28)		Private	MP 47.40 Deep Creek (17100305022950, 17100305005863)	400-500	43.051877 -123.737828
										MP 47.40 Trib. To Reed Creek (17100305022461)	300	
10	South Coast	M. F. Coquille River 1710030501	M. F. Coquille River 1710030501	47.40	51.58	22,070	1,167,000 (3.58)		Private	MP 50.23 Middle Fork Coquille River (17100305000232)	300	43.055668 -123.682629
										MP 51.58 Tributary to Jim Belieu Creek (17100305022641)	1380	43.050645 -123.658768

TABLE 2.1.2-11

Hydrostatic Test Water Discharge Locations within the Construction Right-of-Way

Test Segment	Oregon Plan Watershed Basin	HUC (10-digit) (Begin MP)	HUC (10-digit) (Ending MP)	Begin MP [1]	End MP	Section Length [2] (feet)	Volume [3, 4] (gallons) (acre feet)	Potential Water Source (Primary Sources Are in Bold / Alternates are Un-Bolded)	Jurisdiction (Ending MP)	Milepost (MP) Waterbodies Closest to Dewatering Locations [5] (Reach Code)	Distance to Waterbodies [5] (feet)	End Latitude End Longitude
Spread 3												
11	Umpqua	M. F. Coquille River 1710030501	Olalla Creek-Lookingglass Creek 1710030212	51.58	57.76	32,630	1,725,000 (5.29)	MP 57.30 - Ben Irving Reservoir MP 58.79 - Ollala Creek **MP 71.25 - South Umpqua River**	Private	MP 57.76 Trib. To Olalla Creek 17100302002221	570	43.066609 -123.551655
										MP 57.76 Olalla Creek 17100302000048	900	
12	Umpqua	Olalla Creek-Lookingglass Creek 1710030212	Clark Branch-South Umpqua River 17100302011	57.76	71.37	75,029	3,967,000 [4] (12.17)		Private	MP 71.37 Tributaries to South Umpqua River 17100302006366	100	43.052768 -123.328794
										MP 71.37 South Umpqua River 17100302000086	500	
Spread 4												
13	Umpqua	Clark Branch-South Umpqua River 17100302011	Myrtle Creek 1710030210	71.37	81.30	52,430	2,772,000 (8.51)	**MP 71.25 - South Umpqua River** Additional Potential Sources: South Myrtle Creek	Private	81.30 South Myrtle Creek 17100302008796	500	43.034704 -123.187105
14	Umpqua	Myrtle Creek 1710030210	Days Creek-South Umpqua River 1710030205	81.30	88.63	38,702	2,046,000 (6.27)	**MP 71.25 - South Umpqua River** MP 94.70 - South Umpqua River	Private	MP 88.63 Days Creek 171003020000511	325	42.987597 -123.100547
15	Umpqua	Days Creek-South Umpqua River 1710030205	Days Creek-South Umpqua River 1710030205	88.63	89.30	3,538	187,000 (0.57)		Private	No Water Release at MP 89.30.		
16	Umpqua	Days Creek-South Umpqua River 1710030205	Days Creek-South Umpqua River 1710030205	89.30	92.00	14,256	754,000 (2.31)		Private	No Water Release at MP 92.00.		
17	Umpqua	Days Creek-South Umpqua River 1710030205	Days Creek-South Umpqua River 1710030205	92.00	94.65	13,992	740,000 (2.27)		Private	MP 94.65 Trib. to South Umpqua River (17100302036587)	460	42.933586 -123.040408
										MP 94.65 South Umpqua River (17100302011455)	1000	
Spread 5												
18	Umpqua	Days Creek-South Umpqua River 1710030205	Days Creek-South Umpqua River 1710030205	94.65	96.20	8,184	433,000 (1.33)	**MP 94.70 - South Umpqua River**	Private	MP 96.20 Tributary To Lick Creek 17100302036576 17100302036782	300-600	42.914216 -123.029303
										MP 96.20 Tributary To East Fork Stouts Creek 17100302037851 17100302037373	300-450	
19	Umpqua	Days Creek-South Umpqua River 1710030205	Days Creek-South Umpqua River 1710030205	96.20	101.15	26,136	1,382,000 (4.24)		Private	MP 101.15 East Fork Stouts Creek 17100302000619	830	42.865092 -123.001491
										MP 101.15 Trib. to E. F. Stouts Creek 17100302037549	800	

TABLE 2.1.2-11

Hydrostatic Test Water Discharge Locations within the Construction Right-of-Way

Test Segment	Oregon Plan Watershed Basin	HUC (10-digit) (Begin MP)	HUC (10-digit) (Ending MP)	Begin MP [1]	End MP	Section Length [2] (feet)	Volume [3, 4] (gallons) (acre feet)	Potential Water Source (Primary Sources Are in Bold / Alternates are Un-Bolded)	Jurisdiction (Ending MP)	Milepost (MP) Waterbodies Closest to Dewatering Locations [5] (Reach Code)	Distance to Waterbodies [5] (feet)	End Latitude End Longitude
										MP 101.15 Tributary to Hatchet Creek 17100302036849 17100302036895	370-775	
20	Umpqua	Days Creek-South Umpqua River 1710030205	Upper Cow Creek 1710030206	101.15	110.23	47,942	2,535,000 (7.78)	**MP 94.70 - South Umpqua River**	USFS-Umpqua	No Water Release at MP 110.23.		
21	Umpqua Rogue (MP 110.23)	Upper Cow Creek 1710030206	Trail Creek 1710030706	110.23	114.70	23,602	1,248,000 (3.83)	**MP 122.80 - Rogue River**	Private	MP 114.70 Tributary to Wall Creek 17100307010304 17100307020372 17100307018181	850-1000	42.733301 -122.876871
										MP 114.70 Tributary to West Fork Trail Creek 17100307008733 17100307008734 17100307013978	540-650	
22	Rogue	Trail Creek 1710030706	Trail Creek 1710030706	114.70	118.23	18,638	986,000 (3.03)	**MP 122.80 - Rogue River** Additional Potential Sources: South Myrtle Creek and Indian Lake (Segment 22)	Private	MP 118.23 Tributary to Buck Rock Creek 17100307015562 17100307009117 17100307014926	800-1000	42.688283 -122.852207
										MP 118.23 Tributary to West Fork Trail Creek 17100307010045 17100307020541 17100307018799	1000-1150	
23	Rogue	Trail Creek 1710030706	Shady Cove-Rogue River 1710030707	118.23	122.80	24,130	1,276,000 (3.92)		Private	No Water Release at MP 122.80.		
24	Rogue	Shady Cove-Rogue River 1710030707	Big Butte Creek 1710030704	122.80	132.50	51,216	2,708,000 (8.31)		Private	MP 132.50 Trib. to Quartz Creek 17100307003292	250	42.577342 -122.680434
Spread 6												
25	Rogue	Big Butte Creek 1710030704	Little Butte Creek 1710030708	132.50	141.00	44,880	2,373,000 (7.28)	**MP 141.00 - Star Lake** MP 133.4 - Medford Aquifer (if this is used, will have to cut in another test)	BLM-Medford	MP 141.00 Tributary to Salt Creek 17100307004267 17100307014303	650-1000	42.485451 -122.610284
26	Rogue	Little Butte Creek 1710030708	Little Butte Creek 1710030708	141.00	151.44	55,123	2,915,000 (8.95)		BLM-Medford	MP 151.44 Tributary to North Fork Little Butte Creek 17100307010462 17100307013836 17100307013832	500-770	42.379242 -122.525296
										MP 151.44 Tributary to South Fork Little Butte Creek 17100307015744 17100307016676	400-475	
27	Rogue	Little Butte Creek 1710030708	Little Butte Creek 1710030708	151.44	162.00	55,757	3,060,000 [4] (3.39)		USFS-Rogue River	No Water Release at MP 162.00.		
Spread 7												

TABLE 2.1.2-11

Hydrostatic Test Water Discharge Locations within the Construction Right-of-Way

Test Segment	Oregon Plan Watershed Basin	HUC (10-digit) (Begin MP)	HUC (10-digit) (Ending MP)	Begin MP [1]	End MP	Section Length [2] (feet)	Volume [3, 4] (gallons) (acre feet)	Potential Water Source (Primary Sources Are in Bold / Alternates are Un-Bolded)	Jurisdiction (Ending MP)	Milepost (MP) Waterbodies Closest to Dewatering Locations [5] (Reach Code)	Distance to Waterbodies [5] (feet)	End Latitude End Longitude
28	Rogue	Little Butte Creek 1710030708	Spencer Creek 1801020601	162.00	179.00	89,760	4,635,000 (14.22)	**MP 199.2 - Klamath River** MP 212.00 - Lost River	Private	MP 179.00 Tributary to Clover Creek 18010206005432	1000	42.230473 -122.084719
	Klamath (MP 167.58)						4,635,000 (14.22)			MP 179.00 Tributary to Clover Creek 18010206003627	550	
29	Klamath	Spencer Creek 1801020601	Lake Ewauna / Upper Klamath River 1801020412	179.00	191.39	65,419	3,459,000 (10.62)		Private	MP 191.39 Tributary to Klamath River 18010204013935	600	42.135675 -121.905079
30	Klamath	Lake Ewauna / Upper Klamath River 1801020412	Lake Ewauna / Upper Klamath River 1801020412	191.39	199.20	41,237	2,236,000 (6.86)		Private	No Water Release at MP 199.20.		
31	Klamath	Lake Ewauna / Upper Klamath River 1801020412	Mills Creek - Lost River 1801020409	199.20	212.00	67,584	3,518,000 (10.80)		Private	MP 212.00 Lost River 18010204004545	250	42.057325 -121.637374
32	Klamath	Mills Creek - Lost River 1801020409	Mills Creek - Lost River 1801020409	212.00	228.81	88,757	4,693,000 [4] (14.40)		Private	MP 228.81 T Canal 18010204015324	2500	42.035247 -121.373198
						Total [6]	**64,275,000 (197.25)**					

[1] Mileposts were not calculated from engineering stationing. " R" and "BR" represent a revised milepost location based on the incorporation of reroutes into the Proposed Route.
[2] Section length is calculated directly from engineering footage.
[3] Section volumes were calculated using section length directly from engineering footage.
[4] Water will be cascaded between test sections, where practical, to minimize test water volume requirements, withdrawals, and potential water hauling. It is expected that the largest volume of water to be released would be associated with the longest test segment within a basin.
[5] Waterbodies were determined from USGS National Hydrography Dataset water course data(http://nhd.usgs.gov/). Distances are between the test break/header location (at MPs provided in this column) to the closest water course regardless of flow characteristics (*i.e.*, perennial, intermittent, or ephemeral); dewatering structures for the test break/header locations will be located a minimum of 150 feet from waterbodies/wetlands.
[6] Without cascading (not proposed), the maximum test volume for all individual test segments would be 64,275,000 gallons. With the use of cascading, which is proposed, the minimum test water volume to be withdrawn would be 25,832,000 gallons. The actual volume will be within this range and is expected to be at the lower end of the range.

After the test is complete, hydrostatic test water would be discharged to an upland area through a filter bag or straw bale structure to remove particulates. Hydrostatic test water would be discharged into vegetated upland areas at a rate to prevent scour, erosion, and sediment migration. Discharge rates would range from several hundred gallons per minute to several thousand gallons per minute, depending on the length of the test section, profile, topography, vegetation cover, and soil type, and as reviewed by the contractor and the EI.

Dust and Fire Control Water

During Pipeline construction, PCGP would need to obtain water for dust and fire control purposes. PCGP estimates that there would be approximately five 3,000-gallon water trucks per construction spread on a given day. Thus, the total the Pipeline would use about 75,000 gallons of water per day for dust suppression and fire control, contained in 25 water trucks over the five spreads combined. Watering trucks would spray only enough water to control the dust or to reach the optimum soil moisture content to create a surface crust. Runoff should not be generated during this operation. Water may be obtained through municipal sources or withdrawn from surface water or groundwater sources. All appropriate permits/approvals would be obtained prior to withdrawal. Table 2.1.2-12 lists potential dust control water sources that have been identified by PCGP.

TABLE 2.1.2-12

Potential Dust Control Water Sources for the Pipeline

County	Approximate MP	Source
Coos	16.5	Aqueduct Lake
Coos	37.0	Brewster Lake (WI-602)
Douglas	50.2	Lang Creek Reservoir
Douglas	79.0	Big Lick Reservoir
Jackson	128.5	Indian Lake Reservoir
Jackson	133.4	Eagle Point Irrigation Canal Crossing (Medford Aqueduct)
Jackson	141.0	Star Ranch Lake
Jackson	144.0	Unnamed Reservoir
Jackson	145.0	Gardener Reservoir
Klamath	228.5	High Line Canal
Klamath	228.7	Capek Reservoir
Klamath	229.4	Low Line Canal

Additionally, PCGP has indicated it may utilize a synthetic product such as Dustlock®, in addition to water, for dust control. Dustlock is a naturally occurring by-product of the vegetable oil refining process. Dustlock penetrates into the bed of the material and bonds to make a barrier that is naturally biodegradable, ensuring that the surrounding ground and water are not contaminated, and minimizing any potential effects to fish and wildlife. While there are no known health risks by the use of Dustlock to fish and wildlife resources, PCGP would not use Dustlock within riparian areas.

Cleanup and Restoration

Cleanup

PCGP has indicated it would make every effort to complete final cleanup of an area within 20 days after backfilling the trench. Final cleanup would include final grading and installation of permanent erosion control structures. During final cleanup, PCGP would remove all construction debris. Fences, gates, drainage ditches, culverts, and other structures that may have been temporarily removed or damaged during construction would be permanently repaired, returned to their preconstruction condition, or replaced. All drain tiles crossed by the pipeline would be checked, and if damaged, they would be repaired. PCGP would install erosion control fabric (such as jute or excelsior) to stabilize streambanks during restoration. In residential and cropland areas, additional cleanup activities prior to the preparation of a proper seedbed may include rock removal. The right-of-way would be restored as close to its original topographic contours as practicable. However, if it appears that construction may continue into the winter because of unforeseen delays and cleanup and reseeding is delayed until the spring, PCGP would implement the winterization plan (see attachment E to the ECRP in appendix F). This plan describes the procedures that would be implemented to minimize potential impacts associated with delayed cleanup (i.e., temporary erosion controls procedures, topsoil stabilization, reseeding, etc.).

Permanent Erosion Control Devices

PCGP would install permanent erosion control devices or BMPs consistent with the requirements of Section V.B. of the FERC's *Plan*, and as described in the Pipeline project-specific ECRP provided in appendix F. This would include permanent waterbars on steep slopes, spaced as specified in the PCGP's ECRP. Table 2.1.2-13 lists specifics from PCGP's ECRP for the installation of slope breakers.

TABLE 2.1.2-13

Permanent Slope Breaker Spacing From PCGP's ECRP a/

Slope	Highly Erosive Granitic Soils b/	Soils With Moderate or Low Potential for Erosion
0 to 5 percent	None required	None required
5 to 15 percent	100 feet	200 to 300 feet
15 to 30 percent	50 to 75 feet	75 to 100 feet
Greater than 30 percent	50 feet	50 feet

a/ Actual spacing would be determined at the time of installation based on site-specific topographic conditions on the right-of-way to ensure proper slope breaker construction and proper drainage to stable off-site areas. On the Umpqua National Forest between about MPs 109 and 110, where the alignment would cross the historic Thomason cinnabar claim group, waterbars would be installed at 50-foot intervals as recommended by the Forest Service.
b/ Granitic formations would be crossed by the pipeline between: MPs 79.1 to 80.5; MPs 81.6 to 82.2; MPs 87 to 88.8; MPs 97 to 101.2; MPs 103 to 105.4; and MPs 114.8 to 115.

Revegetation

All areas disturbed by construction, including the construction right-of-way, TEWAs, UCSAs, and contractor yards as necessary, would be restored and revegetated in accordance with PCGP's ECRP. Prior to seeding, the disturbed areas would be prepared as a seedbed approximately 3 to 4 inches deep using appropriate equipment, as necessary in certain areas, as determined by the EI. This could include chisel plowing or disking. In most areas, typical regrading and contouring during restoration would create a suitable rough, yet firm, seedbed, conducive to capturing seeds and retaining soil moisture. Usually, in agricultural areas, the landowner determines whether or not PCGP would be responsible for seeding. In some situations, the owner of agricultural land may do the final restoration and seeding and PCGP would compensate the landowner for those efforts.

In residential areas, PCGP would restore disturbed lawns, ornamental shrubs, gardens, and other landscape features in accordance with their agreement with the landowner. The restoration work in residential areas would be done by a contractor familiar with local horticultural or landscape practices, or PCGP may choose to compensate a landowner to restore their property.

Based on Oregon State University Extension Service recommendations for fertilization rates for nitrogen fertilizer on new pasture seedlings, PCGP intends to use a standard fertilization rate of 200 pounds per acre bulk triple-16 fertilizer on disturbed areas to be seeded. The NRCS did not recommend the addition of lime or other soil pH modifiers. Fertilizer would not be used in wetlands, unless required by the land-managing agencies, and would not be applied within 100 feet of streams. The fertilizer would be stored outside of riparian reserves and away from streams, and would not be applied during heavy rains or high wind conditions. It could be either broadcast, or incorporated in the slurry for hydroseeding.

The seed mixtures were determined in consultations with the land-managing agencies and the NRCS. The seed mixture seeding rates are based on Pure Live Seed. The seed mixture should be free of noxious weeds. Tables 10.9-1, 10.9-2 and 10.9-3 of the ECRP list species required in specific ecozones.

Of the approximate 2,100 acres of forested areas affected by the construction right-of-way and temporary extra work areas, 1,583 acres will be replanted with tree species, leaving 517 acres cleared for the 30-foot operational corridor. PCGP would plant native trees/shrubs extending 100 feet from streambanks on federal lands. Prior to construction, PCGP would submit a Request for Service to vendors and growers to provide the necessary quantity of native seed that would be required for restoration and revegetation.

It is expected that seeding would be timed to begin in August and could extend into the winter months at lower elevations. Seeding may be done by broadcast methods, drilling, or hydroseeding. Broadcast seeding, using a mechanical broadcaster seeder, is the preferred method of seeding on steep slopes. After broadcast, the seedbed would be dragged by chains or other appropriate harrows to cover the seeds thinly with soil. Hydroseeding would be done in accessible upland areas. Hydroseeding equipment would include tanks, pumps, nozzles, and other devices for mixing the seed hydraulically with wood fiber mulch and tackifier. A built-in agitator would keep the seed, mulch, tackifier, and water mixed together homogeneously until pumped from the tank. A drill seeder pulled by a tractor may be used in gently sloping areas.

Mulch would be applied on slopes were necessary to stabilize the right-of-way after seeding. Mulch would consist of native wood chips, wood fiber mulch mixed with the hydroseed, bonded fiber matrix to be used on slopes steeper than 40 percent grade (greater than 2.5 to 1), and certified weed-free straw.

Waterbody Crossings

The Pipeline would affect 346 waterbodies (63 are not crossed by the centerline): 66 are perennial, 168 are intermittent, 98 are ditches, 10 are lakes or stock ponds, and 4 are estuarine (Coos Bay/2 crossings and one HDD pullback and the Coos River). The table in appendix M lists the waterbodies affected by the Pipeline and provides the proposed crossing method for each, the rationale for the proposed method, whether federally listed species are present, the ODFW-recommended in-water work window, and whether a crossing bridge is required. All waterbodies would be crossed during the ODFW recommended in-water work windows; except the rivers crossed using HDDs or Direct Pipe (DP) technology, because no in-water work is expected at those crossings. PCGP would cross waterbodies in accordance with FERC's *Procedures*, and the *Stream Crossing Risk Analysis* (GeoEngineers, Inc. 2017d and 2017e),[7] which identified design guidance, contingency measures, and monitoring protocol specific to each crossing.

Installation of Temporary Equipment Bridges over Waterbodies

PCGP would install temporary equipment bridges over flowing waterbodies before those streams are crossed by equipment. The temporary equipment bridges would be constructed to maintain unrestricted flow and to prevent soil from entering the waterbody. Soil would not be used to stabilize equipment bridges. The bridges would span the entire ordinary high water mark (OHWM) of the waterbody. If it is not possible to span the OHWM with the bridges, a temporary culvert or pier may be required. The temporary crossings may be constructed of:

- equipment mats and culvert(s);
- equipment mats or railroad car bridges without culverts;
- clean rock fill and culverts; or
- flexi-float or portable bridges.

For any temporary equipment crossings on any stream channel (whether intermittent or perennial, wet or dry) on NFS lands, the Forest Service has stated that it is the their policy that equipment crossings must be accomplished using (1) a bridge, (2) a temporary culvert with temporary road fill to be removed after work is completed, or (3) a low water ford with a rock mat. While FERC's *Procedures* (at section V.B.5.a.) allow clearing equipment to cross waterbodies prior to bridge installation, PCGP would only cross waterbodies with its equipment after bridge placement. Where feasible, PCGP would attempt to lift, span, and set the bridges from the streambanks.

To allow for the delivery of materials and equipment up and down the construction right-of-way, it may be necessary to install some bridges outside the ODFW recommended in-water construction windows. Temporary bridges would be set during clearing operations in the first year of construction as well as during mainline construction the following year. The temporary bridges set during clearing operations would be temporarily removed after clearing is complete and would not be left in place across a waterbody over the winter. During mainline construction in the second year of construction, the temporary bridges would be reset and would be removed as soon as possible after permanent seeding. Equipment bridges would be removed as soon as possible after final cleanup.

Minor or Intermediate Waterbody Crossings

FERC defines minor crossings as waterbodies less than 10 feet across, while intermittent streams are between 10 and 100 feet wide. PCGP plans to cross intermittent flowing streams, and irrigation canals and ditches when they are dry, using standard upland, cross-country pipeline construction methods. If water is flowing at the time of the crossing, a dry crossing method would be used (i.e., flume or dam-and-pump, see below). The standard depth of cover would be 5 feet below intermittent flowing streams and ditches. Virtually all minor or intermittent

[7] Appendix O.2 to Resource Report 2 in PCGP's September 2017 application to the FERC.

waterbodies would be crossed using dry open-cut methods as discussed below. The Pipeline would cross numerous irrigation canals and ditches in agricultural fields in Klamath County. Some of the irrigation canals and ditches in this area are part of Reclamation's Klamath Project. PCGP would conventionally bore Reclamation's facilities, which would comply with Reclamation's requirement that the pipeline be installed at least 3 feet below the bed of facilities over which it has jurisdiction. Reclamation would also require that irrigation canals and ditches under its jurisdiction be crossed between October 15 and March 15, outside of the irrigation season. PCGP developed the *Klamath Project Facilities Crossing Plan* (see appendix O to the POD) to identify and protect Reclamation's facilities during construction,.

Dry Open-Cut Crossing Methods

Flume. The flume method typically is used to cross small to intermediate flowing waterbodies that are either fish-bearing or non-fish-bearing streams. The flume technique involves diversion of stream flow into a carefully positioned steel pipe of suitable diameter to convey the maximum flow of the stream across the work area, and ensures that stream flow rate is not interrupted.

Dam-and-Pump. With the dam-and-pump method, stream flow is diverted around the work area by pumping water through hoses over or around the construction work area. The goal of this technique is to create a relatively "dry" work area to avoid or minimize the transportation of heavy sediment loads and turbidity downstream of the crossing. This crossing method may be used on all waterbodies where stream flow can be diverted by pumping around the work area.

Erosion, Turbidity, and Suspended Sediments Related to Dry Stream Crossings

Some turbidity would result during instream activities and when the water is diverted to the backfilled areas; when upstream and downstream dams used to isolate the construction area are installed or removed; when water leaks through the upstream dam; when in-stream rocks or boulders have to be removed; and when streamflow is returned to the construction work area after the crossing is complete and the dams and flume are removed. GeoEngineers, Inc. (2017f) evaluated the potential risk of turbidity during construction across waterbodies and the results are detailed in the appropriate species' sections.

Reid et al. (2004) measured suspended sediment downstream from 12 flumed pipeline crossings and 23 dam-and-pump crossings. The study estimated that suspended sediment concentrations averaged 99 mg/l for flumed crossings and 23 mg/l at the dam-and-pump crossings. Reid et al. (2002) found that below four separate dam-and-pump crossings, mean suspended sediment was less than 20 mg/l within 30 meters (100 feet) downstream. PCGP estimated that suspended sediment concentrations produced during construction during summer low-flow conditions may be highest for the 10 waterbodies crossed by fluming within the Coos Bay-Frontal Pacific Ocean fifth-field watershed and 11 waterbodies crossed by fluming in the Myrtle Creek fifth-field watershed (see table 3.2-16 in PCGP's Resource Report 3). However, even for these streams, nearly all dry crossing estimates of TSS would be less than 100 mg/l within 50 meters downstream of the crossing site (see table 3.2-21 in PCGP's Resource Report 3). For the other fifth-field watershed crossings where estimates could be made, the average suspended sediment concentrations produced during fluming and dam-and pump construction would be near background suspended sediment levels (about 2 mg/l). Nearly all estimates were less than 10 mg/l between 50 and 150 meters downstream from construction sites.

PCGP would implement the BMPs in its ECRP, including sediment fences, which would reduce bank erosion into streams. Turbidity and sedimentation impacts associated with dry open-cut methods are generally minor and temporary. Pipeline construction across intermediate sized streams using dry crossing techniques is not expected to cause major erosion, turbidity, or sedimentation that could significantly affect water quality or impact aquatic species.

<u>*Removal of Substrata*</u>

The FERC *Procedures* require that the upper one foot of the trench to be backfilled with clean gravel or native cobbles in all waterbodies that contain cold water fisheries. PCGP has requested a modification to backfill the trench with existing materials removed from the stream, where the substrate is not gravel or cobbles, and site access is limited and would require unreasonable efforts to transport clean gravel to the waterbody. The Forest Service would require site-specific approval of the modifications on NFS lands.

Water Temperatures

In forested areas, shade would be reduced at waterbody crossings where trees are removed. Studies have been conducted to determine if the clearing of riparian forest would adversely affect stream water temperatures. PCGP has proposed supplemental riparian plantings as outlined in the ECRP (see appendix F) to help ensure that the core coldwater habitat temperature criteria are not exceeded at the maximum point of impact. These measures are designed to speed up the rate of riparian area recovery and provide more effective shade immediately following construction. Much of the riparian area would be allowed to regrow from plantings with herbaceous plants (only 10 feet wide would be maintained without some growth) and conifer and other trees (all but 30-foot width). On small streams and to a lesser extent on larger streams, even 10- to 15-foot-high trees would supply shade, reducing solar heating effects on streams. Thus plantings and vegetation regrowth in riparian areas would help moderate potential temperature increases in the short-term (a few years). Also, PCGP has developed a Large Woody Debris (LWD) Plan to offset impact from removal of riparian trees (reducing LWD recruitment potential) and to provide an overall benefit by enhancing stream habitat with no potential for LWD recruitment, PCGP proposes to place LWD at the waterbody flow types identified by watershed. Placement of LWD in streams adds structural complexity to aquatic systems, traps fine sediments, and can contribute to reductions in stream temperatures over time. One study (GeoEngineers, Inc. 2017c) examined 15 stream crossings, varying in width from 2 feet to 85 feet. Assuming a 75-foot-wide construction right-of-way at each crossing, and conditions typical of August, the model predicted water temperature increases averaging 0.03°F, with the maximum temperature increase at the narrowest stream crossing being 0.3°F. Modeling results indicate that within a short distance downstream from all crossings, instream water temperatures would return to ambient conditions.

Any temperature changes that may occur would gradually be reduced or eliminated over time as plantings and natural vegetation growth increases stream shading. Pipeline rights-of-way are narrow, and water would flow quickly past the crossing locations, with greater volumes in larger streams. In addition, stream temperatures are influenced by the infusion of fresh water from springs, seeps, and other groundwater sources, in addition to surface tributary runoffs, both upstream and downstream of pipeline crossings. Construction of the pipeline across streams and the removal of riparian vegetation is not expected to raise water temperatures enough to have significant impacts on aquatic species.

Major Waterbodies

Major waterbodies as defined by FERC's *Procedures* are those greater than 100 feet wide (section I.B). These waterbodies include, from west to east along the pipeline route, Coos Bay, Coos River, South Umpqua River, Rogue River, and Klamath River. The methods for crossing these major waterbodies are discussed below. Coos Bay and the Coos River, Rogue River, and Klamath River would be crossed using an HDD. The South Umpqua River would be crossed using DP technology for the western crossing, and a diverted open-cut for the eastern crossing. HDDs and DPs would not cause erosion, sedimentation, or suspended sediments in the river, except in the unlikely case of a failure, or "inadvertent return" as discussed below. Conventional bores are also likely to avoid impacting waterbodies.

Coos Bay, Coos River, Rogue River, and Klamath River

PCGP is proposing to use the HDD method for two crossings of Coos Bay and the crossings of the Coos River (MP 11.1R), the Rogue River (MP 122.7), and the Klamath River (MP 199.4). Appendix E provides HDD crossing plans for Coos Bay and for each river as well as a *Drilling Fluid Contingency Plan* and a *Failure Mode Plan*.

The HDD method involves boring under a feature and pulling the pipeline into place through the borehole that has been reamed to accommodate the diameter of the pipeline. This procedure involves three main phases, pilot hole drilling, subsequent reaming passes, and pipe pullback. HDD typically is used for the crossing of major waterbodies (i.e., those greater than 100 feet wide).

<u>Pilot Hole</u>

The pilot hole establishes the ultimate position of the installed pipeline. For this operation, an initial hole is drilled from the entry point to the exit point on the opposite side of the crossing. The head of the pilot drill string contains a pivot joint to provide directional control of the drill string. By altering or steering the drill head, the operator can control the direction as the drill progresses. Thus, the pilot hole can be directed downward at an angle until the proper depth is achieved, then turned and directed horizontally for the required distance, and finally angled upward to the surface. Tracking and steering of the HDD drill head is generally guided using a two-wire system. The system consists of two insulated wires (approximately 0.25 inch in diameter) that are laid on the ground and are charged with an electrical current. A magnetometer accelerometer probe located behind the drill bit detects the electric current to triangulate the drill bit for steering.

As the pilot drill string is advanced, additional sections of drill pipe are added at the drill rig located at the entry point. High-pressure jetting of drilling fluid at the drill head and, in harder soil formations, rotation of the drill bit, facilitates advancement of the drill string. The drilling fluid (mud) is typically a non-toxic bentonite clay mixed with freshwater to make a slurry. Once the pilot hole exits in an acceptable location, the reaming operation is initiated.

<u>Reaming</u>

During the reaming phase, a reaming head is attached to the drill pipe and pulled back through the pilot hole to enlarge it. Several reaming passes may be made with incrementally larger reaming heads to enlarge the hole to approximately 1.5 times the diameter of the pipeline. Various reaming heads can be utilized, depending on the substrate encountered. High-pressure drilling fluid is jetted through the reaming head to float out drill cuttings and debris, to cool the drilling head, and to provide a cake wall to stabilize the hole. Once the drill hole is enlarged to the proper diameter, the pipe is pulled back through the reamed hole.

Pullback

The last step to complete a successful installation is the pullback of the pre-fabricated product pipe into the enlarged hole. The pullback process is the most critical step of the HDD process. A reinforced pullhead is welded to the leading end of the product pipe and to a swivel connected to the end of the drill pipe. The swivel is placed between the drill rig and the product pipe to reduce torsion and prevent rotation from being passed to the product pipe.

During pullback, the pull section is supported with a combination of roller stands and/or product pipe handling equipment to direct the product pipe into the hole at the correct angle, reduce tension during pullback, and prevent the product pipe from being damaged. After the product pipe is in place, the installed crossing is hydrostatically tested, pigged (optional), and tie-in welds on each side of the crossing are completed.

Failures or Inadvertent Returns Related to HDDs and DPs

The HDD method has the potential for inadvertent releases of drilling mud into the waterbody. If a fault or crack in the overburden is encountered, the drilling mud can escape to the surface. This is referred to as an "inadvertent return." Drilling mud typically comprises bentonite clay and water, and can include additional additives specific to each drilling operation and would therefore be considered a pollutant. PCGP would approve any additive compounds prior to use by the drilling contractor to ensure compliance with all applicable environmental and safety regulations. Toxic additives would not be used in the bentonite drilling mud for the HDDs.

If an inadvertent return occurs, the HDD operation would be stopped temporarily to determine an appropriate response plan. PCGP would work to determine the cause of the hydraulic fracture and inadvertent return and would implement procedures to correct or mitigate the situation. Those procedures may include:

- increasing the drill fluid viscosity;
- introduction of lost circulation materials back into the hole;
- installation of steel casings; or
- use of a grout mixture.

Any inadvertent release of drilling mud into a waterbody would be monitored, and the appropriate agencies would be contacted, and approved corrective measures would be implemented. Impacts would be localized and short term, limited to species in the immediate vicinity of the inaedvertent return, and ameliorated by river volume.

While the HDDs are expected to be successful, PCGP considered procedures to be implemented in the event of a failure. If the pilot hole collapsed, material falls into the hole, pipe becomes lodged in the hole, or there is a mechanical breakdown of the rig, the contractor would remove the pipe, and the HDD would be reattempted at the same location, or slightly offset after obtaining any necessary review and approval from applicable state agencies. If the hole has to be abandoned, the contractor would grout the top five vertical feet of the hole on both the entry and exit side of the crossing with a cement type grout and the top 12 inches of the hole would be filled with native material or in accordance with the permit requirements.

Noise Generated by HDDs and DP Crossings

Some portions of HDD operations would occur as 12-hour work shifts, while other activities would normally occur as 24-hour-per-day operations. The overall duration of HDD operations should last from 2 to 4 weeks at each site.

PCGP estimated that at the various NSAs, HDD, or DP operations would generate estimated L_{dn} levels of: 1) 53.2 to 65.1 dBA/Coos Bay West; 2) 43.8 to 61.8 dBA/Coos Bay East; 3) 59.6 to 72.7 dBA/Coos River; 4). 35.3 to 64.2 dBA/South Umpqua River; 5) 67.6 to 78.5 dBA/Rogue River east entry; 6) 62.6 to 70.8 dBA/Rogue River west entry; 7) 68.3 to 79 dBA/Klamath River east entry; and 8) 57 to 58.4 dBA/Klamath River west entry.

Construction noise levels from HDD and DP activities would exceed the FERC limit of 55 dBA Ldn. PCGP has proposed mitigation measures that would be used during construction, which if implemented would result in predicted noise levels below acceptable limits.

South Umpqua River – MP 71.3

PCGP would use DP technology to cross the South Umpqua River at MP 71.3. DP is a trenchless construction method to install pipelines beneath rivers, highways, railroads, levees, wetlands and other features that require special attention to environmental and logistical concerns. DP is, in its simplest definition, a combination of the traditional microtunneling process and HDD. DPs are completed using an articulated, steerable microtunnel boring machine (MTBM) mounted on the leading end of the product pipe or casing which is jacked into position using a pipe thrusting machine mounted at or near the ground surface (see appendix E).

Internal instrumentation is typically used to survey the progress of the MTBM so that its location can be compared to the design requirements. A gyroscope mounted within the MTBM locates the orientation and a precision manometer is used to locate the elevation of the MTBM.

The MTBM exerts continuous and controllable pressure at the excavation face and is capable of excavating a wide variety of soils under significant groundwater pressures. Soil and rock are excavated by the cutting head and removed through pressurized slurry pipes to the launching pit at a rate that is balanced with the advance rate of the machine, as the MTBM and pipe are jacked through the formation. A pipe thrusting machine located in or near the launching pit provides the necessary force to advance the product pipe and provide the face pressure required for excavation. The product pipe is typically prefabricated in a continuous section or in smaller sections, typically 300 to 500 feet. The smaller sections are welded to the back of subsequent sections after each section is advanced.

Friction between the pipe and surrounding soil can create significant resistance during DP installation. To reduce the frictional resistance, over cutting is employed to create a small annular space between the pipe and external soil. The over cut is typically on the order of 1 to 2 inches. The use of bentonite slurry helps reduce the frictional resistance between the pipe and soil as well as reducing the risk of collapse of the annulus around the pipe. Bentonite lubrication is typically added from the launch seal and from a specialized lubrication ring located behind the MTBM and in front of the jacking pipe.

Following completion of the tunneling process, the MTBM is retrieved from the receiving pit. If the DP-installed pipe is to be used as casing, after completion of the grouting the product pipe may be installed within the casing using centralizers or resting on the bottom of the casing if the product pipe is concrete coated. After the product pipe is installed and tested, the interior annular space between the casing and product pipes may be filled with cement grout.

South Umpqua River – MP 94.7

The second crossing of the South Umpqua River at MP 94.7 would be done as a dry diverted open-cut, planned for the ODFW recommended in-water work window between July 1 and August 31 during the first year of construction. The South Umpqua River channel at MP 94.73 is sufficiently flat, wide, and shallow to divert all of the river flow to one side or bank of the river while work is proceeding in the dry on the opposite bank. Typically in August water levels at the crossing have been sufficiently low that a diverted open-cut crossing method could easily have been utilized at this crossing location.

This crossing method would require TEWAs to be located in the river and would require equipment to work in the river to place the diversion structures or dams to divert the river flow from one side of the river and then to the other. The diversion could be constructed using imported riprap, concrete jersey barriers, water bladder portadams, and/or sand bags to divert the river's flow temporarily away from the work area in order to minimize contact between stream flow and the excavation and backfill activities. This would require PCGP to place equipment within the stream to install, maintain, and ultimately remove the diversion structures. The crossing would take a minimum of 14 days to complete including 3 to 4 days of in-stream work to install, rearrange, and remove the diversion structures. Some turbidity would result during in-stream activities and when the water is diverted to the backfilled areas.

The diverted open-cut crossing method at this location would require an in-stream tie-in, but it would be made in the dry behind the diversion structure. During the crossing, initial trenching would first occur on the dry side of the river; however, depending on the water levels during the season, it may be necessary to install a diversion to push or divert the flow to at least the middle of the river. Once the construction right-of-way has been isolated by the diversions and/or sediment control devices, trenching would proceed to approximately the middle of the river. Trench spoil would be stored within the stream channel behind the diversion or sediment control structures to ensure that sedimentation from saturated materials does not flow back into the river. After the trench has been completed, a section of pipe would be placed in the trench. Trench boxes or another marker form would be placed at the end of the pipe section in the middle of the riverbed for the tie-in. The trench would be backfilled and the streambed restored to the original contour configuration, except for the immediate area around the tie-in.

The diversion structure would then be removed and rearranged to divert the flow temporarily to the other side or dry side of the river in order to minimize contact between stream flow and the excavation and backfill activities. This would again require PCGP to place equipment within the stream in order to rearrange the diversion structures. Once the diversion structures have been properly reconfigured and extended beyond the tie-in location and the river flow diverted to the opposite side of the river, excavation for the other section of pipe would begin. Trenching would proceed across the river bed to the tie-in point in the middle of the river where it would be uncovered. Once the excavation is complete, the second pipe section would be carried in and tied-into the first section. After the tie-in has been made, the streambed would be restored to its original contours and configuration and the diversions structures would be removed. Streambanks would be reestablished and stabilized.

During the diverted open cut, multiple discharge pumps would be required to keep the tie-in area dry while the welds are being made and to control any flow seepage in the work areas. The discharge from this activity would occur to a straw bale discharge structure located in an upland area as far away from the river as possible to prevent any silt-laden water from flowing into the river.

Medford Aqueduct (MP 133.4)

Conventional bores of waterbodies are proposed at the Medford Aqueduct (MP 133.4) and Reclamation's facilities. The specific type of bore (i.e., jack and bore, slick bore, hammer, etc.) that would be utilized would be determined during the design phase of the Pipeline and depends on construction characteristics, the type of soils present, and the contractor's familiarity with the method. The hammer is typically utilized in difficult soils containing consolidated rock, and the slick bore is used in soils with fewer frictional characteristics. Although each type of bore is somewhat different, the requirements and risks associated with each are similar. In all cases, the bore must be completed along a straight pathway requiring excavation of a bore pit on either side of the crossing (called launching and receiving pits). The depth of the bore pits must be several feet deeper than the bottom of the pipeline and can be quite deep when accounting for the depth of the feature to be crossed and the depth of cover between the bottom of the feature (e.g. stream bed) and the top of the pipeline. Welders and other laborers must work within the confined space of the bore pit; and the presence of water can be problematic.

During a standard boring operation, the spoil material is passed into the bore pit. Trackhoes then remove this spoil from the bore pit. Pipe is welded up and eventually pulled through the bore hole. Each section of the pipe is joined using full-penetration welding procedures and 100 percent of the welds are inspected using non-destructive testing procedures (x-ray) to form a continuous pipeline segment. This is a difficult operation, requiring the welders to work in the confined space of the bore pit. Because conventional boring does not limit water migrating into the bore, an important factor in the design of launching and receiving pits is groundwater control. Dewatering systems using deep wells or well points are frequently used. Trench boxes or sheet piling are often used to support the pit walls and to cut off groundwater inflows.

Timing of Construction

PCGP anticipates starting construction in the first half 2020, when Early Works (MPs 0 – 7.34R, including the two HDDs across Coos Bay) will be initiated. PCGP plans to conduct civil survey and road improvements and to clear the majority of the right-of-way in 2021 (clearing would continue into 2022). Horizontal directional drills of five waterbodies (Coos Bay Estuary/2 crossings; Coos River; Rogue River; and Klamath River) and DP installation technology for a sixth waterbody (South Umpqua River) are scheduled for 2020 and 2022. A sixth HDD to avoid severe steep side-slope on a narrow ridgeline parallel to an existing powerline easement containing two large power transmission lines and the Coos County gas transmission pipeline between them is proposed at MP 25. Figure 2.1.2-2 provides a general schedule for the Pipeline.

Mainline and facility construction is planned to begin second quarter 2022 with the in-service date scheduled for third quarter 2023. Restoration of construction disturbance in each given area is expected to begin once construction is completed in that area; restoration would be completed by the end of the winter season when forest, wetland, and riparian plantings would be installed. Depending on site-specific conditions, it may be necessary to continue restoration through the spring. Timber clearing in areas of NSO and MAMU would be conducted outside the critical breeding seasons (see table 2.1.2-14). Construction activities are scheduled to take advantage of the drier periods of the year to minimize winter construction, to reduce potential environmental impacts and construction safety risks.

PCGP plans to conduct forest clearing starting third quarter 2021 prior to mainline construction, to minimize overall work space and TEWA requirements. TEWA requirements have been minimized by proposing a two-year construction window because the same work areas used to stage right-of-way logging timber clearing activities and provide log storage and decking space would then be utilized for construction activities. Logging concurrently with pipeline construction would require additional space to work safely and efficiently. Scheduling clearing and mainline construction activities over a two-year period will minimize winter construction requirements resulting from seasonal and biological construction windows. The detailed schedule for clearing activities will include areas of known seasonal restrictions along the route. Temporary erosion control and stabilization measures will be installed where necessary in areas of disturbance. These measures will be maintained throughout construction until the Pipeline is in-service and disturbed areas are stable.

A schedule has been developed taking into consideration seasonal construction constraints (timing windows) stipulated to protect biological resources (NSO, MAMU, in-stream construction/fisheries, and big game wintering habitats) (see table 2.1.2-14). The schedule allows for reasonable time requirements to remove timber and construct the Pipeline to reduce potential environmental impacts and construction safety risks associated with winter construction. If stipulated timing windows for two or more resources conflict with each other or cannot be considered for environmental and safety reasons, efforts have been taken to reduce the seasonal constraints near the ends of recommended in-stream construction windows (ODFW 2000) and/or NSO and MAMU breeding seasons. Construction across waterbodies would occur within the ODFW-recommended in-stream construction timing windows, although the majority of bridges, where required, would be installed prior to and removed after the in-stream timing window. General timing of activities is shown schematically in figure 2.1.2-2.

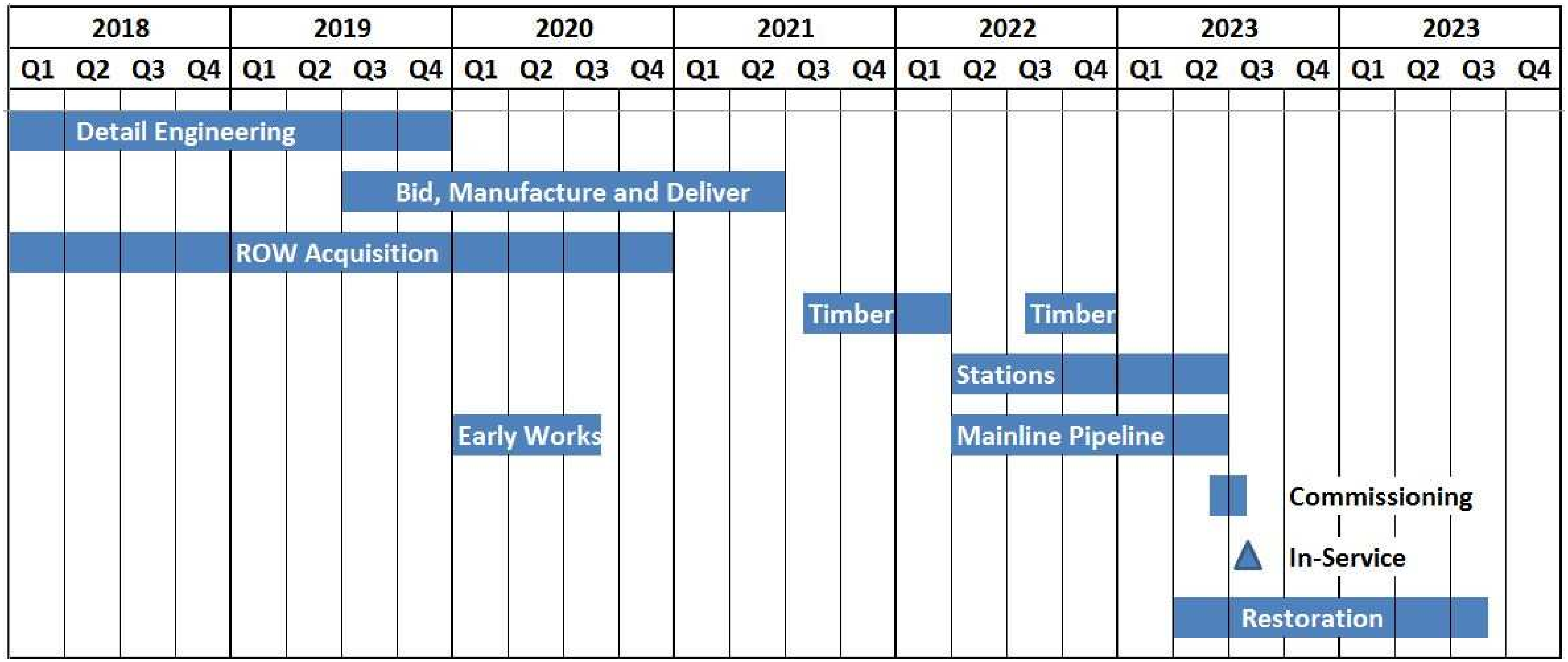


Figure 2.1.2-2 General Construction Schedule for the Pipeline

TABLE 2.1.2-14
Summary of Seasonal Timing Restrictions for Migratory Birds, Endangered Species and Raptors Based on Pipeline Activities

Pipeline Activity	Seasonal Timing Restrictions for Timber Felling, Logging, Clearing and Construction Activities						
	Migratory Birds (wooded habitat)[1]	Northern Spotted Owl[2]	Marbled Murrelet[2]	Great Grey Owl[2]	Bald Eagle[3]	Golden Eagle[3]	Peregrine Falcon[4]
Felling and Brush Mowing [5]	NO WORK Apr 1 - Jul 15	NO WORK Mar 1 - Sept 30	NO WORK Apr 1 - Sep 15 within 300-ft buffer from stand	NO WORK Mar 1 - Jul 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Jul 31
Logging, Skidding and Processing	NO RESTRICTION [6]	NO WORK [6] Mar 1 - Jul 15	DTR [6, 7] Apr 1 - Aug 5; Apr 1 - Sep 15 w/ helicopters [8]	NO WORK Mar 1 - Jul 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Jul 31
Clearing, Grubbing, and Stump Removal	NO RESTRICTION [6]	NO WORK [6] Mar 1 - Jul 15	DTR [6, 7] Apr 1 - Aug 5	NO WORK Mar 1 - Jul 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Jul 31
Driving Through Restricted Area on Right-of-Way	NO RESTRICTION [6]	NO RESTRICTION [6]	DTR [6, 7] Apr 1 - Aug 5	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION
Driving Through Restricted Area on Existing Access Road	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION	NO RESTRICTION
Pipeline Construction	NO RESTRICTION [6]	NO WORK [6] Mar 1 - Jul 15	DTR [6, 7] Apr 1 - Aug 5; Apr 1 - Sep 15 w/ helicopters [8]	NO WORK Mar 1 - Jul 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Jul 31
Maintenance on Existing Access Roads	NO RESTRICTION [6]	NO WORK [6] Mar 1 - Jul 15	DTR [6, 7] Apr 1 - Aug 5	NO WORK Mar 1 - Jul 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Jul 31
Access Road Improvement and New Road Construction	NO RESTRICTION [6]	NO WORK [6] Mar 1 - Jul 15	DTR [6, 7] Apr 1 - Aug 5	NO WORK Mar 1 - Jul 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Aug 31	NO WORK Jan 1 - Jul 31

[1] Only considers migratory bird “wooded” habitat (meaning all forest regenerating areas [not including recent clear-cuts], deciduous tree groves, shrub/brush thickets, etc.) Note: understory and residual slash in felled timbered areas would not be considered migratory bird habitat.
[2] Applies to areas within 0.25 mile of nest site (northern spotted owl, great gray owl) or marbled murrelet stand (presumed occupied, occupied), unless otherwise noted.
[3] Applies to areas within 0.5 mile of nest site (bald eagle, golden eagle).
[4] Applies to areas within 1.5 miles of peregrine falcon eyrie as delineated by Umpqua National Forest.
[5] Includes all forested areas (not including recent clear-cuts), deciduous tree groves, shrub/brush thickets (i.e., oak).
[6] Applies if trees and brush are previously felled. Otherwise, see restriction for “felling and brush mowing.”
[7] DTRs (Daily Timing Restrictions) stipulate no work until two hours after sunrise and work must stop two hours before sunset.
[8] Where large transport helicopter use is necessary to remove logs or supply pipe.

2.1.2.4 Operations, Maintenance, and Monitoring –Pipeline

PCGP would test, operate, and maintain the proposed pipeline facilities in accordance with DOT regulations provided in 49 CFR Part 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards, FERC's guidance at 18 C.F.R. §380.15, and maintenance provisions of the FERC's *Plan* and *Procedures*. The Pipeline right-of-way would be clearly marked where it crosses public roads, waterbodies, fenced property lines, and other locations as necessary. Table 2.1.2-15 lists the habitat types affected by operations of the Pipeline facilities.

The Pipeline would be inspected regularly by aerial patrols or on-the-ground personnel to observe general right-of-way conditions and to identify any indications of soil erosion that may expose the pipe, stressed vegetation that may indicate a leak in the line, damage to erosion control structures, unauthorized encroachment onto the right-of-way, and other conditions that could present a safety hazard or require preventive maintenance or repairs. All inspections would be in accordance with DOT standards. Areas susceptible to damage from large storm events would be inspected and repaired as appropriate depending on the nature of damage. Permanent erosion control devices would be maintained.

In accordance with the FERC's *Plan*, a corridor centered on the Pipeline not more than 10 feet wide could be maintained in an herbaceous state annually. However, mowing would not be conducted between April 15 and August 1, to reduce impacts on nesting birds. Not more than every three years, a 30-foot-wide corridor centered on the Pipeline could be maintained. Trees within 15 feet of the pipeline could be cut. During maintenance, vegetation may be cut/trimmed in 4- to 6-foot lengths and scattered across the permanent easement to naturally decompose, discourage OHV traffic, and benefit wildlife habitat. Occasionally where site conditions allow, chipping of this material may also occur. PCGP believes that the slash materials generated and scattered across the permanent easement during maintenance activities would not exceed the fuel loading specifications discussed above. No herbicides would be used to control vegetation on the permanent easement unless approved or required by the landowner.

In forested and shrub wetland areas, vegetation maintenance would be as described above except trees and shrubs would be selectively removed as necessary to minimize equipment operating within the wetland. Where the Pipeline crosses a waterbody, vegetation maintenance would be limited to allow a riparian strip, measured from the waterbody's OHWM, to permanently revegetate with native species, with the exception of maintenance required to remove trees within 15 feet of the centerline of the pipe. On federal lands where riparian reserves are affected, a 100-foot riparian strip (or less if the pre-construction riparian vegetation did not extend to 100 feet) would be planted perpendicular to the waterbody on both sides of the waterbody (subject to the restrictions of trees within 15 feet of the centerline).

Permanent Easement

A permanent easement is needed for long-term operation and maintenance of the Pipeline. The permanent easement would be 50 feet wide, centered over the pipe. The permanent easement for the Pipeline would consist of approximately 1,374 acres. Within the permanent easement, long-term effects to wildlife habitats are based on the 30-foot maintenance corridor (821 acres) that is kept clear of large trees. The 30-foot strip centered on the pipeline would be maintained in herbaceous cover, with trees being removed due to operational considerations, such as pipeline surveys.

Cathodic Protection System

The Pipeline would be protected from external corrosion using a low voltage impressed current electrical system, referred to as a cathodic protection (CP) system, which would be installed about one year following construction, to allow for collection of post-construction data of electroconductivity soil potentials, which is required before the CP system can be designed and installed. This system would input a low-voltage electrical charge into the pipeline underground. Permitting for the CP system is not applied for in the FERC Certificate application because the system design would be conducted after the pipeline is installed. The CP system cannot be designed properly until the ground is settled and there is good soil contact with the new pipe following construction. PCGP would consult with federal, state, and local agencies regarding permitting of the CP system following Pipeline construction. The grounding bed spacing would likely be in the 30 to 40 mile range; however, soil conditions might dictate a closer spacing in some areas depending on site-specific conditions, such as rock and climate. The Pipeline is expected to need approximately 7 to 9 ground beds and rectifiers which are expected to be installed on land used within the construction footprint. The ground beds are typically parallel and adjacent to the pipeline and can normally be in the pipeline easement or what was used as temporary workspace during construction. Rectifiers are typically sited at a mainline valve site whenever possible. Should a deep well ground bed and rectifier unit need to be sited separately (200 feet x 5 feet for the ground bed and 10 feet x 10 feet for the rectifier unit), they could still be sited in the construction right of way and most likely within the permanent easement.

If a vertical deep well anode bed were to be installed, it would require a trunk-mounted drill rig to drill a 10-inch-diameter well 300 feet deep. A horizontal anode bed would require the use of a standard backhoe for installation within an area approximately 300 feet long, 2 feet wide, and 5 feet deep. Approximately 2 acres of ground surface would be disturbed during the installation of the CP system.

PCGP intends to install the CP system in full compliance with any seasonal restriction or daily timing restriction for any federally listed avian species should any of the CP sites be located within an area (e.g., MAMU stand or NSO Core area). To the extent that the CP system design allows flexibility of placement of sites, all specified avoidance and minimization efforts would be followed to locate CP sites outside of such areas. CP sites are typically installed in the operational right-of-way or immediately adjacent in the construction right-of-way, so it is not expected that additional timber removal would be required. Systems are usually designed to utilize existing permanent access roads, so crossing of streams or waterbodies by temporary bridging is not anticipated. CP sites would not be installed in riparian zones.

TABLE 2.1.2-15

Summary of Operation-Related Disturbance to Habitat by the Proposed Pipeline (acres)

General Vegetation Type	Mapped Vegetation Category Type	Forest Stand by Age	Pipeline Facilities							Aboveground Facilities																		Total Operation Impacts by Habitat Type
			30-foot Maintenance Corridor	Permanent Access Roads	Subtotal Late Successional Old-Growth Forest	Subtotal Mid-Seral Forest	Subtotal Clearcut / Regenerating Forest	Subtotal By Habitat Type	Permanent Easement (50-foot)	Jordan Cove MS & BVA #1 [5]	BVA #2	BVA #3	BVA #4 [5]	BVA #5	BVA #6 [5]	BVA #7	BVA #8	BVA #9	BVA #10 [5]	BVA #11 [5]	BVA #12	BVA #13	BVA #14	BVA #15 [5]	BVA #16 [5]	Klamath CS, BVA #17, MS [5]	Subtotal Aboveground Facilities [6]	
Forest-Woodland	Westside Lowland Conifer-Hardwood Forest	L-O [1]	34.77	0.01					*58.63*							0.09												
		M-S [2]	82.72	0.20	34.78	82.92	100.92	218.62	*139.00*				0.09														0.17	**218.79**
		C-R [3]	100.89	0.03					*170.19*							0.00												
	Montane Mixed Conifer Forest	L-O [1]	5.13	0.00					8.50																			
		M-S [2]	3.23	0.00	5.13	3.23	14.56	22.92	5.30																		0.09	**23.01**
		C-R [3]	14.37	0.19					23.93													0.09						
	Southwest Oregon Mixed Conifer-Hardwood Forest	L-O [1]	77.99	0.24					130.07																			
		M-S [2]	33.95	0.07	78.24	34.03	67.84	180.10	56.73									0.01									0.09	**180.19**
		C-R [3]	67.49	0.35					113.32									0.08										
	Ponderosa Pine Forest and Woodlands	L-O [1]	16.11	0.00					26.97																			
		M-S [2]	15.53	0.00	16.11	15.53	19.77	51.41	25.97																		0.00	**51.41**
		C-R [3]	19.77	0.00					32.88																			
	Westside Oak and Dry Douglas-fir Forest and Woodlands	L-O [1]	8.14	0.00					13.59																			
		M-S [2]	7.70	0.05	8.14	7.74	0.00	15.89	12.93																		0.00	**15.89**
		C-R [3]	0.00	0.00					*0.00*																			
	Western Juniper and Mountain Mahogany Woodlands	L-O [1]	0.73	0.00					1.23																			
		M-S [2]	14.84	0.12	0.73	14.95	13.35	29.04	24.03																		0.23	**29.27**
		C-R [3]	13.35	0.00					22.25														0.23					
Subtotal Forest-Woodland by Age Class		L-O [1]	***142.89***	***0.25***					*238.99*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	***0.09***	***143.23***
		M-S [2]	***157.96***	***0.43***	143.14	158.39	216.45	517.98	*263.95*	**0.00**	**0.00**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	***0.09***	***158.49***
		C-R [3]	***215.87***	***0.57***					*362.58*	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**	**0.00**	**0.00**	**0.00**	**0.09**	**0.23**	**0.00**	**0.00**	**0.00**	***0.40***	***216.84***
Subtotal Forest-Woodland			**516.72**	**1.26**	**143.14**	**158.39**	**216.45**	**517.98**	***865.52***	**0.00**	**0.00**	**0.00**	**0.09**	**0.00**	**0.00**	**0.09**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.09**	**0.23**	**0.00**	**0.00**	**0.00**	**0.58**	**518.56**
Grasslands-Shrubland	Sagebrush Steppe		26.02	0.16				26.18	44.01																	21.40	21.40	**47.58**
	Shrublands		38.92	0.25				39.17	64.50												0.09		0.20				0.29	**39.46**
	Westside Grasslands		42.39	1.86				44.25	71.25						0.49		0.09		0.09	0.27							0.94	**45.18**
	Eastside Grasslands		16.10	0.00				16.10	26.75																		0.00	**16.10**
Subtotal Grasslands-Shrubland			**123.43**	**2.27**				**125.70**	***206.51***	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.49**	**0.00**	**0.09**	**0.00**	**0.09**	**0.27**	**0.09**	**0.00**	**0.20**	**0.00**	**0.00**	**21.40**	**22.63**	**148.33**
Wetland/ Riparian	Westside Riparian-Wetlands/Eastside Riparian-Wetlands	L-O [1]	0.00	0.00					0.00																			
		M-S [2]	0.26	0.00	0.00	0.26	0.25	0.50	0.43																		0.00	**0.50**
		C-R [3]	0.25	0.00					0.41																			
		Shrub	0.45	0.00				0.45	0.83																		0.00	**0.45**

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TABLE 2.1.2-15

Summary of Operation-Related Disturbance to Habitat by the Proposed Pipeline (acres)

General Vegetation Type	Mapped Vegetation Category Type	Forest Stand by Age	Pipeline Facilities							Aboveground Facilities																		Total Operation Impacts by Habitat Type
			30-foot Maintenance Corridor	Permanent Access Roads	Subtotal Late Successional Old-Growth Forest	Subtotal Mid-Seral Forest	Subtotal Clearcut / Regenerating Forest	Subtotal By Habitat Type	Permanent Easement (50-foot)	Jordan Cove MS & BVA #1 [5]	BVA #2	BVA #3	BVA #4 [5]	BVA #5	BVA #6 [5]	BVA #7	BVA #8	BVA #9	BVA #10 [5]	BVA #11 [5]	BVA #12	BVA #13	BVA #14	BVA #15 [5]	BVA #16 [5]	Klamath CS, BVA #17, MS [5]	Subtotal Aboveground Facilities [6]	
	Herbaceous Wetlands		20.31	0.07				20.37	33.76		0.07																0.07	**20.45**
Subtotal Wetland/Riparian			**21.27**	**0.07**	**0.00**	**0.26**	**0.25**	**21.33**	**35.44**	**0.00**	**0.07**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.07**	**21.41**
Agriculture	Agriculture, Pastures, and Mixed Environs		96.61	2.30				98.91	160.82		0.01	0.09		0.09										0.09	0.09		**0.36**	**99.27**
Subtotal Agriculture			**96.61**	**2.30**				**98.91**	**160.82**	**0.00**	**0.01**	**0.09**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.09**	**0.09**	**0.00**	**0.36**	**99.27**
Developed / Barren	Urban and Mixed Environs		7.89	0.10				7.99	13.27	1.72																	**1.72**	**9.71**
	Beaches		0.05	0.00				0.05	0.09																		**0.00**	**0.05**
	Roads		52.12	0.39				52.51	84.64																	0.01	**0.01**	**52.52**
Subtotal Developed / Barren			**60.06**	**0.50**				**60.56**	**98.01**	**1.72**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**1.73**	**62.28**
Open Water	Open Water - Lakes, Rivers, and Streams		2.49	0.01				2.50	4.46																		**0.00**	**2.50**
	Bays and Estuaries		0.02	0.00				0.02	2.90																		**0.00**	**0.02**
Subtotal Open Water			**2.51**	**0.01**				**2.51**	**7.37**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.51**
Subtotal Non-Forest			**303.88**	**5.14**	**0.00**	**0.26**	**0.25**	**309.02**	**508.15**	**1.72**	**0.09**	**0.09**	**0.00**	**0.09**	**0.49**	**0.00**	**0.09**	**0.00**	**0.09**	**0.27**	**0.09**	**0.00**	**0.20**	**0.09**	**0.09**	**21.40**	**24.77**	**333.79**
Pipeline Project Total			**820.60**	**6.40**	**143.14**	**158.65**	**216.69**	**827.00**	**1,373.67**	**1.72**	**0.09**	**0.09**	**0.09**	**0.09**	**0.49**	**0.09**	**0.09**	**0.09**	**0.09**	**0.27**	**0.09**	**0.09**	**0.44**	**0.09**	**0.09**	**21.40**	**25.34**	**852.34**

[1] The "Late Successional and Old-Growth" category (L-O) describes those forest areas with a majority of trees over 80 years of age. Forests with stands greater than 175 years are considered to have old-growth characteristics.
[2] The "Mid-Seral" category (M-S) describes those forest areas with a majority of trees over 40 years of age but less than 80 years of age.
[3] The "Grass-shrub-sapling or Regenerating Young Forest" category (C-R) describes those forest areas that are either clear-cut (tree age 0-5 years) or regenerating (tree age 5 to 40 years).
[4] Total by Habitat Type includes the 30-foot maintenance corridor, permanent access roads, and aboveground facilities; 1.61 acres associated with communication towers are not included in this table (previously disturbed sites).
-Columns and rows do not necessarily sum correctly due to rounding.

3.0 SPECIES ACCOUNTS, CRITICAL HABITAT, PROJECT EFFECTS, AND DETERMINATIONS OF EFFECT

This section describes the current status of the species and critical habitat (if applicable) analyzed in this APDBA. Information provided includes descriptions of species' range and/or critical habitat that may be affected by construction, operation, and maintenance activities of the LNG terminal and Pipeline and any information relevant to a species' current status.

As applicable, the *Endangered Species Consultation Handbook* (FWS and NMFS 1998) was used for guidance to analyze the potential Project effects to plant and animal species listed under the ESA, their proposed or designated critical habitats, and their recovery. Information on listed species' distributions, habitat requirements, and potential occurrence in the project area and vicinity was gathered from many sources including 1) published scientific literature; 2) agencies' published and unpublished reports including proposed and final actions published by FWS and NMFS in the Federal Register; 3) agencies' unpublished raw and/or compiled data; 4) agencies' geo-spatial databases, which document species observations; 5) on-site surveys for species and habitats; and 6) personal communications with agency personnel knowledgeable about species ecological status in the project area and vicinity.

3.1 INTRODUCTION

The following subsections describe how the species accounts, critical habitat, Project effects, and determinations of effect were developed or determined for the species addressed in this section. Also included are rationales used to exclude seven species that are listed or proposed for listing under the ESA from consideration in this APDBA, , based on determinations of no effect.

3.1.1 Determination of Effects

Biological Assessments (BA) may serve multiple purposes, but the primary role is to document an agency's conclusions and the rationale to support those conclusions regarding the effects of their proposed actions on protected resources. Generally, one of the following three determinations will apply:

- "No effect" (NE) means there will be no impacts, positive or negative, to listed or proposed resources. Generally, this means no listed or proposed resources will be exposed to action and its environmental consequences. Concurrence from the relevant Service is not required for a NE determination.
- "May affect, but not likely to adversely affect" (NLAA) means that all effects are beneficial, insignificant, or discountable. Beneficial effects have contemporaneous positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact, and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. NLAA determinations require written concurrence from the relevant Service.

  "May affect, and is likely to adversely affect" (LAA) means any adverse effect to listed species that may occur as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not beneficial, insignificant, or discountable. LAA determinations require formal consultation with the relevant Service.

3.1.2 Determinations of No Effect

There are six listed species, and one species proposed for listing as threatened that occur or could occur within Oregon but would not be affected by the proposed action. The six listed species include the Contiguous United States DPS of Canada lynx (*Lynx Canadensis*), Coterminous United States Population of bull trout – Klamath River DPS (*Salvelinus confluentus*), yellow-billed cuckoo – Western DPS (*Charadrius nivosus nivosus*), streaked horned lark (*Eremophila aphestris strigata*), the western lily (*Lilium occidentale*), and slender orcutt grass (*Orcuttia tenuis*). In addition, the North American wolverine (*Gulo gulo luscus*), occurs in Oregon and has been proposed for listing as threatened under ESA. Brief synopses of the rationales to exclude these species from consideration in this APDBA are provided below.

Canada lynx. When FWS (2000a) listed Canada lynx as threatened in a final rule, Oregon was included in the species' range based on 12 verified lynx records (see McKelvey et al. 1999) in the state during the previous 100 years. The records (in museum collections) were from the 1800s and early 1900s including one in the U.S. National Museum from the east side of the Cascade Range at Fort Klamath (pre-1900) in Klamath County (Verts and Carraway 1998). Recent lynx documented in the state were from Wallowa County (1964), Benton County (1974), and Harney County (1993), all in atypical habitats suggesting animals were dispersing from Canadian population centers (Verts and Carraway 1998; McKelvey et al. 1999). Currently, northeast Oregon/southeast Washington is recognized as a peripheral area in the lynx recovery plan (FWS 2005a) and could sustain short-term survival during lynx dispersal. Currently, there is no evidence of Canada lynx being present in the action area. There appears to be an extremely remote chance of a lynx dispersing into southwest Oregon but that is not foreseeable during the construction of the Project and as a result Canada lynx are not considered in this APDBA.

Bull trout. Bull trout in the Klamath River DPS inhabit seven isolated stream areas in the Klamath River Basin (FWS 1998b). Critical habitat for bull trout in the coterminous United States includes CHU 9, Klamath River Basin. Unit 9 includes three subunits: Upper Klamath Lake, Sycan River, and upper Sprague River subunit (FWS 2010a). The Upper Klamath Lake subunit is within the Long Lake Valley-Upper Klamath Lake fifth-field watershed, which is not crossed by the Pipeline project. Agency Lake is the only waterbody in Unit 9 with hydrologic connectivity to the Klamath River (within the Lake Ewauna-Klamath River fifth-field watershed); connectivity is through Agency Straits, Upper Klamath Lake, and Link River. As of 2010, Agency Lake was not occupied by bull trout (FWS 2010b) and no bull trout are present in the action area. Neither the species nor potentially occupied habitat would be affected by the proposed action.

Yellow-billed cuckoo. FWS listed the yellow-billed cuckoo - western DPS that nests west of the Continental Divide as threatened under the ESA on October 3, 2014 (79 Federal Register 59991). In Oregon, the western DPS included birds that nest along the Willamette River and Columbia River although the last confirmed nesting records are from the 1940s and the birds disappeared in Oregon by 1945 (Wiggins 2005). Although ORBIC (2017b) includes Klamath County within the range of yellow-billed cuckoo, surveys conducted during 1988 in Klamath County did not find any cuckoos (FWS 2013a). There are recent records (1990 to 2009) from Deschutes, Malheur, and Harney counties (FWS 2013a). Yellow-billed cuckoos are considered a riparian-obligate species and are usually found in large tracts of cottonwood/willow habitats with dense sub-canopies, but may also be found in urban areas with tall trees (FWS 2007b). No suitable habitats are present within the action area, and the species will not be affected by the proposed action.

Streaked horned lark. The streaked horned lark was listed as threatened in Washington and Oregon (Benton, Clackamas, Clatsop, Columbia, Lane, Linn, Marion, Multnomah, Polk, Washington, and Yamhill Counties) in October 2013 (FWS 2013b) with critical habitat designated in Washington and Oregon (Clatsop, Columbia, Lane, Linn, Marion, Multnomah, Polk, and Yamhill Counties (FWS 2013b). None of the counties affected by the Pipeline or the LNG Terminal are included in the streaked horned lark species range or include critical habitat. FWS (2013b, citing Gabrielson and Jewett 1940) has noted that there are historical records prior to 1940 of nonbreeding horned larks in Clatsop, Tillamook, Coos, and Curry counties. Based on communication with FWS (2017b), streaked horned larks are not present in Coos Bay and have not been documented on the Oregon Coast for more than 20 years. Streaked horned larks overwinter in areas near their nesting grounds, and therefore, would not be expected in the Coos Bay area in the wintertime (FWS 2017b). The species occurs in bare and sparsely vegetated habitats such as coastal dunes, beaches, gravel roads, airport runways, grazed pastures, and dry mudflats; however, it does not occur on rolling or steep areas at these sites. Where deflation plains occur, streaked horned larks are often behind the foredune (Pearson 2013). No such suitable habitats are present within the analysis area and the species would not be affected by the proposed action.

Western Lily. The western lily was listed as endangered on August 17, 1994 (FWS 1994). Western lilies occur in early successional fens (bogs) and in coastal scrub habitat within an extremely restricted distribution along the coast of southern Oregon and northern California. The plant has been documented in seven widely separated regions, all within 4 miles of coast. Such populations are densely clumped and occur mostly in isolated wetlands that are fewer than 10 acres in size (FWS 1994, 1998c). The nearest known occupied habitat is 5.5 miles from the Project (ORBIC 2017b).

All potential habitat for western lilies within the analysis area (i.e., poorly drained bogs with acidic organic soils and within 6 miles of the coast below 300 feet elevation) was identified and surveyed for western lilies (SHN 2013a and 2013b; SBS 2008, 2012, 2013, 2014, 2017). Within the vicinity of the LNG Terminal, potential suitable lily habitat was found to be limited due to the lack of appropriate substrate as well as the soil types present and the species' moisture requirements – potential low to moderate quality habitat was limited to the freshwater wetlands. All freshwater wetlands within the the vicinity of the LNG Terminal were surveyed for western lily during floristically appropriate seasons in 2006 and again in 2013, including sites that were in disturbed habitat along existing roads and highly degraded habitat located on fill that functions as drainage for surrounding industrial sites. No western lilies were observed. Within the vicinity of the Pipeline, potentially suitable lily habitat was identified up to MP 12 (approximately 9 miles from the coast) using available aerial photography and evaluating biological features present within the Pipeline project area (i.e., soils, geology, topography, elevation, and existing plant community, and disturbance regimes). Only one area along the Pipeline route near MP 8.2 (6.7 miles from the coast) was identified as potentially suitable lily habitat. Surveys conducted in 2014 at this site identified only a narrow band of marginal habitat that had adequate moisture and seasonally boggy areas, but it had undergone much disturbance during recent agriculture development. No plants were documented. .

While the Project occurs within the range of the species (within 4 miles of the Oregon coast), there is no suitable habitat within, the analysis area, and potentially suitable habitat surveyed for the lily did not document the plant. Based on the above, the negative survey results, habitat quality and distance from the coast, there would be no effect to the western lily, and it is not discussed further.

Slender Orcutt Grass. In 1997, the FWS (1997a) listed the slender orcutt grass as threatened in California with critical habitat designated in California in 2003 (FWS 2003c) and revised in 2006 (FWS 2006e). Slender orcutt grass occurs across a wide range of elevations (90 - 5,781 feet), but is associated primarily with large, deep vernal pools that have relatively long periods of inundation on Northern Volcanic Ashflow and Northern Volcanic Mudflow substrates (FWS 2009f). The species is known from disjunct occurrences from the Modoc Plateau in northeastern California, west to Lake County, California, and south through the Central Valley to Sacramento County (FWS 2005e). The closest designated critical habitat unit (SLEND 1A) is in California more than 50 miles south of the Pipeline (FWS 2006e). The FWS (2018b) indicated that this species may be present within the action area of by the Project, and the current range map and available GIS coverage of potential species range (FWS 2018d) identifies that the species could occur near the end of the Pipeline project; however, the species has not been documented in the vicinity of the Pipeline (ORBIC 2017a) and no suitable habitat occurs in the potential range of this species near the Pipeline (FWS 2006e). Based on the above, there will be no effect to the slender orcutt grass, and it is not discussed further.

North American Wolverine. Wolverines were proposed for listing as threatened under ESA in 2013 but the proposal was withdrawn in 2014 because the threats cited were not sufficient to warrant listing under the ESA (FWS 2014a). However, the U.S. District Court for the District of Montana vacated the FWS' 2014 withdrawal of its proposed rule to list the distinct population segment of the North American wolverine as threatened under the ESA. The wolverine is currently considered a species proposed for threatened ESA status (FWS 2016a). Wolverines have been occasionally documented in Oregon, most recently in the Wallowa-Whitman National Forest in Northeast Oregon during 2011-2012 (Magoun et al. 2013), but no evidence of a reproducing, self-sustaining population has been found. . Currently, there is no evidence of wolverines being present in the action area. There appears to be an extremely remote chance of a wolverine dispersing into southwest Oregon, but that is not foreseeable during the construction of the Pipeline, and as a result, the North American wolverine is not considered further in this APDBA.

3.1.3 Format

There are 31 species listed as threatened, endangered, or proposed for listing under the ESA considered in this section. Included are nine mammals (eight marine mammals, one terrestrial mammal), four birds, five herpetofauna (four reptiles and one amphibian), six fish, one invertebrate, and six plants. This section was organized to address similar information consistently among the diversity of organisms that could be affected by the Project. The following five sections are included for each species:

1. Species Account and Critical Habitat in which the current status under the ESA is identified, past threats that led to listing and current threats to continued existence, recovery plan components if available, abbreviated species' life history, population estimates and/or trends, and critical habitat that has been designated or proposed;

2. Environmental Baseline in which the species analysis area (portions of the Project where species are affected by the proposed action) relevant to each species is described, as well as the species' presence within the action area, species' habitat within the action area, and species' critical habitat present within the action area are described and evaluated;
3. Effects by the Proposed Action in which direct and indirect effects to the species and critical habitats are evaluated in each action area component;
4. Cumulative Effects. FWS and NMFS describe cumulative effects (50 CFR 402.02) as the result of future actions by state or private entities, not involving federal actions, but reasonably certain to occur in the action area considered in this APDBA. Future federal actions that are unrelated to the proposed action are not considered because they require separate consultation pursuant to Section 7 of the ESA.
4. Conservation Measures that have been proposed by PCGP and JCEP in addition to those defined in section 1.3; and
5. Determination of Effects in which the action agency evaluates how the proposed action would affect the species and any designated critical habitat.

3.2 MAMMALS

3.2.1 Blue Whale

3.2.1.1 Species Account and Critical Habitat

Status

The blue whale was listed as endangered throughout its range under the Endangered Species Conservation Act (ESCA) on December 2, 1970 (FWS 1970) and has been listed under the ESA since its implementation in 1973. The Eastern North Pacific blue whale population is classified as depleted and strategic under the Marine Mammal Protection Act (MMPA).

Threats

Commercial whaling played a large role in the decrease of the blue whale population (Sears and Perrin 2009). At least 9,500 blue whales were taken by commercial whalers in the North Pacific Ocean from 1910-1965 (NMFS 2013a). Commercial whaling in the eastern North Pacific is no longer a threat to blue whales. Current threats to the species include vessel strike, anthropogenic noise, hybridization with other species, pollution including entanglement in fishing gear, and environmental ocean changes that may result from climate change.

Though vessel strikes are known to occur with blue whales, this threat factor is not thought to be at a level that would be currently limiting the Eastern North Pacific blue whale population (Monnahan et al. 2015). However, because some ship strikes go undetected and unreported, and some large whales struck by vessels are not identified but could be blue whales, it has been estimated that the number of blue whales struck in the California Current exceeds the determined Potential Biological Removal (PBR) for this stock (Redfern et al. 2013).

The PBR is the maximum number of animals killed, not including natural deaths that would still allow for the population to achieve its optimum sustainable population (Barlow et al. 1995). Between 2007 and 2011, there were 10 blue whales documented as killed or injured by vessel strikes along the West Coast, nine occurred off the California coast and one off the Oregon coast (Carretta et al. 2013). Five of the deaths occurred in 2007, the highest number recorded for any year. Injured whales do not always strand or if they do, they do not always have obvious signs of trauma. Consequently, additional mortality from ship strikes could be going unreported (Carretta et al. 2014a). The risk of ship strike to blue whales is discussed in more detail below (see section 3.2.1.3).

Anthropogenic noise has been identified by NMFS (1998) as a factor influencing the distribution of blue whales. Noise from ships and boats, and other anthropogenic sources may interfere and mask cetacean communication, finding prey, avoiding predators, and possibly navigation (Würsig and Richardson 2009). Underwater noise levels vary spatially and temporally throughout the blue whales habitat. This threat factor is discussed with relevance to the Oregon coast in more detail in section 3.2.1.3.

Hybridization between blue whales and fin whales has been documented, and may decrease the fitness of hybrid offspring of the blue and fin whales (Berube and Aguilar 1998). It is difficult to quantify the level to which hybridization occurs or the risk that hybridization may pose to existing blue and fin whale populations.

The effects of pollution on blue whales are also difficult to quantify. Pollutant spills that occur in areas occupied by blue whales or their prey species have possible health consequences to individuals. Entanglement with fishing gear, particularly gillnets, is a more tangible threat to blue whales (as well as to many other species of marine life) but the number of entangled blue whales, and the extent of injuries or death is not well understood and again difficult to quantify with relevance to the Eastern North Pacific population (NMFS 1998, NMFS 2015a).

The effects of climate change on blue whales is also uncertain. The impacts from climate change could have repercussions throughout the food chain of the North Pacific Ocean, and this may have consequences on the metabolic demands of blue whales in warmer oceans. Marine populations may shift their distributions towards the poles or in the ocean depths (Fogarty and Powell 2002). Distributional variations may also occur in response to changes in ocean stratification. However, quantifying the effect of climate change as a threat to blue whales is not currently possible.

Of these identified threats, vessel strike and underwater noise have relevance to the Project and are further discussed with reference to the Oregon coast in section 3.2.1.3.

Species Recovery

NMFS drafted a recovery plan in July 1998 for the blue whale. The goals of the recovery plan (NMFS 1998) are to identify actions that will result in the minimization or elimination of effects from human activities that are detrimental to the species recovery (NMFS 1998). The stepdown outline to achieve the goal includes the following:

- Determine stock structure of blue whale populations occurring in U.S. waters and elsewhere.
- Estimate the size and monitor trends in abundance of blue whale populations.
- Identify and protect habitat essential to the survival and recovery of blue whale populations.
- Reduce or eliminate human-caused injury and mortality of blue whales.
- Minimize detrimental effects of directed vessel interactions with blue whales.
- Maximize efforts to acquire scientific information from dead, stranded, and entangled blue whales.
- Coordinate state, federal, and international efforts to implement recovery actions for blue whales.
- Establish criteria for deciding whether to delist or down list blue whales (NMFS 1998).

Life History, Habitat Requirements, and Distribution

Blue whales are the largest animals on earth, and occur throughout the world’s oceans in three separate populations: Northern Atlantic, Northern Pacific, and Southern Hemisphere. This migratory species moves seasonally between high and low latitude regions. In the eastern North Pacific Ocean, blue whales generally inhabit the Gulf of California and offshore waters of Central America during late fall and winter then migrate northwards off the west coast of North America during April and May. During the spring and summer, the whales are widely dispersed, with many blue whales occurring off the California coast, some migrating to Canadian waters while others disperse north to the Gulf of Alaska or west toward the Aleutian Islands (Sears and Perrin 2009). Blue whales also exhibit some variability in the seasonal movements, habitat use, and timing patterns.

Blue whales inhabit and feed in the coastal and pelagic environments and, as a result, are found over the continental shelf and farther offshore in deep waters. They prey mainly on two krill species, *Euphausia pacifica* and *Thysanoessa spinifera* (NMFS 1998). *E. pacifica* is an offshore euphausiid that is smaller than the more neritic euphausiid *T. spinifera*. Recent studies have shown a shift in the distribution of blue whales closer to the coast of California due to a shift in feeding more on *T. spinifera* (NMFS 1998). Blue whales typically travel alone or in pairs, but can be found in larger aggregations in feeding areas. This species generally dives for between 5 to 20 minutes, and can reach depths of 150 to 200 meters (492 and 656 feet), but shallow dives are common (Shirihai and Jarrett 2006).

Blue whales are thought to reach sexual maturity between 5 and 15 years of age, with parturition occurring in the warm winter waters. The calving interval is approximately two years (NMFS 1998). The gestation period for blue whales is between 10 and 12 months, and the calves are weaned between 6 and 8 months. Little is known of the longevity and natural mortality of blue whales, but the lifespan is estimated at up to 90 years (Shirihai and Jarrett 2006). Ice entrapment is not a known factor of natural mortality for the Pacific population of blue whales, but there has been documented killer whale predation on this population (NMFS 1998). Shark predation also occurs, though this is usually limited to neonatal and juvenile animals.

Blue whales are occasionally washed ashore, but based on records spanning 72 years (1930 - 2002), blue whales are the least frequent of five balaenopterid species found stranded on Oregon and Washington coasts, with only one female reported stranded in Washington (Norman et al. 2004).

Population Status

Blue whales occurring along the Pacific Coast of the U.S. are part of the Eastern Northern Pacific population. The best estimate of the population size is 1,647 whales, based on the time period of 2008 - 2011 (Calambokidis and Barlow 2013). The minimum population size is estimated at approximately 1,551 whales (Carretta et al. 2017a). The PBR for this blue whale population is 9.3 whales per year, but because this population spends only one-quarter of its time in United States waters, the PBR is reduced to 2.3 whales per year in U.S. waters (Carretta et al. 2017a). The Eastern North Pacific blue whale population has not been observed to increase since the early 1990's, and this is thought to be due to density dependent effects rather than specific threat factors (Carretta et al. 2017a). As of 2013, this population is now thought to be at 97% carrying capacity (Monnahan et al 2015).

Critical Habitat

As of October 2017, critical habitat for this species has not been designated in U.S. waters.

3.2.1.2 Environmental Baseline

Analysis Area

The analysis area applicable to blue whales, and all the marine mammals species presented in this document, includes the fan shaped area directly off Coos Bay out to the continental shelf break as shown in figure 2.1.1-2). Following the biological oceanographic convention, the edge of the continental shelf was defined as the 200 m contour (see Lalli and Parsons 1993). At this location along the Oregon coast, the continental shelf break is approximately 12 nautical miles (nmi) from shore. This marks the division between the inshore neritic and the offshore oceanic realms (Lalli and Parsons, 1993). As the potential effects to blue whales would be associated with the LNG carriers inbound and outbound from the LNG Terminal, the marine analysis area was refined to include that portion of the ocean under the jurisdiction of the United States relevant to the Project related traffic.

Potential markets for LNG exported from the LNG Terminal are expected to be Asian countries. JCEP executed a preliminary agreement with JERA Co., Inc., and ITOCHU Corporation for a least 1.5 mtpa of LNG capacity each from the Project. Negotiations continue with other LNG buyers for the balance of the plant capacity. For reasons described below, LNG carriers transiting to and from the LNG Terminal are assumed to traverse the continental shelf on a heading of east (inbound) or west (outbound), and for the purpose of the potential effects assessment it is assumed that the path of travel is perpendicular to the coast. The analysis area described for blue whales is the same as for all whale species for determination of the potential effects related to the LNG Terminal. For brevity, this section will be referenced, for the other marine mammal species identified in this document.

Species Presence

While inter-annual variability exists, long-term acoustic data indicates that blue whales are seasonally present in the waters between Oregon and Vancouver Island, British Columbia, Canada from July to January, but that they occupy waters farther offshore than in the more southerly parts of their U.S. range (Stafford et al. 1999). However, more recent data also indicates the use of both the inshore and offshore waters off the coast of Oregon (NMFS 2015a). Acoustic data further indicates that blue whales are present in offshore Oregon waters for an average of 21 weeks with detections commencing in October, and that they occur in lower densities than in the more southern regions of the U.S. range (Burtenshaw et al. 2004). The acoustic data suggest that the fall and winter blue whales present off Oregon are less densely aggregated than in other areas of the eastern North Pacific (Burtenshaw et al. 2004).

Line-transect ship surveys have been conducted off the coasts of Oregon and Washington during the summer and fall of 1996, 2001, 2005, and 2008 (Barlow and Forney 2007; Forney 2007; Barlow 2010). The line-transects were pre-determined to survey for pelagic cetaceans within approximately 300 nmi of the U.S. west coast. The sightings data have been used to estimate population sizes (Barlow and Forney 2007; Forney 2007; Barlow 2010), as well for habitat modeling to determine important areas and habitat-based density estimates (see Becker et al. 2012 and Calambokidis et al. 2015).

Habitat

Blue whales are not evenly distributed throughout the marine habitats of the U.S. west coast, and tend to be aggregated, particularly along the continental shelf edge, with a preference for Californian waters, rather than off Oregon or Washington (Calambokidis et al. 2015). The U.S. west coast is one of the most important feeding areas during summer and fall, although increasingly blue whales have been found feeding outside of this area (Carretta et al. 2014a). Most blue whales of this stock are believed to migrate in the winter to highly productive areas off Baja California and the Gulf of California (Carretta et al. 2017b).

Though blue whales inhabit inshore and offshore regions, the habitat-based density models of Becker et al. (2012) indicate that blue whale densities increase with decreasing latitude from Washington to California, with highest densities off San Francisco and Santa Barbara. Nine

Biologically Important Areas (BIAs) have been identified in western U.S. waters, with all occurring off the coast of California (Calambokidis et al. 2015).

Predicted mean densities of blue whales using the continental shelf habitats off Oregon, are relatively lower in the northern waters than off central and southern Oregon and range from 0.0006 – 0.0058 whales/square kilometer (km^2) throughout the state (Calambokidis et al. 2015). For comparison with other coastal areas, the lowest densities are predicted for Washington waters (0.0002 – 0.0005 whales/km^2), while the highest densities occur off southern California (0.0074 – 0.0102 whales/km^2, Calambokidis et al. 2015).

Critical Habitat

Critical habitat has not been designated for this species.

3.2.1.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include the risk of ship strikes potential adverse effects from vessel underwater noise, and potential adverse effects from accidental release of fuel. Fuel spills could additionally indirectly affect blue whales by impacting forage species. These effects are addressed below.

Ship Strike

There is an ongoing threat of ship strikes to large cetaceans around the world, causing mortality or injury. Data suggest that cetaceans collide with ships relatively infrequently (Laist et al. 2001; Jensen and Silber 2003; Douglas et al. 2008; Carretta et al. 2013). Research has identified a number of factors, related to both vessels and whales, that can influence the probability of a vessel-whale strike (e.g., Richardson et al. 1995, JWGVSAI 2012, Vanderlaan and Taggart 2007, Laist et al 2001). However, it is recognized that estimates are undoubtedly negatively biased since vessel strikes can go unreported because the event is either not witnessed, the injured or deceased animal is not observed, or the stranded carcass is not discovered.

Data provided by Carretta et al. (2013) indicated one blue whale was struck in the Oregon-Washington Exclusive Economic Zone (EEZ) between 2007 and 2011, which yielded an annual rate 0.20 blue whales struck for this region. Jensen and Silber (2003) reported 0.31 blue whales struck per year between 1987 and 2002 along the entire U.S. Pacific Coast. The existing estimates of ship strike to blue whales are below the calculated PBR for this species at 2.3 whales/year within the U.S. EEZ. Most ship strikes occur where vessel densities overlap with container port ships and blue whale feeding aggregations. There is still uncertainty about the actual rate of anthropogenic mortality due to many factors including understanding of the current carrying capacity for blue whales (Monnahan et al. 2015). Redfern et al. (2013) (as cited by Carretta et al. 2017a) has stated that the number of ship strike deaths of blue whales in the California Current likely exceeds PBR, yet Monnahan et al. (2015) suggested that current ship strike levels do not pose a threat to this population of blue whales.

Feeding aggregations of blue whales are not currently documented to occur in Oregon waters. However, some level of risk of ship strike to blue whales exists because of the spatial overlap between blue whales in the marine analysis area, the transiting Project related vessels, and existing ship traffic.

Exports of LNG originating from the LNG Terminal would likely be to markets primarily in Asia. Shipping traffic between Asia and the U.S. West Coast travels the "Great Circle route," arriving and departing the West Coast perpendicularly (east-west) or diagonally (southeast-northwest) to the coast (Pacific States/British Columbia Oil Spill Task Force 2002; Berg and Lawrenson 2015). It is expected that the LNG traffic would exit Coos Bay on a westward course, and return on a parallel, but eastwards route, as the Coast Guard has indicated that this is appropriate for LNG traffic between Oregon and Asia (Berg and Lawrenson 2015).

The current large vessel traffic into and out of Coos Bay, Oregon is approximately 50 ships per year. The LNG Terminal is expected to add as many as 120 vessels per year. In terms of the number of east-west transits expected, this adds an additional 240 vessel transits through the marine analysis area, to the existing 100 vessel transits entering and exiting Coos Bay.

Ship Strike Risk Estimation

The risk of ship strikes to large cetaceans has been assumed to be the product of ship traffic and the cetacean population densities. An index of relative ship strike risk within an explicitly defined gridded study area was described by Williams and O'Hara (2009). In that assessment, the whale density estimates at each grid point were multiplied by the nearest value of shipping intensity using regular-interval ship locations from agencies' remote monitoring of shipping in Canadian waters. Similar fine-scale data are not available within the marine analysis area. However, in order to appropriately assess the potential impact from ship strikes to the different marine mammal species, a quantitative metric was employed.

A Whale Strike Risk Estimation Model (WSREM) was developed to evaluate the relative risk to the different whale species, with the addition of vessels transiting to the LNG Terminal added to the existing conditions. The WSREM metric considered the ship strike risk to be the product of the species density, the length of the whale, the proportion of the time spent at the surface, the annual number of vessels, the number of transits/vessel, and the distance travelled per transit within the marine analysis area. This value was then multiplied by the proportion of the year each species is present in the analysis area, and divided by the spatial extent of the analysis area to yield a comparable metric in whales/km^2. The final metric is expressed in whales/1000 km^2 for ease of comparison by reducing the number of decimal places for each metric. The upper and lower whale density estimates were based on the habitat specific densities for blue whales, fin whales and humpback whales (Becker et al. 2012, Calambokidis et al. 2015). Quantified comparable estimates for other species were not available, but the existing data were examined to qualitatively determine the level of risk to these species.

The WSREM metric was calculated with the following physical variables (table 3.2.1-1)

TABLE 3.2.1-1

Physical Variables Included in the WSREM for all Species

Marine Analysis Area (km^2)	85.80
Number of Vessels	
LNG carriers Only	120
Existing Traffic Conditions	50
Exiting Traffic Plus LNG carriers	170
Number of Transits per Vessel	2
Distance Travelled Per Transit, km	24.54

This WSREM was based on several assumptions including:

- the all species in analysis area had an equal probability of being struck,
- there is an equal probability of vessel strike throughout the analysis area,
- all vessels have an equal probability of striking whales, all vessels transit the maximum length within the marine analysis area,
- all vessels complete two full transits of the marine analysis area, and
- the species are evenly distributed throughout the marine analysis area.

For conservative results, the maximum length of each species was included, but since vessel strike risk is related to the length of the whale, this assumption will result in an overestimate for all but the largest members of each species. Additionally, the risk is also related to the length and draft of the vessel, but due to the variations in different vessels, the WSREM included the area of the analysis area and assumed an equal risk throughout for all vessels for conservative results. This approach did not aim to quantify the number of individuals that could be struck due to the number of uncertainties associated with the different input variables, but rather assess the relative risk with the addition of LNG Terminal related vessels for the purpose of mitigation and strike risk reduction planning. As such, the results of the WSREM do not indicate the number of whales that would be struck, but rather the risk that is associated throughout the marine analysis area. The WSREM metric does not include any behavioral responses, learned responses or previous experiences that may be associated with different age classes and different species of whale.

Nevertheless, the WSREM is used to estimate the change in relative risk from current conditions with the forecasted number of vessels transiting to the LNG Terminal, and based on this estimate, propose potential mitigation measures to avoid or minimize vessel strike risk. The WSREM does include that the actual risk to the individual whales will change over time in response to the whales' actual distributions and habitat use which can change in response to environmental variables through the inclusion of the habitat based density estimates, the time spent at the surface which will may differ by age classes, and the number of vessels transiting which can change in response to global economic forces. As these variables can be updated, the WSREM is dynamic as it is easily adjusted to compare to future conditions with regard to shipping traffic, project related traffic and updated estimates of whale species habitat specific densities.

Estimated Ship Strikes to Blue Whales.

Determination of the WSREM for blue whales (table 3.2.1-2) included the following variables:

- Blue whale length: 30.48 m (https://www.fisheries.noaa.gov/species/blue-whale)
- Time at Surface: 5% (Lagerquist et al. 2000)
- Density – Lower = 0.0036 whales/km^2 (Calambokidis et al. 2015)
- Density – Upper = 0.0058 whales/km^2 (Calambokidis et al. 2015)
- Proportion of year in marine analysis area: July to January = 0.583

TABLE 3.2.1-2

Results of WSREM for Blue Whales

Marine Traffic	Risk Lower Estimate (whales/1000 km)	Risk Upper Estimate (whales/1000 km)
LNG Carriers Only	0.22	0.35
Existing Traffic Only	0.09	0.15
Cumulative Results	0.31	0.50

Since the LNG Terminal is expected to increase the vessel traffic in Coos Bay, from an approximately 50 vessels per year, to 170 vessels per year (including the 120 vessels/year from LNG Terminal), the estimated whale strike risk increases from existing levels. The WSREM yields an increased cumulative risk to blue whales in the marine analysis area ranging from 0.31 – 0.50 whales/1000 km. This risk was limited to the time period that blue whales are known to occur off the coast of Oregon during seven months of the year (July – January). The current conditions characterizes the existing risk and the number of blue whales known to be struck is very low (see preceding section). Therefore, while the risk is increased from the existing risk levels with the addition of LNG Terminal related vessels, the overall risk is still considered to be low, which must be analyzed recognizing that the WSREM results are considered conservative.

In addition, though there is a localized increase in the risk of ship strikes to blue whales by LNG carriers from existing levels, this localized increase is not thought to be significant for the Eastern North Pacific population as the coast of Oregon does not contain identified critical habitat nor is it a recognized area for feeding aggregations, and that current documented ship strikes in this region are low.

Underwater Noise

All vessels produce noise from the machinery and equipment onboard. The propeller cavitation produces most of the broadband noise with dominant tones derived from the propeller blade rate. Propellers create more noise if damaged, operating asynchronously, or operating without nozzles. Engines and auxiliary machinery can also radiate noise during operation which is related to ship size (larger ships are generally noisier than small ones), speed (noise increases with ship speed), and mode of operation (ships underway with full loads, towing or pushing loads, are noisier than unladen ships) (Greene and Moore 1995).

When whales are exposed to low-level sounds from distant or stationary vessels, they appear to ignore the sounds. However, in general, rorquals move away, abruptly change direction, or dive to avoid close approach by vessels. Baleen whales can interrupt normal behavior and swim away from strong or rapidly changing vessel noise, especially if a vessel is headed directly toward the whale (Richardson 1995). However, radiated ship noise of oncoming ships may not be immediately detected by whales near the surface due to bow null-effect acoustic shadow zones (Allen et al. 2012). Because of these acoustic shadow zones, whales may not hear approaching ships to allow time for their avoidance response even though whale auditory ranges overlaps with peak intensities of ship noise.

Steam turbine power has been replaced by dual fuel diesel electric (DFDE) power plants adapted to utilizing LNG gas boil-off and diesel fuel to power electric drives in many recently constructed LNG carriers. The DFDE propulsion system is more fuel efficient with less engine noise and vibration (Gilmore et al. 2005). Whether or not lower noise-producing propulsion systems would cause increased ship-strikes with marine mammals is unknown.

Ambient noise in the northeast Pacific Ocean has changed throughout the 20th century. Comparisons of ambient noise from the 1990s with noise measurements taken during the 1960s indicates an increase by about 10 dB (Andrew et al. 2002). More recent long-term analyses of vessel-traffic related noise shows that along the US west coast, noise levels are either holding steady or increasing slightly off Southern California, but decreasing off Oregon and Washington (Andrew et al. 2011). In addition to the anthropogenic sources, ambient ocean noise is a product of wind, precipitation, wave noise, and sounds generated by a diversity of marine wildlife (McDonald et al. 2008). Other sources of underwater noise include occasional events such as earthquakes and meteorological events (i.e. storms including high winds, thunder), and in high latitudes ice formation and thawing. The recent long-term acoustic analyses in the eastern North Pacific Ocean indicate non-linear changes to the ambient ocean noises over time and space.

As a result of overlap in the frequency ranges emitted and used by vessels and cetaceans, anthropogenic noise, including that from vessels, may affect communication, prey detection, predator avoidance, and possibly navigation (Würsig and Richardson 2009). While anthropogenic noise and vessel disturbance may affect blue whales, there is little information available to describe or quantify the effects, and it is difficult to determine whether, or how, vessel noise affects blue whales (NMFS 2013a). For instance, a vocalizing blue whale that had been calling prior to nearby passage of a merchant ship continued to call during the passage even though the ship noise at the whale's position exceeded the ambient sound level by as much as 26 dB (McDonald et al. 1995).

However, consideration of the effects of underwater noise is important because the intensity, duration and sound energy can have short or long term effects on the hearing of marine animals. Anthropogenic noise can cause hearing loss in cetaceans which can be temporary (abbreviated TTS for Temporary Threshold Shift) or permanent (abbreviated PTS for Permanent Threshold Shift). Repeated TTS may lead to PTS in which sensory hair cells in the inner ear are destroyed with damage to the cochlea (Nordmann et al. 2000). NMFS (2016a) has developed a new comprehensive guidance on sound characteristics likely to cause injury based on known causes of PTS from impulsive and non-impulsive sound sources. The Level B acoustic thresholds were not included in the Level A refinements, and remain unchanged (table 3.2.1-3). Both sets of acoustic thresholds are applied in MMPA permits and ESA Section 7 consultations for marine mammals to evaluate the potential for sound effects.

TABLE 3.2.1-3

NOAA Current In-water Acoustic Thresholds for Level B

Criterion	Criterion Definition	Acoustic Threshold
Level B	Behavioral disruption for impulsive noise (e.g., impact pile driving)	160 dB_{rms}
Level B	Behavioral disruption for non-pulse noise (e.g., vibratory pile driving, drilling)	120 dB_{rms} b/

a/ All decibels referenced to 1 micro Pascal (re: 1µPa). Note all thresholds are based off root mean square (rms) levels.
b/ The 120 dB threshold may be slightly adjusted if background noise levels are at or above this level.
Source: NOAA 2017

Southall (2004) provided the following descriptions of impulsive noise and non-pulse noise, based on characteristics at the noise source:

- **Single Pulse:** Single sound of short duration, fast rise time generated by a single explosion, single airgun, watergun, or sparker pulse, single ping of certain sonars/depth sounders.
- **Single Non-Pulse:** Single sound of long duration, slow rise time generated by a single vessel pass, drilling event, aircraft overflight, single ping of certain sonars.
- **Multiple Pulse:** Multiple sounds each of short duration, fast rise time generated by airguns, some sonar/depth sounder systems, waterguns, sparkers, pile driving, serial explosions.
- **Multiple Non-Pulse:** Multiple sounds of long duration, slow rise time generated by multiple vessel/aircraft passes, certain sonar systems, tomography sources.

Noises generated by vessels, including LNG carriers, transiting the marine analysis area are assumed to be single non-pulse sources during each transit and could potentially cause behavioral disruption. These are often referred to as continuous noise sources, and may affect marine wildlife through masking detection of important sounds (intraspecific communication, prey and/or predator detection, imminent ship-strike), for species within distances at which vessel noise exceeds 120 dB re 1µPa rms. Occurrences of single pulse sounds by LNG carriers cannot be completely ruled out (e.g., depth or echo sounders); however, while the sound level from this source is audible to some marine mammals, it is unlikely to cause disruption (Deng et al. 2014). As such, the acoustic thresholds with regard to these impulsive sounds have not been evaluated for vessel traffic from the LNG Terminal.

A review of LNG carriers in service during 2013 (Colton 2013; MarineTraffic 2013) revealed there are 267 vessels with capacities of 148,000 m^3 or less, the current size limit for LNG carriers utilizing the LNG Terminal. Hatch et al. (2008) determined underwater noise levels from various commercial ships while transiting the Stellwagen Bank National Marine Sanctuary off the Massachusetts coast. Estimates of sound levels from the Berge Everett (also known as the BW Suez Everett), an LNG carrier built in 2003 with 138,028 m^3 capacity (93,844 gross tonnage), are used here to estimate exposure of marine mammals to project-related shipping noise. The reported noise levels from that vessel serves as the standard for the following analysis of noise effects on blue whales (as well as other whales, where applicable) within the marine analysis area.

The LNG carrier in the Hatch et al. (2008) study produced average sound levels (with one standard error) of 182 ± 2 dB re 1 µPa @1 m (Hatch et al. 2008). Using the Practical Spreading Loss Model, the sound attenuates to 120 dB at about 13.6 km. Doubling this distance to account for both sides of the vessel (27.8 km), and taking into account the lower and upper density estimates for blue whales (see Estimated Ship Strikes to Blue Whales in section 3.2.1.3), there could be an estimated 0.10 – 0.16 blue whales/km within the area of sound attenuation to 120 dB. Assuming 120 LNG carriers call at the LNG Terminal annually, with each carrier making two transits through the marine analysis area per call and a 30-year life span of the Project, it is estimated that the number of blue whales that could be present and potentially affected could range between 432 and 648 blue whales within the 120 dB attenuation area (0.06*240*30=432 or 0.09*240*30=648) over the life of the Project.

Further, since tractor tugs would travel to meet each incoming LNG carrier and return to the port after guiding each outgoing LNG carrier from the Project, blue whales could be exposed to noise levels above 120 dB in the marine analysis area. The distance that the noise from tractor tugs could attenuate to 120 dB averaged about 5 km, as compared to 120 dB attenuation of about 13.6 km for LNG carriers. Because the lateral area within the 120 dB attenuation area for tractor tugs would be roughly 37 percent of that for LNG carriers, as many as between 160 and 240 blue whales could occur within the 120 dB attenuation area for tractor tugs over the life of the Project.

Existing commercial vessels within the marine analysis area produce underwater noise levels that are comparable to or exceed noise from the LNG carrier described by Hatch et al. (2008). Noise generated by various types of commercial ships (container ships, crude oil tankers, product tankers, bulk carriers, and others) were recently evaluated by McKenna et al. (2012). Underwater noise levels varied by ship type and also by vessel length, gross tonnage, vessel speed, and to some extent, vessel age (older vessels tended to be louder than newer vessels). For example, a 54,000-Gross Ton container ship generated the highest acoustic source level of 188 dB re 1 µPa @ 1 meter while a 26,000 Gross Ton chemical tanker had the lowest at 177 dB re 1 µPa @1 meter (McKenna et al. 2012). Noise levels from the vessels examined in that study are assumed to be typical of ship noise in the marine analysis area and would produce radiated noise levels that would exceed the threshold for Level B for continuous noise at 120 dB_{rms} (see table 3.2.1-3, above).

Some blue whales may be exposed to sound levels from LNG carriers and tugs that could cause behavioral disturbance. However, the potential numbers that could be affected are a very small fraction of the estimated population size of the Eastern North Pacific blue whale population.

Sound levels to which blue whales (or other marine mammals considered in this APDBA) will be exposed will be well below the peak sound levels and exposure would be well below the cumulative exposure levels that were developed by NMFS in 2016 and those found in NMFS' 2018 Revisions to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts. U.S. Dept. of Commer., NOAA. NOAA Technical Memorandum NMFS-OPR-59.

In particular, average sound levels of LNG carriers studied by Hatch et al was 182 dB (re 1µPA@1 meter) while the peak PTS values for low frequency and mid-frequency whales are 199 dB and 198 dB respectively. Cumulative exposure would not occur because both the noise source and the whales would be moving and would only be in proximity for a short duration

Fuel Spills

Direct effects on blue whales from spills at sea include irritation and burning from direct contact, ulcers and internal bleeding if ingested, and inhalation of toxic fumes. Inhalation of petroleum vapors can cause pneumonia in humans and animals, due to large amounts of foreign material (vapors) entering the lungs (Lipscomb et al. 1994). Indirect effects include depletion or contamination of food sources. However, effects of potential spills from LNG carriers are not comparable to spills from oil tankers because LNG carriers only carry quantities of oil used for propulsion fuel and not the quantities transported by oil tankers.

The Federal Water Pollution Control Act, as amended by the CWA (33 U.S.C. 1251–1387), prohibits the discharge of oil upon the navigable waters of the U.S., which include out 12 nmi from shore, Contiguous Zones , and, where it can be determined that the natural resources of the United

States are impacted, out to the EEZ (200 miles). In addition to U.S. Law, International Regulation under Annex I to the International Convention for the Prevention of Pollution from Ships (commonly referred to as MARPOL 73/78)[1] requires that all ships have an oily water separator, which is a piece of equipment used to pump a vessel's bilges. As the bilge water is pumped through this equipment, water is discharged overboard, while the oil is diverted to a holding tank. Ships are also required to have waste oil holding tanks of sufficient capacity to keep all waste oil aboard for later disposition either burned in an incinerator or discharged ashore in compliance with applicable regulations.

LNG carriers calling on the LNG Terminal would be required by the Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills. LNG carriers would also be required to obtain a vessel general permit from the EPA that would outline regulations for avoiding release of even small quantities of fuel or lubricants during normal operations such as washing the vessel deck. As a result, effects to blue whales from accidental spills are expected to be insignificant and discountable.

Cumulative Effects

Analysis of direct and indirect effects to blue whales focused on the risk of ship strike, underwater acoustics, and risk of fuel spills to blue whales. As included in the WSREM, the future incidence of increased risk to the whales is assumed to be related to the blue whale population density, habitat use patterns in the analysis area, and volume of vessel traffic within the marine analysis area. The Port of Coos Bay is currently utilized by about 50 deep-draft commercial cargo ships and 50 barges per year. Annual commercial ship traffic into and out of the Port has declined in recent years from a high of 310 deep-draft vessel calls at the Port in 1988 to 52 in 2016. The Port is also visited, by conservative estimates, by 50 tug/barge units per year, with 14 tug/barge units requesting pilotage during 2016 as per data from the Coos Bay Pilots Association.(Whipple 2017).

The vessels transiting to and from the LNG Terminal would contribute to the ambient noise levels in the marine analysis area. However, the contribution of additional noise will occur within a context of regional diminishing traffic-related noise (Andrew et al. 2011), so the cumulative impact should be limited. Also, the number of blue whales that are expected to be potentially exposed within the area of underwater sound attenuation to 120 dB is very low.

Unintentional spills or releases of diesel fuel and/or gasoline are possible in the foreseeable future; these events are documented annually throughout the eastern North Pacific waters from a variety of vessel types (OSTF 2017). According to the 2016 Annual Report of the Pacific States/British Columbia Oil Spill Task Force, Oregon has had one the lowest rate of calls of spills compared to other Pacific U.S. states and British Columbia to the emergency response hotline from 1999 – 2015, with the annual number of calls generally less than 25/year (Oil Spill Task Force [OSTF] 2016). The state of Oregon participates in an international program (Spills aren't Slick) coordinated through the Pacific Oil Spill Prevention Education Team (POSPET) that recognizes there are numerous avenues from fuel docks to recreational boaters, to commercial fishing and transport that may contribute to the annual rate of spills and releases. From this data source, it appears that the background rate of spills off the Oregon coast (incidence of spills in proportion to total vessel operation) by fishing vessels, recreation vessels, and other vessel types is generally

[1] The U.S. regulations implementing MARPOL Annex I are found in 33 CFR subchapter O, parts 150-160.

low and expected to continue at low frequencies in the foreseeable future as a result of the existing programs and coordinated efforts to minimize this risk to the environment.

The foreseeable cumulative effect of the additional 120 LNG carriers per year with regard to risk of vessel strike, underwater noise, or accidental release is expected to be low. Consequently, cumulative effects to blue whales would be the same as the estimate of direct effects discussed in the previous sections. Those effects were judged to be discountable.

Critical Habitat

The proposed action would not affect critical habitat because none has been designated.

3.2.1.4 Conservation Measures

Conservation measures are included in the LNG Terminal plan to reduce the impact to marine mammals, and potentially other marine wildlife such as turtles, with regard to the risk of vessel strike, acoustic disturbance, and fuel spills. The conservation measures described for blue whales, will also apply to the other marine mammal species in this document as well as non-ESA listed species, due to the broad nature of the actions related to the LNG carriers transiting to and from the LNG Terminal. All LNG vessels calling at the LNG terminal will be required to confirm that they will comply (or have been in compliance) with all NMFS recommendations to reduce the risk of whale strikes in the waters off the coast of Oregon and the U.S. West Coast. This will be confirmed during the vessel vetting and compatibility acceptance process that each vessel will undergo prior to its first call at the terminal and at intervals of six months thereafter if the same vessel will call at the terminal on a regular basis. In addition, the LNG terminal has agreed with the Coast Guard that the LNG Vessel Transit Management Plan for Coos Bay requires LNG vessels to remain more than 50 miles off the U.S. West Coast until clearance is granted by both the Coast Guard and the Terminal for the vessel to enter port and berth at the Terminal. To further reduce the risk of vessel strike to blue whales, JCEP would require all LNG carriers calling on the LNG terminal to adherence to NMFS's best practice recommendations NMFS (2017k) such as to reduce speed to 10 knots or less within 12 nmi of the entrance to Coos Bay during the blue whale migratory period and post extra lookouts either on the bow (weather permitting) or the bridge wings who have been briefed in the techniques of spotting signs of migrating whales. If whales are spotted or are known to be in a specific area through reports, LNG Carrier to avoid transiting the specific area and go around. Additionally to report any sightings or incidents to NMFS and/or the Coast Guard as required.

During the 96-hour pre-notification process, required of all LNG carriers calling on the LNG Terminal, the LNG Carriers shall consult the Local Notice to Mariners (issued by the Coast Guard) and US Coast Pilot to understand seasonal migration patterns, times and routes and obtain current information on whale sightings in the waters off Coos Bay and the latest recommendations and advisories from the NMFS and Coast Guard. The LNG Carrier Master shall take this into account and adjust the vessel speed and route accordingly. In addition, three tractor tugs would guide the LNG carrier from a point approximately five nmi offshore of the entrance to Coos Bay and on to the LNG Terminal.

The LNG carrier operators would be required to consult the current whale sightings in the continental shelf waters near Coos Bay, prior to transiting to or from the LNG Terminal. Vessel operations would be required to be aware of the blue whale distributions in the continental shelf waters near Coos Bay, and adjust operations accordingly to avoid aggregations of blue whales as navigably possible. Vessels transiting to and from the LNG Terminal would be required to post a watch for marine mammals for the duration of the vessels' transit across the continental shelf and have the information relayed directly to the vessel master.

LNG carriers would be required to reduce speed to 10 knots or less when cow-calf pairs, or large groups are observed near an underway LNG carrier, when navigably possible. LNG carriers would also be requested to route around and maintain a 100-yard distance from the whales observed and to avoid crossing in front of the whales and maintain a parallel route, when navigably possible. In addition, for safety of the vessel and crew, course adjustments would need to be made gradually away from the whales' location or direction of travel. Lastly, the LNG carrier operators would be encouraged to review and adopt when possible guidelines to reduce underwater noise from commercial ships (International Maritime Organization [IMO] 2014).

To further increase the awareness of local marine mammal species and risk factors, JCEP would provide a Ship Strike Avoidance Measures Package to shippers calling on the LNG Terminal in Coos Bay. This package would include:

- Training to LNG carrier bridge crews, including the use of a reference guide such as the *Marine Mammals of the Pacific Northwest, including Oregon, Washington, British Columbia and South Alaska* (Folkens 2001). This is a pamphlet that would be provided to LNG carriers calling on the terminal and would be included as part of the terminal use agreement to the shippers.
- A copy of an accredited mariners guide to whales. Two options are currently considered. The first is the NMFS CD-ROM–based training program entitled *A Prudent Mariner's Guide to Right Whale Protection* (NMFS 2009b). While this training program is specific to right whales, NMFS has stated that the guidance and avoidance measures are also applicable to fin, humpback, and sperm whales. The second option is focused on Pacific species but is directed to mariners in Canadian waters (Mariners guide to whales, dolphins and porpoises of western Canada, Coastal Ocean Research Institute [CORI] 2016). In the event, that a U.S. based Pacific guide is developed before operations commence, this guide would be used. The final decision would be made in consultation with a qualified marine mammal zoologist or biologist to use the most relevant and up-to-date guide available.
- Measures discussed in the 2010 workshop in California (Reducing Vessel Strikes of Large Whales In California (DeAngelis 2010) as relevant for the species expected in coastal Oregon.
- Sightings of marine mammals are to be documented and reported to a central database. This would be arranged with consultation of NMFS and the Oregon Institute of Marine Biology. This reporting would assist in understanding patterns of distribution and occupancy in the continental shelf waters of Oregon by blue whales.
- Written guidance on expectations regarding:
    - Active watch for marine mammals.
    - Sightings data documentation, and reporting procedures.
    - Vessel speeds of 10 knots or less when mother-calf pairs or groups are sighted.
    - Maintenance of a minimum distance of 100 yards from whales, when navigably possible. This is particularly relevant if advance notice of whales locations are provided by NMFS.

- Maintenance of a parallel course to the whale(s) and avoidance of excessive speed or abrupt course changes until the vessel and whale are no longer proximal.
  - When whales are sighted in a ship's path or in proximity to a moving ship, reduce speed to 10 knots or less or shift the engine to neutral until whales are clear of the area or path of the ship, as navigably possible.
- Participate in the Oregon Emergency Response system (1-800-452-0311) to report any observed spills

LNG carrier masters would also be asked to report sightings of any injured or dead whales as soon as is practicable, regardless of whether the injury or death is caused by the ship. If the injury or death is caused by collision with the ship, within U.S. the appropriate regulatory agency (NMFS) would be notified within 24 hours of the incident. Information to be provided would include the date and location (latitude/longitude) of the strike, the ship name, the species or a description of the animal, if possible.

3.2.1.5 Determination of Effects

Species

The LNG Terminal **may affect** blue whales because:

- blue whales may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) from current levels within the marine analysis.

However, the Project is **not likely to adversely affect** blue whales because:

- based on existing information, ship strikes on blue whales within the marine analysis area are expected to be discountable,
- the increase in annual ship traffic due to the proposed action is expected to result in a localized increase of the risk of ship strike to blue whales, but because blue whales do not aggregate in this region the increase in risk would be discountable,
- JCEP would provide a ship strike avoidance measures package to shippers transporting LNG cargo from the LNG Terminal that would consist of multiple measures to avoid striking marine mammals;
- LNG carriers approaching Coos Bay would be traveling slowly and be escorted by tractor tugs from 5 nmi offshore to the LNG Terminal; and
- LNG carrier noise would contribute to overall noise within the marine analysis area while transiting to and from Coos Bay and effects of ship noise on blue whales could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise, but are not expected to cause injury, and the exposure is expected to be to a discountablepercentage of the population.

Critical Habitat

No critical habitat has been designated or proposed for blue whales.

3.2.2 Fin Whale

3.2.2.1 Species Account and Critical Habitat

Status

Fin whales were listed as endangered under the ESCA on June 2, 1970 (FWS 1970). Under the ESA, this status remains in effect today for the Northeast Pacific stock of fin whales (NMFS 2015a). Under the MMPA, this stock is classified as depleted and strategic (NMFS 2015a). The stock structure within the eastern North Pacific Ocean is unclear for this species, but there are three management stocks recognized in U.S. Pacific waters: 1) Alaska (Northeast Pacific), 2) California/Oregon/Washington, and 3) Hawaii (NMFS 2015a).

Threats

Commercial whaling was the primary reason for the depletion of fin whales, however this threat ceased when commercial whaling for this species in the North Pacific ended in 1976 (NMFS 2012a). Ship strikes and disturbance by vessels are modern threats to fin whales (NMFS 2010a). Between 2010 and 2014 there were at least nine fin whales documented killed or injured by vessel strikes along the Pacific west coast (Carretta et al. 2017a). It is expected that not all vessel-whale collisions are documented, therefore estimates are expected to underrepresent the actual numbers. The total documented incidental mortality and serious injury of 2.0 whales per year (0.2 whales per year due to fisheries and 1.8 whales per year due to ship strikes) is well below the calculated PBR (81) (Carretta et al. 2017a). Further, Nadeem et al. (2016) report that this population of fin whales has increased since the early 1990s.

As with blue whales, anthropogenic noise is concern identified by NMFS (2010a) as a factor influencing the distribution of fin whales. Noise from vessels and other anthropogenic sources may interfere and mask cetacean communication, predator-prey detection, and possibly navigation (Würsig and Richardson 2009). Coastal developments and its associated anthropogenic noise may compromise the migration routes and seasonal areas used by fin whales (NMFS 2010a). As discussed previously for blue whales, pollution and climate change may affect fin whales or their prey species. The potential effect of climate change on fin whales is uncertain, but there may be effects that impact habitat selection, prey availability, breeding behaviors, and migration patterns (NMFS 2010a).

Species Recovery

NMFS finalized a recovery plan in 2010 (NMFS 2010a) and the most current five-year status review was released in December 2011 (NMFS 2011a). The goal of the recovery plan is to achieve the delisting of the species. (NMFS 2010a).

The recovery plan identifies the following recovery actions:

- Coordinate state, federal, and international actions to implement recovery actions and maintain International Regulation of Whaling for fin whales;
- Determine population discreteness and stock structure;
- Develop and apply methods to estimate population size and monitor trends in abundance;
- Conduct risk analyses;

- Identify, characterize, protect and monitor habitat important to fin whale populations in U.S. waters and elsewhere;
- Identify causes and reduce the frequency and severity of human-caused injury and mortality;
- Determine and minimize any detrimental effects of anthropogenic noise in the oceans;
- Maximize efforts to acquire scientific information from dead, stranded, and entangled or entrapped fin whales; and
- Develop a post-delisting monitoring plan.

Life History, Habitat Requirements, and Distribution

Fin whales are a baleen whale and the second-longest whale species. They are widely distributed throughout the world's oceans. The gestation period is assumed to be less than a year, and fin whale calves are nursed for 6 to 7 months. Most mating and calving takes place in winter. In the North Pacific, fin whales appear to prefer a diet of euphausiids and large copepods, followed by schooling fish such as herring, walleye pollock, and capelin (NMFS 2010a).

Fin whales can be found in groups of three to seven, but group sizes have been recorded as large as 50-100 animals in rich feeding grounds. Dive times are typically 3-15 minutes, with depths from 100-230 meters (328-755 feet). A series of two to five shallow dives for between 10 and 20 seconds is common (Shirihai and Jarrett 2006).

The reproductive age of fin whales is believed to have decreased from 12 to six years for females and 11 to four for males from the 1950s to the mid-1970s as a result of the overharvesting. They are believed to reproduce every two to three years upon reaching sexual maturity. Fin whales live between 85 to 90 years (Shirihai and Jarrett 2006).

The seasonal movements, habitat use and distribution of eastern North Pacific fin whales are not well understood. However, this species is known to occur year-round off the coast of Oregon, with seasonal abundance fluctuations with numbers being lower during the winter and spring compared to the summer and fall (Carretta et al. 2017a, Green et al 1992).

Population Status

The best estimate of the California/Oregon/Washington stock of fin whales is 9,029 whales (CV=0.12), based on line transect data from 1991-2014 (NMFS 2017). There is strong evidence this population is increasing from the time of the cessation of whaling (Carretta et al. 2014a, Moore and Barlow 2011). The minimum population is estimated at approximately 8,127 whales in 2014 (Carretta et al. 2014a). The annual PBR for this fin whale stock is 81 (NMFS 2017).

Critical Habitat

As of October 2017, critical habitat for this species has not been designated in U.S. waters.

3.2.2.2 Environmental Baseline

Analysis Area

The analysis area applicable to fin whales is the marine analysis area as described for blue whales (see section 3.2.1.2).

Species Presence

The same line-transect ship surveys discussed above for blue whales (Barlow and Forney 2007; Forney 2007; Barlow 2010) were used to estimate fin whale populations off the coasts of Oregon and Washington. The mean density of fin whales in the Oregon-Washington stratum is 0.129 whales per 100 km^2 or 0.038 whales per 100 nmi^2. Based on habitat modeling, the predicted densities of fin whales in Oregon coastal waters range from 0.0013 - 0.0048 whales/km^2, with densities in the continental shelf region off Coos Bay ranging from 0.0028 – 0.0036 whales/km^2 (Calambokidis et al. 2015).

Habitat

Fin whales occur in both nearshore and pelagic waters (Calambokidis et al 2015), but based on the line transect data referred to in the previous section, fin whales are typically found in the continental slope and pelagic zones of the Oregon coast (NMFS 2014a). Observations show fin whales to be present year-round in central and Southern California; year-round in the Gulf of California; and occurring off Oregon in the summer. However, acoustic signals from fin whales have also been detected year-round off northern California, Oregon, and Washington, with a concentration of vocal activity between September and February (NMFS 2010a). Since fin whales feed on euphausiids, similar to blue whales, they may likewise follow primary production blooms of phytoplankton and associated euphausiid biomass increases off the Oregon coast as the blooms advance from south to north (Burtenshaw et al. 2004). Green et al (1992) found fin whales using continental slope waters 85-90 km west of Newport, Oregon. Though this species has been observed in continental shelf waters, a greater proportion of sightings have occurred over the continental slope (Green et al. 1992).

Critical Habitat

Critical habitat for this species has not been designated.

3.2.2.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, underwater noise, and potential adverse effects from fuel spills. Spills could additionally indirectly affect fin whales by impacting forage species. These effects are addressed below.

Ship Strikes

There is an ongoing threat of ship strikes to fin whales throughout the world's oceans. Reduction of human-caused injury and mortality to fin whales is a principal objective for the species' recovery (NMFS 2010a). From 2007 to 2011 ship strikes of fin whales averaged 0.2 death or injury per year off the Oregon-Washington coast (Carretta et al. 2013). However, of the ship strikes reported in Carretta et al. (2013) no fin whales were reported struck in Oregon waters. Jensen and Silber (2003) reported a rate of 0.5 fin whales struck per year off the coasts of California and Washington from 1991 through 2002. Likewise, Douglas et al. (2008) compiled records of ship-strikes of fin whales in Washington State from 1980 to 2006 with an average of 0.07 whales struck per year. These are likely underestimates, as ship strikes with cetaceans can go unnoticed and therefore unknown and unreported, but reports from Oregon suggest low levels of ship strike in comparison to other parts of the Pacific Ocean off the coast of the United States.

Ship-strike risk was estimated for fin whales, as described above for blue whales (see section 3.2.1.3).

Estimated Ship Strikes to Fin Whales

Determination of the WSREM for fin whales (see table 3.2.2-1) included the following variables:

- Fin whale length: 25.91 m (https://www.fisheries.noaa.gov/species/fin-whale)
- Time at Surface: 5% (Ray et al. 1978)
- Density – Lower = 0.0028 whales/km^2 (Calambokidis et al. 2015)
- Density – Upper = 0.0036 whales/km^2 (Calambokidis et al. 2015)
- Proportion of year most likely to occur in marine analysis area: June through February = 0.75

TABLE 3.2.2-1

Results of WSREM for Fin Whales

Marine Traffic	Risk Lower Estimate (whales/1000 km)	Risk Upper Estimate (whales/1000 km)
LNG carriers Only	0.19	0.24
Existing Traffic Only	0.08	0.10
Cumulative Results	0.26	0.34

As with blue whales, the estimated vessel strike risk increases from existing levels but is again limited to the time of year that fin whales are known to occur off Oregon. Therefore, while the risk is increased from the existing risk levels (which with rounding to two decimal places have the same value for the lower and upper risk estimates) with the addition of vessels transiting to the LNG Terminal, this risk is still considered to be low based on the results of the WSREM and low documented rates of actual ship strikes in Oregon waters. In addition, though there is a localized increase in the risk of ship strikes to fin whales by LNG carriers, this localized increase is not significant for the California/Oregon/Washington stock of fin whales as the coast of Oregon does not contain identified critical habitat nor is it a recognized area for feeding aggregations.

Underwater Noise

Determining and minimizing detrimental effects of anthropogenic underwater noise on fin whales is a principal objective for the species' recovery (NMFS 2010a). The potential effects of underwater noise on fin whales are as described in section 3.2.1.3 for blue whales.

Based on the same evaluation as presented in the blue whale discussion, there could be 0.06 – 0.07 fin whales/km within the area of sound attenuation to 120 dB during the time of year that fin whales are present off the coast of Oregon. Based on the above data, and since fin whales are present in densities of roughly 0.06 - 0.07 fin whales per km^2 within the area of sound attenuation to 120 dB, there could be between 432 and 504 fin whales potentially occurring within the 120 dB attenuation area over the life of the Project. Similar to the analysis for blue whales, as many as between 160 and 186 fin whales could occur within the 120 dB attenuation area for tractor tugs over the life of the Project.

Some fin whales may be exposed to sound levels produced by Project related vessels that could cause behavioral disturbance. However, the potential number of whales that could be affected are a small fraction compared to the estimated population sizes of the Northeast Pacific stock of fin whales or the California/Oregon/Washington stock.

Fuel Spills

The potential effects of fuel spills on fin whales, as well as the laws and regulationsregarding environmental protection are the same as described as for blue whales (see section 3.2.1.3). As a result, effects to fin whales from accidental spills or release of fuel or lubricants at sea are expected to be insignificant and discountable.

Cumulative Effects

The definition of cumulative effects to fin whales is as described as for blue whales (see section 3.2.1.3). The foreseeable cumulative effect of the additional 120 LNG carriers per year with regard to vessel traffic noise, risk of vessel strike or accidental release is expected to be low. Consequently, cumulative effects to fin whales would be the same as the estimate of direct effects discussed in the previous sections. Those effects were judged to be discountable.

Critical Habitat

The proposed action would not affect critical habitat because none has been designated.

3.2.2.4 Conservation Measures

The same Conservation Measures to minimize potential effects that was described in section 3.2.1.4 (blue whales) applies to fin whales.

3.2.2.5 Determination of Effects

Species

The Project **may affect** fin whales because:

- fin whales may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG) within the marine analysis area.

However, the Project is **not likely to adversely affect** fin whales because:

- ship strikes to fin whales within the marine analysis area have not been documented;
- the risk of ship strike is expected to be discountabledue to the low occurrence of fin whales in the nearshore environment of the marine analysis area and this species' habitat preferences;
- JCEP would provide a ship strike avoidance measures package to shippers transporting LNG cargo from the LNG terminal that would consist of multiple measures to avoid striking marine mammals;
- LNG carriers approaching Coos Bay entrance would be traveling slowly and escorted by tractor tugs from 5 nmi offshore to the Port; and

although LNG carrier noise would contribute to overall noise within the marine analysis area while transiting to and from the LNG Terminal and effects of ship noise on fin whales could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise, these noise levels are not expected to cause injury, and the exposure is expected to be to a discountablepercentage of the population.Critical Habitat

No critical habitat has been designated or proposed for fin whales.

3.2.3 Killer Whale

3.2.3.1 Species Account and Critical Habitat

Status

Eight stocks of killer whale are recognized within Pacific United States waters, with three relevant to the Oregon coast (NMFS 2013b):

1. Eastern North Pacific Southern Resident stock – occurring from Alaska to California, with a summer preference for the inland waters of Washington and southern British Columbia (winter preferences are not defined), listed as endangered under the ESA November 18, 2005 (NMFS 2005a). The Southern Resident population is classified as depleted and strategic under the MMPA;
2. Eastern North Pacific Transient stock – occurring from Alaska to California (unlisted);
3. Eastern North Pacific Offshore stock – occurring from Southeast Alaska to California (unlisted).

A status review of Southern Resident killer whales conducted in 2002 concluded that listing as threatened or endangered was not warranted because Southern Resident killer whales were not a species or DPS for ESA application (NMFS 2005a). The status review recognized, however, that the Southern Resident killer whale was a depleted stock under the MMPA. A challenge to NMFS' decision to not the list the species ("not warranted") and subsequent judicial intervention resulted in an updated status review, which found that the Southern Resident killer whale stock is discrete and significant with respect to other resident stocks and should be considered a DPS for listing under ESA (NMFS 2005a).

NMFS (2012b) published a 90-day finding on a petition to remove (delist) the Southern Resident killer whale DPS from the ESA list. The finding determined that the petitioned action might be warranted and NMFS announced their initiation of a status review to determine if the petitioned action is warranted. In 2011, NMFS completed a five-year review of the status of Southern Residents killer whales and concluded that no change was needed in the species' ESA listing status; the Southern Resident killer whale DPS would remain listed as endangered (NMFS 2011b).

Threats

The Southern Resident killer whale DPS primarily occurs in the inland transboundary waters of British Columbia and Washington in the summer and fall and in outer coastal waters in winter and spring. The spring and winter habitat use (including Oregon waters) is not well defined, and therefore the threats associated with this time of year can only be generalized. The NMFS (2008a) identified the factors that currently pose a risk for Southern Residents, including the following:

- Reductions in quantity or quality of prey;

- High levels of organochlorine contaminants and increasing levels of many "emerging" contaminants (e.g., brominated flame retardants), putting Southern Residents at risk for serious chronic effects similar to those demonstrated for other marine mammals (e.g., immune and reproductive system dysfunction);
- Sound and disturbance from vessel traffic; and
- Oil spills.\

Reductions in prey availability, primarily that of salmon, over the past 150 years has limited the carrying capacity for the Eastern North Pacific Southern Resident stock (NMFS 2008a). Other reasons for the reduction in Southern Resident stock numbers includes the live-capture of whales for aquaria, and targeted shooting that was common before 1960 (NMFS 2013b).

Commercial and recreational vessel traffic have increased considerably during the past decades. The threats to killer whales from acoustic disturbance, and risk of ship strike are as previously discussed for blue and fin whales.

Environmental pollution is a known threat to killer whales. High levels of polychlorinated biphenyls (PCBs) have been found in the Southern Resident stock, and increasing levels of polybrominated diphenyl ethers and other contaminants are being found in ocean habitats with increasing frequency (NMFS 2008a). Ross et al. (2000) found that the Southern Resident stock was one of the most contaminated cetaceans worldwide, and noted that fish-eating marine mammals that are found in industrialized coastal waters are generally high in PCB concentration levels.

Killer whale food sources may be damaged and they may gain new stressors with certain climate changing processes such as global warming similar to those discussed above for blue whales (Fogarty and Powell 2002).

Species Recovery

NMFS published a recovery plan for the Southern Resident killer whales in 2008 (NMFS 2008a). The goal of the recovery plan is to remove the species from the ESA. The interim goal is to reclassify the Southern Resident killer whale DPS from endangered to threatened. The following is a list of recovery measures needed to achieve the goals and objectives provided in the recovery plan (NMFS 2008a):

- Protect the Southern Resident killer whale population from factors that may be contributing to its decline or reducing its ability to recover (salmon stock, pollution, vessel disturbance).
- Protect Southern Resident killer whales from additional threats that may cause disturbance, injury, or mortality, or impact habitat (oil spills, acoustic effects, disease, invasive species).
- Develop public information and education programs.
- Respond to killer whales that are stranded, sick, injured, isolated, pose a threat to the public, or exhibit nuisance behaviors.
- Encourage transboundary and interagency coordination and cooperation.
- Monitor status and trends of the Southern Resident killer whale population.
- Conduct research to facilitate and enhance recovery efforts for Southern Resident killer whales.

Life History, Habitat Requirements, and Distribution

Killer whales are found in all oceans, but the Southern Resident killer whale population occurs only in the coastal waters of the western U.S. and Canada. Southern resident killer whales live in stable matrilineal societies, with the groups consisting of family units of both sexes and a range of ages. Southern resident killer whales prey upon a number of different fish species including salmonids, lingcod (*Ophiodon elongates*), halibut (*Hippoglossus stenolepis*), rockfish (*Sebastes* spp.) and Dover sole (*Microstomus pacificus*)sh, but seasonality existing with the summer and fall months diet consisting mostly chinook and chum salmon (*Oncorhynchus tshawytscha* and *O. keta*) - (Fisheries and Oceans Canada 2011; Hanson et al. 2010). Genetic stock identification analyses are indicating that the main chinook salmon stocks that southern resident killer whales target are from the relatively large drainages of Washington and California (Hanson 2015). Less is known of the diet composition during the winter and spring months, and research into this important life history component is continuing.

Sexual maturity of female killer whales is size dependent and occurs when the whales reach lengths of approximately 15 to 18 feet. Mating appears to occur at any time, with no identified breeding season (American Cetacean Society 2004). The female Southern Resident killer whales average births every 4.9 to 7.7 years, and are polygamous. This species can live beyond the reproductive years with males living up to about 50 years and females nearing 100, however, it is possible that males may continue to be reproductively viable throughout their lives. Males tend to have death rates that increase by 18 percent each year after reaching 30 years old (American Cetacean Society 2004). Dives are relatively short, with patterns consisting of several shallow dives with breaths every 10 to 35 seconds , followed by deeper, longer dives lasting up to about 17 minutes (Shirihai and Jarrett 2006).

Population Status

In 1993 there were 96 individual killer whales in the three pods that comprise the Eastern North Pacific Southern Resident stock. The population increased to 99 whales in 1995, then declined to 79 whales in 2001, and most recent population size is 78 whales, as of December 2016 (CFWR 2017).

It is believed that the entire population is identified and accounted for each year due to extensive effort and photographic identification of individual animals. The recent analysis of long-term population growth, from 1979 to 2011, for the Southern Resident killer whale DPS indicates the maximum annual growth rate is R_{MAX} = 3.5 percent (Carretta et al. 2017a). The PBR is calculated at 0.14 whales per year and appears to be approaching a rate of zero for human-related mortality and serious injury (Carretta et al. 2017a).

Southern resident killer whales are known to use the outer coasts of British Columbia, Washington, Oregon and California, particularly during the winter and spring months (Hanson 2015). Observations of Southern Resident killer whales in Oregon are infrequent and have been restricted to offshore areas near Depoe Bay (1999 and 2000), near Yaquina Bay (2000), and near the Columbia River (2006) (NMFS 2006a). Passive acoustic and telemetry data also indicate that during the winter/spring months southern resident killer whales transit Oregon waters, through more utilized habitats appear to be in northern California and Washington (Hanson 2015). Since the Eastern North Pacific Southern Resident killer whale stock has been sighted along the Oregon coast and as far south as Monterey Bay, California (Carretta et al. 2017a), these animals may occur in the marine analysis area on an infrequent basis with likely short residency times based on the sparse sightings data.

Critical Habitat

Critical habitat for the Eastern North Pacific Southern Resident stock of killer whales was designated on November 28, 2006 (NMFS 2006a). Three specific areas were designated:

1. the Summer Core Area in Haro Strait and waters around the San Juan Islands;
2. Puget Sound; and
3. the Strait of Juan de Fuca.

None of the identified critical habitats are in Oregon waters.

NMFS (2014b) announced a 90-day Petition Finding and Request for Information for possibly revising the 2006 critical habitat designation for the Southern Resident killer whale DPS. The petition requests revision of critical habitat to include inhabited Pacific Ocean marine waters along the West Coast of the United States that constitute essential foraging and wintering areas. Additionally, the petition requests adoption of protective in-water sound levels as a primary constituent element for both currently designated critical habitat and the proposed revised critical habitat. NMFS found that the petition to revise critical habitat presented substantial scientific information indicating the petitioned action may be warranted. However, this petition did not result in any additions to the critical habitat identified for Southern Resident killer whales.

3.2.3.2 Environmental Baseline

Analysis Area

The analysis area applicable to killer whales is the marine analysis area as previously described for blue whales (see section 3.2.1.2).

Species Presence

Most sightings of the ESA-listed Southern Resident killer whales have occurred during summer and fall within inland waters of Washington and southern British Columbia. The specific areas that make up their winter range are uncertain (Carretta et al. 2014a), but acoustic detections have shown a higher than expected usage of the waters near the Columbia River (Hanson et al 2013). While southern resident killer whales are known to occur off the Oregon Coast the data indicate their presence in this part of their range is lower than the more northerly extents (Hanson et al. 2013).

While, Southern Resident killer whales may occur in or travel through the marine analysis area, this occurrence is likely on an infrequent and seasonal basis. Killer whales occasionally enter lower Coos Bay in search of prey resources (COE 1994), but these are likely to be transient killer whales (mammal eating), not Southern Resident killer whales. The available sightings data for southern resident killer whales in Oregon (see above) indicate that the habitats used are in the more northern areas of the state, and in areas with larger riverine drainages.

Habitat

Killer whales are less restrained by depth, temperature, and salinity of the water than other whales (NMFS 2008a). The Southern Resident stock tends to spend more time in deeper water or waters where there is more salmon abundance. Documented occurrences off of Oregon have led to the belief that the California Current ecosystem is used by this stock (NMFS 2008a). Green et al (1992) found that killer whales were widely distributed in Oregon waters, but that all sightings were over continental shelf waters, particularly near the shelf break. These sightings were thought be transient (mammal-eating) type killer whales, but this was not definitive (Green et al. 1992). Habitat-based density estimates were not available for Southern Resident killer whales, and are likely inappropriate due to the small population size and social dynamics.

Critical Habitat

No critical habitat for southern resident killer whales occurs in or near Oregon waters.

3.2.3.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, effects due to ship noise, potential adverse effects from a fuel spills, and potential effects on prey resources. These effects are addressed below.

<u>Ship Strikes</u>

Ship strikes are a concern for killer whales. However, of 10 whale species studied by Jensen and Silber (2003), killer whales were the least likely to be struck by ships, with one documented occurrence of a killer whale calf being struck by a ship. One killer whale from the Southern Resident stock was killed by a ship strike in 2006, but this was an unusual occurrence because that whale (L98) had become habituated to vessel interaction while it resided in Nootka Sound after being separated from its pod. In the five-year period, 2007-2011, no killer whales had been struck by vessels (Carretta et al. 2013, 2014b).

The available information indicates that killer whales are less susceptible to ship-strike than larger baleen whales, as carcasses indicating trauma and/or wounds from boat propellers have not been reported along the Oregon and Washington coasts (Norman et al. 2004). From 1995 to 2006, 10 killer whales were injured (eight) or killed (two) within the inland waterways of British Columbia (including L98, see Williams and O'Hara 2009) but none of the records were from whales struck in the open ocean.

<u>Estimated Ship Strike Risk to Southern Resident Killer Whales</u>

Due to the lack of data and habitat-based density estimates, it was not possible to quantify the risk of vessel strike to Southern Resident killer whales in the marine analysis area. However, qualitatively this risk is considered to be very low based on the apparently low use of the region by Southern Resident killer whales and the low rate at which these animals are struck in other open ocean parts of their eastern North Pacific range. It is worth noting that southern resident killer whales are known to successfully live in areas (i.e. Puget Sound) with extensive deep sea traffic. In any event, all vessel strike related conservation actions would also pertain to killer whales.

<u>Underwater Noise</u>

Determining and minimizing any detrimental effects of anthropogenic underwater noise on killer whales is a principal objective for the species' recovery (NMFS 2008a). Killer whales are highly vocal, producing a variety of clicks, whistles, and pulsed calls for echolocation and social communication (Ford 2009). As described for blue whales above, southern resident killer whales are also exposed to a variety of underwater noises. Southern Resident killer whales critical habitat was delineated in the inshore waters of Washington and British Columbia that are also used by a variety of vessel traffic, including those going to commercial ports near Seattle and Vancouver. Studies have shown that killer whales can increase their call amplitude by 1 dB for every 1 dB increase in background ambient noise levels (Holt 2008).

Due to the lack of occupancy data and habitat-based density estimates, it was not possible to quantify the potential exposure to underwater noise by Southern Resident killer whales in the marine analysis area. However, qualitatively this risk is considered to be very low based on the apparently low use of the region by Southern Resident killer whales.

While the effects by Project LNG carrier-related noise on killer whales are possible in the marine analysis area, the noise sources are not novel, and within the experience of Southern Resident killer whales given their use waters in and near shipping lanes in U.S. and Canadian critical habitats, which includes Juan de Fuca Strait with designated traffic separation schemes for deep sea vessel transit between the open Pacific waters and the Ports of Seattle and Vancouver. The exposure would be commensurate with existing noise levels and would not be expected to cause injury or disturbance.

It is unlikely that LNG carriers transiting the marine analysis area would produce noise at levels that could negatively affect Southern Resident killer whales, due to the low usage of the marine analysis area waters, the experience with commercial vessel traffic, and the absence of critical habitat in Oregon.

Prey Resources

Because the Coos Bay estuary and associated riverine extents crossed by the Pipeline are salmon habitats, and southern resident killer whales primarily target salmon stocks, the construction and operation of the Project have a potential to affect the prey resources for this marine mammal. However, as discussed below, the effects are likely to be very low because southern resident killer whales primarily target salmon stocks from other river systems and southern resident killer whales spend a low proportion of their time on the Oregon coast.

The construction of the Project has a potential to affect salmon habitat that could, in turn, affect southern resident killer whales if there were a significant reduction in their primary prey species, which are Chinook salmon. However, relatively few adult fall Chinook salmon and fewer adult spring Chinook salmon are expected to be present in Coos Bay and in known riverine habitats at the time of construction.

The distribution of spawning fall and spring Chinook (ODFW 2017d) includes streams in several of the 5th field watersheds crossed by the Pipeline project (Coos River, Coquille River, South Umpqua River, and Upper Rogue River sub-basins) although no spring Chinook apparently inhabit streams within the Coos River sub-basin. There is relatively little Chinook salmon habitat within the four sub-basins crossed by the Pipeline compared to the habitats available within Oregon (smaller yet if comparisons included occupied habitats in Washington and California), particularly for occupied and spawning habitats used by spring Chinook.

Recent research indicates that southern resident killer whales prey on adult Chinook salmon, at least on the whales' summer range in the Salish Sea, as Chinook salmon return to the Fraser River (Ford et al. 2016). During late summer and fall, the southern resident killer whale DPS feeds on

Puget Sound Chinook (as well as chum and coho). Some whales may travel as far south as Monterey Bay, California during winter. Whales prey on Chinook from Grays Harbor, the Columbia River, the Klamath and Sacramento river systems (spring-run Chinook) during winter and early spring (NOAA 2014). Abundance of Chinook salmon prey has been positively related to fecundity of the Southern Resident killer whale DPS (Ward et al. 2009).

The Project would potentially affect a very small portion of Chinook salmon habitat and consequently could potentially affect a very small portion of the prey base potentially utilized by southern resident killer whales as they occasionally travel along the coast from Washington to Monterey Bay. However, this potential effect is considered to be very low since in this area, the salmonid fishes have not been identified as primary habitats or targeted prey species of southern resident killer whales. Because the Project could potentially affect a very small portion of Chinook salmon habitat, it would not have a measureable impact to the prey base for southern resident killer whales.

Fuel Spills

The potential effects of fuel spills on killer whales, as well as the laws and regulations regarding environmental protection are the same as described as for blue whales (see section 3.2.1.3). As a result of these factors limiting the effects of spills, and low usage of the marine analysis area by killer whales, the effects of fuel spilled from LNG carriers are expected to be insignificant and discountable.

Cumulative Effects

The definition of cumulative effects to Southern Resident killer whales is as described for blue whales (see section 3.2.1.3). The foreseeable cumulative effect of the additional 120 LNG carriers per year with regard to vessel traffic noise, risk of vessel strike or accidental release is expected to be low, or effects to prey species. Consequently, cumulative effects to Southern Resident whales would be the same as the estimate of direct effects discussed in the previous sections. Those effects were judged to be discountable, particularly in light of the apparently low usage of the marine analysis area by Southern Resident killer whales.

Critical Habitat

The proposed action would not affect designated critical habitat as it is located in the inland waters of British Columbia and Washington, and does not extend into the open Pacific waters, nor is near Oregon. There is no identified critical habitat for this species in Oregon.

3.2.3.4 Conservation Measures

The same Conservation Measures to minimize potential effects to blue whales that was described in section 3.2.1.4 applies to killer whales.

3.2.3.5 Determination of Effects

Species

The Project **may affect** southern resident killer whales because:

- these whales may occur within the marine analysis area during construction and operation of the proposed action; and

- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area.

However, the Project is **not likely to adversely affect** killer whales because:

- ship strikes to killer whales within the marine analysis area are discountable;
- the risk of ship strike is expected to remain discountable due to the low usage of the area by Southern Resident killer whales, and their low rate of ship strike in other areas;
- JCEP would provide a ship strike avoidance measures package to shippers calling on the LNG terminal that consists of multiple measures to avoid striking marine mammals;
- LNG carriers approaching the Coos Bay entrance would be traveling slowly and escorted by tractor tugs from 5 nmi offshore to the LNG Terminal;
- LNG carrier noise would contribute to overall noise within the marine analysis area while transiting to and from the LNG Terminal and effects of ship noise on Southern Resident killer whales could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise, but are not expected to affect Southern Resident killer whales due to the low usage of the area;
- no expected change in the quantity or quality of prey species populations that may occur within the marine analysis area is expected as a result of the proposed action;
- an insignificant amount of habitat for prey species would be affected and would not result in measureable impacts to the killer whale's prey base;
- no expected change in the quantity or quality of prey species populations that may occur within the marine analysis area is expected as a result of the proposed action; and
- while southern resident killer whales may occasionally use Oregon coastal waters, it is not recognized as a regularly used area and the whales primarily target salmonids from other larger river systems.

Critical Habitat

The Project would have **no effect** on designated critical habitat for the Eastern North Pacific Southern Resident stock because:

- there is no critical habitat in Oregon;
- the nearest critical habitat to Coos Bay is the Strait of Juan de Fuca, Washington, more than 390 nmi north; and
- no LNG carriers associated with LNG Terminal are expected to transit designated critical habitat.

3.2.4 Humpback Whale

3.2.4.1 Species Account and Critical Habitat

Status

Humpback whales were listed as endangered under the ESCA on December 2, 1970 (FWS 1970). This status remained under the ESA implemented in 1973. As discussed in the 2016 Stock Assessment (Carretta et al. 2017), "NMFS has conducted a global Status Review of humpback whales (Bettridge et al. 2015), and recently revised the ESA listing of the species (81 FR 62259, September 8, 2016)." "The humpback whale ESA listing final rule established 14 distinct population segments (DPSs) with different listing statuses. The DPSs that occur in waters under the jurisdiction of the United States do not necessarily equate to the existing MMPA stocks. Some of the listed DPSs partially coincide with the currently defined [California/Oregon/Washington] CA/OR/WA stock. Until such time as the MMPA stock delineations are reviewed in light of the DPS designations, NMFS considers this stock to be endangered and depleted for MMPA management purposes (e.g., selection of a recovery factor, stock status). Consequently, the CA/ORWA stock is automatically considered as a "strategic" stock under the MMPA."

Threats

Commercial whaling was the primary contributor to the decline of Pacific humpback whale populations (NMFS 1991). This threat is no longer present. The main threats are entanglement in fishing gear and vessel strikes (NMFS 2013c). Anthropogenic noise is also considered a habitat concern for this species (NMFS 1991; Carretta et al. 2007). The effects of climate change on the North Pacific Ocean coastal ecosystem may also affect humpback whales, but as with the previously discussed species, it is currently not possible to quantify this potential threat factor.

Species Recovery

NMFS finalized a recovery plan in 1991 (NMFS 1991). The plan identifies three main goals: biological, numerical and political; the intent is to achieve humpback whale populations that are large enough to be resilient to episodic changes, that the population equals at least 60% of the historical environmental carrying capacity for the Atlantic and Pacific ocean basins where whales enter U.S. jurisdictional waters, and that populations are abundant enough that the species can be down listed or delisted. The plan's four major objectives are:

- Maintain and enhance habitats used by humpback whales currently or historically;
- Identify and reduce direct human-related injury and mortality;
- Measure and monitor key population parameters; and
- Improve administration and coordination or recovery program for humpback whales.

Life History, Habitat Requirements, and Distribution

The humpback whale is a large baleen whale occupying all ocean basins. Migration and reproduction is tied to seasonal progression (NMFS 1991). The Pacific humpback whales over-winter in temperate and tropical waters and migrate in summer to waters of high biological productivity in higher latitudes (NMFS 1991). Breeding and parturition take place in wintering areas, when little feeding takes place. Although along the U.S. west coast, one stock of humpback whales is recognized, there appears to be division into two separate feeding groups: 1) California and Oregon, and 2) northern Washington and British Columbia. The humpback whale diet of both groups consists of krill, along with fish including cod, pollock, anchovies, and mackerel.

Humpback whales generally travel alone or in pairs, with cow-calf pairs often very close together. Group sizes range from 12-15 animals. Dives usually last from 3 to 15 minutes, but can last up to 40 minutes – particularly in breeding habitats. Humpback whales can dive to 150 meters (492 feet). Humpback whales display cooperative hunting behaviors including a coordinated encirclement of prey in bubble nets (Shirihai and Jarrett 2006).

Sexual maturity for humpback whales is generally reached between 4 and 6 years of age. Once mature, females tend to give birth every two to three years (NMFS 1991). The gestation period is 11-12 months, with calves being weaned by 12 months of age. Calves may continue to associate with their mothers for one to two years. Information is lacking on lifespan and natural mortality but humpbacks are known to live to be at least 50 years old (Shirihai and Jarrett 2006). Predators include killer whales and sharks, though as with other large baleen whales, predators generally target neonates or juveniles.

Population Status

The best estimate of abundance for the California/Oregon/Washington stock of humpback whales is 1,918 (CV≈0.03), with a minimum population estimate of 1,876 animals (Carretta et al. 2017a). The observed annual growth rate of the California/Oregon/Washington stock is estimated between 6 and 7% (Carretta et al. 2017a).

The PBR for humpback whales is estimated at 22 animals, but since this stock spends half its year outside U.S. waters, the U.S. allocation of the PBR is reduced to 11 whales/year (Carretta et al. 2014a).

Critical Habitat

As of October 2017, critical habitat for this species has not been designated in U.S. waters.

3.2.4.2 Environmental Baseline

Analysis Area

The analysis area applicable to humpback whales is the marine analysis area as described for blue whales (see section 3.2.1.2).

Species Presence

The California/Oregon/Washington stock of humpback whales is separate from other populations that may occur in the Pacific waters west of the United States. The northern boundary of this population is the border of Washington and British Columbia, with individuals being found throughout the West Coast feeding area and concentrated primarily off of California (Carretta et al. 2007).

Systematic surveys have documented humpback whales in Oregon waters between May and November (Green et al. 1992). However, as the population size has increased since these surveys, humpback whales may now occur outside of this temporal frame, though will likely be limited by this species' annual migratory patterns. The minimum population estimate for the California/Oregon/Washington stock of humpback whales is 1,876 animals (NOAA 2014a).

Based on habitat modeling, the predicted mean densities of humpback whales off the Oregon coast range from 0.003835 – 0.008106 whales/km^2, with densities off Coos Bay higher than in some other coastal areas at 0.005330 – 0.008106 whales/km^2 (Calambokidis et al. 2015). This difference in densities could be related to the productivity and bathymetric relief of the coastal waters of south/central Oregon (see next section).

Habitat

Humpback whales are present along the west coast of the United States primarily during the spring and fall migrations. They are present off the coast of the United States in migratory routes and feeding grounds where they search alone or in groups for krill and small fish, and employ "bubble netting" to corral and trap their prey (Shirihai and Jarrett 2006). Modeled habitat use indicates that humpback whales are strongly associated with latitude and bathymetric features (including depth, slope and distance to the 100-meter isobath). Predictive habitat modeling identified seven humpback whale feeding BIAs, with one in northern Oregon at Stonewall and Heceta Bank from May – November, and one just south of the Oregon/California border at Point St. George from July to November (Calambokidis et al. 2015). Preferred habitat for this species off Oregon includes the continental shelf and slope waters (Green et al. 1992).

Critical Habitat

Critical habitat for this species has not been designated.

3.2.4.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, adverse effects from vessel underwater noise, and potential adverse effects from fuel spills at sea. Spills could indirectly affect humpback whales by impacting forage species. These effects are addressed below.

Ship Strikes

There is an ongoing threat of ship strikes to humpback whales around the world. From published accounts, humpback whales collide with ships relatively often compared to other species, with calves being particularly vulnerable (Laist et al. 2001). Jensen and Silber (2003) found that humpback whales were second most likely behind fin whales to be struck by ships. They reported two humpback whales struck between 1995 and 2000 along the U.S. Pacific Coast, whereas Douglas et al. (2008) reported only one strike off Washington between 1980 and 2006, with an average rate of 0.04.

A more recent, but temporally compressed evaluation, found that ship strikes of humpback whales averaged 0.2 deaths per year along the entire Pacific Coast between 2000 and 2004, and 0.17 deaths per year within Oregon and Washington waters, combined (Carretta et al. 2007). The average annual serious injury and mortality of humpback whales attributable to ship strikes during 2010-2014 is 1.0 whale per year (Carretta et al. 2017a). However, only one humpback whale was reported as struck in Oregon waters, and review of the case specific details yielded that the whale had breached and landed on a sail boat (Carretta et al. 2013). As with other species, these estimates are likely conservative since ship strikes may go unknown and unreported.

Estimated Ship Strike Risk

Ship-strike risk was estimated for humpback whales, as described above for blue whales (see section 3.2.1.3).

Estimated Ship Strikes to Humpback Whales

Determination of the WSREM for humpback whales (table 3.2.4-1) included the following variables:

- Humpback whale length: 18 m (NMFS 2017a) (http://www.fisheries.noaa.gov/pr/species/mammals/whales/humpback-whale.html)
- Time at Surface: 5% (NMFS 2017b)
- Density – Lower = 0.0053 whales/km^2 (Calambokidis et al. 2015)

– Density – Upper = 0.0081 whales/km^2(Calambokidis et al. 2015)
– Proportion of year in marine analysis area: spring and fall = 0.5

TABLE 3.2.4-1

Results of WSREM for Humpback Whales

Marine Traffic	Risk Lower Estimate (whales/1000 km)	Risk Upper Estimate (whales/1000 km)
LNG carriers Only	0.16	0.25
Existing Traffic Only	0.07	0.10
Cumulative Results	0.23	0.35

Since the LNG Terminal is expected to increase the vessel traffic in Coos Bay, from approximately 50 vessels per year, to 170 vessels per year (including the 120 vessels/year from the LNG Terminal), the estimated whale strike risk increases from existing levels. The WSREM yields an increased risk to humpback whales from the existing conditions at 0.07 – 0.10 whales/1000 km to 0.23 – 0.35 whales/1000 km in the marine analysis area. As with other species, the risk is limited to the time period that humpback whales are known to occur off Oregon during the spring and fall migrations.

To reference the projected risk, the current conditions characterize the existing risk and the number of humpback whales known to be struck in Oregon is very low (see Ship Strikes above). Therefore, while the risk is increased from the existing risk levels with the addition of Project related vessels, this risk is still considered to be very low based on the low documented rates of actual ship strikes in Oregon waters and WSREM results.

In addition, though there is a localized increase in the risk of ship strikes to humpback whales by Project-related LNG carriers from existing levels, this localized increase is not thought to be significant since the recognized biologically important area (Point St. George) is not within the marine analysis area.

Underwater Noise

Humpback whales are well known for their vocalizations, particularly in breeding habitats. Male humpback whales sing long, complex songs that function to attract females and may play roles in establishing dominance hierarchies or cooperative behavior among males (Clapham 2009). Studies have found that low frequency sounds, whether generated by sonar or ships, cause singing humpback whales to lengthen their singing, perhaps as compensation for the acoustic interference (Miller et al. 2000). Characteristics of humpback whale songs (duration, tempo or pace, frequency structure) indicated masking of songs by noise from large boats (Norris 1995).

Determining and minimizing any detrimental effects of anthropogenic underwater noise on humpback whales is a principal objective for the species' recovery (NMFS 1991). The potential effects of underwater noise on humpback whales are the same as described for blue whales.

Based on the same evaluation as presented in the blue whale discussion, there could be 0.07 – 0.11 humpback whales/km within the area of sound attenuation to 120 dB during the time of year that these whales are present off the coast of Oregon. Based on the above data, and since humpback whales are present in densities of between 0.07 and 0.11 humpback whales per km within the area of sound attenuation to 120 dB, there could be between 504 and 792 humpback whales potentially occurring within the 120 dB attenuation area over the life of the Project. Again, as similar to the analysis for blue whales, as many as between 186 and 293 humpback whales could occur within the 120 dB attenuation area for tractor tugs over the life of the Project.

Some humpback whales may be exposed to sound levels produced by the Project related vessels that could cause behavioral disturbance. However, the potential numbers that could be affected are a small fraction compared to the estimated population sizes of the California/Oregon/ Washington stock of humpback whales.

Fuel Spills

The potential effects of fuel spills to humpback whales, as well as the laws and regulations regarding environmental protection are the same as described as for blue whales (see section 3.2.1.3). As a result, effects to humpback whales from accidental spills or release of fuel or lubricants at sea are expected to be insignificant and discountable.

Cumulative Effects

The definition of cumulative effects to humpback whales is as described as for blue whales (see section 3.2.1.3). The foreseeable cumulative effect of the additional 120 LNG carriers per year with regard to vessel traffic noise, risk of vessel strike or accidental release is expected to be low. Consequently, cumulative effects to humpback whales would be the same as the estimate of direct effects discussed in the previous sections. Those effects were judged to be discountable.

Critical Habitat

The proposed action would not affect critical habitat because none has been designated.

3.2.4.4 Conservation Measures

The same Conservation Measures described to minimize potential effects to blue that was described in section 3.2.1.4 applies to humpback whales.

3.2.4.5 Determination of Effects

Species

The Project **may affect** humpback whales because:

- humpback whales may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area.

However, the Project is **not likely to adversely affect** humpback whales because:

- existing information indicates ship strikes to humpback whales within the marine analysis area are discountable;
- the risk of ship strike due to the increase in vessel traffic is considered to be discountable due to the relatively small area used by the vessels for transit;
- the seasonal use of the area by humpback whales and that the recognized biologically important area is outside of the marine analysis area;

- JCEP would provide a ship strike avoidance measures package to shippers calling on the LNG Terminal that consists of multiple measures to avoid striking marine mammals;
- LNG carriers approaching the entrance of Coos Bay would be traveling slowly and escorted by tractor tugs from 5 nmi offshore to the LNG Terminal; and
- LNG carrier noise would contribute to overall noise within the marine analysis area while transiting to and from the LNG Terminal and effects of ship noise on humpback whales could exceed NMFS interim noise exposure criteria for Level B single non-pulse noise, but are not expected to cause injury, and the exposure is expected to be to a discountable percentage of the population.

Critical Habitat

No critical habitat has been designated or proposed for humpback whales.

3.2.5 Sei Whale

3.2.5.1 Species Account and Critical Habitat

Status

Sei whales were listed as endangered under the ESCA on December 2, 1970 (FWS 1970) and have been listed as endangered throughout its range under the ESA since its implementation in 1973. Sei whales off the U.S. West Coast are in the Eastern North Pacific stock and are classified under the MMPA as depleted and strategic.

Threats

Commercial whaling was the cause of the sei whale population decline. This cause is no longer a threat in the eastern North Pacific Ocean; however as with other whale species, vessel strike, interactions with fisheries gear, and anthropogenic noise are contemporary threats (Carretta et al. 2014b, Carretta et al. 2007, NMFS 2011c). In addition, the effect of climate change on the eastern North Pacific ecosystem may be a threat factor for sei whales, but the magnitude of the threat is currently not quantifiable.

Species Recovery

A draft plan for recovery of the sei whale (and fin whale) was issued in 1998 (NMFS 1998a) and the plan was finalized in 2011 (NMFS 2011c). The goal of the recovery plan is to promote recovery of the species in order to eventually down list and ultimately delist this species. The two main objectives for sei whales are to 1) achieve sufficient and viable populations in all ocean basins, and 2) ensure significant threats are addressed (NMFS 2011c). The recovery plan lists the following tasks as those necessary to achieve the goal:

- Coordinate state, federal, and international actions to maintain international regulation of whaling for sei whales.
- Develop and apply methods to collect sei whale data.
- Support existing studies to investigate population discreteness and population structure of sei whales using genetic analyses.
- Continue to collect data on “unknown” threats to sei whales.
- Maximize effort to acquire scientific information from dead, stranded, and entangled sei whales.

- Estimate population size and monitor trends in abundance.
- Initiate new studies to determine population discreteness and population structure of sei whales.
- Conduct risk analyses.
- Identify, characterize, protect, and monitor habitat important to sei whale populations in U.S. waters and elsewhere.
- Investigate human-caused threats, and, should they be determined to be medium or high, reduce frequency and severity.
- Develop a post-delisting monitoring plan (NMFS 2011c).

Life History, Habitat Requirements, and Distribution

The sei whale is a large baleen whale found in both the northern and southern hemispheres. They feed in temperate waters on zooplankton (especially copepods and euphausiids), small schooling fish, and squid (Shirihai and Jarrett 2006). Calving occurs in midwinter, in low latitude portions of the species' range (OBIS-SEAMAP 2007). Sei whales are generally found alone or in pairs, although sometimes they may be found in groups of up to five. They generally dive between 5 and 20 minutes relatively close to the surface (Shirihai and Jarrett 2006). They are known for moving away from boats, and being one of the fastest swimming large whales, capable of speeds up to 26 knots (Laist et al. 2001).

Females reach reproductive age when 10 years old. Once mature, females give birth every 2 to 3 years to one calf. The gestation time is between 11 and 13 months, and calves are weaned between 6 and 9 months. It is expected that sei whales live up to 70 years (Shirihai and Jarrett 2006).

Population Status

Sei whales are encountered less frequently than other baleen whales that were depleted by commercial whaling. The best estimate of abundance for California, Oregon and Washington waters combined is 519 (CV=0.40), with a minimum population estimate of 374 whales (Carretta et al. 2017a). There are no data to estimate the current population trend for sei whales (Carretta et al. 2014a). The PBR for sei whales is 0.17 (Carretta et al. 2017a).

Critical Habitat

As of October 2017, critical habitat for this species has not been designated in U.S. waters.

3.2.5.2 Environmental Baseline

Analysis Area

The analysis area applicable to sei whales is the same as described for blue whales (see section 3.2.1.2).

Species Presence

Sei whales are an offshore species and generally do not occupy coastal habitats. Nine confirmed sightings of sei whales were made in California, Oregon, and Washington waters during extensive ship and aerial surveys between 1991 and 2008 (Carretta et al. 2017a). Two of the reported sightings were off the coast of Oregon (Carretta et al. 2007), but were westward of the continental shelf break. As there were only two sightings in pelagic waters westward of the continental slope of Oregon, it is unlikely this species would be encountered.

Habitat

Sei whales tend to use temperate waters, and do not associate with specific coastal features (Carretta et al. 2007) and are uncommonly associated with waters of continental shelves (Horwood 2009). Consequently, they are seldom observed.

Critical Habitat

Critical habitat for this species has not been designated.

3.2.5.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, effects from anthropogenic underwater noise, and potential adverse effects from fuel spills at sea. Spills could indirectly affect sei whales by impacting prey species. These effects are addressed below.

<u>Ship Strikes</u>

As with all large whale species, the risk of ship strike is a risk factor for sei whales. Sei whales are struck by ships less often than most other whales (Jensen and Silber 2003). Ship strikes of sei whales averaged 0.2 deaths per year along the Pacific Coast between 2000 and 2004 (Carretta et al. 2007), which exceeded the PBR (Carretta et al. 2007), but that rate has not been documented since then. In this time, only a single sei whale was documented struck and killed off Washington in 2003 (Douglas et al. 2008). For the period of 2004 to 2008, the average observed annual mortality due to ship strike was zero (Carretta et al. 2014b). The current PBR for sei whales from California to Washington is 0.17 whales per year.

<u>Estimated Ship Strike Risk to Sei Whales</u>

Currently data on this species are insufficient to estimate a project specific ship strike risk. However, qualitatively the risk of vessel strike within the marine analysis area is considered to be extremely low as a result of the rarity of the species, the low rate of population increase, and habitat preference for waters further from shore.

<u>Underwater Noise</u>

Determining and minimizing any detrimental effects of anthropogenic underwater noise on sei whales is a principal objective for the species' recovery (NMFS 2011c). The potential effects of underwater noise on sei whales is the same as described for blue whales (see section 3.2.1.3).

Currently data on this species are insufficient to estimate a Project specific vessel noise exposure level. However, qualitatively the risk of that behavioral disturbance would occur is considered to be extremely low as a result of the rarity of the species, the low rate of population increase, and habitat preference for waters further from shore.

<u>Fuel Spills</u>

The potential effects of fuel spills on sei whales, as well as the Federal Requirements regarding environmental protection are the same as described as for blue whales (see section 3.2.1.3). As a result of the federal environmental protections, the low probability of occurrence in the marine analysis area, and the overall rarity of this species, effects to sei whales from accidental spills or release of fuel or lubricants at sea are expected to be insignificant and discountable.

Cumulative Effects

The definition of cumulative effects to sei whales is as described as for blue whales (see section 3.2.1.3). The foreseeable cumulative effect of the additional 120 LNG carriers per year with regard to vessel traffic noise, risk of vessel strike or accidental release is expected to be low. Consequently, cumulative effects to sei whales would be the same as the estimate of direct effects discussed in the previous sections. Those effects were judged to be discountable, particularly in light of the rarity of the species.

Critical Habitat

The proposed action would not affect critical habitat because none has been designated.

3.2.5.4 Conservation Measures

The same Conservation Measures described to minimize potential effects to blue whales by LNG carriers that was described in section 3.2.1.4 applies to sei whales.

3.2.5.5 Determination of Effects

Species

The Project is **not likely to adversely affect** sei whales because:

- likelihood of encountering sei whales in the marine analysis area is discountable;
- all conservation measures for other species would also apply to sei whales, if a chance encounter occurred with this species.
-

Critical Habitat

No critical habitat has been designated or proposed for sei whales.

3.2.6 Sperm Whale

3.2.6.1 Species Account and Critical Habitat

Status

Sperm whales were listed as endangered under the ESCA on December 2, 1970 (FWS 1970) and have been listed as endangered throughout their range under the ESA since its implementation in 1973. For the MMPA stock assessment reports, sperm whales within the Pacific United States are divided into three discrete, non-contiguous areas: 1) California, Oregon, and Washington waters; 2) waters around Hawaii; and 3) Alaskan waters. The latter two will not be specifically discussed. Sperm whales are classified as depleted and strategic under the MMPA.

Threats

Commercial whaling was the cause of population reduction and for the endangered status (NMFS 2012c). This threat no longer exists in the eastern North Pacific Ocean. Contemporary threats include fisheries gear entanglement, ingestion of plastic debris, collisions with vessels, contaminants and pollutants, and possibly increasing levels of anthropogenic ocean noise (NMFS

2014c, NMFS 2010b, Carretta et al. 2007). As discussed previously for other large whale species, the effect of climate change on sperm whales is uncertain, but there may be effects that impact habitat selection, prey availability, breeding behaviors, and migration patterns (NMFS 2010a, NMFS 2010b).

Most populations were depleted by modern whaling, and commercial whaling ended in 1988 with a moratorium issued by the International Whaling Commission (NMFS 2010b). However, Japan continues to take a small number of sperm whales each year (NMFS 2010b). The only commercial fishery that is considered to likely incidentally take sperm whales is the offshore drift gill-net fishery. From 2000 to 2004, the California and Oregon thresher shark and swordfish drift gill-net fishery accounted for no deaths, but an unspecified fishery was reported to have caused one death (Carretta et al. 2007). A total of 18 sperm whales were stranded in Washington and Oregon from 1930 to 2002, with seven in Oregon and 11 in Washington (Norman et al. 2004).

Species Recovery

A draft recovery plan was released in June 2006 (NMFS 2006b) and a five-year status review was initiated on January 22, 2007 (NMFS 2007a). The recovery plan was finalized in 2010 (NMFS 2010b). The goal of the recovery plan is to eventually down list and then delist the species. To that end, the final recovery plan lists the following recovery measures:

- Coordinate state, federal, and international actions to implement recovery actions and maintain international regulation of whaling for sperm whales.
- Develop and apply methods to estimate population size and monitor trends in abundance.
- Determine population discreteness and population structure of sperm whales.
- Conduct risk analyses.
- Identify and protect habitat essential to the survival and recovery of sperm whale populations in U.S. waters and elsewhere.
- Investigate causes and reduce the frequency and severity of human-caused injury and mortality.
- Determine and minimize any detrimental effects of anthropogenic noise in the oceans.
- Maximize efforts to acquire scientific information from dead, stranded, and entangled or entrapped sperm whales.
- Develop post-delisting monitoring plan.

Life History, Habitat Requirements, and Distribution

Sperm whales are the largest of the toothed whales and exhibit sexual dimorphism, with males larger than females. They are a deep water species, and prey upon deep water squid, sharks, skates, and fishes. They are deep divers, with the average dive depth greater than 400 meters (1,300 feet) that can last longer than 2 hours (NMFS 2007a). Cows, calves and juveniles can be found in groups ranging from 10 to 50 animals, with bachelor groups of males occurring separately (Shirihai and Jarrett 2006).

The breeding season can be extended - lasting from December to August, but the peak breeding season occurs from March/April to May. Length of the gestation period is not exactly known, but likely ranges from 15 to 18 months (NMFS 2010b). Most sperm whales fully sexually mature in their twenties, although females begin ovulation between the ages of seven and thirteen. Females give birth every 4 to 6 years once sexually mature, with senescence occurring sometime after the age of 40. Sperm whales have a low reproductive rate, with a maximum of no more than two percent per year. Compounding the effects of this slow rate of increase, is that larger and older mature males were targeted by commercial whalers, and this has been a primary reason for the reduction of reproductive rates, meaning that both large and older males and females are needed to increase the rate of reproduction (NMFS 2010b).

Longevity exceeds 60 years for sperm whales. Known natural reasons for mortality include predation, competition, and disease. Calves are susceptible to predation by killer whales and sharks. Diseases that are believed to have an impact on sperm whales include myocardial infarction, gastric ulceration, and a type of cumulative bone necrosis that is believed to be caused by deep dives and resulting nitrogen bubbles during ascents (NMFS 2010b).

Population Status

The best estimate of sperm whale abundance in the California Current is 2,106 animals (CV=0.58), with a minimum population estimate of 1,332 (Carretta et al. 2017a). The current population trend is not clear, but the PBR is estimated at 2.7 animals/year (Carretta et al. 2014a).

3.2.6.2 Environmental Baseline

Analysis Area

The analysis area applicable to sperm whales is as described for blue whales (see section 3.2.1.2).

Species Presence

Sperm whales are widely distributed across the entire North Pacific and into the southern Bering Sea in summer, but the majority are thought to be south of latitude 40º N in winter (Carretta et al. 2007). Sperm whales have been reported off Oregon between March and September (Mate 1981), and Green et al (1992) documented sperm whales during the summer and fall.

Habitat

Sperm whales are considered to be almost cosmopolitan, preferring areas along the continental slope where water is as deep as 1,000 to 3,000 meters (3,280 to 9,843 feet) (Shirihai and Jarrett 2006). This deep water species can utilize the entire water column, but has shown a preference for foraging on or near the bottom (NMFS 2010b).

Critical Habitat

As of October 2017, critical habitat for this species has not been designated in U.S. waters.

3.2.6.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, effects due to anthropogenic underwater noise, and potential adverse effects from fuel spills. Spills could indirectly affect sperm whales by impacting forage species. These effects are addressed below.

<u>Ship Strike</u>

Ship strikes with sperm whales are infrequent in coastal U.S. waters, compared with other large whale species. From the available literature, one sperm whale was struck by a ship off the U.S.

West Coast in 1965 (Jensen and Silber 2003) resulting in injury but not mortality, another single animal was reported injured by an apparent ship strike (propeller injury) off the Oregon coast and another was reported as a possible ship-strike in Washington State between 1980 and 2006 (Douglas et al. 2008). More recently (2007-2011), two sperm whales were reported struck, with one of these from the waters offshore of Lane County, Oregon – the other was in the offshore waters of Washington (Carretta et al. 2013). The data from Carretta et al. (2013) yield an average yearly rate of 0.40 strikes per year for the U.S. Pacific west coast, although no ship strikes were reported for the five-year period between 2008 and 2012 (Carretta et al. 2014b).

Ship Strike Risk Estimation. The ship strike risk to sperm whales could not quantitatively addressed because habitat based density estimates were not available for the marine analysis area. Qualitatively, the risk of ship strike to sperm whales in the marine analysis area is considered to be very low based on the spatial separation of the analysis area and preferred habitats of this species. Ship strike to sperm whales in the Oregon continental shelf analysis area is possible as animals do occasionally move outside of preferred habitats, but death or injury of sperm whales by ship strikes in the marine analysis area is considered unlikely.

Underwater Noise

Determining and minimizing any detrimental effects of anthropogenic underwater noise on sperm whales is a principal objective for the species' recovery (NMFS 2010b). The potential effects of underwater noise on sperm whales is the same as described for blue whales (see section 3.2.1.3).

Reduced calling or cessation of vocalizations by sperm whales have been documented in response to pingers and military sonar signals, in response to low-frequency "Acoustic Thermometry of Ocean Climate"–like sounds, and in response to seismic surveys (Weilgart 2007). However, sperm whales and other cetaceans have been documented remaining in or returning to high noise environments, probably motivated by food and/or availability of mates (Weilgart 2007). In those situations, an individual's hearing could be damaged. For example, two sperm whales killed by collision with a ferry in waters off the Canary Islands never responded behaviorally to low frequency sounds that were generated as a test to warn and repel sperm whales from the ferry routes. Histological analyses of the inner ears of both animals showed nerve degeneration and fibrous growth in response to low frequency inner ear damage, consistent with prolonged exposure to noise from heavy maritime traffic (André and Degollada 2003). It is also possible that the whales did hear the warning signal, but did not correlate the warning signal with the approach of the ferry.

The exposure to Project related sound levels that could cause disturbance to sperm whales could not quantitatively addressed because habitat based density estimates were not available for the marine analysis area. However, qualitatively effects of Project related noise on sperm whales are possible in the marine analysis area, but increased noise levels are not expected to influence or affect sperm whales due to their general absence from the nearshore waters over the continental shelf.

Fuel Spills

The potential effects of fuel spills on sperm whales, as well as the laws and regulations regarding environmental protection are the same as described as for blue whales (see section 3.2.1.3). As a result of these regulatory requirements, and the low probability of occurrence in the marine analysis area, effects to sperm whales from fuel spills are expected to be insignificant and discountable.

Cumulative Effects

The definition of cumulative effects to sperm whales is as described as for blue whales (see section 3.2.1.3). The foreseeable cumulative effect of the additional 120 LNG carriers per year with regard to vessel traffic noise, risk of vessel strike or accidental release is expected to be low. Consequently, cumulative effects to sperm whales would be the same as the estimate of direct effects discussed in the previous sections. Those effects were judged to be discountable, particularly in light of the low probability of occurrence in the marine analysis area.

Critical Habitat

The proposed action would not affect critical habitat because none has been designated.

3.2.6.4 Conservation Measures

The same Conservation Measures described to minimize potential effects to blue whales that was described in section 3.2.1.4 applies to sperm whales.

3.2.6.5 Determination of Effects

Species

The Project is **not likely to adversely affect** sperm whales because:

- sperm whales generally do not inhabit the continental shelf waters off Oregon;
- JCEP would provide a ship strike avoidance measures package to shippers calling on the LNG terminal. The package consists of multiple measures to avoid striking marine mammals;
- LNG carriers approaching the Coos Bay entrance would be traveling slowly and escorted by tractor tugs from 5 nmi offshore to the Port;
- LNG carrier noise would contribute to overall noise within the marine analysis area while transiting to and from the LNG Terminal but effects of ship noise on sperm whales are not expected due to the low probability of occurrence in the marine analysis area; and
- all conservation measures for other species would also apply to sperm whales, if a chance encounter occurred with this species.

Critical Habitat

No critical habitat has been designated or proposed for sperm whales.

3.2.7 North Pacific Right Whale

3.2.7.1 Species Account and Critical Habitat

Status

North Pacific right whales were listed as endangered under the ESCA (35 Federal Register 18319, Dec. 2, 1970) (FWS 1970) and remained classified as endangered when the ESA was passed in 1973 (NMFS 2013d). Consequently, the North Pacific right whale is listed as depleted and strategic under the MMPA. Sightings of this species are extremely rare due to commercial whaling that continued through the 1960s (NMFS 2013d).

The North Pacific population has been further divided into a western and an eastern population, with the eastern population primarily located in the U.S. EEZ (NMFS 2013d). The eastern North Pacific right whale population is the most endangered stock of large whales in the world for which abundance estimates are available (NMFS 2015b). The western population is located primarily in the EEZ of the Russian Federation, Japan and China (NMFS 2013d). This population will not be further discussed.

Threats

Commercial whaling decimated this population, which continued illegally into the 1960's. There are a variety of potential threats to eastern North Pacific right whale population, that are similar to other large baleen whales and includes vessel interactions (strikes and disturbance), anthropogenic noise, contaminants, interactions with marine debris and fishery gear entanglements (NMFS 2013d). However, the magnitude of these threats cannot be assessed due to the species rarity and scattered distribution (NMFS 2013e). Impacts from direct hunts as well as changes in prey species resulting from climate change are also unknown (NMFS 2013d). One of the greatest threats to this populations' survival is its very small population size, estimated at about 30 individuals (NMFS 2013d).

Species Recovery

A recovery plan for the North Pacific right whale was published in June 2013 (NMFS 2013d). The primary goal of this recovery plan is data collection to facilitate improved population size estimation, monitoring trends in abundance, and determining the population structure (NMFS 2013d). The goals of the recovery plan are to first down list the right whale from endangered to threatened and then eventually delist the species all together. These goals are attained through two objectives:

1. Achieve sufficient and viable populations throughout the ocean basin; and
2. Ensure threats are addressed.

The recovery plan describes the criterion for determining when the objectives are met, which includes descriptions of factors that may interfere with population growth. The outline for Recovery Action includes the following:

- Coordinate state, federal, and international actions to maintain international regulation of whaling for North Pacific right whales,
- Determine right whale occurrence, distribution, and range,
- Identify, characterize, protect, and monitor habitat important to North Pacific right whale populations;
- Estimate population size and monitor trends in abundance; and
- Investigate human-caused threats, and should they be determined to be medium or high, reduce frequency and severity.

Life History, Habitat Requirements, and Distribution

North Pacific right whales are large, black baleen whales with a stocky body, and are distinguishable by their lack of dorsal fin. Further distinguishing characteristics include a broad, deeply notched tail and callosities on the head. The few data gathered indicate that right whales generally live for about 50 years with females having their first calf at 9-10 years. Right whales feed on zooplankton; however, their feeding method differs than that of most baleen whales. This species moves through the water open-mouthed and removes prey from patches of zooplankton, a method known as skimming (NMFS 2013d).

The International Whaling Commission has identified four different habitat categories for the right whale that includes: feeding, calving, nursery, and breeding. Breeding and nursery habitats are not known, but are thought to be in shallow coastal waters. Calving occurs in the winter in lower latitudes, while foraging occurs in the spring and summer in higher latitudes (NMFS 2013d).

Historic populations of eastern North Pacific right whales occupied waters ranging from the Gulf of Alaska to Baja, Mexico. Recent sightings of eastern North Pacific right whales have occurred in Bristol Bay, the southern Bering Sea, near Hawaii and off California.

Population Status

The rarity of sightings and few individuals seen in any one year indicate the eastern North Pacific population is very small. The minimum population estimate for eastern North right whales is 26 individuals (Muto et al 2017). There are no data on population trends and calf sightings are extremely rare. The PBR for this species is 0.05 whales, or 1 whale every 20 years, however this is considered unreliable as the population is far below the historic population which exceeded 11,000 whales (NMFS 2015b).

Critical Habitat

Two areas have been designated as critical habitat for the North Pacific right whale. One area is within the Gulf of Alaska and the other area is within the Bering Sea (NMFS 2013d) - neither area is in or near the Oregon coast.

3.2.7.2 Environmental Baseline

Analysis Area

The analysis area applicable to North Pacific right whales is the continental shelf as described for blue whales (see section 3.2.1.2).

Species Presence

Since 1950, there have been at least four sightings of North Pacific right whales off Washington, but none off Oregon (NMFS 2013d). No abundance or density estimates are available for Oregon (Forney 2007).

Habitat

Based on habitat preferences during calving in the Atlantic Ocean, the Southern California Coast and Baja Peninsula were judged to provide suitable calving habitat for North Pacific right whales (Good and Johnston 2009) but no evidence of calving is present in historical records (Gendron et al. 1999).

The distribution of eastern North Pacific right whales includes the U.S. West Coast extending south to Baja California (NMFS 2013e). North Pacific right whales have been sighted off the California coast and coastal Baja California during winter (January to early April) and spring (April to June) and may indicate a seasonal pattern of migration to southwestern coast during winter (Gendron et al. 1999). There are so few North Pacific right whales left, that it is difficult to determine what constitutes their preferred habitat, but it is unlikely that the continental shelf waters of Oregon are key habitats based on the complete lack of sightings and acoustic recordings.

Critical Habitat

Two areas have been designated as critical habitat for the North Pacific right whale, one within the Gulf of Alaska, the other within the Bering Sea (NMFS 2013d). Neither are in or near the analysis area for the Project.

3.2.7.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, effects due to ship noise, and potential adverse effects from fuel spills. Spills could indirectly affect North Pacific right whale by impacting forage species. These effects are addressed below.

Ship Strike

As with all large whales, ship strike is a concern for North Pacific right whales (NMFS 2013d). However, due to the lack of habitat use data, it was not possible to quantify the Project related ship strike risk to eastern North Pacific right whales. However, qualitatively, the risk of vessel strike within the marine analysis area is considered to be extremely low due to the rarity of the species, the low rate of population increase and the lack of sightings from this part of the range.

Underwater Noise

Determining and minimizing any detrimental effects of anthropogenic underwater noise on eastern North Pacific right whales is a principal objective for the species' recovery (NMFS 2013d). Existing data indicates that this species' response to noise disturbance and vessel activities depends on their behavior at the time; feeding or courting right whales may be relatively unresponsive to loud sounds and slow to react to approaching vessels (NMFS 2013d). However, due to the extremely low population size, lack of data on use of the continental shelf of Oregon, and very low probability of occurrence, the noise associated with the LNG carriers or the assisting tug boats is unlikely to influence or affect North Pacific right whales.

Fuel Spills

The potential effects of fuel spills on North Pacific right whales, as well as the Federal Requirements regarding environmental protection are the same as described as for blue whales (see section 3.2.1.3). NMFS (2013d) lists the relative impact to recovery of North Pacific right whales from contaminants and pollution, including oil spills, as unknown due to lack of data from past spills and unknown likelihood of future spills occurring and eastern North Pacific right whales being exposed to the spilled oil. As a result of this and the extreme rarity of the species, effects to North Pacific right whales from fuel spills are expected to be insignificant and discountable.

Cumulative Effects

The definition of cumulative effects to eastern North Pacific right whales is as described as for blue whales (see section 3.2.1.3). The cumulative effects of the Project to this species is determined to be insignificant and discountable in the marine analysis area as a result of the species rarity and the extremely low probability that this species occurs in this region.

Critical Habitat

The proposed action would not affect critical habitat as none has been designated in or near Oregon.

3.2.7.4 Conservation Measures

The same Conservation Measures described to minimize potential effects to blue whales that was described in section 3.2.1.4 applies to North Pacific right whales, in the rare event that they were encountered by Project related vessels.

3.2.7.5 Determination of Effects

Species

The Project is **not likely to adversely affect** right whales because:

- there is no existing information to indicate that ship strikes to right whales occur within the marine analysis area; and

likelihood of encountering North Pacific right whales within the marine analysis area is discountable, but if they were encountered, the conservation measures would equally apply to this species.Critical Habitat

The Project would have **no effect** on critical habitat for the North Pacific right whale because:

- no critical habitat has been designated in or near Oregon.

3.2.8 Gray Whale (Western North Pacific Stock)

3.2.8.1 Species Account and Critical Habitat

Status

In 1970, the gray whale was listed as endangered under the ESCA (FWS 1970), and in 1973 was listed as endangered throughout its range under the ESA. There are two geographic distributions of a single species of gray whale in the North Pacific Ocean: 1) the eastern North Pacific population, and 2) the western North Pacific stock (Carretta et al. 2016a). The eastern population is found along the west coast of North America from Baja California, Mexico to the Bering, Beaufort, and Chukchi Seas, while the western stock is found in eastern Asia and Russia. In 1994, the eastern population was removed from the ESA list due to numerical recovery (NMFS 1994), but the western Pacific stock maintained its ESA endangered status (NMFS 1994; Carretta et al. 2016a). The western Pacific gray whale stock is classified as depleted under the MMPA (Carretta et al. 2016a). The eastern Pacific population will not be further discussed, unless relevant to the western North Pacific gray whale stock.

Threats

Commercial whaling decimated the western North Pacific gray whale stock, and it was considered extinct until small group of animals was discovered in the 1990s (Marine Mammal Commission 2017). Though commercial whaling is no longer a threat (Swartz et al. 2006), a variety of anthropogenic threats threaten this small stock including: entrapment and entanglement in fishing gear, vessel collision, local catastrophic events such as oil spills, illegal and/or resumed legal whaling, acoustic disturbance, physical disturbance and contamination of prey populations, and habitat degradation (Weller et al. 2002, Brownell et al. 2010). Activities related to oil and gas exploration, such as geophysical seismic surveying, pipe-laying and drilling operations, increased vessel traffic, and oil spills interest near the primary feeding ground near Sakahlin Island, Sea of Okhotsk, are of primary concern to the recovery of the western North Pacific stock (Reeves et al. 2005).

In addition, natural threats also exist. These include predation, disease, entrapment in ice, starvation, and the small stock size. This latter point is compounded by the low numbers of reproductively active females which could limit recovery (Reeves et al. 2005).

Species Recovery

No recovery plan exists for the western North Pacific gray whale.

Life History, Habitat Requirements, and Distribution

Gray whales are a medium size migratory baleen whale that primarily inhabits the shallow coastal waters along the margins of the North Pacific Ocean. As the name implies, these animals have a gray colouration that can be mottled with white patches, scars and external parasites. Gray whales generally feed in northern areas in the summer and early autumn, then migrate south for the winter to the breeding and calving grounds (Swartz et al. 2006).

During the summer, the western North Pacific gray whale stock occupies feeding areas in the Sea of Okhotsk, and the Bering Sea off the southeastern Kamchatka Peninsula, Russia (Carretta et al. 2016a; Weller et al. 2012; Reeves et al. 2005). The main feeding habitat is the shallow (5-15 m depth) shelf of northeastern Sakhalin Island, particularly off the southern portion of Piltun Lagoon, where the main prey species appear to be amphipods and isopods (Weller et al. 1999). Offshore feeding grounds in 30-35m depth southeast of Chayvo Bay, are also sometimes used, where benthic amphipods and cumaceans are the main prey species (Fadeev 2003). Other habitats include the waters off western Kamchatka (Reeves et al. 2005), and in Severnaya Bay on the north coast of Sakhalin (IUCN 2006).

The migration route and wintering reproductive areas are poorly known, but may include the eastern shore of Sakhalin Island, Japanese coasts, and the Chinese coast from the northern Yellow Sea to the Hainan Strait in the south (references in Weller et al. 2012). No sightings off South Korea have been reported since 1968 (Reilly et al 2008). Most recent Japanese observations are on the Pacific side, suggesting this is now the more important migration route (Reilly et al 2008). The calving grounds are unknown but may be around Hainan Island, this being the southwestern end of the known range (Brownell and Chun 1977).

Migratory gray whales travel alone or in small, unstable groups up to 16 individuals, but in northern feeding grounds gray whales are often solitary (Leatherwood et al. 1982; NOAA 2016). Recent information from telemetry studies, photo-identification, and genetic studies have documented western North Pacific gray whales occurring in the range of the eastern North Pacific gray whale population (Weller et al. 2012). It is not known if this is a distributional anomaly, a recent occurrence or has been occurring, but undocumented for longer periods of time.

Observations outside the putative usual range for the western North Pacific gray whale have occurred during the winter migratory period (Weller et al. 2012; Carretta et al. 2016a). Up to 27 individual western North Pacific gray whales have been identified in the range of the eastern North Pacific gray whale (Mate et al. 2011, Weller et al. 2012, NOAA 2015a). Western gray whales that have migrated to eastern Pacific have been observed in small groups and/or in close proximity to conspecifics (Weller et al. 2012). It is thought that perhaps not all western North Pacific gray whales share a common wintering ground (Weller et al. 2013).

Population Status

Both stocks of gray whales were greatly reduced from commercial whaling in the 18th and 19th centuries. The eastern gray whale has returned to pre-exploitation population numbers (eastern gray whale population consists of approximately 20,990 individuals; Caretta et al. 2016a; Weller 2010). Abundance of western gray whales prior to commercial hunting has been estimated to be between 1,500 and 10,000 individuals (Yablokov and Bogoslovskaya 1984 in Reeves et al. 2005), but by the 1930s the population was considered extinct or was so low in abundance that whales were not observed (Weller et al. 2002). A small number are now known to exist.

A recent population assessment of the western gray whale estimates that there are approximately 140 individuals (excluding calves), including an estimated 36 reproductive females (Caretta et al. 2016a; Cooke et al. 2013); total population estimate including calves was approximately 155 in 2012 (IUCN 2012). An increase in the western gray whale population was observed from 2002 to 2012; the estimated average annual rate of population increase during this period was 3.3 percent (Cooke et al. 2013). Although population growth has been observed for the western gray whale, the population is relatively small so that additional deaths, particularly females, could jeopardize the recovery of the population (Reeves et al. 2005). The overall potential biological removal for gray whales in the western population is 1 whale per every 17 years (Carretta et al. 2016a).

Details of the life history of the western North Pacific stock are not well known. However, calf production has been monitored annually since 1995 through photo-identification surveys off Sakhalin Island, and the numbers are very small ranging from 2 calves in 1995 to 15 calves in 2011 (Burdin et al. 2012; Mate et al. 2011).

Migratory gray whales travel alone or in small, unstable groups up to 16 individuals, but in northern feeding grounds gray whales are often solitary (Leatherwood et al. 1982; NOAA 2016). Recent information from telemetry studies, photo-identification, and genetic studies have documented western North Pacific gray whales occurring in the range of the eastern North Pacific gray whale population (Weller et al. 2012). It is not known if this is a distributional anomaly, a recent occurrence or has been occurring, but undocumented for longer periods of time.

Observations outside the putative usual range for the western North Pacific gray whale have occurred during the winter migratory period (Weller et al. 2012; Carretta et al. 2016a). Up to 27 individual western North Pacific gray whales have been identified in the range of the eastern North Pacific gray whale (Mate et al. 2011, Weller et al. 2012, NOAA 2015a). Western gray whales that have migrated to eastern Pacific have been observed in small groups and/or in close proximity to conspecifics (Weller et al. 2012). It is thought that perhaps not all western North Pacific gray whales share a common wintering ground (Weller et al. 2013).

Critical Habitat

Critical habitat for this species has not been designated.

3.2.8.2 Environmental Baseline

Analysis Area

The analysis area applicable to western gray whales is the marine analysis area as previously described for blue whales (see section 3.2.1.2).

Species Presence

The degree to which western gray whales occur in Oregon waters is uncertain, however a few records do exist from the known spatial and temporal overlap with the eastern gray whale population (Weller et al. 2012). These records include six western North Pacific gray whales off Vancouver Island, two off California, 13 whales in San Ignacio Lagoon, Mexico, and three migrating from Russia to the west coast of North America (Weller et al. 2012; Lang et al. 2011; Urban et al. 2013; Mate et al. 2015). One whale, named "Flex" was confirmed within 11 nmi (20 km) of the central Oregon coast (Mate et al. 2011).

Therefore, western North Pacific gray whales may occasionally occur in the marine analysis area, but the frequency of occurrence and duration of stay cannot be quantified. Qualitatively, if western gray whales did occur in the analysis area, it would most likely be related to the winter migration, with a very low probability of occurrence given the small size and rarity of this stock.

Habitat

Gray whales are a coastal species that occupy shallow continental shelf waters up to 152 meters (500 feet). They typically use the nearshore waters within about 20 miles of shore (Greene et al. 1995). Weller et al. (2012) also noted that western gray whales may spend an extended period of time feeding off the coast of the Pacific Northwest prior to setting out for the long-distance, open water crossing to summer feeding grounds off the coast of Russia.

Critical Habitat

Critical habitat for this species has not been designated.

3.2.8.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, effects due to ship noise, and potential adverse effects from fuel spills. Spills could indirectly affect western gray whales by impacting forage species. These effects are addressed below.

Ship Strikes

As with other baleen whales, ship strike is a concern for western North Pacific gray whales (Weller et al. 2002), and although no vessel strikes to western gray whales have been reported, Reeves et al. (2005) stated that at least one western gray whale off the northeastern coast of Sakhalin Island had scars that appeared to be caused by a vessel. However, due to the lack of habitat use data and frequency of occurrence in the marine analysis area, it was not possible to quantify the Project.

Qualitatively, the risk of vessel strike within the marine analysis area is considered to be extremely low due to the small population size, the low rate of population increase, that occurrence in Oregon waters currently appears infrequent, existing data indicate that movements to the eastern North

Pacific are temporally limited to the winter migratory period, and that this stock primarily inhabits the western North Pacific Ocean.

Underwater Noise

The effects of underwater noise on western North Pacific gray whales is difficult to characterize. Disturbance from underwater noise is a recognized potential threat in the foraging grounds of western North Pacific gray whales (Reilly et al. 2008), and it is known from eastern North Pacific gray whale research that underwater noise along the migratory corridor could result in altered routes (Brownell et al. 2010; Gailey et al. 2016). However, recent behavioral observations of western gray whales from 4-D seismic surveys off northeastern Sakhalin Island, Russia, found no significant change in whale movement in response to the loud seismic activity, but did observe variation in the orientation of gray whales in relation to vessel activity depending on whether the vessel was less than 15 km, or greater than 25 km distance away (Gailey et al. 2016). Threats from underwater noise within the migratory route of the western gray whale is considered a low conservation concern due to the many factors contributing to existing noise along the annual migratory corridor that gray whales have been subjected to including military training ranges, oil and gas exploration and development areas, and shipping lanes that converge at some of the world's busiest and largest port cities (Brownell et al. 2010).

Due to the small population size, the low rate of population increase, that occurrence in Oregon waters currently appears infrequent, existing data indicate that movements to the eastern North Pacific are temporally limited to the winter migratory period, and that this stock primarily inhabits the western North Pacific Ocean, the noise associated with LNG carriers of the assisting tug boats is unlikely to influence or affect the western North Pacific grey whales within the marine analysis area.

Fuel Spills

The potential effects of fuel spills on western North Pacific gray whales, as well as the laws and regulations regarding environmental protection are the same as described as for blue whales (see section 3.2.1.3). While chemical pollution in migratory corridors is a recognised threat (Weller et al. 2002), the marine analysis area is outside the putative migratory corridors for western North Pacific gray whales. As a result of this and the rarity of the members of this population in the eastern North Pacific, effects to the western North Pacific gray whales from fuel spills are expected to be insignificant and discountable.

Cumulative Effects

The definition of cumulative effects to western North Pacific gray whales is as described as for blue whales (see section 3.2.1.3). The cumulative effects of the Project to this stock is determined to be insignificant and discountable in the marine analysis area as a result of the rarity and the extremely low probability that individuals from the western North Pacific occur in this region.

Critical Habitat

The proposed action would not affect critical habitat because none has been designated.

3.2.8.4 Conservation Measures

The same Conservation Measures described to minimize potential effects to blue whales that was described in section 3.2.1.4 applies to western North Pacific gray whales, in the rare event that they were encountered by Project related vessels.

3.2.8.5 Determination of Effects

Species

The Project is **not likely to adversely affect** gray whales from the western population because:

- western North Pacific gray whales generally do not inhabit the continental shelf waters of Oregon;
- the western North Pacific gray whale stock is very small, with a range that is well beyond the limits of the marine analysis area; and
- likelihood of encountering western North Pacific gray whales in the marine analysis area is discountable, but if they were encountered, the conservation measures would equally apply to this species.
-

Critical Habitat

No critical habitat has been designated or proposed for the western North Pacific stock of gray whales.

3.2.9 Gray Wolf

3.2.9.1 Species Account and Critical Habitat

Status

The gray wolf was listed as endangered in 1974 (FWS 1974). FWS delisted the gray wolf within the Northern Rocky Mountain (NRM) DPS on May 5, 2011. The NRM DPS includes wolves in Montana, Idaho, Wyoming, the eastern one-third of Washington and Oregon, and a small part of north-central Utah (FWS 2011a). However, some gray wolves in the Pacific Northwest, including western Washington, western Oregon, and northern California, are not included in the NRM DPS and are still listed as endangered. FWS still regards any wolf residing in the western two-thirds of Oregon as a listed species that is therefore protected under the ESA (ODFW 2017b).

New information on gray wolf taxonomy, cited by FWS (2013c), indicates that the gray wolf subspecies in the contiguous United States does not warrant listing under the ESA, and FWS (2013c) published a proposed rule to remove the gray wolf from the list of endangered and threatened wildlife. In 2015, FWS acted on a petition to reclassify the gray wolf as threatened throughout the conterminous United States. The FWS (2015) found that the petition did not warrant initiation of a status review and the gray wolf, except for the NRM DPS and nonessential experimental populations, remains listed as endangered.

Threats

Wolves in the Pacific Northwest (Oregon and Washington) were pursued and killed by humans through the 1940s and were primarily restricted to remote mountainous areas, primarily in National Forests of the Cascades, before they were completely extirpated from the region (FWS 2012a).

Mech and Boitani (2010) summarize the following as ongoing threats to the species: 1) competition with humans for livestock, especially in developed countries; 2) exaggerated concern by the public concerning the threat and danger of wolves; and 3) fragmentation of habitat, with resulting areas becoming too small for populations with long-term viability.

Species Recovery

FWS released a recovery plan for gray wolves in the NRM DPS in 1987. The plan focused on recovery in Montana, Wyoming, and Idaho. Although eastern Oregon and eastern Washington coincided with the historical distribution of wolves in the NRM DPS, no recovery areas were designated for either state. Recovery goals of the NRM DPS of equitably distributed wolf population containing at least 300 wolves and 30 breeding pairs in three recovery areas within Montana, Idaho, and Wyoming for at least three consecutive years were reached in 2002 (FWS et al. 2016). By 2012, the entire NRM DPS was delisted, and wolves were managed under State authority in those areas (FWS et al. 2016).

No recovery plan has been developed for ESA-listed gray wolves in western Oregon. Wolves are classified as endangered under the Oregon State ESA (ORS 496.171 to 496.192 and 498.026). ODFW (2017b) has developed a draft Wolf Conservation and Management Plan (Oregon Wolf Plan) to achieve recovery of the species and manage wolves in the state once they became de-listed from the ESA.

The Oregon Wolf Plan established recovery goals to protect wolves from overutilization for commercial, recreational, scientific, and educational purposes. The plan would serve as a deterrent to illegal killing of wolves by the public in the absence of federal protections. With the de-listing of the NRM DPS in 2011, the Oregon Wolf Plan applies to wolves in the eastern one-third of the state. The boundary between east and west wolf management zones is defined by U.S. Highway 97 from the Columbia River to the junction of U.S. Highway 20, southeast on U.S. Highway 20 to the junction with U.S. Highway 395, and south on U.S. Highway 395 to the California border (ODFW 2017b). Wolves west of that boundary are still under federal protection.

Life History, Habitat Requirements, and Distribution

Gray wolves are predators of large ungulates, including elk, mule deer, white-tailed deer, and moose, where available, and occasionally of other, smaller prey such as ground squirrels, snowshoe hare, and grouse (Larsen and Ripple 2006). Wolves are habitat generalists that only require ungulate prey and human-caused mortality rates that are not excessive (FWS 2013d). Habitats supporting wolves historically varied considerably, but extant populations in the NRM DPS and British Columbia utilize forest habitats adjacent to open habitats (meadows, prairies, tundra). Prey availability and minimal human presence and/or harassment are important components of suitable habitat (WDFW 2009). Wolves appear most vulnerable to human disturbance in and around denning and rendezvous sites (Larsen and Ripple 2006). Based on these characteristics, key components of wolf habitat that appear consistent across the diversity of landscapes inhabited by wolves include the following: 1) a sufficient year-round prey base of ungulates and alternate prey, 2) suitable and somewhat secluded denning and rendezvous sites, and 3) sufficient space with minimal exposure to humans (Larsen and Ripple 2006).

Wolves are highly social and their formation of packs, centered on male-female pair bonding, is essential to successful reproduction, survival of offspring, and successful hunting (FWS 1987). Most packs produce one litter per year ranging from one to nine pups. Wolf pairs (packs) establish home ranges/territories, centered on the den location, and are defended against other wolves (ODFW 2017a). Wolf pack territory size is a function of prey density, and can range from 25 to 1,500 square miles (FWS 2013d). Bunnell and Kremsater (1990) concluded that wolves need about 7,818 mi^2 (20,250 km^2) to maintain a viable population of 50 individuals. Herman and Willard (1978) summarized that gray wolves choose home territories with a variety of topographic features. Forests, open meadows, rocky ridges, and lakes or rivers all comprise a pack's territory. Both male and female wolves disperse, sometimes more than 600 miles (FWS 2013d).

Because of the proximity of northeastern Oregon to Idaho packs, dispersing wolves initially occupied areas in northeastern Oregon. Wolf breeding pairs in these areas could be considered more secure and stable because of their proximity and connectivity to the wolves in Idaho. Wolf movement and dispersal between the two populations would allow gene flow between the populations. Oregon's close proximity to the Idaho and Greater Yellowstone populations that number more than 786 wolves provides certainty that dispersing wolves will continue to enter Oregon at an unknown rate (ODFW 2017b).

Population Status

In 2016, an estimated 112 wolves in 11 packs and 8 breeding pairs were documented in Oregon (ODFW 2017b), including wolves in the southwest. By 2015, the conservation objective of four breeding wolf pairs for three consecutive years in the East Wolf Management Zone (the boundary shown in figure 3.2-9-1) had been achieved (Management Phase I Objective), and by 2016 there were at least seven breeding pairs for three consecutive years indicating the Management Phase III Objective had been achieved. Although the population objective for the East Wolf Management Zone (WMZ) was achieved in 2015, the population in the West WMZ is low and there are fewer than seven breeding pairs present. A breeding pair of wolves is defined as an adult male and an adult female with at least two pups surviving to the end of December. Management of wolves in the West WMZ remains at Phase I.

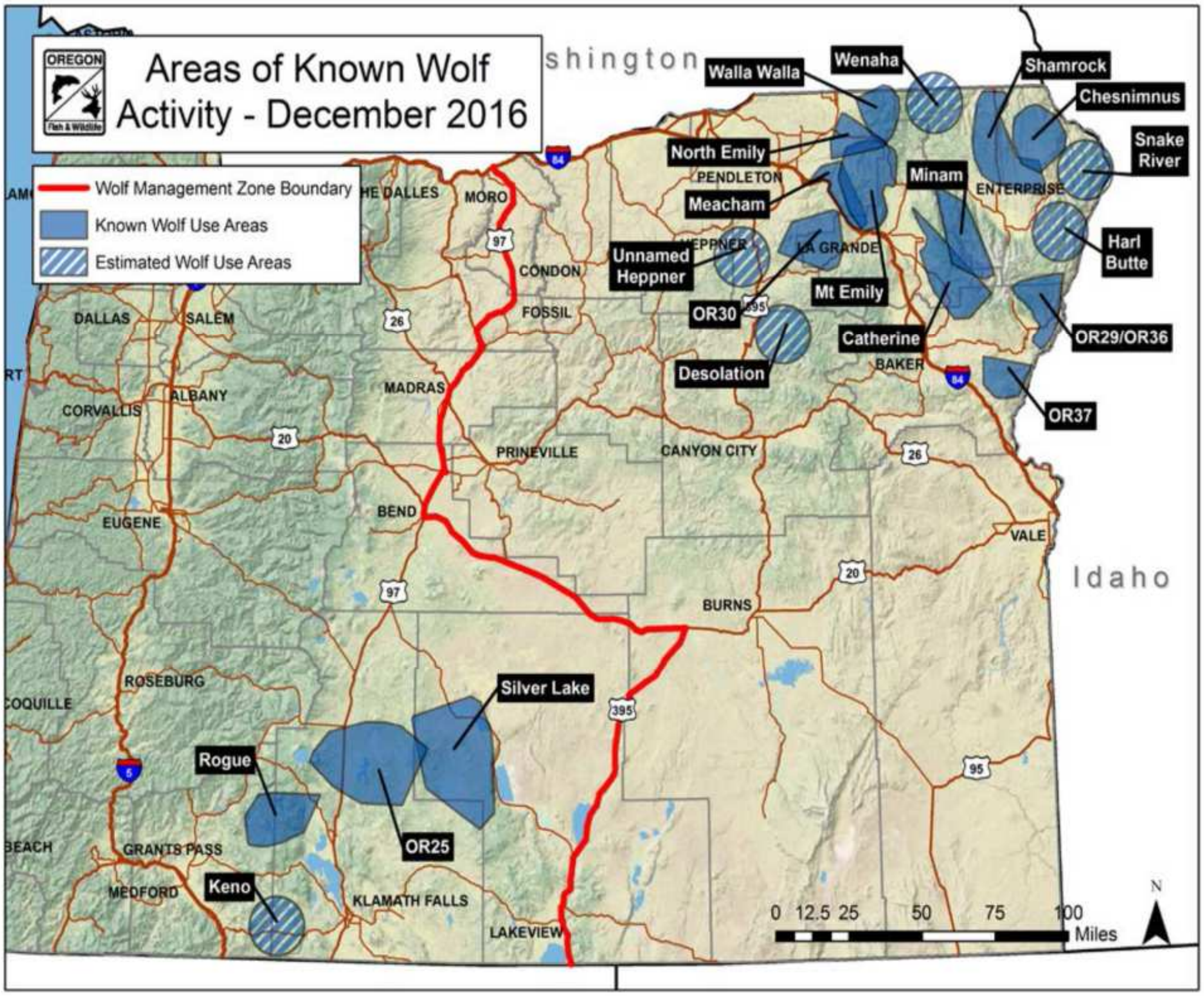


Figure 3.2.9-1 Areas of Known Wolf Activity as of December, 2016 (from ODFW 2017b)

Critical Habitat

Critical habitat for the gray wolf has not been designated in Oregon.

3.2.9.2 Environmental Baseline

Analysis Area

The action area includes all areas that would be affected directly or indirectly by the proposed action and not just the immediate area involved in the action. Because the proposed action potentially can affect such a variety of species inhabiting diverse habitats within marine, estuarine, riverine, and various terrestrial locations, there are multiple components of the action area that have been defined as species' analysis areas, the areas where individual or groups of listed species are affected by the proposed action. The gray wolf analysis area is based on the Area of Known Wolf Activity initially designated for OR-7 (now the Rogue pack) in 2014 in Jackson, Klamath, and Douglas Counties (ODFW 2014a). Although current known and estimated wolf use areas in the southern Cascades were refined in January 2017, the gray wolf analysis area is based on this larger initially identified area because it includes the extent of suitable wolf habitat in the vicinity of the Pipeline, and the areas where wolves have the potential to occur. The analysis area for gray wolves extends as far as project-related noise attenuates to ambient noise, assumed to be 40 dB on both sides of the construction right-of-way.

Species Presence

The Rogue pack currently occupies portions of southwestern Oregon, including habitats north of the Project in Jackson and Klamath Counties (ODFW 2017b). The Rogue pack was initiated by a single male wolf (OR-7) that dispersed from northeastern Oregon in 2010. Wolf OR-7 was born in northeastern Oregon in spring 2009, a member of the Imnaha pack that inhabits the Imnaha River drainage in Wallowa County, Oregon (ODFW 2017b). OR-7 dispersed from the Imnaha pack in September 2011 and was located (via radio telemetry) within Baker, Grant, Harney, Deschutes, Lake, Klamath, and Douglas counties during its migration. OR-7 traveled more than 373 miles in a straight line distance from where he was born to northern California (FWS 2013c). Since moving, the wolf had been living in the southern Cascades in Jackson, Klamath, and Douglas Counties, Oregon (ODFW 2014a) and in Siskiyou, Modoc, Shasta, Lassen, Tehama, Butte, and Plumas Counties, California (CDFW 2013).

In 2014 OR-7 was joined by a female, probably from the same area, and they produced their first litter that year. Additional pups were born in 2016 (ODFW 2017b). The Area of Known Wolf Activity (AKWA) for the Rogue Pack covered 359.3 square miles in 2015 and was about 7.1 miles northeast of MP 131.76 at its closest point (ORBIC 2017). In 2016, the AKWA shifted in size and shape but was still within 9 miles from the Pipeline project. In 2014, FWS indicated that the den was located on the west slope of the Cascades between Crater Lake and Mt. McLoughlin, in the Rogue River National Forest (Young 2014). The proposed route is greater than 6 miles from the den. The pack has spent the majority of its time in the South Cascades in the upper Rogue River watershed and the Rogue Wildlife Management Unit in eastern Jackson County.

A second AKWA (Keno) was established in southwest Oregon in 2014 with limited evidence that three wolves inhabited an area approximately 280 square miles. The Keno AKWA lies southwest of the Pipeline but overlaps the route from MP 173.93 to MP 176.41. In 2016 and 2017, three different wolves were documented in the Keno AKWA but there have been no reports of breeding. In January 2015, ODFW designated an estimated Wolf Use Area for this wolf activity (Keno, figure 3.2.9-1; ODFW 2017b). The Pipeline runs along the northeast boundary of the Keno Estimated Wolf Use Area.

Three other radio-collared wolves dispersed from northeastern Oregon to southwest Oregon. One single male wolf (OR25) dispersed in 2015 and established an AKWA spanning northern Klamath County with portions in adjacent Jackson County and Lake County. A radio-collared female wolf (OR28) dispersed in late 2015 and was joined by a collared male (OR3) to establish the Silver Lake AKWA which coincides with the Silver Lake Wildlife Management Unit in western Lake County. The pair produced one pup in 2016 but the male was killed in 2016 (ODFW 2017b). In 2016, ODFW (2017b) reported four depredation incidents on livestock (four calves dead or injured) within the Rogue AKWA. One incident was reported in the Silver Lake AKWA. Given the recent occurrence of both dispersing and resident wolves in the southwestern Cascades in the vicinity of the Pipeline, wolves are expected to occur in the wolf analysis area.

Habitat

The route crosses the gray wolf analysis area (OR-7's previous Area of Known Wolf Activity) for about 33 miles, from MP 147.7 to MP 180.7. The Pipeline would cross Very Sensitive Wildlife Areas in the Rogue Wildlife Management Area for about 8 miles from MP 147.7 to MP 155.8.

Black-tailed deer and Roosevelt elk occur within the gray wolf analysis area. Those big game species are likely to provide a prey base for wolves, especially during winter when animals are concentrated and old, sick individuals are more easily preyed on, and/or carrion is more readily available. Often, big game will remain on or near winter ranges during birthing, which also would provide wolves that are present with accessible prey (newborns). The gray wolf analysis area coincides with multiple big game winter ranges:

- elk and deer winter range in the Keno Wildlife Management Area;
- Very Sensitive Wildlife Areas (big game winter ranges) in the Rogue Wildlife Management Area;
- Very Sensitive Wildlife Areas (big game winter ranges) and Sensitive Big Game Ranges in the Dixon Wildlife Management Area; and
- Sensitive Big Game Ranges in the Indigo Wildlife Management Area.

Based on ODFW population index data, black-tailed deer in the Rogue Wildlife Management Area Unit had been significantly increasing ($P<0.01$) between 1998 and 2012. In western Oregon, black-tailed deer are found in heavy brush areas at the edges of forests and chaparral thickets, but not in dense forests. Black-tailed deer prefer early successional stages created by clear-cuts or burns, because they provide grasses, forbs, and shrubs (ODFW 2006a; Csuti et al. 2001). Most black-tailed deer that summer in the high Cascades winter at lower elevations on the west slope, although some may winter east of the Cascade crest (ODFW 2006a).

Critical Habitat

Critical habitat for the gray wolf has not been designated in Oregon.

3.2.9.3 Effects of the Proposed Action

Direct and Indirect Effects

Approximately 2.48 miles of Pipeline in Spread 4 would pass through the Keno AKWA which has most recently been occupied by three wolves. However, breeding has not been reported in the AKWA. Potential direct effects of the Pipeline include disturbance from:

- Construction-related noise,
- Increased risk of collision with construction vehicles along project area roadways;
- Wildland fire as an indirect effect associated with increased Pipeline project-induced human presence;
- Habitat alteration; and
- Locally concentrated human activities.

<u>Project-Related Noise.</u> Pipeline construction would produce noise, cause locally concentrated human activities, and remove forested habitat that might be used by some species that are preyed upon by wolves. Specific studies to measure impacts to the gray wolf from noise generated from construction of a pipeline have not been conducted; however, it is expected that construction noise

in remote areas that are relatively free from noise would have a greater potential to disturb wildlife including the gray wolf. Ambient sound levels in much of the Pipeline project area probably would be similar to the Washington Fish and Wildlife Office's determination (FWS 2003b) of 40 dB in the Olympic National Forest. Considering ambient sound as a base, noise levels associated with some common machines and activities which would be present during construction are included in table 3.2.9-1. Distances at which noise would attenuate to ambient levels would depend on local conditions such as tree cover and density, topography, weather (humidity), and wind, all of which can alter background noise conditions.

TABLE 3.2.9-1

Common Sound Levels for Equipment/Activities Potentially Associated with the Pipeline

Measured Sound Source	Range of Reported dB Values (at Distance Measured 50 ft)	Relative Sound Level a/
Chain Saw (various types/conditions)	61 – 93	Low - Very High
Pickup Truck (idle to driving)	55 – 71	Very Low - Moderate
Mowers	68 – 85	Low - High
Log Truck	77 – 97	Moderate - Very High
Dump Truck	84 – 98	High - Very High
Rock Drills	82 – 98	High - Very High
Pumps, Generators, Compressors	87	High
Drill Rig	88	High
General Construction	84 – 96	High - Very High
Track Hoe	91 – 106	Very High - Extreme
Helicopter or Airplane (various types/conditions)	96 – 112	Very High - Extreme
Rock Blast	112 b/	Extreme

Source: FWS 2006a.

a/ A general, subjective ranking of noise levels created by the sources considered when used for analysis of relative noise effects on species.

b/ Blasting required for the Pipeline project would be underground and muffled which should result in a lower dB value at 50 feet.

These project-related noises could disturb wolves potentially present if close enough to detect the noise above ambient levels, assumed to be 40 dB. If noise due to helicopter or blasting is the highest level produced during construction (112 dB), those noise levels would be expected to attenuate to ambient levels as far as 38,800 feet (7.3 miles) away (assuming no intervening topography or vegetation and a noise reduction rate of 7.5 dB for every doubling of distance from the source). On the other hand, noise from a pickup truck generating 70 dB while driving would attenuate to ambient levels about 800 feet away (with the same assumptions as above). Pipeline noise from helicopters or blasting could be detected by wolves in the Rogue pack as their Wolf Use Area is within 7.3 miles of the Pipeline. Individuals within the Keno AKWA could also detect construction noise because the AKWA borders the Pipeline. Additionally, dispersing or currently undocumented wolves in the immediate vicinity of the Pipeline would detect construction noise.

The response of wolves to project-related noise would probably be similar to their response to other anthropogenic noise including noise related to recreation, hunting, and logging that already occur within the gray wolf analysis area. There is no information specific to wolves' responses to existing anthropogenic noise. Larsen and Ripple (2006) found that road density, human density, and human presence were all lower in wolf pack areas than random polygons within their study area, although this avoidance was not attributed to noise specifically, and dispersing wolves have been shown to travel through areas of high road densities in order to find suitable habitat (Mech 1995). Thiel (1985) found that wolf breeding occurred in areas with relatively low road densities, although Mech (2006) suggested that these findings were a result of wildlands being the only place where wolves avoided human persecution historically. Additionally, wolves have been documented denning in wheat fields in Europe (Vila et al. 1993 as cited in Mech 2006), and denning and raising pups in other areas of high human disturbance (Heilhecker et al. 2008; Thiel et al. 1998 as cited in Mech 2006). There is a small chance that a gray wolf present in the Pipeline project area at the time of construction would detect project-related noise above ambient forest noise. There would be a much smaller chance that a wolf present during operation would detect project-related noise and a chance that project-related noise could interfere with wolf communication is expected to be very remote. As a result, the effects of Project noise on wolves if present, including denning wolves, are expected to be insignificant.

Vehicle-Related Mortality. A small number of wolves have been killed by vehicles. For example, 80 percent of all wolf mortalities in the Northern Rocky Mountain population are caused by humans but only 3 percent are due to accidental human interactions including vehicle collisions and capture mortality (FWS 2012a). The chance that a project-related vehicle would kill or injure a gray wolf would be remote.

Wildland Fire. Potential indirect effects from the construction and operation of the Pipeline include increased human access and presence in the area which increases the possibility of human-related wildfire. Many vegetation communities within the Pipeline project area have been directly and indirectly affected by fire over the past 100 years; highest fire risks in the Pipeline project area are the overstocked mixed conifer stands with saplings as ladder fuels. The possibility of ignition in both mixed conifer and sagebrush/grass fuel types could range from low to extreme depending on weather conditions and patterns, current fire risk rating, moisture conditions, and fuel loadings. There is some possibility of human-caused fire, whether related to Pipeline project activities or to project-induced increase of human presence in the area (see Comer 1982).

Habitat Alteration. The portion of the Pipeline that coincides with the gray wolf analysis area passes through several types of forested habitats for 33.05 miles (from MP 147.66 to MP 180.73); including Southwest Oregon Mixed Conifer-Hardwood Forest for 15.8 miles; Westside Oak and Dry Douglas-fir Forest and Woodlands for 0.5 mile; Ponderosa Pine Forest and Woodland for 5.2 miles; and Montane Mixed Conifer Forest for 6.3 miles (habitat categories follow Johnson and O'Neil 2001). Most of the Pipeline passes through forested habitats that are regenerating (11.8 miles), clearcut (0.03 mile), mid-seral (4.5 miles), late successional (6.5 miles) or old growth (5.1 miles). Within the gray wolf analysis area, the construction of the Pipeline would remove 87.0 acres of old-growth forest (more than 175 years old), 97.8 acres of late successional forest (80 to 175 years old), 77.7 acres of mid-seral forests (40 to 80 years old), 249.72 acres of regenerating forest (5 to 40 years old), and 0.7 acre of recent clear-cut forest (0 to 5 years old). The Pipeline project would create a corridor through those forest-woodland types and seral stages.

Corridors created within forested habitats are used for movement and foraging by big game species. A study conducted in Alberta by Brusnyk and Westworth (1985) focused on forage and browse production and big game use on a 17-year-old pipeline right-of-way and on a two-year-old right-of-way. Deer appeared to utilize browse in the 17-year-old corridor but returned to adjacent undisturbed forest, probably utilizing available hiding or thermal cover. Deer utilized the corridors for travel in early winter prior to when deep snow limited travel. Elk utilized forage on the two-year-old right-of-way primarily where portions were adjacent to forested habitats. The principal conclusion of this study was that pipeline corridors increased local habitat diversity and that diversity, i.e., juxtapositions of browse or forage to undisturbed forested habitat, increased use of the corridors by ungulates; however, this increase was not necessarily due to increased vegetative production, per se, within pipeline rights-of-way. Increased herbivore density provides a food source for predators (Forman 1995), so predator density can be increased along the edge created by the corridor as well.

Locally Concentrated Human Activities. Wolves potentially present could be drawn to conflict situations brought about by construction if attracted to garbage at the workplace and/or drawn to roadside carrion killed by project vehicles. Some wildlife species may be directly impacted by construction if they are killed by vehicles traveling to and from construction sites. Species most susceptible to vehicle-related mortality include those that are more active at dusk and dawn such as deer (Leedy 1975; Bennett 1991; Forman and Alexander 1998; Trombulak and Frissel 2000). However, carcasses of prey species (e.g., deer and elk) naturally occur on the landscape, usually associated with road kills or wildlife killed by natural causes (ODFW 2010). Food associated with human presence during construction activities could increase some wildlife populations within the vicinity of the Pipeline.

The response of gray wolves to human activities would likely be similar to their response to other anthropogenic disturbances including noise related to recreation, hunting, and logging that may already occur within the area. Wolves selected logged areas less during the denning period and rendezvous during summer where road density was highest; wolves selected roads most where road density was low. During fall and winter, when logging activities and traffic were low, wolves showed a strong selection for roads (Houle et al. 2010). However, wolves crossed high-use roads less than low-use trails; while neither were absolute barriers to movements, the presence of roads and trails altered wolf movement across their territories (Whittington et al. 2004). Denning wolves, when disturbed by humans, tended to move pups to an alternate site although reproductive success of wolves was not influenced by human disturbance (Frame et al. 2007). During winter, wolves subject to heavy snowmobile use were found to have higher levels of fecal glucocorticoids than wolves inhabiting areas with no snowmobile use (Creel et al. 2002), indicating a physiological stress response to snowmobile stimuli (Creel et al., 2002). Project-related stimuli could elicit a similar response in wolves within the Rogue AKWA and Keno AKWA if any was present at the time of construction.

Cumulative Effects

Cumulative effects to the gray wolf would be generated by timber harvesting and other sources of disturbance, habitat loss, and increased human presence on non-federal lands in the foreseeable future in the gray wolf analysis area. However, the majority of the gray wolf analysis area is on federal land, including the Rogue River and Winema National Forests, and Medford and Lakeview BLM Districts. No specific foreseeable state or private actions have been identified within the gray wolf analysis area.

Critical Habitat

Critical habitat for the gray wolf has not been designated in Oregon.

3.2.9.4 Conservation Measures

PCGP has stated that all trash, food waste, and other items attractive to predators and scavengers would be picked up and removed from the project area on a daily basis to minimize potential attraction of predators, including the gray wolf.

3.2.9.5 Determination of Effects

Species

The Project **may affect** the gray wolf because:

- dispersing and resident wolves have been documented recently within the gray wolf analysis area;
- the OR-7 wolf family den was located in the vicinity of the Pipeline in 2014;
- construction noise could disturb wolves if present in the vicinity of the Pipeline; and
- increased human presence associated with construction activities could impact wolf behavior and movements, including the chance of collisions with vehicles.

However, the Project is **not likely to adversely affect** the gray wolf because:

- human presence and noise generated during construction may be detected and would disturb wolves if present, but project-related noises are not likely to be substantially different from the noise produced by existing recreation, hunting, and logging land uses that wolves have been shown to tolerate;
- the one known den in southwestern Oregon is at least 6 miles from the proposed Pipeline;
- following construction, the Pipeline corridor is likely to increase local habitat diversity, forage, and be used for movements by ungulates that would be prey for gray wolves; and
- during construction, on-site trash and carrion caused by animal-vehicle collisions could attract the gray wolf to the project area and create conflict situations but trash would be removed on a daily basis and roadside carrion is expected to be present as an existing condition, and not substantially increased by the Project. Project-related effects to the gray wolf would be insignificant and discountable.

Critical Habitat

Critical habitat for the gray wolf has not been designated in Oregon.

3.3 BIRDS

3.3.1 Short-tailed Albatross

3.3.1.1 Species Account and Critical Habitat

Status

The short-tailed albatross was proposed for listing in the United States in 1980 under the ESA and was listed as endangered throughout its range in the United States on July 31, 2000 (FWS 2000b).

Threats

The primary threat leading to the species' decline and ultimate listing was over-harvest for their feathers in the early 1900s (FWS 2000b), but that threat is no longer present. Another major threat to the short-tailed albatross is their small population size and the existence of few breeding populations, one of which is threatened by volcanic activity on Torishima Island (Japan) as well as by mudslides and erosion (FWS 2005b, 2008a). Petroleum development occurs in many parts of the short-tailed albatross' marine range, and oil spills are a threat to conservation and recovery.

The possibility of volcanic eruption on Torishima remains the primary ongoing threat to short-tailed albatross because 80 to 85 percent of the breeding population nests there (FWS 2005b). Typhoons and monsoon rains generating mudslides and erosion threaten extant nesting colonies on a regular basis. Secondary threats include adverse effects related to global climate change (oceanic circulation and patterns of upwelling), incidental take by commercial fisheries (longline fisheries trawl fishing in the North Pacific), ingestion of plastic debris (especially beverage bottle caps), contamination by oil and other pollutants (metals, pesticides, PCBs), vulnerability to predation by non-native species, and other human actions including collisions with airplanes (FWS 2005b). When populations are small and confined to only a few locations such as the known breeding colonies for short-tailed albatrosses, there is a heightened risk of catastrophic loss from random or unpredictable events (environmental stochasticity).

Species Recovery

The FWS drafted a recovery plan for the short-tailed albatross in October 2005 (FWS 2005b), describing actions necessary to achieve conservation and survival of the species. Human harvest of the short-tailed albatross no longer is a threat to the species' existence, nor are human-related limitations. Therefore, focus for recovery is on protection and creation of safe breeding colonies (i.e., without potential for volcanic eruption or massive erosion) on remote islands in the Pacific Ocean (FWS 2008a). The goal of the plan is to recover the species to the point that protection under the ESA is no longer required. The plan listed the following recovery tasks:

- Support ongoing population monitoring and habitat management on Torishima.
- Monitor a second population in Japan (Senkaku population).
- Conduct telemetry studies.
- Establish one or more nesting colonies on non-volcanic islands.
- Continue research on impact from fisheries operations and mitigation measures.
- Conduct other research.
- Conduct other management-related activities.
- Conduct outreach and international negotiations as appropriate.
- Develop models and protocols for all aspects of recovery work.

Life History, Habitat Requirements, and Distribution

The short-tailed albatross nests on flat or sloped sites with sparse or full vegetation on isolated windswept offshore islands with limited human access (FWS 2000b). It requires remote islands for breeding (FWS 2005b). The only terrestrial area within U.S. jurisdiction where the short-tailed albatross is currently nesting is the Midway Atoll (FWS 2012b).

In the North Pacific, the coastal habitat for the short-tailed albatross is in high-productivity areas with expansive deep water beyond the continental shelf. Short-tailed albatrosses eat squid, fish, eggs of flying fish, shrimp, and other crustaceans (FWS 2000b). Short-tailed albatross foraging areas are closely associated with shelf-edge habitats where tidal currents and steep bottom topography generate strong vertical mixing of ocean waters. Areas are most prominent along the Aleutian Archipelago but also include several locations along the U.S. West Coast in the Santa Barbara Channel and Monterey Bay Canyon in California and the Juan de Fuca Canyon near Vancouver Island (Piatt et al. 2006).

Population Status

Prior to the publication of the final rule to list the birds, FWS (2000b) estimated a worldwide population of 600 breeding age birds and 600 immature birds (younger than 6 years old) for a total of 1,200 individuals. In 2005-06, there were an estimated 500 breeding pairs and approximately 2,000 individual short-tailed albatrosses (FWS 2005b). Population estimates in 2008-2009 indicate 418 breeding pairs (836 breeding adults) on Torishima with a total adult population of 1,045 and an estimated adult population on Minami-kojima of 200 during the 2008-2009 nesting season. The worldwide total adults of breeding age in 2008-2009 was 1,245 birds and 1,327 birds of sub-breeding age (under age 5 or 6) (FWS 2009a). The total population estimate for breeding age short-tailed albatrosses in the 2013-2014 nesting season was 1,928 individuals (FWS 2014b). Overall population size of 750 breeding pairs required for reclassification to threatened was estimated to have been met in 2013 and the delisting criteria of 1,000 breeding pairs is estimated to be met in 2017 (P. Sievert, pers. comm. 2010 as cited in FWS 2014b). More recent population data were not available.

Critical Habitat

Critical habitat has not been designated for the short-tailed albatross. Designation of critical habitat is "not prudent" given, overall, the lack of habitat-related threats to the species within the United States and its territories and absence of specific areas under U.S. jurisdiction that could serve as critical habitat (FWS 2005b).

3.3.1.2 Environmental Baseline

Analysis Area

The analysis area within which the proposed action could affect the short-tailed albatross is the edge of the marine analysis area along the continental shelf. Within the analysis area, effects to the short-tailed albatross would be associated with LNG carriers, which are assumed to transect the marine analysis area perpendicularly – east and west – as they approach and depart from Coos Bay (see the discussion above under section 3.2.1.3).

Species Presence

The short-tailed albatross has not been documented within 25 miles of the proposed JCEP LNG Terminal or Pipeline (ORBIC 2012), and the nearest known nesting population is within the Hawaiian Islands, on the Midway Atoll. Three percent of locations for sub-adult short-tailed albatrosses tagged with satellite transmitters in Alaskan waters were along the continental shelf margin, within 200 nmi, of the U.S. West Coast (Suryan et al. 2007). The data is gridded on 1° lines making it unclear if albatrosses within the study area came within the marine analysis areas. Most recent records for the species in Oregon have been at sea in the vicinity of Perpetua Bank, which is 32 miles west of Yachats, Lincoln County (Marshall et al. 2006). Short-tailed albatrosses have also been observed at Heceta Bank (Audubon Society of Portland 2013), 15 to 30 miles off the central Oregon coast, part of the same seamount ridge formation as Perpetua Bank, promoting upwelling of ocean currents interacting with seafloor topography with concomitant primary production.

Habitat

Short-tailed albatrosses spend much of their time feeding in nutrient-rich areas of ocean upwelling which often occur at continental shelf breaks (FWS 2005b). In Oregon, the continental shelf extends from 10 miles off the coast at Cape Blanco to 46 miles from the Oregon central coast (Oregon Ocean-Coastal Management Program 2008). The Perpetua Bank and Heceta Bank are within the continental shelf break zone and ocean upwelling presumably occurs in the vicinity to support foraging by short-tailed albatross. This habitat occurs on the edge of the marine analysis area, approximately 12 nmi to the outer continental shelf.

Critical Habitat

Critical habitat has not been designated for the short-tailed albatross.

3.3.1.3 Effects of the Proposed Action

Direct Effects

None of the factors that have threatened the short-tailed albatross in the past or that are ongoing threats to the species would be produced by any components of the proposed action.

Seabirds collide with fishing trawlers in the North Pacific although take of short-tailed albatross has not been reported (FWS 2009a). Collisions of seabirds with stationary objects (including off-shore wind energy turbines) are possible, either by collisions of ships with birds on the ocean surface or collisions of birds in flight with ship structures although empirical data are limited (Wilson et al. 2007). Collisions between short-tailed albatrosses and LNG carriers are possible but not likely within the marine analysis area.

Cumulative Effects

The definition of cumulative effects to short-tailed albatross is as described as for blue whales (see section 3.2.1.3). As discussed above for blue whales, ship traffic at the Port has declined in the past two decades and is not expected to change from the current level in the near future (ECONorthwest 2012), although it may increase in the distant future if proposed improvements are implemented (Port of Coos Bay 2014).

The foreseeable cumulative effect of the additional 120 LNG carriers per year with regard to risk of vessel strike, underwater noise, or accidental release is expected to be low. Consequently, cumulative effects to short-tailed albatross would likely be the same as the estimate of direct effects discussed in the previous section. Those effects were judged to be discountable.

Releases of diesel fuel and/or gasoline by commercial and recreational vessels are possible. According to annual reports published by the Pacific States/British Columbia Oil Spill Task Force (2002), ODEQ reported 34 spills from fishing vessels or other harbor craft in 2002, 38 spills in 2003, and 7 spills from fishing vessels plus spills from 27 other vessel types in 2004. Those relatively consistent incidences apparently increased in 2005 with 18 spills from fishing vessels, 20 from recreational vessels, and 27 spills by other vessel types. By contrast in 2006, there were three spills from fishing vessels, six spills from recreational vessels, and only six spills from other vessel types. Though not known, it appears that the background rate of spills off the Oregon coast (incidence of spills in proportion to total vessel operation) by fishing vessels, recreation vessels, and other vessel types is generally low. Based on existing information, future rates of offshore releases are also expected to be low and potential for short-tailed albatross to be affected by contamination by oil and other pollutants is not expected to increase above existing levels.

Critical Habitat

No critical habitat would be affected by the proposed action; none has been designated.

3.3.1.4 Conservation Measures

No measures have been included in the proposed action to specifically conserve short-tailed albatross. However, the same Ship-Strike Reduction Plan that was described in section 3.2.1.4 (Blue Whale) to minimize potential ship strikes to cetaceans by LNG carriers could benefit short-tailed albatross within the marine analysis area.

3.3.1.5 Determination of Effects

Species

The Project **may affect** short-tailed albatross because:

- short-tailed albatross may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area.

However, the Project is **not likely to adversely affect** short-tailed albatross because:

- collisions of any albatross species with ships are unknown and are expected to be highly unlikely;
- the increase in annual ship traffic due to the proposed action is expected to cause an ummeasurable increase for potential ship strikes to short-tailed albatrosses; and
- LNG carriers approaching Coos Bay would be traveling slowly and escorted by tractor tugs from five nmi offshore to the LNG Terminal.

Critical Habitat

No critical habitat has been designated or proposed for the short-tailed albatross.

3.3.2 Western Snowy Plover

3.3.2.1 Species Account and Critical Habitat

Status

The Pacific Coast population of western snowy plover has been listed as a threatened species under the ESA since March 5, 1993 (FWS 1993). In March 2004, FWS issued an initial 90-day review in response to a petition to de-list the western snowy plover. However, in April 2006 after further review, the de-listing petition was found to be unwarranted (FWS 2006c). It is also listed under Oregon's ESA as threatened.

Threats

Historic records indicate that western snowy plovers nested in at least 29 locations on the Oregon coast (FWS 2009b). At the time of the species' listing, there were only six known nesting locations

(FWS 1993). The breeding population in Oregon declined from 139 adults in 1983 to 30 adults in 1992. Similar declines within wintering habitats were also reported in Southern California (FWS 1993). Active nesting areas and breeding and wintering populations declined due to habitat degradation caused by urban development (industrial, residential, recreational facilities including homes, parking lots, and commercial establishments), introduced beachgrasses used to stabilize sand dunes, expanding predator populations, particularly corvids (crows, ravens), and non-native red foxes, and human disturbance (beach walking and jogging, ORV use, horseback riding, beach raking, pet walking [FWS 2007a]). Nesting from mid-March through mid-September corresponds with the period of intensive human use of beaches during summer, which has been documented to adversely affect adult survival as well as reproduction and fledging success.

Habitat destruction and degradation continue as the primary threats to western snowy plovers along the Pacific coast (FWS 2007a). Beach stabilization efforts have continued with permanent habitat losses due to homes, resorts, parking lots, and increased human recreational use of beaches. Other human-related threats include sand mining, disposal of dredged materials that also alter beach habitat dynamics and increase recreational access to habitats, driftwood removal (for firewood, decoration), camping and campfires, reduction in sand delivery to beach by water diversions or waterbody impoundments, and maintenance of salt ponds (FWS 2007a). Non-native beachgrasses continue to degrade the landscape along the Oregon coast by changing patterns of dune stabilization, making beach habitats less suitable for nesting and brood-rearing snowy plovers (FWS 2007a).

Species Recovery

In 2007, the FWS issued a recovery plan for the western snowy plover, Pacific Coast population, with the primary objectives to increase the numbers and productivity of breeding adults throughout the Pacific Coast and to provide for long-term protection of breeding and winter plovers and their habitat. The recovery plan provides management goals for six recovery units established within the breeding range of the Pacific Coast population in Washington, Oregon, and California. Recovery Unit 1, specifically population OR-13 (Coos Bay North Spit), is near the proposed action. The management goal for recovery unit OR-13 is 54 breeding plovers (FWS 2007a). The 2007 recovery plan's primary objective is to remove the species from the List of Endangered and Threatened Wildlife and Plants by:

- increasing population numbers distributed across the range of the Pacific Coast population;
- conducting intensive ongoing management for the species and its habitat and developing management mechanisms; and
- monitoring western snowy plover populations and threats to determine success and refine management actions.

The recovery plan lists the following necessary actions:

- Monitor breeding and wintering populations and habitats of the Pacific Coast population of the western snowy plover to determine progress of recovery actions to maximize survival and productivity.
- Manage breeding and wintering habitat of the Pacific Coast population of the western snowy plover to ameliorate or eliminate threats and maximize survival and productivity.

- Develop mechanisms for long-term management and protection of western snowy plovers and their breeding and wintering habitat.
- Conduct scientific investigations that facilitate the recovery of the western snowy plover.
- Conduct public information and education programs about the western snowy plover.
- Review progress towards recovery of the western snowy plover and revise recovery efforts, as appropriate.
- Dedicate FWS staff to allow the Arcata Fish and Wildlife Office to coordinate western snowy plover recovery implementation.
- Establish an international conservation program with the government of Mexico to protect western snowy plovers and their breeding and wintering locations in Mexico.
- Coordinate with other survey, assessment, and recovery efforts for the western snowy plover throughout North America (FWS 2007b).

The BLM administers the bulk of the lands on the Coos Bay North Spit (about 1,864 acres) with other federal and state agencies having jurisdiction over various portions of the North Spit; privately owned lands are also scattered throughout the area (U.S. Army Corps of Engineers 2016a). Snowy plover habitat on the North Spit is currently owned by the BLM and COE and managed by the BLM, Forest Service, and Oregon Parks and Recreation Department (OPRD). U.S. Army Corps of Engineers (2016b) developed a Site management plan to protect habitat for western snowy plovers on lands under their jurisdiction on the Coos Bay North Spit. The plan includes habitat management and restoration, seasonal and area restrictions, access and public use, predator management, and population and productivity monitoring. Additionally, the BLM management plan (BLM 2016a) contains directives to avoid road or trail development within designated critical habitat and restricts timing and location of beach activities to avoid distrupting nesting behaviors. A Habitat Conservation Plan was prepared, as part of OPRD application for an incidental take permit, to implement OPRD management and regulatory activities along the Oregon Coast that could affect the snowy plover (ICF 2010). OPRD would implement potential recreation restrictions and beach management activities within covered lands.

Life History, Habitat Requirements, and Distribution

The Pacific Coast breeding population of the western snowy plover extends from Mexico to mid-way up the Washington coast. Coastal populations, including those in Oregon, typically consist of both resident and migratory birds. Large concentrations of migratory snowy plovers winter primarily in coastal California, Baja California, and along the coastal mainland of Mexico (FWS 1993). The Pacific Coast population of the western snowy plover includes the birds that nest adjacent to tidal waters, including all nesting birds on the mainland coast, peninsulas, offshore islands, adjacent bays, estuaries, and coastal rivers (FWS 1993). They breed on coastal beaches from southern Washington to southern Baja California, Mexico, from early March through late September (FWS 1993 and 2001). Coastal beach breeding habitat is often dynamic because of unconsolidated soils, high winds, storms, wave action, and colonization by plants. Preferred nesting sites include sand spits, dune-backed beaches, beaches at creek and river mouths, and salt pans at lagoons and estuaries (Wilson 1980; Stenzel et al. 1981). Less frequently, western snowy plovers nest on bluff-backed beaches, dredged material disposal sites, salt pond levees, dry salt ponds, and river bars (FWS 2001).

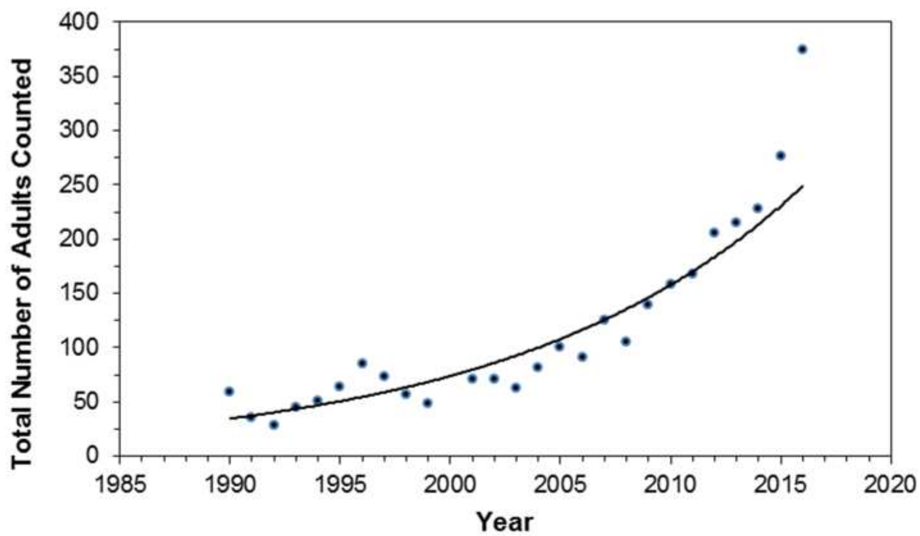
Nesting in Oregon may occur as early as mid-March but peak nest initiation occurs from mid-April through mid-July (Wilson-Jacobs and Meslow 1984). Nests typically occur in flat, open areas with sandy or saline substrates; vegetation and driftwood are usually sparse or absent (Wilson 1980). Nests consist of a shallow scrape or depression lined with beach debris (e.g., small pebbles, shell fragments, plant debris, and mud chips); nest lining progresses as incubation progresses.

Usual clutch size is three eggs but can vary from two to six. Both males and females incubate the eggs. After losing a clutch or brood (i.e., group of chicks) or successfully hatching a nest, western snowy plovers may re-nest at the same site or move substantial distances to nest at other sites (Wilson 1980; Warriner et al. 1986).

Eggs hatch within 30 days. Young are very precocial and ready to leave the nest within 1 to 3 hours of emergence at which point the attending parent would lead them to suitable feeding grounds. Broods rarely remain in the nesting area and have been observed on the North Spit as far as three miles north of the jetty at the mouth of the bay (Todd 2007). Chicks are able to fly approximately one month after hatching (FWS 2007a). Plovers feed on small invertebrates in wet sand areas of the intertidal zone, along the wrack line, in dry sandy areas above the high tide line and along surf-cast driftwood and kelp.

Population Status

Along the Oregon Coast there are nine main nesting areas, though several other areas may be utilized in some years (FWS 2007a). The lowest population estimates for nesting plovers on the Oregon Coast averaged 33 individuals annually between 1991 and 1993. From 1993 to 2016, the Oregon Coast population of adults has increased to 375 birds following an exponential trend (see figure 3.3.2-1). In 2016, nesting success for those breeding sites was the highest recorded since monitoring began in 1990, with 339 birds fledging in 2016 compared to only six birds that fledged in 1991 (Lauten et al. 2016). The plover population exceeded recovery goals exceeded in 2016 (Lauten et al. 2016).



Source: Lauten et al, 2016

Figure 3.3.2-1 Number of Adult Western Snowy Plovers Observed During the Breeding Season on the Oregon Coast, 1990 to 2016. The exponential relationship is significant (r^2 = 0.87, P<0.001)

The 2016 estimate of resident snowy plovers on the Oregon Coast was 518 individuals, the highest estimate recorded since monitoring began in 1990. This estimate was attained using the 10-day interval method by comparing minimum numbers of unbanded individuals against the number of banded individuals (Lauten et al. 2016).

Critical Habitat

Critical habitat for the western snowy plover was designated on January 6, 2000 (FWS 1999a), including 278 acres in proximity to Coos Bay, and re-designated in 2005 (FWS 2005c). The most recent revised designation of critical habitat for the western snowy plover was in June 2012 (FWS 2012c). The closest critical habitat to the Project is Unit OR-10 which occupies 273 acres on the Coos Bay North Spit, approximately 2.6 miles southwest of the proposed LNG Terminal site. A second critical habitat Unit OR-9, at the mouth of Tenmile Creek on the Siuslaw National Forest, is 7.7 miles northwest of the LNG Terminal site at its closest location to the Project. Both CHUs were occupied by western snowy plovers at the time of listing (1993) and in 2016. Approximately 55 breeding resident males with 42 fledglings occupied Unit OR-9 in 2016, while 83 breeding male snowy plovers with 43 fledglings were documented with Unit OR-10 on the North Spit in 2016 (Lauten et al. 2016).

Based on the Pacific Coast western snowy plover's requirements for reproduction, feeding, forage and shelter, the FWS (2012c) identified the following essential physical and biological features of designated critical habitat: 1) sparsely vegetated areas above daily high tides that are relatively undisturbed by the presence of humans, pets, vehicles or human-attracted predators; 2) sparsely vegetated sandy beach, mud flats, gravel bars or artificial salt ponds subject to daily tidal inundation, but not under water, that support small invertebrates; and, 3) surf or tide-cast organic debris such as seaweed or driftwood located on open substrates. Critical habitat in the vicinity of the project area (Unit 10 Coos Bay North Spit), contains expansive, sparsely vegetated interdune flats, areas of sandy beach above and below the high tide line with occasional surf-cast wrack supporting small invertebrates, and close proximity to tidally influenced estuarine areas (FWS 2012c).

Threats that may require special management in this unit are introduced European beachgrass that encroaches on the available nesting and foraging habitat; disturbance from humans, dogs and OHVs in important foraging and nesting areas; and predators such as the American crow and common raven (FWS 2005c).

3.3.2.2 Environmental Baseline

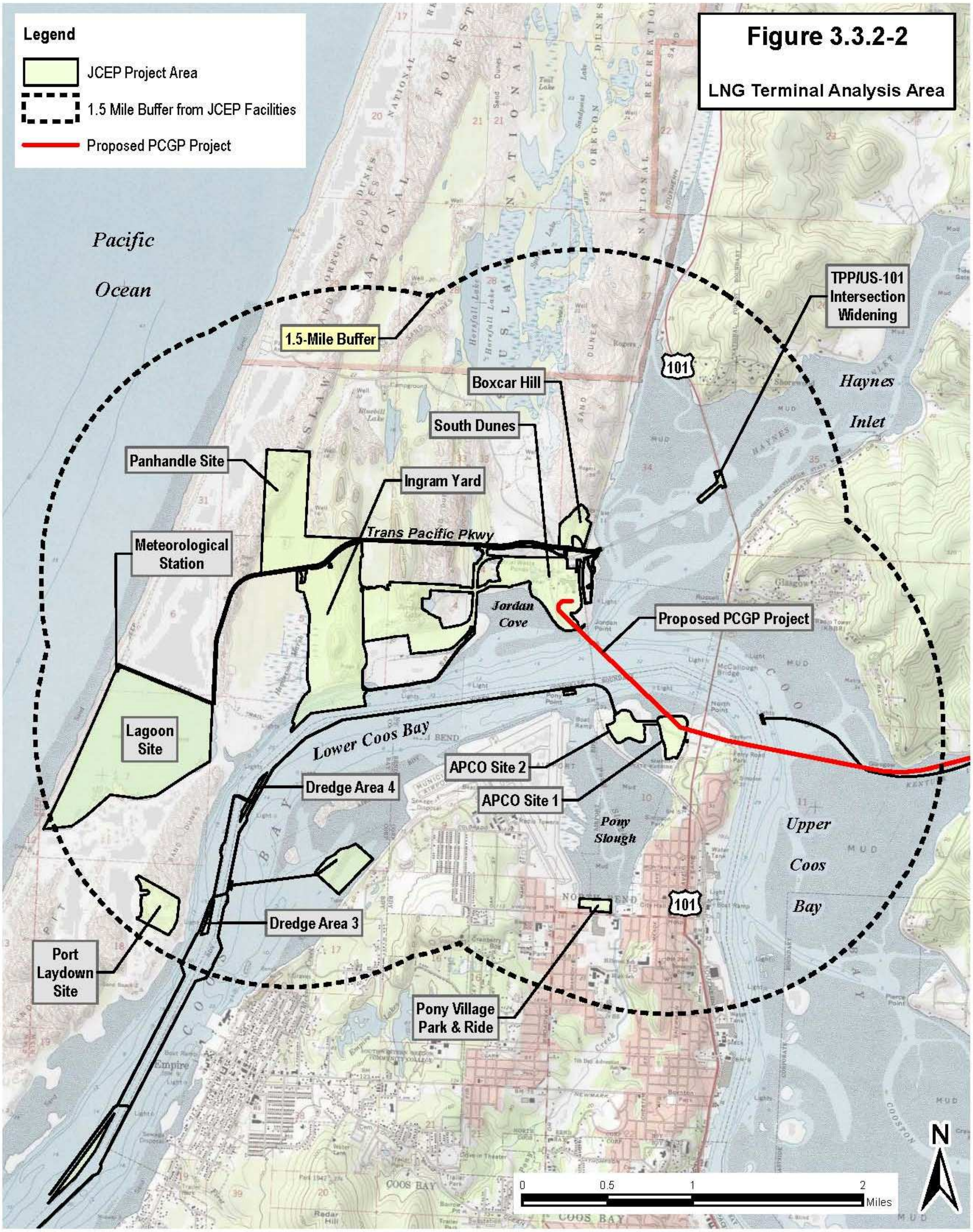
Analysis Area

The LNG Terminal analysis area extends for 1.5 miles beyond the perimeter of the LNG Terminal Site (see figure 3.3.2-2) to include project components on the North Spit and APCO Site, which historically provided western snowy plover nesting habitat. The only portion of the Pipeline that occurs within this analysis area either overlaps the LNG Terminal site, APCO site, or is submerged across Coos Bay. The LNG carrier transit route and Navigation Reliability Improvements are included in the estuarine analysis area with Dredge Area 1 located within 0.25 mile of Critical Habitat (see figure 2.1.1-2). Therefore, the only proposed Project facilities addressed within this analysis area are the LNG Terminal facilities, APCO Site, Port Laydown Site, Dredge Area 1, Meteorological Station, the PCGP Jordan Cove Meter Station, and the pipeline HDD from the APCO Site to where it exits on South Dunes after crossing beneath Coos Bay.

Species Presence

Western snowy plovers have been recorded on the National Audubon Society's Christmas Bird Counts (CBC) in the Coos Bay count circle most years since 2000, and sporadically in earlier surveys. There is no CBC data for the Coos Bay count circle for 2010 and 2014, and no plovers were counted in 2002 and 2007. For the years with data between 2000-2016, an average of 9.9 snowy plovers have been counted per year; the most reported in any annual survey were 32 counted during 130 observation hours in 2011 (Audubon Society 2016). Western snowy plovers are known to nest at the upper edge of the beach below the foredunes, on bare spits at small estuary mouths and on old dredge spoils (Marshall et al. 2006). No western snowy plovers were detected during field surveys of the LNG Terminal site (LBJ Enterprises 2006).

In the summer of 2012, 16 adults (8 males, 8 females) were documented by the Forest Service on the Tenmile Creek Unit OR-9 and 52 adults (35 males, 17 females) were documented by personnel with BLM and COE on the Coos Bay North Spit, CHU OR-10. In 2012, the nest success rate on the North Spit was 87 percent, similar to 2011, and the highest rate on the Oregon Coast since predator management was implemented in 2002 (Lauten et al. 2012). Nesting success at the Tenmile Creek unit has been very poor; only 13 percent of nests were successful in 2012, mostly due to depredations by corvids (common ravens) and great horned owls (Lauten et al. 2012). The total number of nests documented on the North Spit has increased most years between 2006 and 2016 (see figure 3.3.2-3).



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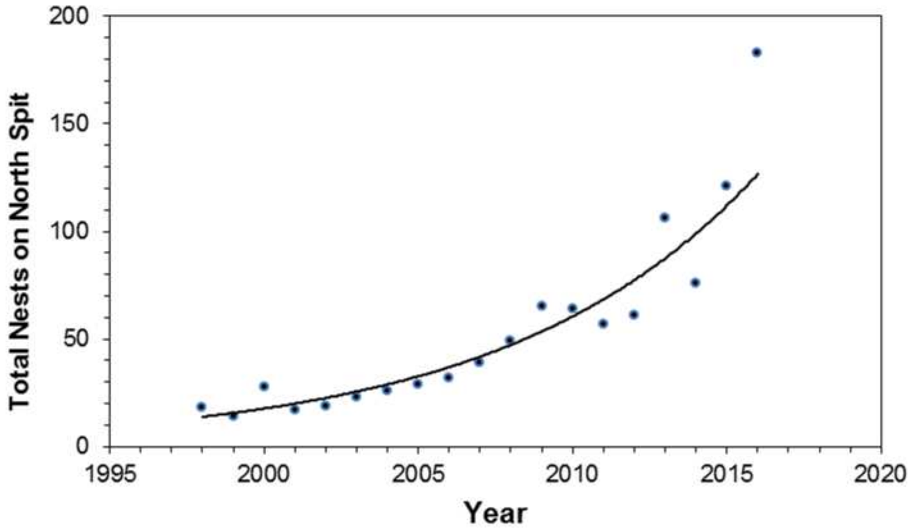


Source: Lauten et al. 2016

Figure 3.3.2-3 Total Number of Western Snowy Plover Nests Observed on the Coos Bay North Spit from 1998 to 2016. The increasing exponential trend is significant (r^2 = 0.92, P<0.001)

However, overall nest success at the North Spit in 2016 was the lowest since monitoring began and over 40 percentage points lower than 2015 (Lauten et al. 2015; Lauten et al. 2016). In 2016, combined nest success at the three sites measured at the North Spit was 35 out of 183, or 19%. Although 100 more eggs were laid at the North Spit in 2016 than in 2015, more than 100 fewer eggs hatched, yielding the lowest recorded hatch rate for this site (Lauten et al. 2016). The mean fledglings per male was 0.6, the lowest rate in the 13-years of study, considerably lower than the average of 1.34 +/- 0.33 over that time (Lauten et al. 2016). Lauten et al. state that "the low number of fledglings per resident male was due to many males never successfully hatching nests, and thus having no productivity in 2016." In 2016, a total of 149 adult plovers were determined to be present at the North Spit, all of which were residents. This is the largest plover population of the nine study areas (Lauten et al. 2016). Western snowy plovers may be encountered in the LNG carrier transit route from nearshore coastal waters to the LNG Terminal.

In the 2016/2017 winter window survey, 91 western snowy plovers were observed at the Coos Bay North Spit on US Army Corps of Engineer and BLM lands. No plovers were documented on the Horsfall Beach – N Jetty Coos Bay area (US Forest Service, County and Department of State Lands). There has been an increase in the number of wintering birds observed in this area beginning in 2015/2016 counts (85 birds) compared to the previous six year counts that ranged from 10 to 37 birds) (FWS 2018a).

Habitat

The northern end of critical habitat on the North Spit is approximately 2.6 miles from the LNG Terminal site. Nesting habitat, reported by ORBIC (2017a), extends north of the North Spit designated critical habitat for nearly 2 miles along the beach. The 2016 surveys on the North Spit indicated that the closest active nest to the Project was approximately 1 mile from the LNG Terminal site, which is approximately 0.5 mile south of Horsfall Beach (Lauten et al. 2016). The Meteorological Station is located approximately 100 feet east of the northern extent of known nesting sites (ORBIC 2017a). In 1990, one western snowy plover nest was documented at Menasha Spoils at the mouth and along the east side of Pony Slough at its confluence with Coos Bay (ORBIC 2017a), approximately 0.2 mile west of MP 1.08 where the HDD exits at North Point from crossing beneath Coos Bay. Since 1990, vegetation has invaded the Menasha Spoils site and the site may no longer be suitable as snowy plover nesting habitat since it is no longer an expanse of sparsely vegetated interdune flats. The nest was unsuccessful and there have been no nest sites documented within the Coos Bay estuary since 1990.

The existing land use of the LNG Terminal site is industrial. It has been disturbed by past and present activities. The site area has been filled in the past as evidenced by deposits of clamshells and wood chips and it is a licensed landfill facility. Elevation ranges from near sea level to an approximate elevation of 67 feet. Topography is variable, ranging from low lying deflation basins to semi-stable dunes. Existing vegetation comprises upland coniferous dune forests and upland herbaceous dominated areas.

There is no suitable habitat for western snowy plover within the JCEP Project Area.

Critical Habitat

No designated critical habitat for western snowy plover is present in the LNG Terminal analysis area. The northern end of critical habitat (OR-10) on the North Spit is located approximately 2.6 miles from the LNG Terminal site.

3.3.2.3 Effects of the Proposed Action

Direct Effects

Direct effects of the proposed action include increased noise associated with construction of the LNG Terminal and operation activities associated with LNG carrier traffic.

<u>Noise</u>

Noise associated with construction and operation of the facility is the only potential direct effect to plovers associated with the proposed action. The 2007 western snowy plover recovery plan states that: "sources of noise that would disturb snowy plovers should be avoided," but the levels of noise likely to disturb plovers are not provided. The recovery plan identifies noise associated with dredging as having a potentially negative effect on breeding and wintering western snowy plovers; noise associated with driftwood removal, especially if chainsaws and vehicles are used, can disrupt nesting; noise from beach cleaning machinery, from beach pyrotechnics, and from aircraft overflights (especially helicopters) can also cause adverse effects (FWS 2007a).

Ambient noise levels in the vicinity of the LNG Terminal were measured continuously for 24 hours between August 31 and September 1, 2005 at two residences (noise sensitive areas [NSA]), one of which was 1.4 miles south of the Terminal and the other 2.3 miles east. A new sound level survey was performed in May 2017. Ambient noise levels were not reported directly at the LNG Terminal site or on the Coos Bay North Spit (see JCEP's Resource Report 9). Average noise levels from these studies of 52.7 dBA at NSA 1, south of the LNG Terminal site, and 65.2 dBA at NSA 2, east of the site. At REC 1, the recreation area west and northwest of the LNG Terminal site, ocean surf sounds are a significant and continuous source of ambient sounds. Occasional aircraft could be heard at the Southwest Oregon Regional Airport just across the bay from the site. NSA 3, the Horsfall campground northeast of the LNG Terminal, and REC 1 were added to the 2017 noise study. The ambient noise results at these sites was 56.3 dBA at NSA 3 and 55.2 dBA at REC 1 (see JCEP's Resource Report 9). Local conditions such as aircraft, vehicle traffic, vegetation, topography, breaking waves, and winds characteristic of the location can alter background noise conditions. Noise levels at existing NSAs nearest the LNG Terminal site are controlled primarily by vehicular traffic. Noise levels experienced at the NSAs are similar in level to those in suburban areas where traffic is the primary source of noise (see JCEP's Resource Report 9). Sound levels (dB) at outdoor rural residential locations of about 40 dB, averaged for day and night periods (see for example, EPA 1974) have been accepted as standard. More than likely, ambient noise levels on the North Spit, near breaking waves, would be higher than 40 dB; noise generated by breaking wavecrests in the surf zone can be 15 dB higher than background levels (Dean 1999). Daytime ambient noise is typically 10 dB higher that night levels (EPA 1974).

Construction – LNG Terminal Facilities

Construction of the LNG Terminal site wouldcontribute to potential noise sources within the analysis area. Noise levels 50 feet away from typical construction equipment that might be used during LNG Terminal construction are provided in table 3.3.2-1.

TABLE 3.3.2-1

Average Maximum Noise (Lmax) at 50 feet from Construction Equipment and
Estimated Distance to Attenuate to Ambient Levels near the Surf Zone on the North Spit a/

Construction Activity	Equipment	Noise dBA (Lmax measured at 50 feet) b/	Distance (feet) to Attenuate to Assumed Ambient Noise Level of 55 dBA a/	
			Soft Site Reduction at 7.5 dBA per double of distance	Hard Site Reduction at 6 dBA per double of distance
Clearing and Grading	Grader	85	800	1,600
	Scraper	84	729	1,425
	Warning Horn	83	665	1,270
	Dozer	82	606	1,131
	Excavator	81	553	1,008
	Backhoe	78	419	713
	Pickup Truck	75	317	504
	Flatbed Truck	74	289	449
Rock Excavation	Mounted Impact Hammer	90	1,270	2,851
	Auger Drill Rig	84	729	1,425
	Rock Drill	81	553	1,008
Stationary Equipment	Concrete Saw	90	1,270	2,851
	Pneumatic Tools	85	800	1,600
	Generator	81	553	1,008
	Air Compressor	78	419	713
	Welder Torch	74	289	449

a/ WSDOT 2011
b/ FHWA 2006

The standard for noise reduction from point sources such as construction machinery is 6 dBA per doubling of distance under hard site conditions (over calm water, or hard, smooth ground surface) and 7.5 dBA per doubling of distance under soft site conditions (because of roughened ground and/or vegetation cover; WSDOT 2011). Based on the data in table 3.3.2-1, the noise produced by construction activities would attenuate to daytime ambient noise levels (estimated at 55 dBA because of breaking wave noise) within distances of 230 feet to 2,850 feet, depending on equipment/actions and hard site or soft site reduction ground surface conditions. Obscuring vegetation (tree cover), topography (interruption of line-of-sight), and atmospheric conditions (wind, air temperature, humidity) also affect noise reduction but can be highly variable between locations and over time and are generally not taken into account in estimates of noise attenuation over short distances (see JCEP's Resource Report 9). Consequently, predictions of noise levels some distance from the noise source are likely to be higher than actual noise levels. Based on this information, general construction noise would not affect nesting or wintering western snowy plover located approximately 1 mile from the LNG Terminal.

Construction of the LNG Terminal and slip is expected to take 60 months (see JCEP's Resource Report 1). Prior to the excavation work starting for the LNG carrier slip, an open cell sheet pile bulkhead and retaining wall would be installed. Sheet piling is typically installed with a vibratory pile driver. Pile-driving activities would take place over approximately an 24-month period and are expected to occur on a schedule of two shifts, 6 days per week (see JCEP's Resource Report 9). Sheet pile driving would occur initially followed by the on-shore berthing structures as the marine foundation work begins. Sheet piling could be installed during the snowy plover breeding, nesting or rearing periods. The cumulative long term average airborne sound level created by pile driving activities for 14 impact pile driving rigs and 6 vibratory pile driving rigs in operation, simultaneously, was used to calculate the day and night sound levels (L_{nd}) (see JCEP's Resource Report 9). The same analysis model was used to calculate the pile driving daytime average (L_d or L_{eq} daytime) to determine potential impacts to nesting and wintering snowy plovers. The noise produced by sheet pile and pile installation activities would attenuate to daytime ambient noise levels (estimated at 55 dBA because of breaking wave noise) within distances of approximately 4,200 feet (SRL 2017). Based on the distance of construction from western snowy plover critical habitat (2.6 miles) and potential nesting sites (1 mile) on the North Spit, acoustic disturbances from the proposed action are not expected to affect western snowy plover wintering, breeding, nesting, or rearing activities.

A Meteorological Station would be installed on the west side of the Lagoon adjacent to the northern extent of the snowy plover nesting area (ORBIC 2017a). In reviewing the Western Snowy Plover Annual Reports from 2010 to 2017, the number of documented nests at the north end of Coos Bay North Spit is low and no nests have been documented immediately adjacent to the proposed location for the meteorological station. The annual reports documented one nest located about 1.8 miles north of the station in 2016 and 2017 and one to three nests per year located 1.3 to 3 miles south of the station during this eight-year period (FWS 2018a). Although western snowy plovers were not observed during the winter window surveys, they could occur on the beach adjacent to the station but this area is not documented as being used in the winter. Based on this information, the use of the beach by snowy plovers immediately adjacent to the meteorological station is likely low. The Meteorological Station would be constructed outside the nesting season (March 15 to September 15) to avoid disturbance to snowy plovers. The station would be mounted on an approximately 30 to 40-foot-high lattice tower. If guy wires are required during final design, bird deterrent measures would be added to the wire to reduce the likelihood of bird collisions. Deterrent measures such as cones or other anti-perching/anti-nesting devices would also be installed on any surface that could provide potential perching/nesting habitat for predatory species. Security lighting would be installed at the station and would be shielded in order to minimize glare while meeting safety requirements.

Additional construction staging and temporary laydown of equipment would occur during construction of the LNG Terminal at the Port Laydown site. This site is located on the North Spit over 3,500 feet from the northern extent of the snowy plover nesting area (ORBIC 2017a). Based on the data in table 3.3.2-1, noise produced by construction activities would attenuate to below daytime ambient noise levels in the vicinity of western snowy plover nests.

The Navigation Reliability Improvements would occur in four locations along the edge of the FNC. Access to Navigation Reliability Improvements will be by marine transport. No land-based access near primary snowy plover habitat is planned for pedestrians or vehicles. Dredge Area 1 is located approximately 0.25 mile from known nesting habitat and designated Critical Habitat OR-10. Dredging operations would take place within the ODFW in-water work window, which is outside of the nesting period for western snowy plovers but wintering birds may forage on the bay side of the North Spit. An airborne noise analysis for dredging determined that the 55 dBA contour, which is the estimated ambient noise level, would extend to the nearshore area of the bay where plovers may forage. Airborne noise from dredging within Critical Habitat was determined to be 40 to 45 dBA. Predicted dredging noise levels are shown in figure 9.4-3 in JCEP's Resource Report 9. Since these levels are below estimated ambient noise levels, dredging is not anticapted to impact wintering plovers. The remaining dredge areas are located over one mile from known nesting habitat and are not expected to impact snowy plovers during winter or nesting seasons.

While noise levels from dredging activities are anticipated to be at or below ambient noise levels, temporary mooring piles to support the dredging equipment may need to be set with an impact hammer. Impact hammers could be used between 0.25 mile and about 1 mile from known snowy plover habitat. As noted above in Table 3.3.2-1, mounted impact hammers attenuate to 55 dBA at 2,851 feet over hard site conditions and 1,270 feet over soft site conditions. The areas between the dredge areas and snowy plover habitat are a mix of hard and soft site conditions; the distance varies based on the roughness of the water and other environmental conditions on a given day. These distances are within the range of snowy plover habitat along the eastern edge of primary nesting area at 0.25 mile (1,370 feet) away from Dredge Area 1. If present, noise from an impact hammer could temporarily disturb snowy plovers wintering within this area on the North Spit.

The Navigation Reliability Improvement disposal site is located at the APCO site. Placement of dredge spoils could create nesting habitat for western snowy plover. Creation of nesting habitat for plovers is considered undesirable because it could result in dispersal of existing breeding populations on the North Spit to an area where they could be more susceptible to nest predations. Additionally, any habitat created would be temporary, as opposed to the permanent habitat available on the North Spit. To prevent plover use of the area, it is recommended to plant American dune grass (FWS 2017b).

Construction - Pipeline

Construction of the Pipeline across Coos Bay may occur between January 1 through August 31, which is within the nesting and fledgling season for the species on the Oregon coast (early April through August; FWS 2001). It is not possible to anticipate any local occurrence of western snowy plover in the project area at the time of construction, although habitat near the HDD activity does not currently provide suitable nesting habitat, even though an historic snowy plover nest was documented at Menesha Spoils in 1990, approximately 0.2 mile from HDD activity.

Construction of the Jordan Cove Meter Station and the HDD beneath Coos Bay will require surface disturbance of 13.63 acres of previously developed industrial land on the Jordan Cove side and 2.87 acres of industrial land on the North Point side 0.2 mile from Menasha Spoils at the mouth and along the east side of Pony Slough at its confluence with Coos Bay. Neither site currently provides suitable nesting habitat.

Operation

The following major noise-producing equipment would normally be in operation at the LNG Terminal:

- five (5) refrigerant compressors, combustion turbines, heat recovery steam generators (HRSGs), and associated piping;
- refrigerant compressor interstage and discharge aerial coolers;
- three (3) steam turbines and their associated air-cooled condensers;
- two (2) boil-off gas (BOG) compressors with interstage and discharge aerial coolers; and
- various other condensers, coolers, pumps and valves.

The above equipment packages have been specified to meet sound level requirements appropriate to support an overall far-field sound level that does not exceed the applicable FERC regulatory limits. As explained in section 9.3.2.1 of JCEP's Resource Report 9, a constant sound level of less than 48 dBA would ensure compliance with all applicable regulations, including the FERC requirement limiting the average day/night noise level at the nearest residential NSAs to ≤55 dBA. With that restriction, noise generated by equipment at the LNG Terminal would not exceed 55 dBA at western snowy plover breeding, nesting or rearing habitat on the North Spit. Therefore, noise from operations at the LNG Terminal would have no affect the snowy plover.

Operational activities at the Meteorological Station will be maintenance only. Planned maintenance activities that would generate noise levels above ambient conditions would be scheduled outside of nesting season to minimize potential disruption to western snowy plover. Other activities will be limited to existing pathways and inside fence lines.

During operations of the Pipeline, aerial inspections would occur over the permanent right-of-way. Nesting snowy plovers are not expected to be impacted since the closest nesting population is more than four miles from proposed aerial inspections and air traffic is a constant disturbance with the existing North Bend Municipal Airport within less than three miles of the nesting habitat on North Spit.

Indirect Effects

All indirect effects to western snowy plovers are expected to be due to an increased human population base, whether as a result of the requirements of the action itself (the workforce needed to construct or operate the Project) or as a consequence of the action (need for ancillary goods, services, opportunities resulting from the Project). Potential indirect or secondary effects by a project include increased recreation demand (including OHV use), increased habitat conversion, habitat degradation by human encroachment, and increased illegal harvest (Comer 1982).

The following indirect effects of the proposed action on western snowy plovers could occur: 1) increased human presence at the LNG Terminal site, and 2) increased predation of western snowy plovers by crows and ravens due to increased human presence. In addition, increased human presence may lead to destruction of nests and/or disturbance of plovers from the following activities: OHV usage, visitors or their dogs, predators such as crows and ravens (that are attracted to areas with humans and their garbage), beach walking or jogging, horseback riding, and beach raking.

Human Presence

The Coos Bay North Spit is currently utilized by a variety of recreational users for OHV driving, beach combing, boating, bay-shore clamming and crabbing, day hiking, picnicking, kayaking, surfing, and fishing (Natural Resource Trustees 2006). In addition, the North Spit has become one of the most popular horseback riding areas in the region (BLM 2005). Snowy plover habitat on the North Spit is currently owned by the BLM and COE and managed by the BLM, Forest Service, and OPRD. This area is known as the Coos Bay North Spit Recreation Management Area (CBNS RMA) and extends about 3.4 miles north from the southern tip of the North Spit along the ocean-side shoreline, encompassing some, but not all, of the Snowy Plover Critical Habitat on the North Spit.

According to the OPRD 2007 Plover Habitat Conservation Plan, the peak number of visitors to the 15.6 miles of beach from Tenmile Creek to Coos Bay (the beach segment including the CBNS RMA) was 3.8 people per mile (OPRD 2005 and 2007), and the distribution of these visitors was described as "dispersed." The number of visitors per mile at the eight recreational management areas currently utilized by nesting plovers ranged from 3.5 to 13.2 (OPRD 2007). The Habitat Conservation Plan for Western Snowy Plovers published by the OPRD in September 2007 states (with regard to the CBNS RMA), "This beach is open to street legal vehicle driving only, but is closed during the breeding season. There is illegal ATV [all-terrain vehicle] use on this beach. Recreation use here is low, but higher than other RMAs due to its close proximity to Coos Bay/North Bend/Charleston. The area is a popular surfing site."

The primary reasons that the public accessed the North Spit beach were to walk/run (16 percent) or to relax (21 percent). Of those surveyed, 4 percent reported bringing dogs to the beach (OPRD 2007). The percentage of people with dogs was significantly lower than the statewide average of 35 percent. All of the human-caused disturbances listed above can result in destruction of nests (by dogs or through inadvertent trampling and deliberate vandalism) and in diverse plover responses to human presence, including: flushing from and abandonment of nests, separation from broods, shifting to marginal habitat, cessation of foraging and adoption of vigilant or cryptic behaviors (FWS 2007a).

The number of people employed on the North Spit in 2007 was approximately 110 (Southport Lumber Products – 70, Roseburg Forest Products – 20, DB Western Marine Division – 20). The Project would result in a large but temporary increase in people employed on the North Spit during construction (an average of 1,023 construction workers per month over the four-year construction period) and a much smaller long-term increase of operations staff (180 employees at the LNG Terminal). Construction would take approximately 60 months, and the number of construction personnel would peak at 1,996 workers.

An increase in workers supporting the Jordan Cove Project would likely result in an increase in recreational activities in the area. Recreation on the beach has been shown to cause a reduction in plover productivity. In total, it was estimated that between 2000 and 2006, recreational activities on the Oregon Coast resulted in the loss of 30 hatchlings and 11 fledglings per year, which equated to an annual loss of 5 adult equivalents (Jones and Stokes 2007). It is difficult to predict how the increase in short-term and long-term employment due to the LNG Terminal Site on the North Spit would translate into increased recreational use of areas near snowy plover habitat. However, it is reasonable to assume that the LNG Terminal operations staff, their family and friends would be introduced to the area, and some minor increases in recreational use could occur. This increase in recreational use could result in increased plover disturbance. However, mitigation measures to educate construction and operations employees on recreational use restrictions will be employed to minimize any such effect. The measures are discussed below in Conservation Measures, section 3.3.2.4.

Predators

Predation of snowy plovers along the Oregon coast has been attributed to the low nest success in 2016. Northern harriers (*Circus cyaneus*) supplanted corvids as the most frequently identified nest predator along the Oregon coast. A minimum of 61 nests were depredated by harriers in 2016, far more than the previous high of 20. Harriers-caused nest failure was far more prevalent at the North Spit than the other eight sites, accounting for 74% of total harrier depredation along the coast (45 of 61 nests; Lauten et al. 2016). One harrier was removed from the North Spit to alleviate nest depredation, although harrier depredation continued after its removal (Bell 2017 as cited in Lauten et al. 2016). Harriers are anticipated to be an ongoing threat to nesting plovers unless removed. The study suspects that harriers were also responsible for all unknown causes of depredation after April and likely some earlier depredations as well.

Corvids caused nine nests to be lost at the North Spit in 2016, where no corvid depredations had been recorded since 2005 (Lauten et al. 2016). In study areas along the coast where harriers have been removed, ravens in particular have increased their plover depredation rates. Exclosures have been used less frequently in recent years and not at all in 2016 due to increased nest success, presence of predators that can cause adult plover mortalities at exclosed nests, workload limitations, and a plover population above recovery goals (Lauten et al. 2016).

Increased foot traffic through snowy plover nesting has been shown to increase scavenger predation (Buick and Paton 1989; Castelein 2008). Therefore increased recreational use of the North Spit ocean beaches by off duty employees could create additional predation pressure. Food enticements associated with human presence could increase predator populations on the North Spit. Corvids, coyotes, cats and skunks are all curious, adaptable animals attracted to food waste and non-food human refuse. An increase in the numbers of these predators could be detrimental to the recovery of snowy plover populations; however, mitigation measures will be employed to minimize any such effect. The measures are discussed below in Conservation Measures, section 3.3.2.4

Cumulative Effects

Additional projects within the action area (estuarine analysis area and the LNG Terminal analysis area) are anticipated as human population growth continues in the region. Associated road and commercial development, as well as maintenance and upgrading of existing infrastructure within the estuary, are likely to occur in the foreseeable future. For example, the Port of Coos Bay owns and operates the Charleston Marina, the Charleston Marina RV Park, and Charleston Shipyard. As a component of the Port's economic development, the focus of the Charleston Marina Master Plan is to develop commercial fishing and seafood processing, recreational fishing and boating, tourism, and growth in the retail and commercial sectors. Other, similar economic developments in the region could occur and, if they did, could contribute to the region's human population growth which could be detrimental to western snowy plovers within and around the Coos Bay estuary.

A standard of "reasonably certain to occur" is clarified as "those actions that are likely to occur, bearing in mind the economic, administrative, or legal hurdles which remain to be cleared".

Further, NMFS provides that "speculative actions that are factored into the cumulative effects analysis add needless complexity into the consultation process…" (51 Federal Register 19933). No specific state or private actions have been identified within the action area that meet this standard. Further, activities described above are somewhat speculative in nature and cannot be quantified here. Therefore, a logical conclusion is that there would be no cumulative effects to western snowy plover associated with the proposed action.

Within the action area and estuarine analysis area, gradual habitat and water quality improvements may also occur over time as federal, state and private conservation and habitat enhancement efforts are implemented. There are a number of potential federally permitted projects (e.g. repair of the entrance jetties and widening and deepening of the lower portion of the Federal Navigation Channel) that could result in cumulative effects. However, because these projects would require federal permits, their impacts would be evaluated through the federal permitting process when and if they occur.

Critical Habitat

The northern end of critical habitat on the North Spit, OR-10, is located approximately 2.6 miles from the LNG Terminal. The proposed action would not directly or indirectly affect designated critical habitat or any of the essential physical and biological features within OR-10 that might be utilized by western snowy plovers. Cumulative effects due to increased human presence may occur within the action area.

3.3.2.4 Conservation Measures

Current management activities and use restrictions within the Coos Bay North Spit Recreation Management Area include:

- predator management (i.e., nest exclosures, lethal and non-lethal predator removal and hazing);
- symbolic fencing (ropes and signs installed around nesting areas);
- habitat restoration (removal of European beachgrass, placement of shell hash, maintenance of gaps through the dunes);
- public outreach and education provided by BLM staff;
- monitoring of snowy plover populations;
- recreational use restrictions in place from March 15 – September 15 each year, including:
  - seasonal re-routing of the foredune road;
  - vehicles, camping, and dogs are prohibited;
  - kite flying would be prohibited under the draft conservation plan; and
- non-prohibited recreational use (i.e., jogging, beach combing, horseback riding) is restricted to the wet sand outside of roped and signed breeding areas.

JCEP will work with the agencies to assist with ongoing management activities and recreation use restrictions on the North Spit. Management activities may include fencing, siganage, application of shell hash, tree removal, beach grass elimination, and maintenance.

JCEP would mitigate potential impacts to western snowy plovers, including from increased predator density and increased human presence, through implementation of 1) BMPs, and 2) education and outreach programs.

Best Management Practices

Structures associated with the LNG Terminal would be monitored to discourage use by avian predator species. Frequent inspections would ensure that nests are not being constructed and all nests found would be removed immediately. It is anticipated that there would be sufficient inspections and other activities mandated by safety and security requirements to keep the structures nest free. However, in the unlikely event that a nest becomes established and it is not discovered until young birds are present, the disposition of the nest would be handled in accordance with any applicable statutes including the Migratory Bird Treaty Act.

During construction and operation, the LNG Terminal site would be kept clear of construction debris and food wastes that could attract predators of the western snowy plover. Covered, animal-resistant receptacles would be provided in eating and break areas, parking lots, and at appropriate locations around the construction site. During construction, the site would be monitored on a daily basis to remove any food or other debris left by construction workers. During operations, the facility and grounds would be regularly inspected to ensure that no garbage is allowed to accumulate. These measures will minimize potential predation of snowy plover eggs and chicks from increased predator presence.

The dredged material placement areas would be regularly policed to ensure that no predator denning is occurring in the hillocks. The proposed placement areas would be located near construction activities that would discourage use by individual birds. If necessary, nylon mesh or other exclusion fencing would be installed around the perimeter of the placement areas to prevent the establishment of coyote or skunk dens until the slopes are stabilized or constructed upon.

To prevent plover use of the APCO dredge disposal site, it will be stabilized using American dune grass or other appropriate measures in consultation with USFWS.

Access to Navigation Reliability Improvements dredging areas will be by marine transport. No land-based access near primary snowy plover habitat is planned for pedestrians or vehicles.

The Meteorological Station would be constructed outside the nesting season (March 15 to September 15) to avoid disturbance to snowy plovers. If guy wires are required during final design, bird deterrent measures would be added to the wire to reduce the likelihood of bird collisions. Deterrent measures would also be installed if the final design provides any potential perching habitat for predatory species. Security lighting would be shielded in order to minimize glare while meeting safety requirements. Planned maintenance activities at the Meteorological Station that would generate noise levels above ambient conditions will be scheduled outside of nesting season to minimize potential disruption to western snowy plover. Unplanned activities will be limited to existing pathways and inside fence lines.

Education and Outreach

Surveys conducted in 2002 indicated that 76 percent of beach visitors were unaware of restrictions associated with snowy plovers (OPRD 2007). This indicates that increased education could have a substantial impact on public awareness of issues surrounding snowy plovers. Furthermore, the Forest Service at the Oregon Dunes National Recreation Area and the BLM staff have reported that the majority of contacted individuals are more willing to comply with beach-use restrictions after better understanding the reasons for them (FWS 2007a).

Although snowy plovers do not occur on JCEP property, increased human presence can increase the presence of predators locally which could potentially expand their territory to snowy plover-occupied areas. JCEP would train all construction and operations staff on the need for snowy plover conservation; current snowy plover regulations and recreational use restrictions; and the importance of conservation measures, including: litter control, avoidance of nesting and foraging areas, keeping pets on-leash, and remaining on established roads and trails in designated critical habiat. The training program would be developed based on guidance provided in appendix K of the 2007 Plover Recovery Plan (OPRD 2007). JCEP would consult with agencies prior to implementation.

3.3.2.5 Determination of Effects

Species

The Project **may affect** western snowy plovers because:

- impact hammer noise associated with the Navigation Reliability Improvement temporary facilities may disturb wintering western snowy plovers if present along the eastern edge of the primary nesting area on the North Spit;
- the closest western snowy plover nesting habitat to the Project is on the North Spit approximately 100 feet from the Meteorological Station and 1 miles from LNG Terminal site, and the primary active nesting by western snowy plovers occurs approximately 2.0 miles from the LNG Terminal at its closest location to the Project;
- the Project would result in a large but temporary increase in people employed on the North Spit during construction (1,996 construction workers in the peak months) and a much smaller long-term increase of operations staff (180 permanent employees at the LNG Terminal);
- it is reasonable to assume that the LNG Terminal construction and operations personnel would increase recreational uses of the North Spit, which could result in increased plover disturbance; and
- scavengers and predators (corvids, coyotes, striped skunk, feral cats), most of which are encouraged or attracted by human disturbance such as campsites, garbage dumps, work sites or even footprints in the sand, may increase effects to nesting plovers as human use of the North Spit increases.

The Project is **not likely to adversely affect** western snowy plover because:

- noise at active nest sites (approximately 1 mile) and critical habitat (approximately 2.6 miles) due to the loudest anticipated construction activity (pile driving) is not expected be above ambient levels;
- construction of the Meterological Station would occur outside the nesting season; and
- JCEP would minimize potential indirect effects to the western snowy plover by humans, pets, vehicles or human-attracted predators through implementation of 1) BMPs to minimize predator density related to increased human presence, and 2) education and outreach programs intended to train all construction and operations staff on the need for snowy plover conservation; current snowy plover regulations and

recreational use restrictions; and the importance of conservation measures, including: litter control, avoidance of nesting and foraging areas, keeping pets on-leash, and remaining on established roads and trails in designated critical habitat.

Critical Habitat

The Project **may affect** designated critical habitat for the western snowy plover even though the northern end of critical habitat OR-10 on the North Spit is located approximately 2.6 miles from the LNG Terminal because.

- the Project is expected to require an average of 1,023 construction workers over the five-year construction period (up to 1,996 workers in the peak months). The additional human presence is likely to increase use of the North Spit with concomitant potential increase of pets, vehicles, and/or human-attracted predators.

However, the Project is **not likely to adversely affect** designated critical habitat for the western snowy plover because:

- JCEP would minimize potential secondary effects to the critical habitat PCE that identifies disturbance by humans, pets, vehicles or human-attracted predators through implementation of 1) BMPs to minimize predator density related to increased human presence and habitat removal, and 2) education and outreach programs intended to train all construction and operations staff on the need for snowy plover conservation; current snowy plover regulations and recreational use restrictions; and the importance of conservation measures, including: litter control, avoidance of nesting and foraging areas, keeping pets on-leash, and remaining on established roads and trails.

3.3.3 Marbled Murrelet

3.3.3.1 Species Account and Critical Habitat

Status

Marbled Murrelet (MAMUs) in Washington, Oregon, and California were listed as threatened under the ESA on October 1, 1992 (FWS 1992a), and were subsequently listed as threatened by the State of Oregon under the Oregon Endangered Species Act in 1992. The final rule listing the MAMU cited loss and modification of forest nesting habitats, mostly by commercial timber harvest of Late Successional Old Growth (LSOG) forests, as the principal threat to the species, along with effects of coastal oil spills and gill-net fishing operations off the Washington coast (FWS 1992a).

Threats

Threats to MAMUs include loss of habitat, predation, effects of gill-net fishing, effects of offshore oil spills, and other factors. There are two components of MAMU habitat that are biologically important: 1) terrestrial nesting habitat and associated stands, and 2) marine foraging habitat, including prey spawning and concentration areas. Threats to MAMU can be found in both the terrestrial nesting environment and the marine foraging environment. Extensive harvest of LSOG the primary reason for listing the MAMU as threatened in 1992 (FWS 1992a). In 1992, the amount of old-growth forest in western Oregon and Washington had been reduced by about 82.5 percent from pre-harvest levels. Because MAMUs utilize old-growth forests for nesting, this dramatic loss of older forested habitats is a serious threat to these birds. Harvesting within previously contiguous areas of old-growth forest causes habitat fragmentation on large and small scales. As forest fragmentation increases, the threat of habitat loss due to windthrow is likely to increase. Fire has also affected older coastal forests; however, unlike clearcut timber harvest, fire often allows diverse structural characteristics to develop in regenerating forests, such as scattered surviving old-growth trees that can be utilized by MAMUs for nesting (FWS 1992a).

Predation is expected to be the principal factor limiting MAMU reproductive success and nest site selection (Ralph et al. 1995; Nelson and Hamer 1995). Known predators of MAMU adults, chicks, and eggs in the terrestrial environment include great horned owls, peregrine falcon, sharp-shinned hawk, northern goshawk, bald eagle, Steller's jays, ravens and other corvids. Common ravens account for the majority of egg depredation (Nelson and Hamer 1995). Predation rates are influenced mainly by habitat stand size, habitat quality, nest placement (on the edge of a stand versus the interior of a stand), and proximity of the stand to human activity centers. Fragmentation of forested stands by timber harvest increases the potential for avian predation (FWS 1992a). An increase in susceptibility of adults to predation can have greater impacts on MAMU populations than predation on eggs or young, as demographic modeling for MAMUs demonstrates (McShane et al. 2004).

Because MAMUs feed offshore, gill-net fisheries, especially for salmon, was an important mortality factor in 1992, primarily in Washington and British Columbia. New gill-netting regulations in northern California and Washington have reduced the threat to MAMUs (McShane et al. 2004). Offshore oil spills, such as the *Exxon Valdez*, have also adversely affected MAMUs by causing direct mortality (FWS 1992a). The 1999 oil spill associated with the grounding and wreck of the *New Carissa* on the Oregon coast near Coos Bay killed 252 MAMUs, the highest mortality for any spill during the 1993 to 2003 period (McShane et al. 2004). Oil spills and related mortality of MAMUs are believed to have remained constant since the species was listed. Although there has been a moratorium on offshore oil drilling off the California, Oregon, and Washington coastlines, there has been increased shipping traffic, including oil tankers, carrying the risk of future spills (McShane et al. 2004).

Other factors contributing to demographic threats and population viability include: 1) loss of genetic variation as a result of low population numbers and low immigration rates, 2) low potential for recolonization or recovery from local disturbances due to low immigration rates, and 3) bacterial, fungal, parasitic, and viral diseases, including potentially West Nile Virus (McShane et al. 2004).

The 2004 MAMU 5-year review (FWS 2004a) and the 2009 MAMU 5-year review (FWS 2009c) continue to consider habitat loss, high predation rates, mortality from oil spills, or entanglement in fishing nets as the primary threats to MAMU. Additionally, the 2009 5-year review identified environmental and anthropogenic factors in the marine environment as new threats to MAMU. Another 5-year review was initiated in April 2017 (FWS 2017c).

Species Recovery

FWS published a recovery plan for the MAMU in 1997 for Washington, Oregon, and California (FWS 1997). The objective of the recovery plan is to stabilize population size at or near current levels by increasing population productivity and removing and/or minimizing threats to survivorship. In the short-term, specific actions identified as necessary to stabilize the population included maintaining occupied habitat, maintaining large blocks of suitable habitat, maintaining and enhancing buffer habitat, decreasing risks of nesting habitat loss due to fire and windthrow, reducing predation, and minimizing disturbance. Long-term conservation actions included increasing productivity and population size, increasing the amount, quality, and distribution of suitable nesting habitat, protecting and improving the quality of the marine environment, reducing or eliminating threats to survivorship, reducing predation in the terrestrial environment, and reducing anthropogenic sources of mortality at sea (FWS 1997).

The recovery plan divided the range of the Washington, Oregon, and California MAMU population into six Conservation Zones that extend inland a distance of up to 35 miles, coinciding with the "Inland Zone 1" boundary line described by the Forest Ecosystem Management Assessment Team (FEMAT) for the Northwest Forest Plan (NWFP): Puget Sound (Conservation Zone 1), Western Washington Coast Range (Conservation Zone 2), Oregon Coast Range (Conservation Zone 3), Siskiyou Coast Range (Conservation Zone 4), Mendocino (Conservation Zone 5), and Santa Cruz Mountains (Conservation Zone 6). FEMAT Inland Zone 1 contains large blocks of suitable habitat critical to the recovery of the MAMU within California, Oregon, and Washington. The proposed action occurs within the highest density zones along Oregon's coast (Conservation Zones 3 and 4), although the largest populations of MAMUs are found in Puget Sound and Strait of Juan de Fuca of Washington – Zone 1 (Huff et al. 2006). Management for Conservation Zones 3 and 4 recommend the following: maintain designated occupied sites, minimize loss of unoccupied but suitable habitat, and decrease the time for development of new habitat. The recovery plan also recommended that specific recovery efforts should focus on maintenance of suitable and occupied MAMU nesting habitat in BLM-administered forests (FWS 1997).

FWS (2006c) concluded that the maintenance and/or increase of suitable nesting MAMU habitat in relatively large, contiguous blocks, whether occupied or unoccupied, would be needed to recover the MAMU, since unoccupied suitable habitat in proximity to occupied habitat could be used by dispersing MAMUs. Despite the above protection measures, an approximately 12.1 percent decline (2 percent decline on federal, 27 percent decline on nonfederal lands) in the amount of available, higher suitable nesting habitat has been observed since the NWFP was implemented (1994 to 2012; Raphael et al. 2016). On federal lands, stand-replacing fires are the major cause of of habitat loss, but also timber harvest and insect damage or disease have also caused losses; habitat loss on nonfederal lands is primarily the result of timber harvest (Raphael et al. 2011 and 2016). Together wildfire and timber harvest have been identified as the primary causes of habitat loss since the NWFP was implemented in 1994 (Falxa and Raphael 2016). Based on Maxtent habitat suitability modeling using updated gradient nearest neighbor (GNN) 2012 habitat data and analyses approach, Raphael et al. (2016) estimated that there are approximately 2.2 million acres of moderately high to high suitable habitat available within the following states: Washington (1.3 million acres), California (108,900 acres), and Oregon (774,700 acres).

Life History, Habitat Requirements, and Distribution

The MAMU is a long-lived, small seabird that spends most of its life in the marine environment, but utilizes a distinct nesting habitat type from other Alcidae (guillemots, puffins, auklets and murres), nesting primarily in coastal, old growth forests characterized by large trees, multi-storied stands, and moderate-to-high canopy coverage from Alaska to Monterey Bay, California (FWS 2006c). They are also known to nest in mature forests with old-growth characteristics. Trees must have large branches or deformities such as high, moss-covered branches or branches with growths of dwarf mistletoe, which serve as nest platforms (Binford et al. 1975; Marshall 1988a; Naslund 1993; FWS 1997). Old-growth conifers generally provide the following requisite conditions for MAMU nesting: 1) openings in forest canopies for nest access, 2) nest platforms on large branches or tree deformities, 3) substrate (mosses or epiphytes) for a nest cup, 4) horizontal and vertical cover at the nest site, and 5) enough height above ground to allow for "drop take-offs" and "stalled drop-in" landings (McShane et al. 2004). Generally, forests that provide suitable nesting habitat and nest trees require 200 to 250 years to develop (FWS 2006c).

The distance inland that MAMUs breed is variable and influenced by a number of factors such as habitat availability, climate suitability, foraging range, and predation rates (McShane et al. 2004). In Oregon, MAMU nest sites and occupied stands are located as far as 30 to 40 miles from salt water (Mack et al. 2003), although most often sites are found within 12 miles of the ocean (FWS 1996). Social interactions may also play an important role in determining nesting location, since research has indicated that MAMUs in California and southern Oregon were less likely to occupy old-growth habitat if it was isolated from other nesting MAMUs by more than 3 miles (Meyer et al. 2002).

Murrelets do not form dense colonies, which is atypical for most seabirds; this is most likely to avoid detection by predators (Ralph et al. 1995). Also, in Oregon, MAMU occupied stands and nest sites are generally located away from high-contrast edge created by certain timber harvest practices and adjacent immature forests, most likely to reduce predation risk on eggs and juvenile MAMUs (Ripple et al. 2003), although many MAMU stands on BLM lands are located in highly fragmented landscapes (BLM 2014). Meyer et al. (2002) found at least a few years passed before birds abandoned fragmented forests. In northern California and southern Oregon, Meyer and Miller (2002) concluded that MAMU occupancy was most related to availability of low elevation, unfragmented old-growth forests within the fog zone that were close to highly productive marine areas. Federal lands account for the majority of suitable MAMU habitat in California, Oregon, and Washington (McShane et al. 2004).

These small seabirds spend most of their lives in the marine environment where they forage in shallow off-shore and inland saltwater areas on a variety of small fish and invertebrates, and large pelagic invertebrates (Marshall 1988a, 1988b, and 1989; Becker 2001). MAMUs forage by diving in relatively shallow waters [generally between 20 and 80 meters (65 to 262 feet)], averaging about 16 seconds in the water column per dive (Strachan et al 1995; Burkett 1995). In Oregon and Washington, anchovy, sand lance, and smelt appear to be the major prey types provided to chicks (McShane et al. 2004). MAMUs generally forage within 3 miles of shore in western North America, although during the breeding season they stay closer to the coast, e.g., within 1.2 miles in Oregon (McShane et al. 2004). Courtship, loafing, molting, and preening also occur in near-shore marine waters (Nelson 1997). The largest populations of MAMUs are in the Puget Sound and Strait of Juan de Fuca of Washington (Huff et al. 2006).

MAMUs are usually present year-round in California, Oregon, and Washington, whereas farther north in their breeding range, seasonal migration is common. MAMUs migrate back to breeding grounds in the north in early to mid-April (McShane et al. 2004). Research suggests that MAMUs demonstrate site fidelity (Huff et al. 2006).

Breeding is asynchronous in the MAMU, varying regionally, although generally occurring between April and September (McShane et al. 2004; Huff et al. 2006). Both sexes share the incubation and foraging duties, usually with duty exchanges occurring at dawn. One to two days after hatching the chick will be left alone while both parents forage at sea. The chick will receive 1 to 8 meals per day, with the majority of the meals delivered in the morning, usually before sunrise. Additional meals are delivered at dusk and occasionally throughout the day. Murrelet chicks fledge from the nest 27 to 40 days after hatching, usually at dusk (McShane et al. 2004). Existing data do not provide information on how far or where fledglings disperse.

Sex ratios of juveniles and adults are equal and breeding begins when birds are 2 to 5 years old; only 1 egg is laid per breeding season (McShane et al. 2004). A substantial proportion of nests is known to fail (Nelson and Hamer 1995); breeding success has been documented as high as 0.46 chicks per breeding pair in southern British Columbia but lower in northern California where telemetry studies documented between 0.135 and 0.324 chick per pair (McShane et al. 2004). Such low breeding success is not expected to sustain populations in which adult survivorship ranges from 0.83 to 0.93. The mean lifespan of MAMUs is 10 years (McShane et al. 2004).

Population Status

The exact population size of MAMUs is not known; however, the North American population is currently thought to be about 24,100 birds (with 95% confidence between 19,700 and 28,600 birds), based on counts at sea (Lynch et al. 2017). Within the Pipeline project area (Conservation Zones 3 and 4), the marbled murrelet population is estimated to be 15,556 birds in 2016 (with 95% confidence between 12,798 and 21,946 birds): 6,813 birds in Conservation Zone 3 (with 95% confidence between 5,389 and 8,821 birds) and 8,743 birds in Conservation Zone 4 (with 95% confidence between 7,409 and 13,125 birds).

In the early 1990s, MAMU abundance in Washington, Oregon, and California had been estimated at 18,550 to 32,000 (Ralph et al. 1995). In the late 1990s, population survey protocols were established to provide a consistent methodology for estimating MAMU population and population trends. Using the data and trends provided in Lynch et al. (2017), the trend in murrelet densities off-shore in Conservation Zones 3 and 4 has increased significantly ($P<0.05$) between 2000 and 2016. While this research indicates a positive trend, this positive trend in Conservation Zone 3 is uncertain (lower confidence interval overlaps zero). Using that trend, the predicted estimate of marbled murrelet densities within Conservation Zones 3 and 4 by proposed Pipeline in-service year (2022) is 5.77 birds per km^2 but could range from 3.30 to 8.24 birds per km^2 using the 95% prediction intervals (see table 3.3.3-0). Figure 3.3.3-1 shows the increasing population trend from 2000 to 2016 in Conservation Zones 3 and 4, combined, as well as projections of murrelet populations through construction and initial operation of the Pipeline (through 2022) using data from Lynch et al. (2017) which also shows an increasing trend in marbled murrelet density from 2000 to 2016 for all of Oregon (see Figure 4 in Lynch et al., 2017).

TABLE 3.3.3-0

Estimated (2000-2016) and Predicted (2017-2022) Marbled Murrelet Densities (birds/km^2) in Conservation Zones 3 and 4 [1]

Year	Birds	Area (km^2)	Density (birds/km^2)	Regression (Density vs Year)	Prediction (Density)	Lower 95PI	Upper 95PI
2000	11,604	2755	4.21	3.48	*	1.28	5.67
2001	11,389	2755	4.14	3.58	*	1.41	5.74
2002	11,087	2755	4.03	3.69	*	1.55	5.81
2003	10,361	2755	3.76	3.79	*	1.68	5.89
2004	11,950	2755	4.34	3.90	*	1.80	5.97

TABLE 3.3.3-0

Estimated (2000-2016) and Predicted (2017-2022) Marbled Murrelet Densities (birds/km^2) in Conservation Zones 3 and 4 [1]

Year	Birds	Area (km^2)	Density (birds/km^2)	Regression (Density vs Year)	Prediction (Density)	Lower 95PI	Upper 95PI
2005	9,485	2755	3.44	4.00	*	1.92	6.06
2006	10,343	2755	3.76	4.11	*	2.04	6.16
2007	7,787	2755	2.83	4.21	*	2.15	6.25
2008	11,026	2755	4.00	4.31	*	2.26	6.35
2009	10,741	2755	3.90	4.42	*	2.36	6.46
2010	10,891	2755	3.95	4.52	*	2.46	6.57
2011	13,459	2755	4.89	4.63	*	2.55	6.69
2012	9,773	2755	3.55	4.73	*	2.64	6.81
2013	13,926	2755	5.06	4.84	*	2.72	6.93
2014	8,841 [1]	1595	5.54	4.94	*	2.80	7.06
2015	8,743 [2]	1159	7.54	5.04	*	2.87	7.20
2016	6,813 [1]	1595	4.27	5.15	*	2.95	7.34
2017	*	*	*	*	5.25	3.01	7.48
2018	*	*	*	*	5.36	3.08	7.62
2019	*	*	*	*	5.46	3.14	7.77
2020	*	*	*	*	5.57	3.19	7.92
2021	*	*	*	*	5.67	3.25	8.08
2022	*	*	*	*	5.77	3.30	8.24

Notes :
[1] Zone 4 not surveyed in 2014 and 2016
[2] Zone 3 not surveyed in 2015

Source : Lynch et al. 2017

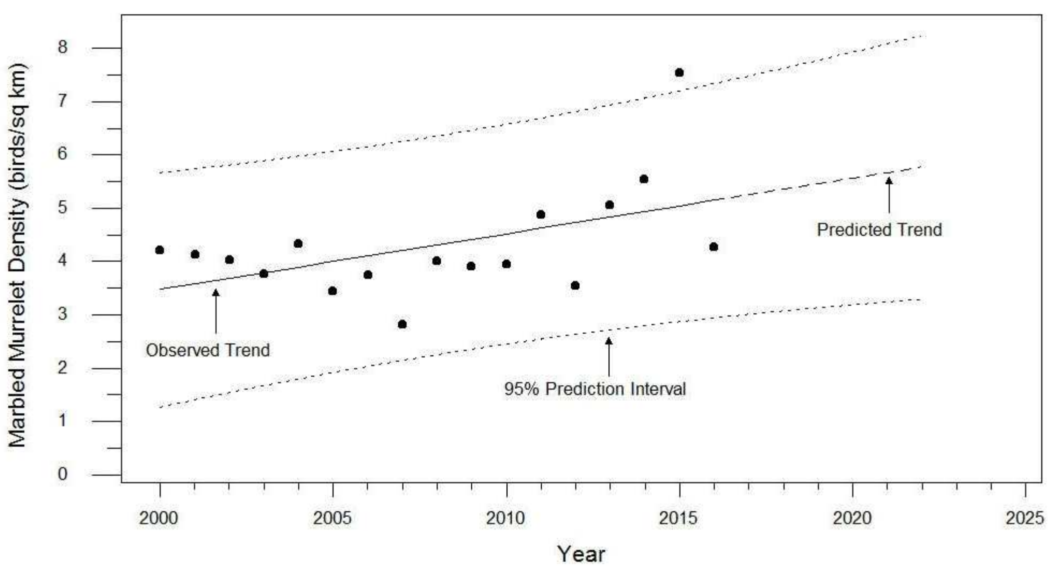


Figure 3.3.3-1 Density trend from 2000 to 2016 and predicted density estimates through 2022, the first year of operation of the Pipeline Project. The linear relationship is significant (r^2 = 0.253, P<0.05). (Data from Lynch et al. 2017)

Critical Habitat

Critical habitat for the MAMU was first designated in Washington, Oregon, and California on May 24, 1996 and included 3,887,000 acres in 32 critical habitat units (CHUs) (FWS 1996). On July

31, 2008, FWS proposed a revision to the 1996 critical habitat designation, proposing to remove approximately 254,070 acres in northern California and Oregon. This proposal was based on new information indicating that these areas do not meet the definition of critical habitat (FWS 2008b). Based on proposed revisions in 2008 critical habitat for the MAMU was revised in 2011, removing approximately 189,671 acres in northern California and southern Oregon from the 1996 designation (FWS 2011b and 2016b). Currently, designated critical habitat includes approximately 3,698,100 acres in 22 CHUs within Washington, Oregon, and California (FWS 2016b).

There are two components of MAMU habitat that are biologically important: 1) marine foraging habitat, including prey spawning and concentration areas, and 2) terrestrial nesting habitat and associated stands. Because FWS is unable to define specific marine areas essential to the conservation of the species, only terrestrial habitat is considered for designation as critical habitat. Throughout the forested portion of their range, MAMU habitat use is positively associated with the presence and abundance of mature and old-growth forests, large core areas of old-growth, low amounts of edge and fragmentation, proximity to the marine environment, and increasing forest age and height, although the presence of platforms is the most important characteristic of nesting habitat (FWS 2006c). As a result, the FWS designated the following as PCEs (FWS 2006c) that remain applicable to the revised critical habitat designated for the MAMU (FWS 2008b, 2011b): 1) forested stands containing large-sized trees, generally greater than 32 inches in diameter with potential nesting platforms at sufficient heights (≥ 33 feet); and 2) surrounding forested areas within 0.5 mile of these stands with a canopy height of at least one-half the site-potential tree height. In Oregon, MAMU nests have been located in trees with platforms greater than 19 inches diameter at breast height (dbh) and at least 98 feet tall (FWS 2006c).

Late-Successional Reserves

Additional habitat protection for the MAMU was established when the BLM and Forest Service in Washington, Oregon, and northern California adopted the NWFP in 1994 (Forest Service and BLM 1994). The NWFP divided the nesting portion of the MAMU range into two inland zones: 1) Inland Zone 1, which is a 10- to 35-mile zone closer to the coast where the majority of MAMU nests and detections are located, and 2) Inland Zone 2 where detection data indicated only a small fraction of the MAMU population nests (FEMAT 1993). Large amounts of NFS and BLM lands were allocated for LSRs, with the primary objective of protecting and enhancing conditions of late-successional and old-growth forest ecosystems. These lands could then serve as habitat for old-growth-related species including the MAMU, while maintaining diversity associated with native species and thus providing a network of fully functioning LSRs in National Forests throughout the Pacific Northwest (Forest Service and BLM 1994). The NWFP Standards and Guidelines also state that sites occupied by marbled murrelets but within Matrix lands are considered “unmapped LSRs” and are managed as lands allocated as LSRs by the NWFP.

In August 2016, the BLM issued two Records of Decision for tow Resource Management Plans (RMPs) for Southwestern Oregon and Northwestern and Coastal Oregon (BLM 2016a and 2016b). The NWFP no long applies on BLM-managed lands under the terms of the 2016 RMPs. The 2016 RMPs have similar land allocations that continue to contribute to the conservation of marbled murrelet habitat within BLM-administered lands, including an increase in designated LSRs within the range of the marbled murrelet. The NWFP still applies to lands managed by the Forest Service and is still in effect on the three National Forests crossed by the Pipeline.

The goals for LSR management for both Forest Service and BLM-managed lands are consistent with the function of federally-designated CHUs to contribute to the recovery of marbled murrelets. Management of LSRs should not only protect habitat currently suitable to marbled murrelets, but also promote the development of additional marbled murrelet habitat. Approximately 25 percent of the LSRs crossed overlap with federally designated critical habitats for marbled murrelets. The Pipeline would cross 8.65 miles of lands managed as LSRs within the marbled murrelet range, including 6.35 miles in Coos Bay BLM District and 2.30 miles in Roseburg BLM District; no lands managed by Forest Service are crossed within the marbled murrelet range.

The NWFP Standards and Guidelines also state that occupied MAMU sites and Known Owl Activity Centers (KOAC: 100-acre areas identified by BLM and Forest Service on January 1, 1994) that occur within NWFP-designated Matrix lands, are considered “unmapped LSRs” and managed as lands allocated as LSRs by the NWFP. Coos Bay and Roseburg BLM Districts also provide more specific management direction to protect marbled murrelets and their habitat on BLM-managed lands within the updated RMPs in all land allocations within Inland Zone 1, and within LSRs and Riparian Reserves within Inland Zone 2 unless otherwise directed through concurrence with the FWS, including (BLM 2016a and 2016b): 1) assess the project area for marbled murrelet nesting structure and conduct pre-project surveys following protocol; 2) prohibit activities that disrupt marbled murrelets nesting at occupied sites; and 3) restrict timber harvest within occupied marbled murrelet stands and all forest within 300 feet of a stand, with the exception of linear and nonlinear rights-of-way as long as the stand continues to support murrelet nesting. The 2016 RMPs also require future allocation of marbled murrelet occupied stands to LSR if occupied stands are identified within marbled murrelet Zone 1 within another land use allocation.

3.3.3.2 Environmental Baseline

Analysis Area

MAMU habitat can be categorized into various components, based on the life cycle needs of the species. Three main areas in which MAMU could be affected by the Project are outlined below.

Terrestrial Nesting Analysis Area

The first area in which MAMU could be affected by the Project is the terrestrial nesting analysis area. Per direction provided by FWS in the Revised Conservation Framework (*Revised Conservation Framework for the Northern Spotted owl and Marbled Murrelet: Jordan Cove Energy and Pacific Connector Gas Pipeline Project*, FWS 2014c), the terrestrial nesting analysis area consists of two components that consider effects from: 1) habitat removal or modification, and 2) disturbance/disruption of MAMU during the breeding season, as described below. The terrestrial nesting analysis area extends inland along the Pipeline route to include MAMU Inland Zone 1 – MPs 0.00 to 53.76 - and MAMU Inland Zone 2 – MPs 53.76 to 75.40 and is shown in figure 3.3.3-2.

The FWS (FWS 2008b and 2011b and 2014c) and BLM (BLM 2016a and 2016b) have recognized that forested habitat within 0.5 mile of an occupied stand, or 0.25 mile of occupied murrelet behavior, are important to recruit additional nesting habitat for the marbled murrelet in the future (e.g., “recruitment habitat” which has been defined by FWS as habitat that has the potential to become nesting habitat within 25 years; FWS 1997). To identify areas of higher importance for the marbled murrelet that could play an important role in maintaining and expanding marbled murrelet populations in the Pipeline project area, PCGP delineated marbled murrelet suitable habitat units (SHU), as directed by FWS (2014c) in the Conservation Framework.

The marbled murrelet SHU consists of three elements (FWS 2014c): 1) marbled murrelet occupied and unsurvyed suitable habitat (i.e., "presumed occupied" stands – forested stand identified as potential nesting habitat that has not been ground-truthed for suitable nesting structures and/or surveyed following the 2-year protocol); 2) a 300-foot buffer around each marbled murrelet occupied or presumed occupied stand; and 3) federally-designated critical habitat that occurs within a 0.5-mile buffer of marbled murrelet stands that are within 0.5 mile of critical habitat removal. Critical habitat located within the 0.5-mile buffer is an area considered important to the recovery of the species (FWS 2011b and 2014c). The 300-foot buffer incorporates an area that should maintain the integrity of the marbled murrelet stand from windthrow or other environmental disturbances as well as provide protection from potential predation (FWS 1997, ODF 2004). A protective 300-foot buffer of marbled murrelet stands is also recognized within the updated BLM RMPs (see Option 1 in BLM 2016a and 2016b). Areas included in defined SHUs represent areas of higher importance for the preservation of forested habitat for marbled murrelets. Within the Pipeline project area where marbled murrelet occupied stands are in close proximity to each other (i.e., less than 300 feet or adjacent), SHUs overlap. Approximately 15.71 miles of SHUs (occupied or presumed occupied stand, 300-foot buffer, and 0.5 mile buffer) would be crossed by the Pipeline: 14.08 miles in Inland Zone 1 and 1.63 mile in Inland Zone 2.

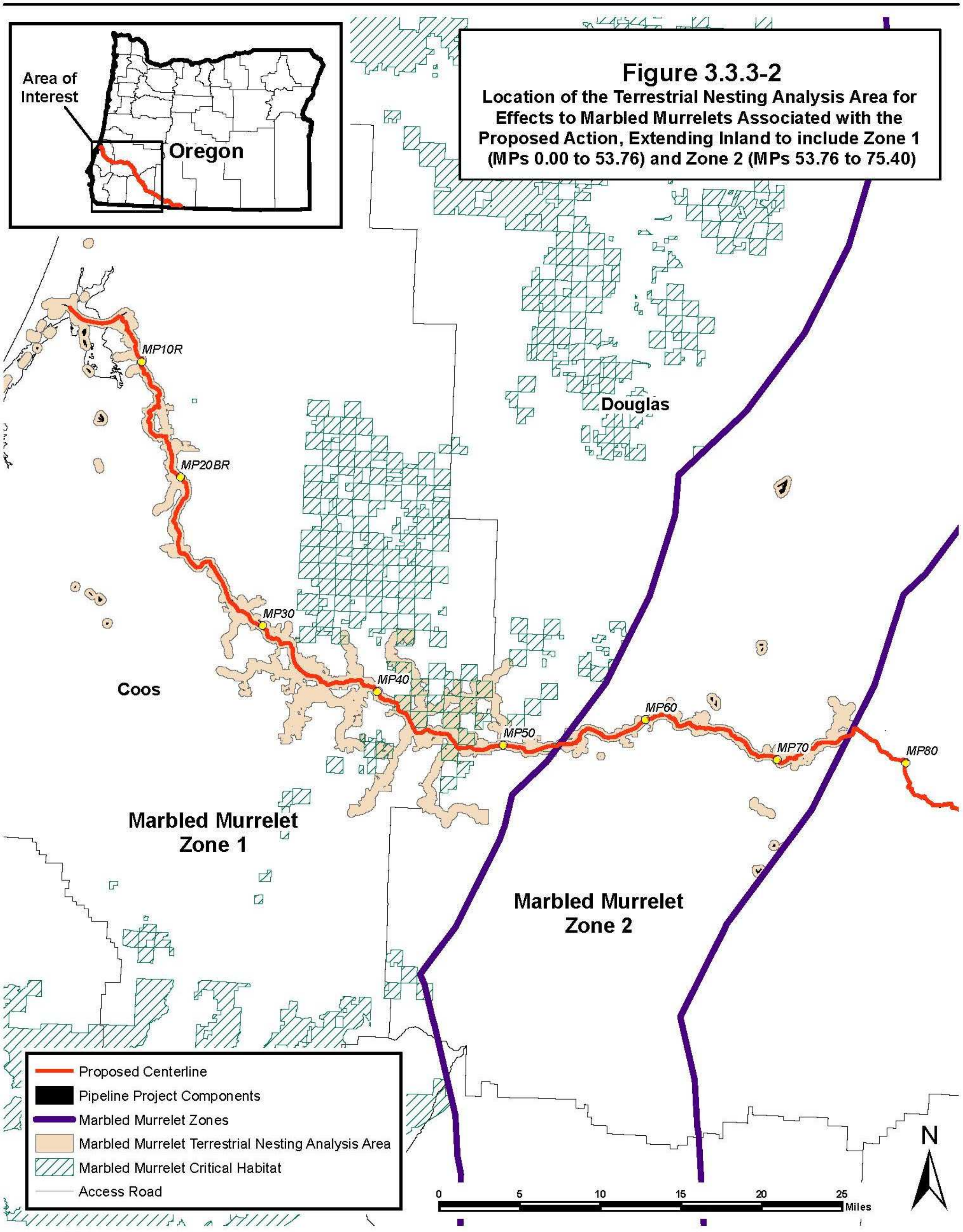


Figure 3.3.3-2
Location of the Terrestrial Nesting Analysis Area for Effects to Marbled Murrelets Associated with the Proposed Action, Extending Inland to include Zone 1 (MPs 0.00 to 53.76) and Zone 2 (MPs 53.76 to 75.40)
Area of Interest
Oregon
MP10R
MP20BR
MP30
MP40
MP50
MP60
MP70
MP80
Douglas
Coos
Marbled Murrelet Zone 1
Marbled Murrelet Zone 2
Proposed Centerline
Pipeline Project Components
Marbled Murrelet Zones
Marbled Murrelet Terrestrial Nesting Analysis Area
Marbled Murrelet Critical Habitat
Access Road
0
5
10
15
20
25
Miles
N

Habitat Removal or modification: This portion of the terrestrial nesting analysis area applies to all Project components that have the potential to remove or modify habitat, including construction of the LNG facilities and Pipeline , as well as a 100-meter (328-foot) wide buffer along each edge of the area of habitat impact (e.g., edge of right-of-way, TEWAs, new roads built for access, etc.) in recruitment or capable habitat throughout the entire range of MAMU. It also includes MAMU SHUs that are included for analysis within this APDBA.

Disturbance/Disruption (breeding season only): The terrestrial nesting analysis area also includes all lands within 0.25 mile of the Project components (including identified access roads). Access roads considered do not include paved roads that are used regularly by the public (i.e., county roads and state highways). The size of this analysis area considers the maximum distance (0.25 mile) at which MAMUs could be harassed during the breeding season (April 1 through September 15) by noise generated from general construction, operation, and maintenance activities, smoke from burning slash piles, blasting (with mitigation measures), and/or Boeing Chinook (CH-47) or Boeing Vertol 107 (CH-46) helicopter use (with mitigation measures) during construction, or use of access roads (FWS 2014c; see also PCGP's Blasting and Helicopter Noise Analysis & Mitigation Plan in appendix P).

Estuarine Analysis Area

The second area in which MAMU could be affected by the proposed action is the Coos Bay estuarine analysis area (see figure 3.3.3-3) which encompasses all estuarine waters (and substrates) that are within the estuary between the North Jetty and South Jetty at the Coos Head entrance to the bay. The estuarine analysis area includes: 1) the existing Federal Navigation Channel which forms part of the waterway for LNG carrier traffic to and from the LNG Terminal, 2) the proposed access channel to the terminal slip and pile dike rock apron, 3) the Navigation Reliability Improvements, 4) the area of North Slough adjacent to the Trans Pacific Parkway/U.S. Highway 101 (US-101) Intersection Widening, 5) the Eelgrass Mitigation site, 6) the Kentuck Project site, and 7) sites temporarily occupied during construction activities (see figure 2.1.1-2 under section 2.1.1.1, Jordan Cove Energy Project Component Description .

Marine Analysis Area

The third area in which MAMU could be affected by the proposed action is the marine analysis area (see figure 3.2-1), which extends to the edge of the continental shelf, approximately 12 nmi offshore. Within the marine analysis area, effects to MAMU would be associated with LNG vessels, which are assumed to transect the marine analysis area perpendicularly – east and west – as they approach and depart from Coos Bay (see the discussion above under section 3.2.1).

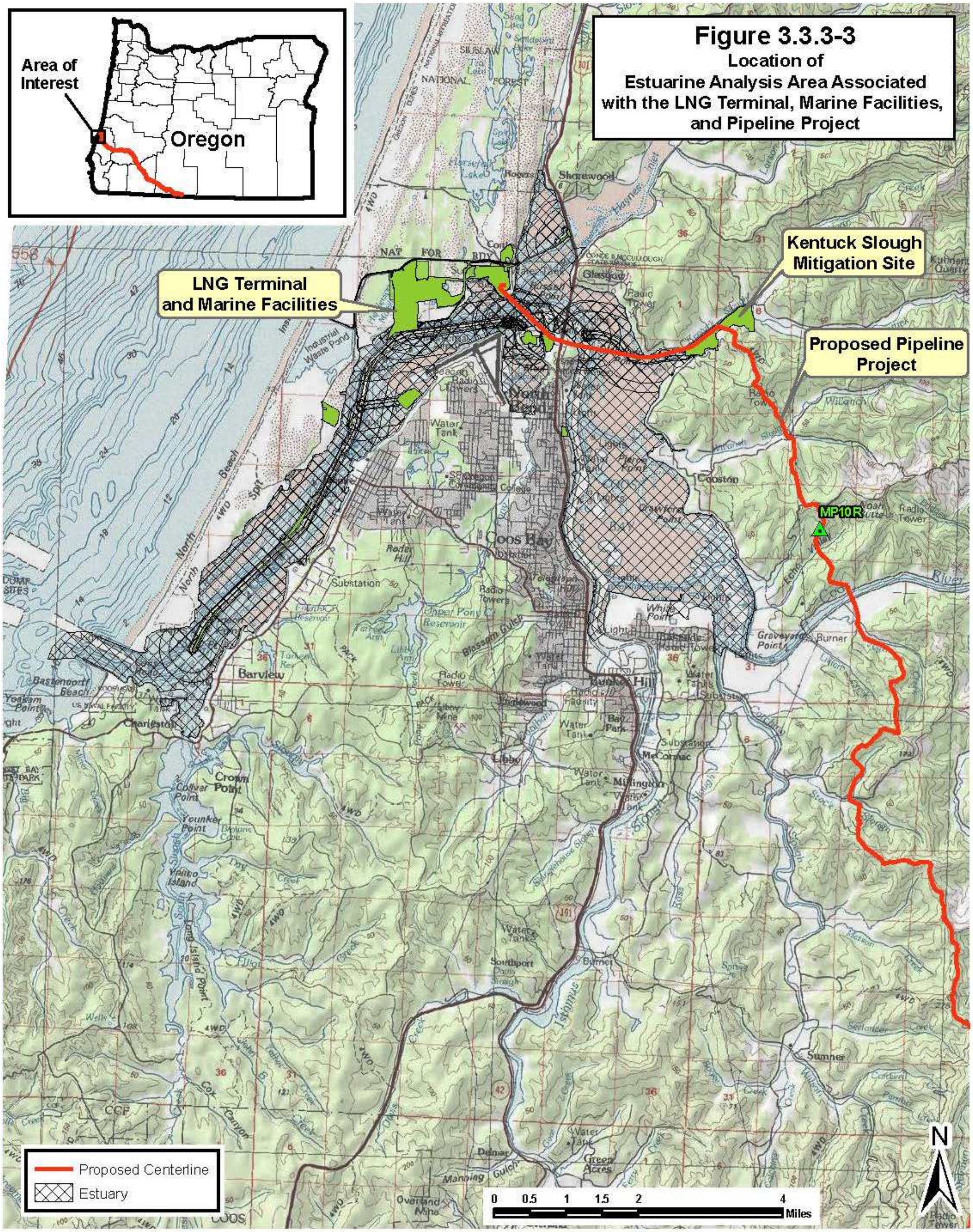


Figure 3.3.3-3
Location of
Estuarine Analysis Area Associated
with the LNG Terminal, Marine Facilities,
and Pipeline Project
Area of Interest
Oregon
LNG Terminal and Marine Facilities
Kentuck Slough Mitigation Site
Proposed Pipeline Project
MP10R
Proposed Centerline
Estuary
0 0.5 1 1.5 2 4 Miles
N

Species Presence

The Project occurs within Marbled Murrelet Inland Zone 1 and Marbled Murrelet Inland Zone 2; MAMU nesting has been documented within the two inland zones in and near the terrestrial nesting analysis area. MAMU nesting behavior is cryptic, however, resulting in few nests being located by biologists. As a result, documented behaviors assumed to be associated with nesting, such as MAMUs flying into the canopy or circling very close above the canopy are used to infer nesting activity and thus occupancy of MAMU stands. Since these occupied behaviors are not detected during every visit to a stand, the Pacific Seabird Group inland MAMU survey protocol (Mack et al. 2003) recommends several visits to a stand that contains potential MAMU nest trees (up to 9 per year) for a duration of two years in order to determine with some certainty that a timbered stand is occupied or unoccupied (probable absence). When occupied behavior is identified, the managing agency delineates the occupied stand and provides a master site number (MSNO). That stand is then considered "occupied" in perpetuity. If after two years of protocol surveys MAMU occupancy has not been determined in potential suitable MAMU habitat, then the site would be considered unoccupied (probable absence) for five years after completion of protocol surveys (Mack et al. 2003).

To determine presence of occupied stands in the vicinity of the Pipeline , PCGP used survey data from 2-year protocol surveys conducted for the Pipeline, as well as GIS data layers with known occupied MAMU stands or areas of suitable MAMU nesting habitat from BLM (2017) and private timber companies (Weyerhauser 2007). Areas identified within the vicinity of the Pipeline that are either known to have suitable nesting structures present but have not been surveyed in accordance with the applicable survey protocol or suitable nesting habitat has been presumed based on age of forested stand or height of trees but actual habitat has not been ground-truthed (i.e., landowners did not permit surveys) are considered "presumed occupied stands."

<u>Known Occupied MAMU Stands</u>

GIS data layers were obtained from Coos Bay and Roseburg BLM Districts (BLM 2017) to determine areas with known MAMU occupancy; 277 occupied stands were provided within the Coos Bay (249 stands) and Roseburg (28 stands) BLM Districts, including 10 stands identified during surveys conducted by PCGP in 2007 and 2008, six stands identified during surveys conducted by PCGP in 2013, and two stands identified during surveys conducted by PCGP in 2014 (see PCGP survey details, below). MAMU survey data were requested from private landowners within the Project area and in 2007 Weyerhaeuser Timber Company provided GIS files with areas of known MAMU occupancy (Weyerhauser 2007); none of the stands identified by Weyerhauser occur within 0.25 mile of the Pipeline or proposed access roads.

<u>Pipeline Project-Specific Marbled Murrelet Surveys</u>

No suitable MAMU nesting habitat occurs at the LNG Terminal site (LBJ Enterprises 2006; SHN 2013c); therefore, MAMU nesting surveys were limited to the Pipeline project area.

Habitat Assessment: To determine species presence within the proposed Pipeline project area, PCGP contracted surveyors (SBS and Rogers & Associates [R&A]) to conduct two-year surveys within habitat containing suitable nesting structures as described by Mack et al. (2003). Prior to surveys, SBS assessed habitat within 0.25 mile of the Pipeline to identify areas with potential suitable marbled murrelet nesting habitat to determine where marbled murrelet protocol surveys should be conducted for the Pipeline project. Delineation of suitable habitat was accomplished using a combination of aerial photographs, BLM Federal Operations Inventory (FOI) GIS data, local knowledge of on-the-ground habitat, and light detection and ranging (LiDAR) that was flown in a corridor including 0.25 mile on either side of the proposed Pipeline. The LiDAR data set was used to display all trees with a canopy height greater than 107 feet. Polygons were derived from these data to indicate possible suitable MAMU nesting habitat and/or trees. Within 20 miles of the coastline a single tree qualified as potential nesting habitat, whereas further inland, clusters of 6 or more large trees within a floating 5 acre window were considered potential habitat as directed by FWS (see SBS 2008a). These polygons were reviewed using aerial photos and BLM FOI data to determine which areas could provide potential suitable nesting habitat for MAMU.

Based on further direction provided by FWS and BLM Districts (Roseburg and Coos Bay), additional areas within 0.25 mile of construction activities and proposed existing access roads for the Pipeline were delineated that could provide potential suitable nesting habitat for MAMU. On BLM-managed lands, potential habitat was delineated from GIS layers provided by Coos Bay and Roseburg BLM Districts (BLM 2017) that identified suitable MAMU habitat. On private land, additional areas were delineated where the NWFP MAMU habitat model that uses maximum entropy (Maxent models) developed by Raphael et al. (2016) had a dense grouping of modeled "value 4" pixels ("highest suitability") and forested habitat was present in an obvious stand that could be delineated.

As the proposed route changed, habitat was reassessed with updated GIS layers, photography, and LiDAR where available and included additional survey efforts, if necessary.

PCGP Surveys (2007 – 2015): In areas where permission to survey was granted, R&A conducted on-the-ground surveys to determine whether timber stands exhibited the characteristics of nesting habitat outlined in the Pacific Seabird Group protocol (Mack et al. 2003). MAMU survey stations were set up on property where access was allowed and timber stands exhibited the characteristics of nesting habitat outlined in the Pacific Seabird Group protocol (Mack et al. 2003). Survey stations were positioned in such a manner that all of the potential habitat in a given stand could be seen, and that any MAMUs present would be able to be seen against the sky.

In areas identified with potentially suitable nesting structures where survey permission had been granted, R&A conducted protocol surveys in 2007 and 2008 and observed occupied behavior in 10 stands on BLM lands; data was provided to BLM to delineate "occupied stands." Full protocol surveys were conducted in nine other stands with suitable nesting structures in 2007 and 2008 but surveyors did not detect occupied behavior and they were considered "unlikely to be occupied" through 2013; five of these stands were resurveyed in 2013 and 2014. Protocol surveys were also initiated in three other areas with suitable nesting structures that were either included because of a pipeline reroute or had only received one year of protocol surveys; all eight areas were determined occupied in 2013 (six stands) or 2014 (two stands). Coos Bay and Roseburg BLM Districts were provided the appropriate survey results after occupied behavior was detected; each District delineated the occupied stands and provided an MSNO for each MAMU stand that are included in analysis for this APDBA.

In 2007 and 2008, 65 of 118 identified stands were examined, of which 46 of 65 (71 percent) timber stands and/or trees were determined not to exhibit the necessary nest tree characteristics and were removed from the list of stands/acreage to be surveyed.

Protocol surveys were also initiated along the Blue Ridge route in 2015 where MAMU occupied behavior was detected in 13 stands with suitable nesting structures present. To-date, only one year of survey effort has occurred in this portion of the Pipeline project. Although occupied behavior was detected in 13 of the stands (sub-canopy murrelet behavior detected), Coos Bay BLM determined that survey results were difficult to interpret and additional survey information was needed in this area since Blue Ridge is the first significant north-south ridge that MAMU encounter as they fly inland from the ocean and behavior documented could have been MAMU flying low over the ridgeline to conserve energy (BLM 2017b). Therefore, stands along the Blue Ridge portion of the proposed Pipeline with occupied behavior detected during 2015 protocol surveys are considered presumed occupied, with presence detected for this APDBA.

PCGP Surveys (2017 – 2018): In 2017 and 2018, additional on-the-ground surveys were conducted in potential habitat (presumed occupied stands) where survey permission was granted to determine whether timber stands exhibited the characteristics of nesting habitat, as outlined in the MAMU protocol (Mack et al. 2003). Surveys in fall 2017 assessed eight presumed occupied MAMU stands for suitable nesting structures, of which six stands were determined to provide suitable nesting structures for MAMU; two stands were removed from further consideration as presumed occupied, of which one was along a previously proposed route. Surveys in late spring (May and June) 2018 assessed 12 additional presumed occupied stands to determine if the forested stands provided suitable structure for nesting: three stands were determined to not provide suitable nesting structures and have been removed from analysis as a presumed occupied stand in this revised APDBA.

Two-year protocol surveys were also initiated in late spring 2018 in nine presumed occupied stands on BLM-managed lands to determine if the stands were occupied by MAMU: occupied behavior was observed in six occupied stands on both Coos Bay and Roseburg BLM lands, MAMU presence was detected above canopy during survey visits at one other stand where survey efforts were increased from five visits to nine visits in 2018 but no occupied behavior was observed, and two other stands did not detect MAMU presence. Survey data where occupied behavior was detected has been provided to BLM to review and officially delineate occupied stands where and if necessary. Second year survey efforts in these nine stands will continue as required by the protocol and be completed in 2019.

Additional Stands Delineated – No Survey

Areas of potentially suitable habitat that have been delineated in the Project area, as described above, but have not been ground-surveyed or not surveyed following the 2-year protocol, are considered “presumed occupied stands” and included for analysis within this APDBA as if they are occupied by marbled murrelets. Some of these areas have been ground-truthed and suitable nesting habitat was observed, but 2-year protocol surveys have not been completed (see table Q-1 in appendix Q). Other areas either did not receive survey permission, or survey permission was not requested due to the habitat location in relation to the Project (i.e., greater than 100 meters from habitat removal or along an existing, proposed access road). The areas greater than 100 meters from habitat removal were included for analysis within this APDBA to assess direct effects from disturbance of the proposed action. PCGP will continue to conduct additional on-the-ground surveys to determine if habitat within delineated presumed occupied stands that are crossed by the Pipeline provide suitable nesting structures. If the habitat is determined suitable nesting habitat through ground reconnaissance, PCGP would continue to presume occupancy. If the habitat is determined to not be suitable for marbled murrelet nesting, then PCGP would not continue to analyze the area as "presumed occupied," but would consider habitat within the delineated stand as "recruitment" habitat for subsequent analyses. Ground reconnaissance survey results would be provided to FWS to update impact analysis categories.

Marbled Murrelet Stands Considered for Analysis within the Terrestrial Nesting Analysis Area

Overall, 175 MAMU stands have been included for analysis within this APDBA: 51 occupied MAMU stands and 124 presumed occupied MAMU stands. MAMU stands were included if located within 0.25 mile of the proposed action, including 0.25 mile from proposed existing access roads (excluding paved public roads used regularly by the public – i.e., county roads or state highways). MAMU stands were also included for analysis if located within 0.5 mile of federally-designated critical habitat that would be affected by the proposed action. Fifty-one occupied stands (as defined by occupied behavior and delineated by BLM) are considered for analysis, including 18 stands detected during survey efforts by PCGP within the proposed Pipeline project area in 2007, 2008, 2013, and 2014. Twenty-six occupied stands are only included because they are within 0.25 mile of proposed existing access roads, including two stands determined to be occupied during PCGP 2007/2008 MAMU survey efforts. The other 124 stands included for analysis in this APDBA are "presumed occupied" – they either have been incorporated into the analysis based on Coos Bay and Roseburg BLM suitable habitat GIS data layers (71 stands; BLM 2017), or have been incorporated into the analysis considering high suitability values in the NWFP MAMU habitat model (Raphael et al. 2016) and/or LiDAR flown for the Project identifying trees greater than 107 feet in height (53 stands).

The number of "presumed occupied" stands deemed to be present within the analysis area is an extremely conservative number resulting in an overestimation. PCGP does not expect presumed occupied stands to have suitable habitat present, especially habitat located on private lands based on 1) on-the-ground surveys adjacent to those stands with no suitable nesting habitat (see maps included in appendix Z1), 2) location of those identified stands within narrow riparian buffers surrounded by clear-cuts and/or residences, 3) extent of timber stand harvests adjacent or near identified stands, and/or 4) proximity of presumed occupied stands greater than 3.0 miles from known occupied stands. For example in regards to #1, in 2007 and 2008, 46 of 65 (71 percent) timber stands and/or trees examined on the ground as potential MAMU nesting habitat were determined not to exhibit the necessary nest tree characteristics and were removed from the list of stands/acreage to be surveyed. Additionally, FWS (2006d) indicated that generally forests that provide suitable nesting habitat and nest trees require 200 to 250 years to develop. The majority of stands identified as "presumed occupied" do not occur in old-growth forest.

Table 3.3.3-1 below summarizes the number of MAMU stands (and status) considered for this analysis within each Marbled Murrelet Zone, by landowner in the terrestrial nesting analysis area. The table also tallies the number of stands that are included because of the stand's proximity to proposed habitat removal and/or access roads for each Zone. Table Q-1 in appendix Q provides details for each stand, including location in relation to proposed action, distance from proposed action including access roads, landowner, land allocation, and overall acres in stand by Marbled Murrelet Inland Zone. Figure 1 in appendix Q shows an overview of occupied and presumed occupied stands within the terrestrial nesting analysis area (occupied stands provided by Coos Bay and Roseburg BLM Districts (BLM 2017) are also depicted beyond the analysis area).

Marbled Murrelet Presence within the Estuarine and Marine Analysis Areas

Because occupied MAMU stands have been documented within the proposed terrestrial nesting analysis area (see table 3.3.3-1), and MAMUs have been recorded on the National Audubon Society's CBCs in the Coos Bay count circle that occurs within the delineated estuarine and marine analysis areas (National Audubon Society 2017), MAMUs are expected to forage within the Project's estuarine and marine analysis areas throughout the year. The most MAMUs reported in any survey were 16 counted during 95 observation hours (0.2 counted per hour) in 1992. On average, MAMUs have been recorded 3.1 times per count since 1977.

TABLE 3.3.3-1

Summary of Marbled Murrelet Occupied or Presumed Occupied Stands within the Terrestrial Nesting Analysis Area that Are Analyzed in this APDBA

		Marbled Murrelet Inland Zone 1			Marbled Murrelet Inland Zone 2			Total		
Status of MAMU Stand a/	**Landowner b/**	**Stands in Zone 1**	**Stands Affected by Construction c/**	**Stands Affected by Access Roads d/**	**Stands in Zone 2**	**Stands Affected by Construction c/**	**Stands Affected by Access Roads d/**	**Total Stands**	**Stands Affected by Construction c/**	**Stands Affected by Access Roads d/**
Occupied	BLM e/	48	22	48	3	3	2	51	25	50
	Other	0	0	0	0	0	0	0	0	0
	Occupied Total	*48*	*22*	*48*	*3*	*3*	*2*	*51*	*25*	*50*
Presumed Occupied	BLM	79	29	76	7	2	6	86	31	82
	Other	38	28	36	0	0	0	38	28	36
	Presumed Occupied Total	*117*	*57*	*112*	*7*	*2*	*6*	*124*	*59*	*118*
Overall Total	BLM	127	51	125	10	5	8	137	56	132
	Other	38	28	35	0	0	0	38	28	36
	Overall Total	**165**	**79**	**160**	**10**	**5**	**8**	**175**	**84**	**168**

a/ "Occupied:" delineated stand that has identified occupied behavior during protocol surveys; " "Presumed Occupied:" forested stand has not been surveyed and habitat present is may provide suitable nesting structures.

b/ BLM includes Coos Bay and Roseburg Districts; three presumed occupied stands with mixed landowner (BLM and private) in MAMU Inland Zone 1 have been included in this category. Other includes private and Bureau of Indian Affairs (BIA); one presumed occupied stand with mixed landowner (private and BIA) in MAMU Inland Zone 1 have been included in this category.

c/ Stand Affected by Construction considers MAMU stands located within 0.25 mile of all proposed disturbance, including uncleared storage areas (UCSAs), as well as stands within 0.5 mile of federally-designated critical habitat removal.

d/ Access roads considered does not include paved roads that are used regularly by the public (i.e., County Roads, State Highways). MAMU stands are included if the stand is within 0.25 mile of a proposed access road.

e/ One occupied MAMU stand occurs in both Marbled Murrelet Inland Zones 1 and 2 but has been included in tabluations for Inland Zone 2.

Table Q-1 in appendix Q provides details for each stand, including location in relation to proposed action, distance from proposed action including access roads, landowner, land allocation, and overall acres in stand by Marbled Murrelet Inland Zone.

Habitat

The proposed action traverses two MAMU habitat inland zones designated by FEMAT. Inland Zone 1 encompasses a strip of land along the coast approximately 0 to 35 miles from the coast, and Inland Zone 2 includes areas along the western fringe of the species' range, about 35 to 50 miles from the coast (figure 3.3.3-2). The most suitable habitat is expected to occur within MAMU habitat Inland Zone 1, and recent surveys provide evidence to support this (Raphael 2006). The proposed action also occurs within Conservation Zones 3 and 4 as described by the MAMU Recovery Plan (FWS 1997). Figure Q-1 in appendix Q provides the location of each MAMU Inland Zone and Conservation Zone within the terrestrial nesting analysis area.

Three categories of MAMU habitat have been identified within the terrestrial nesting analysis area within MAMU Inland Zones 1 and 2: suitable nesting habitat, recruitment habitat, and habitat capable of becoming suitable nesting habitat (capable habitat). The following definitions were considered to classify MAMU habitat considering direction provided in several documents (FWS 1996, 2014c; BLM 1995a, 1995b) to provide standardization of terms for habitat categories: 1) suitable habitat includes coniferous forest that provides structures, or may provide structures and/or a forested buffer necessary for nesting MAMUs, and generally consist of late seral forest; 2) recruitment habitat is coniferous forested stands greater than 60 years of age that do not provide suitable nesting structures for MAMUs and could become suitable habitat within 25 years; and 3) capable habitat is coniferous forested stands from 0 to 60 years of age that could become suitable habitat.

Potential MAMU habitat within the Terrestrial Nesting Analysis area was identified in four steps, building upon each layer. Suitable nesting habitat was identified first, then recruitment; all other coniferous forest not included in the previous two categories was considered capable habitat. Non-forested habitat and deciduous forest was considered non-capable habitat. The vegetation file developed for the Pipeline project was used as the base file. Vegetation cover types were digitized with GIS from 2016 aerial photography and delineated based on the predominate vegetation physiognomy (e.g., trees, shrubs, herbaceous vegetation) and the dominant species present. Forested vegetation was assigned an age class using available GIS data (BLM FOI database, Gradient Nearest Neighbor raster data set [developed by Landscape Ecology, Modeling, Mapping & Analysis, or LEMMA: http://lemma.forestry.oregonstate.edu/], Moeur et al. (2006) LANDSAR late successional old-growth coverage, and an index called the old-growth structure index (OGSI) that further assisted monitoring the abundance of old-growth forest across large landscapes, including the NWFP area in the 20-year late successional and old-growth forest status and trend report (see Davis et al. 2015). Age class within previous versions of mapped vegetation for the Pipeline was also reviewed by BLM and Forest Service biologists on their respective lands with specific focus on verifying/classifying late seral forest stands (Habitat Quality subtask group, 2007 through 2008), as well as verified/revised by SBS who conducted biological surveys for PCGP. Age class for forested stands was categorized within five age ranges: clearcut (0-5 years), regenerating (5-40 years), mid-seral (40-80 years), late successional (80-175 years), and old-growth (175+ years) (Lint 2005). Areas of regenerating forest that appear to be "clearcut" on the aerial photography were identified as "early-regenerating" forest. The PCGP vegetation file extends at least 100 meters (328 feet) from the proposed action and consists of smooth polygons following obvious vegetation breaks. Outside of the Pipeline project vegetation layer and outside BLM-managed lands, the MAMU habitat file becomes more pixelated (25-meter by 25-meter squares) and less refined because it relied on MAMU habitat modeled from Raphael et al. (2016) (see Habitat Modeling, Pacific Northwest Research Station below).

Table 3.3.3-2 provides a summary of MAMU habitat within the terrestrial nesting analysis area by MAMU Inland Zone, Recovery Plan Conservation Zone, general landownership, and within SHUs and outside of SHUs that was developed for the proposed action.

<u>Estimate of Suitable Habitat</u>

For this APDBA, suitable habitat includes all habitat that occurs within BLM delineated occupied stands (BLM 2017) including where BLM-delineated occupied stands include younger forest (e.g., regenerating forest) or non-forested habitat (e.g., roads). Habitat that is included within "presumed occupied stands" analyzed within this APDBA (see species presence section, above) was also included in the MAMU habitat file as suitable habitat, including potential habitat areas identified by Coos Bay and Roseburg BLM Districts (2017 suitable habitat GIS files), or potential habitat based on LiDAR and habitat modeling developed by the Pacific Northwest Research Center (Raphael et al. 2016). Based on the vegetation file developed for the Pipeline project, these “presumed occupied” stands include coniferous forest ranging from mid-seral to old-growth.

TABLE 3.3.3-2

Marbled Murrelet Habitat Available within the Terrestrial Nesting Analysis Area

Conservation Zone	Landowner a/	General Location	Total Acres within Analysis Area	Suitable Habitat b/		Recruitment Habitat c/		Capable Habitat d/		Total MAMU Habitat e/	
				Acres Available	Percent	Acres Available	Percent	Acres Available	Percent	Acres Available	Percent
Marbled Murrelet Inland Zone 1											
Zone 3	Federal	Within SHUs	84	43	50.7	14	16.2	27	32.2	83	99.1
		Outside of SHUs	479	0	0.0	4	0.8	275	57.5	279	58.3
		Total	**563**	**43**	**7.6**	**18**	**3.1**	**302**	**53.7**	**363**	**64.4**
	Non-Federal	Within SHUs	204	17	8.3	34	16.7	102	50.3	153	75.0
		Outside of SHUs	8,996	0	0.0	432	4.8	2,853	31.7	3,285	36.5
		Total	**9,199**	**17**	**0.2**	**466**	**5.1**	**2,956**	**32.1**	**3,439**	**37.4**
	Total Conservation Zone 3	Within SHUs	288	60	20.8	48	16.7	130	45.0	238	82.6
		Outside of SHUs	9,475	0	0.0	436	4.6	3,129	33.0	3,565	37.6
		Total	**9,762**	**60**	**0.6**	**484**	**5.0**	**3,258**	**33.4**	**3,802**	**38.9**
Zone 4	Federal	Within SHUs	18,588	11,557	62.2	3,154	17.0	3,735	20.1	18,446	99.2
		Outside of SHUs	8,412	13	0.2	5,407	64.3	2,889	34.3	8,309	98.8
		Total	**27,000**	**11,570**	**42.9**	**8,562**	**31.7**	**6,624**	**24.5**	**26,756**	**99.1**
	Non-Federal	Within SHUs	4,058	336	8.3	553	13.6	3,072	75.7	3,961	97.6
		Outside of SHUs	18,014	0	0.0	1,440	8.0	14,110	78.3	15,550	86.3
		Total	**22,073**	**336**	**1.5**	**1,993**	**9.0**	**17,182**	**77.8**	**19,511**	**88.4**
	Total Conservation Zone 4	Within SHUs	22,647	11,893	52.5	3,707	16.4	6,807	30.1	22,407	98.9
		Outside of SHUs	26,426	13	0.1	6,848	25.9	16,999	64.3	23,860	90.3
		Total	**49,073**	**11,906**	**24.3**	**10,555**	**21.5**	**23,806**	**48.5**	**46,267**	**94.3**
Outside Conservation Zones	Federal	Within SHUs	2,536	1,610	63.5	442	17.4	389	15.3	2,441	96.2
		Outside of SHUs	1,193	0	0.0	1,107	92.8	56	4.7	1,163	97.5
		Total	**3,729**	**1,610**	**43.2**	**1,548**	**41.5**	**445**	**11.9**	**3,603**	**96.6**
	Non-Federal	Within SHUs	688	66	9.6	132	19.2	405	58.4	600	87.2
		Outside of SHUs	3,226		0.0	666	20.6	1,839	57.0	2,505	77.7
		Total	**3,914**	**66**	**1.7**	**798**	**20.4**	**2,244**	**57.2**	**3,105**	**79.3**
	Total Outside Conservation Zone	Within SHUs	3,224	1,676	52.0	574	17.8	794	24.5	3,040	94.3
		Outside of SHUs	4,419	0	0.0	1,773	40.1	1,896	42.9	3,668	83.0
		Total	**7,643**	**1,676**	**21.9**	**2,347**	**30.7**	**2,689**	**35.1**	**6,708**	**87.8**
MAMU Inland Zone 1 Total	Federal	Within SHUs	21,208	13,210	62.3	3,610	17.0	4,151	19.6	20,970	98.9
		Outside of SHUs	10,084	13	0.1	6,518	64.6	3,220	31.9	9,751	96.7
		Total	**31,292**	**13,223**	**42.3**	**10,128**	**32.4**	**7,371**	**23.6**	**30,722**	**98.2**

TABLE 3.3.3-2

Marbled Murrelet Habitat Available within the Terrestrial Nesting Analysis Area

Conservation Zone	Landowner a/	General Location	Total Acres within Analysis Area	Suitable Habitat b/		Recruitment Habitat c/		Capable Habitat d/		Total MAMU Habitat e/	
				Acres Available	Percent	Acres Available	Percent	Acres Available	Percent	Acres Available	Percent
MAMU Inland Zone 1 Total	Non-Federal	Within SHUs	4,950	419	8.5	719	14.5	3,579	72.2	4,714	95.2
		Outside of SHUs	30,236	0	0.0	2,538	8.4	18,803	62.2	21,341	70.6
		Total	**35,186**	**419**	**1.2**	**3,257**	**9.3**	**22,382**	**63.6**	**26,055**	**74.0**
	Subtotal Marbled Murrelet Zone1	Within SHUs	26,158	13,629	52.1	4,329	16.5	7,730	29.5	25,683	98.2
		Outside of SHUs	40,320	13	0.0	9,056	22.5	22,023	54.6	31,091	77.1
		Total	**66,478**	**13,642**	**20.5**	**13,386**	**20.1**	**29,753**	**44.8**	**56,777**	**85.4**
Marbled Murrelet Inland Zone 2											
Outside Conservation Zones	Federal	Within SHUs	789	641	81.2	23	2.9	100	12.7	764	96.8
		Outside of SHUs	1,095	6	0.6	767	70.1	229	20.9	1,002	91.5
		Total	**1,884**	**647**	**34.3**	**790**	**42.0**	**329**	**17.4**	**1,766**	**93.7**
	Non-Federal	Within SHUs	392	1	0.2	188	47.8	184	47.0	373	95.0
		Outside of SHUs	15,423	20	0.1	3,990	25.9	5,010	32.5	9,021	58.5
		Total	**15,815**	**21**	**0.1**	**4,177**	**26.4**	**5,195**	**32.8**	**9,393**	**59.4**
	Subtotal Marbled Murrelet Zone2	Within SHUs	1,182	641	54.3	211	17.8	284	24.1	1,136	96.2
		Outside of SHUs	16,518	26	0.2	4,757	28.8	5,239	31.7	10,023	60.7
		Total	**17,699**	**668**	**3.8**	**4,968**	**28.1**	**5,524**	**31.2**	**11,159**	**63.0**
Total Marbled Murrelet Range											
Total Marbled Murrelet Range	*Federal*	Within SHUs	21,997	13,851	63.0	3,633	16.5	4,251	19.3	21,734	98.8
		Outside of SHUs	11,179	19	0.2	7,285	65.2	3,449	30.9	10,753	96.2
		Total	**33,176**	**13,870**	**41.8**	**10,918**	**32.9**	**7,700**	**23.2**	**32,488**	**97.9**
	Non-Federal	Within SHUs	*5,342*	*420*	7.9	*907*	17.0	*3,764*	70.4	*5,087*	95.2
		Outside of SHUs	*45,659*	*20*	0.0	*6,528*	14.3	*23,813*	52.2	*30,361*	66.5
		Total	***51,001***	***440***	**0.9**	***7,434***	**14.6**	***27,577***	**54.1**	***35,448***	**69.5**
	Total Marbled Murrelet Range	Within SHUs	*27,340*	*14,271*	52.2	*4,540*	16.6	*8,015*	29.3	*26,819*	98.1
		Outside of SHUs	*56,838*	*39*	0.1	*13,813*	24.3	*27,262*	48.0	*41,114*	72.3
		Total	***84,177***	***14,310***	**17.0**	***18,354***	**21.8**	***35,277***	**41.9**	***67,936***	**80.7**

a/ Federal Landowners include Coos Bay BLM and Roseburg BLM Districts, Non-federal Landowners include private and State lands.
b/ Suitable Habitat: generally late-seral forested stands that provide or are presumed to provide nesting structures for marbled murrelet based on modeling and other available GIS data.
c/ Recruitment Habitat: forested land not currently suitable for marbled murrelet nesting that may be capable of becoming suitable marbled murrelet habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).
d/ Capable Habitat: forested land that has the capability of becoming suitable nesting marbled murrelet habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).
e/ Total MAMU Habitat does not include "non-capable habitat" that occurs within the Marbled Murrelet Terrestrial Nesting Analysis Area.

Suitable habitat was incorporated into the MAMU habitat GIS file first. On BLM lands, additional suitable habitat was incorporated into the MAMU habitat file where GIS data provided by Coos Bay and Roseburg BLM Districts (BLM 2017) identified suitable habitat based on BLM FOI coverage (includes coniferous stands at least 80 years of age); these areas correspond to presumed occupied stands described above for species presence. On non-federal lands, additional suitable habitat was identified using a MAMU habitat model developed by the Pacific Northwest Research Center (see Raphael et al. 2011). Within 0.25 mile of the proposed action, areas modeled with "highest" suitable habitat potential (value 4 in the Raphael et al. 2016 model) and where obvious late seral stands were present (2016 aerial photography and PCGP GIS vegetation layer) were included in the MAMU habitat file developed for the proposed action. Additional description of the MAMU habitat model developed at the Pacific Northwest Research Center is included, below. Suitable habitat included in the MAMU habitat GIS file consists of coniferous forest in the following age classes: old-growth (175+ years), late successional (80 to 175 years), and mid-seral (40 to 80 years), with the exception of some habitat within BLM-delineated MAMU stands that include lower seral and nonforested habitat.

Based on the proportion of suitable habitat known to be occupied by nesting MAMUs either as surveyed per protocol (see Mack et al. 2003), or expected to be occupied based on survey history in the area and the application of an occupancy index to unsurveyed areas, FWS estimated that approximately 408,621 acres of suitable MAMU habitat (51 percent of reported suitable habitat) are likely occupied in Oregon (McShane et al. 2004). Also, 97 percent of the stands identified by SBS that were potential MAMU nesting habitat were determined to be non-suitable nesting habitat after on-the-ground habitat surveys by R&A in 2007; most of those areas are uniform 40-60 year old stands. Therefore, the estimates of suitable nesting habitat included in the MAMU habitat file and summarized in table 3.3.3-2 are most likely an over-estimation.

<u>Estimate of Recruitment Habitat</u>

Recruitment habitat was included into the MAMU habitat file next and only included areas not considered "suitable habitat," as described above. Delineation of recruitment habitat relied on several sources: Roseburg BLM District's MAMU-specific GIS layer (BLM 2017), BLM FOI database, SBS habitat delineation for the Pipeline project and on-the-ground survey results, PCGP's delineated vegetation GIS file, Pacific Northwest Research Center's MAMU habitat model developed by Raphael et al. (2016), and nesting, roosting, and foraging (NRF) and High NRF modeled for the NSO habitat model (discussed below in section 3.3.4 for NSO).

First, areas that were identified as potential suitable nesting habitat (gray habitat) based on LiDAR and aerial photography by SBS but had subsequently been ground-truthed and determined to not provide suitable nesting structures were included as "recruitment" habitat. Next, habitat was identified as recruitment habitat on BLM lands where forest had not been recently harvested (review of 2016 aerial photography) and 1) coniferous forest and mixed forest habitat was 60 years or greater (BLM 2016), and/or 2) where Roseburg BLM District's MAMU-specific GIS layer identified the area as recruitment habitat (BLM 2017).

On non-federal lands not included in the previous steps, the PCGP vegetation GIS file was used to identify additional recruitment habitat. All coniferous late successional and old-growth forest not previously incorporated into the MAMU habitat GIS file as suitable habitat were included as recruitment habitat. Mid-seral habitat included in the vegetation GIS file located on non-federal lands and not previously identified as suitable habitat was included as "recruitment habitat." Outside of PCGP vegetation GIS file, recruitment habitat was incorporated in the MAMU habitat file where Raphael et al. (2016) pixel values were classed as "moderately high" potential to be suitable MAMU habitat (pixel value 3). Recruitment habitat included in the MAMU habitat GIS file consists of coniferous forest in the following age classes: old-growth (175+ years), late successional (80 to 175 years), and mid-seral (40 to 80 years).

Estimate of Capable Habitat

Capable habitat incorporated into the MAMU habitat GIS file includes all other coniferous forested habitat not previously identified as suitable or recruitment habitat (see above). This includes coniferous forest areas that have been clearcut and are regenerating. On BLM lands, mid-seral coniferous forest between 40 and 60 years of age not previously included as suitable or recruitment habitat was also included as capable in the MAMU habitat file. Capable habitat included in the MAMU habitat GIS file consists of coniferous forest in the following age classes: mid-seral (40 to 60 years), regenerating (5 to 40 years), and clearcut (0 to 5 years).

Non-Capable Habitat

This category includes all areas that are non-forested habitat (i.e., waterbodies, agriculture fields, existing rights-of-ways and corridors, grasslands/shrublands) and deciduous forest, as delineated within PCGP's vegetation GIS layer.

Habitat Modeling, Pacific Northwest Research Station

Modeling of potential suitable MAMU nesting habitat has been generated by the Pacific Northwest Research Station (see Raphael et al. 2016; General Technical Report PNW-GTR-933) with the objective to estimate a baseline amount and distribution of potential nesting habitat since the inception of the NWFP in 1994 (Forest Service and BLM 1994). Methods to determine the baseline of MAMU habitat suitability within the NWFP area on both federal and nonfederal lands have been improved and updated during the 10-year (Raphael et al., 2006), 15-year (Raphael et al 2011), and 20-year (Raphael et al. 2016) monitoring reports. Raphael et al. (2006) used vegetation data derived from satellite imagery to model MAMU habitat suitability to establish the habitat baseline. Raphael et al (2011) updated the baseline model focusing on results of a new approach for estimating baseline potential nesting habitat, and on changes to date from the original 2006 baseline. To model relative suitability of MAMU nesting habitat, Raphael et al. (2011) used recently developed habitat suitability modeling software called Maxtent (Phillips et al. 2006; Phillips and Dudík 2008), which estimates probabilities of occurrence at unobserved locations by using information at the observed locations and assuming as little as possible about background sites for which there is not information (Baldwin 2009). The newest model (Raphael et al. 2016) relies on updated spatial habitat data from 1993 through 2012 using GNN methods, updated vegetation disturbances using Landsat-based detection of Trends in Disturbance and Recovery Methodes (LandTrendr), and a slightly expanded set of murrelet nest and occupied sites in Oregon and California. The resulting model includes four habitat classes: highest (value 4), moderately high (value 3), marginal (value 2), and lowest (value 1). In many instances where the earlier models had indicated high or moderately high potential for suitable nesting habitat, the newer model indicated marginal or low. Because available LiDAR indicated trees greater than 107 feet (which was one factor considered to identify presumed occupied stands; see Species Presence section, above), PCGP continued to include presumed occupied MAMU stands that had been previously analyzed, even though the updated MAMU habitat model may not have identified the area as highly suitable habitat. This allowed PCGP to continue with a conservative approach in analyzing impacts to MAMU.

Critical Habitat

Marbled murrelet critical habitat unit OR-06-d has been designated within the Pipeline project area (FWS 2011b and 2016c). Approximately 2.17 miles of marbled murrelet critical habitat are crossed by the Pipeline on BLM-administered lands, although CHUs OR-06-b and OR-06-c are within the terrestrial nesting analysis area located on lands of the Coos Bay and Roseburg BLM Districts (FWS 2011b and 2016c). No designated critical habitat is affected by the LNG Terminal. Habitat modeled for the proposed action (see discussion, above) was intersected with each CHU to determine the amount of MAMU habitat available within the terrestrial nesting analysis area and CHU. Table 3.3.3-3 summarizes the MAMU habitat associated with the CHUs, and identifies known occupied stands from data provided by BLM (2017) within each CHU (both within the entire CHU and CHU within the terrestrial nesting analysis area). PCEs are included in table 3.3.3-3 and below:

- PCE 1 includes individual trees with potential nest platforms, including supporting trees delineated as occupied or suitable (comparable to suitable habitat); and
- PCE 2 includes forest lands of at least one half site-potential tree height, within 0.5 mile of individual trees/suitable habitat stand that are recruitment or capable habitat (comparable to recruitment habitat) not currently suitable for MAMU nesting that may be capable of becoming suitable MAMU habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).

Suitable MAMU nesting habitat within the terrestrial nesting analysis area is considered equivalent to the MAMU critical habitat designation PCE 1 for analysis within this APDBA – individual trees (and delineated stands) with potential nesting platforms. Recruitment habitat (or PCE 2) is defined by FWS (2011b) as coniferous forested land not currently suitable for MAMU nesting that may be capable of becoming suitable MAMU habitat within the next 25 years, generally forested stands 60 years or greater (FWS 2014c). FWS (2011b) considers all forests within 0.5 mile of an occupied stand containing trees with at least one-half the site-potential tree height of the occupied stand to be recruitment habitat. Recruitment habitat is essential to provide and support suitable nesting habitat for successful reproduction of the MAMU. Benefits of this habitat include reducing the differences in microclimates associated with forested and unforested areas, reducing the potential for windthrow during storms, and providing a landscape that has a higher probability of occupancy by MAMUs. FWS (Trask & Associates 2013) requested that for this APDBA, PCE 2 consider recruitment and capable habitat as defined above in the habitat section.

Only 8,417 acres, or 11.2 percent of 75,334 acres available within MAMU CHUs OR-06-b, OR-06-c, and OR-06-d, occur within the terrestrial nesting analysis area, of which approximately 4,301 acres (50.7 percent of the analysis area) are presumed to provide suitable nesting habitat for MAMUs (see table 3.3.3-3). The other portion of CHUs consists of recruitment habitat and forested stands capable of becoming suitable habitat (approximately 28.6 percent and 19.9 percent of available CHU in the terrestrial analysis area, respectively). The majority of CHU within the analysis area (5,431 acres or 64.5 percent) is located on federal lands designated as LSRs. The overlap of CHU with LSR affords a greater degree of protection to the designated critical habitat as the BLM RMP protections for LSRs are automatically imposed on those LSR acres that are found within a CHU. Thus, MAMUs located within these land allocations also benefit from increased protection. Ten occupied MAMU stands occur within CHU OR-06 (b, c, and d) within the proposed terrestrial analysis area, including six occupied stands detected during PCGP survey efforts in 2007, 2008, 2013, and 2014. Twenty-four other stands have also been delineated as presumed occupied stands within designated critical habitat in the terrestrial analysis area: OR-06-b (one stand), OR-06-c (three stands), and OR-06-d (20 stands). Table Q-1 in appendix Q provides land allocations, including CHU that each MAMU stand (occupied and presumed occupied) analyzed within this APDBA is associated with, if applicable.

TABLE 3.3.3-3

Summary of Available Marbled Murrelet Habitat within MAMU Critical Habitat Units within the Terrestrial Nesting Analysis Area

CHU Number	Total Acres in CHU	% Subunit within Analysis Area	Total Acres of CHU in Analysis Area a/	Occupied Stands in CHU (Analysis Area) b/	PCE 1 (Suitable Habitat) c/		PCE 2 (Recruitment Habitat) d/		PCE2 (Capable Habitat) e/		Total MAMU Habitat	
					Acres Available	Percent	Acres Available	Percent	Acres Available	Percent	Acres Available	Percent
Marbled Murrelet (MAMU) Inland Zone 1												
OR-06-b	52,851	1.4	726	15 (1)	478	65.8	137	18.9	110	15.2	724	99.7
OR-06-c	4,762	15.1	721	0 (0)	415	57.6	90	12.5	214	29.7	720	99.9
OR-06-d	17,721	39.3	7,044	11 (9)	3,408	48.4	2,203	31.3	1,362	19.3	6,973	99.0
Total CHU	**75,334**	**11.2**	**8,491**	**26 (10)**	**4,301**	**50.7**	**2,430**	**28.6**	**1,686**	**19.9**	**8,417**	**99.1**

a/ Total Acres within CHU Subunit in the terrestrial nesting analysis area

b/ Occupied stands consider only known occupied stands (BLM 2017); the number in parenthesis identify stands that occur within the terrestrial nesting analysis area.

c/ PCE1/Suitable habitat: individual trees with potential nest platforms, including supporting trees delineated as occupied or suitable (comparable to suitable habitat)

d/ PCE2/Recruitment habitat: forest lands of at least one half site-potential tree height, within 0.5 mile of individual trees/suitable habitat stand that are recruitment or capable habitat (comparable to recruitment habitat) not currently suitable for marbled murrelet nesting that may be capable of becoming suitable marbled murrelet habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).

e/ PCE2/Capable Habitat: forested land that has the capability of becoming suitable nesting marbled murrelet habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).

Late-Successional Reserves

BLM has designated LSR within BLM checkerboard lands on Coos Bay and Roseburg BLM Districts. Approximately 18,065 acres of LSR occur within the terrestrial nesting analysis area, of which 12,045 acres (66.7 percent) provide suitable nesting habitat; 3,903 acres (21.6 percent) provide recruitment habitat; and 1,941 acres (10.7 percent) consist of forested areas capable of becoming suitable habitat. Table 3.3.3-4, below, provides a summary of MAMU habitat that occurs within lands allocated as LSRs in the terrestrial nesting analysis area.

Approximately 5,431 acres of the LSRs within the terrestrial nesting analysis area overlap the FWS designated CHUs for MAMU. The overlap of LSRs with federally designated MAMU critical habitat affords a greater degree of protection to the MAMU and its critical habitat as the protections for LSRs are automatically imposed on those LSR acres that are found within a CHU. Thus, MAMUs located within these land allocations also benefit from increased protection. Table Q-1 in appendix Q provides land allocations, including LSRs that each MAMU stand (occupied and presumed occupied) analyzed within this APDBA is associated, if applicable.

TABLE 3.3.3-4

Summary of Marbled Murrelet Habitat Available within LSRs within the Terrestrial Nesting Analysis Area

Landowner	Total Acres Available in Analysis Area	Suitable Habitat a/		Recruitment Habitat b/		Capable Habitat c/		Total Acres	
		Acres Available	Percent Available	Acres Available	Percent Available	Acres Available	Percent Available	Acres Available	Percent Available
Marbled Murrelet (MAMU) Inland Zone 1									
Coos Bay BLM District	14,563	9,800	67.3	2,922	20.1	1,726	11.9	14,448	99.2
Roseburg BLM District	2,548	1,626	63.8	702	27.6	174	6.8	2,502	98.2
Total MAMU Zone 1	**17,111**	**11,426**	**66.8**	**3,624**	**21.2**	**1,900**	**11.1**	**16,950**	**99.1**
MAMU Inland Zone 2									
Roseburg BLM District	955	619	64.8	279	29.2	41	4.3	939	98.3
Total MAMU Zone 2	**955**	**619**	**64.8**	**279**	**29.2**	**41**	**4.3**	**939**	**98.3**
MAMU Inland Zones 1 and 2									
Coos Bay BLM District	14,563	9,800	67.3	2,922	20.1	1,726	11.9	14,448	99.2
Roseburg BLM District	3,502	2,245	64.1	981	28.0	215	6.1	3,441	98.3
Overall Total	**18,065**	**12,045**	**66.7**	**3,903**	**21.6**	**1,941**	**10.7**	**17,889**	**99.0**

a/ Suitable Habitat: generally late-seral forested stands that provide or are presumed to provide nesting structures for MAMU based on modeling and other available GIS data.
b/ Recruitment Habitat: forested land not currently suitable for marbled murrelet nesting that may be capable of becoming suitable MAMU habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).
c/ Capable Habitat: forested land that has the capability of becoming suitable nesting MAMU habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).

3.3.3.3 Effects of the Proposed Action

Effects of the proposed action include direct and indirect effects within the marine analysis area, estuarine analysis area, and terrestrial nesting analysis area, and are described below.

Direct Effects – Marine and Estuarine Analysis Areas

MAMUs that forage offshore (marine analysis area) and/or within Coos Bay (estuarine analysis area) could be directly affected by 1) underwater noise generated during construction of the LNG Terminal and noise generated by LNG carriers transiting the marine analysis area and estuary, 2) disturbance during feeding by LNG carrier traffic, and 3) injury or mortality due to fuel spills from LNG carriers.

Underwater Noise

Propeller cavitations produce most carrier broadband noise, especially if damaged, operating asynchronously, or operating without nozzles. Engines and auxiliary machinery can also radiate noise during operation that is related to ship size (larger ships are noisier than small ones), speed (noise increases with ship speed), and mode of operation (ships underway with full loads, towing or pushing loads, are noisier than unladen ships) (Greene and Moore 1995).

The Federal Highway Administration, FWS, and WSDOT (2012) developed and agreed to underwater noise level criteria for injury to MAMUs from noise. The criteria are for underwater sound resulting from impact pile driving of steel piles and/or repetitive impulsive underwater sounds (see table 3.3.3-5). However, FWS considers the sound levels in table 3.3.3-5 to be used as guidelines in effects analysis rather than threshold criteria for foraging MAMUs. Other factors, including duration, are important when considering whether exposure in the zones would result in adverse effects. The thresholds do not apply to non-impact, non-impulsive underwater sounds such as ship noise. In this analysis, however, they serve as references for potential effects of ship noise produced by LNG carriers on diving MAMUs.

TABLE 3.3.3-5

Current In-water Acoustic Thresholds for Marbled Murrelets

Criterion Zone	Threshold a/
Auditory Injury Threshold	202 dB SEL b/
Non-auditory Injury Threshold	208 dB SEL
Non-injurious Hearing Threshold Shift Zone	183 dB SEL
Potential Behavioral Effects Zone	150 dB_{rms} c/

a/ All decibels (dB) referenced to 1 micropascal (re: 1 μPa).
b/ SEL – sound level exposure – reported as the cumulative amount of exposure for a single pile driving event.
c/ rms – the root mean squared for pile driving during a single pile driving impulse pressure event.

A review of LNG carriers in service during 2013 (Colton 2013; MarineTraffic 2013) revealed there are 267 carriers with capacities of 148,000 m^3 or less, the current size limit for LNG carriers utilizing the LNG Terminal. Hatch et al. (2008) determined underwater noise levels from various commercial ships while transiting the Stellwagen Bank National Marine Sanctuary off the Massachusetts coast. Estimates of sound levels from one ship, an LNG carrier (the Berge Everett also known as the BW Suez Everett) built in 2003 with 138,028 m^3 capacity (93,844 gross tonnage), are used here to estimate exposure of MAMU to project-related shipping noise. Also, Hatch et al. (2008) reported noise for three tugs in the same area, and they are used here as the standard for the following analysis of noise effects on MAMUs within the marine analysis area.

The ocean or waterway offshore from the entrance to Coos Bay is partially within the southern portion of offshore Conservation Zone 3 and partially within the northern portion of offshore Conservation Zone 4, as defined by Miller et al. (2012). In those portions of the Northern California- Oregon coast, the researchers estimated at-sea densities of MAMUs per km^2 of ocean surveyed from 2000 through 2016.As discussed in section3.3.3.1, the predicted estimate of marbled murrelet densities within Conservation Zones 3 and 4 shows an increasing trend for all of Oregon (see Figure 4 in Lynch et al., 2017).

The LNG carrier in the Hatch et al. (2008) study produced sound levels (with one standard error) of 182 ± 2 dB re: 1 µPa at 1 meter that attenuated to 160 dB at 35 ± 11 meters and to 120 dB at 16,185 ± 5,359 meters (Hatch et al. 2008). MAMUs diving and feeding in the marine analysis area are not expected to be exposed to ship propulsion noise that would cause harm (see table 3.3.3-5), although MAMUs would likely detect noise from LNG carriers transiting the analysis area. MAMU could be exposed to propulsion related noise levels of 160 dB, which could cause potential behavioral effects due to LNG carrier noise. However, since MAMUs forage in shallow offshore areas, they would not be expected to be exposed to LNG carrier noise but would be in areas of potential exposure to tug noise.

Three tractor tugs would guide each LNG carrier from a point approximately five nmi offshore the entrance to Coos Bay and to the LNG Terminal. Noise produced by tugs would attenuate to 160 dB at 11 ± 4 meters (upper end) and to 120 dB at 4,992 ± 1,599 meters (upper end) (Hatch et al. 2008). MAMU diving and foraging would be exposed to noise levels of 160 dB, which could cause potential behavioral effects due to tug noise, such as flushing or avoidance (Bellefleur et al 2009; Agness et al 2008; Teachout 2013). Exposure to noise levels of 120 dB would not be expected to cause potential behavioral effects due to tug noise, as indicated in table 3.3.3-5, although may interfere with communications between MAMUs in the vicinity of the tug (Teachout 2013).

As discussed in section 3.5.1.3, Green Sturgeon, underwater noise can be generated by driving piles on land (dry piles). The propagation of underwater construction noise from the "dry" impact pile driving associated with the MOF was modeled for marine mammals in several reports prepared by JASCO Applied Sciences (Wladichuk et al. 2018). The Phase 5 modeling study examined the threshold radii from driving a pile at the MOF face and at 98.4 feet (30 meters) set-back distance behind the MOF. Based on analysis for listed fish, the model results indicate the 187dB SEL injury level threshold extends a maximum range of 5,653 feet (1,723 meters) for piles at the MOF face and 2,890 feet (881 meters) for pile at the 98.4 feet (30 meter) set-back. The fish noise analysis indicates the MAMU 183dB SEL non-injurious Hearing Threshold Shift Zone (see table 3.3.3-5) may be exceeded. Pile driving of the 8 mooring bollards located at the MOF is anticipated to take 14 days to install. Pile driving associated with the MOF may reduce foraging efficiency by impairing communication between individual MAMU within the impact area shown in figure 3.5.1-2. Based on species presence information above, the number of MAMU in the impact area are anticipated to be low on both a seasonal and annual basis thereby resulting in minimal potential impacts to MAMU from underwater noise..

Underwater noise harassment or potential injury to MAMU could occur from pile driving associated with in-water temporary piles within the estuarine analysis area. However, the low abundance and density of murrelets and the limited number and area of in-water pile installation would make these effects unlikely. The harassment and injury area would be determined by the pile installation methods used and the number of pile driven within in a given area and period of time. Using the NMFS pile driving effects calculator, vibratory installation of piles, presumed to be the primary installation type for pipe piles would exceed harassment thresholds within 328 feet (100 meters) of pile installations from cumulative sound exposure levels for the installation of up to 85 temporary pipe pile. The NMFS pile driving calculator established that impact driven piles, if utilized could produce injurious peak level sound within approximately 40 feet (12 meters) and harassment levels of sound created from cumulative sound exposure extending to 5.3 miles (8,577 meters).

LNG Carrier Traffic

MAMUs are expected to forage in the estuarine analysis area and probably within the marine analysis area at the same time LNG carriers would be in transit to and from the LNG Terminal. No information has been found that describes MAMU response to ships' presence and/or ship above-water noise. However, responses of Kittlitz's murrelet (*Brachyramphus brevirostris*, a congeneric of MAMU) to ships' approach were studied in Glacier Bay, Alaska (Agness et al 2008). The study reported that Kittlitz's murrelets were observed to immediately fly away from carriers; they flew 30 times more from carriers than in the absence of carriers and non-breeding birds (birds not holding fish) were more likely to take flight than breeding birds (those holding a fish; Agness et al 2008) Applying the behavioral response of the MAMU congener to MAMU would suggest that the species may also avoid and disperse from approaching carrier vessels, disrupting foraging and other behaviors in the process.

Modeled estimates of energy expense showed that non-breeding murrelets had a greater increase in energy expenditure when disturbed (up to 30 percent increase under the average scenario of ship traffic and greater than 50 percent increase under the peak scenario of ship traffic) than breeders (up to 10 percent and 30 percent increases under the average and peak carrier traffic scenarios, respectively). Likewise, non-breeding birds were more likely to experience chronic increases in energy expense (i.e., a greater percentage of days with an increase in energy expenditure) than breeding birds which would be expected to adversely affect energy partitioning for reproduction and survival behaviors (Agness et al. 2013).

Similar responses by foraging MAMUs to LNG carrier traffic would be expected once the LNG Terminal is in operation. MAMUs foraging within the marine and estuarine analysis areas could potentially fly away from approaching carriers. This could result in expenditure of additional energy and thus reduce energy available for reproduction and other survival behaviors.

Ship-Strike

There are no records or any indication that MAMUs offshore are susceptible to ship-strikes. Collisions of seabirds with stationary objects (including off-shore wind energy turbines) are possible, either by collisions of ships with birds on the ocean surface or collisions of birds in flight with ship structures although empirical data are limited (Wilson et al. 2007). Collisions between MAMUs and LNG carriers are possible but highlyunlikely within the marine analysis area.

Fuel Spills

MAMUs are adversely affected by spills of oil and other pollutants, primarily as a result of death at the spill site, although reduced breeding success of seabirds due to various forms of marine pollution are also well-known (FWS 1997). Because of their extensive use of nearshore waters for foraging, MAMUs are especially susceptible to the impacts of offshore oil spills (Carter and Kuletz 1995) and industrial pollution (Fry 1995), and have been given one of the highest oil spill vulnerability index values among seabirds (King and Sanger 1979).

Fuel or lubricants accidentally spilled from LNG carriers at sea could adversely affect MAMUs if feathers became coated with these petroleum products, causing death or injury. These products are kept in relatively small quantities on LNG carriers and therefore spills would not result in the types of effects associated with a spill from an oil tanker, as was observed from the grounding and wreck of the *New Carissa* on the Oregon coast near Coos Bay in 1999. However, oiled MAMUs have been reported in the absence of known large and medium spills, indicating that chronic oil pollution from sources such as cleaning of tanks at sea, bilge pumping, and smaller accidental spills can affect MAMUs (FWS 1997; Carter and Kuletz 1995). Mortality from spills, large and small, is poorly documented throughout the range of the species, and impacts are often difficult to demonstrate, requiring detailed pre-event baseline data, careful injury determination, and detailed follow-up data, especially to determine population-level impacts (Carter and Kuletz 1995). Impacts to MAMU from fuel and lubricant spills as a result of the 120 LNG carrier transits per year are unlikely given the relatively low density of MAMUs within the marine and estuarine analysis areas (see figure 3.3.3-1). Implementation of SPCC plans in the event of fuel or lubricant spills will likely reduce the potential effects of spills depending on the size and severity of incidents. Additionally, LNG carriers calling on the LNG Terminal would be required by the Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills. As a result, effects to MAMU from accidental spills are expected to be insignificant and discountable.

Indirect Effects – Marine and Estuarine Analysis Areas

Foraging Habitat

MAMUs forage in shallow offshore and inland saltwater areas on a variety of small fish and invertebrates, including large pelagic invertebrates (Marshall 1988a, 1988b, and 1989; Becker 2001). In Oregon and Washington, anchovy, sand lance, and smelt appear to be the major prey types provided to chicks (McShane et al. 2004).

Turbidity associated with dredging activities within Coos Bay may affect MAMU forage/prey species and their habitat. Turbidity from dredging at the Navigation Reliability Improvements dredge sites are modeled to extend from 2,170 to 2,880 feet upstream beyond each of the dredging footprints and from 2,820 to 4,600 feet downstream from each of the dredging footprints. Dredging could be conducted through up to four in-water work windows. Dredging taking place at the access channel and MOF are expected to produce turbidity plumes approximately half the area of the LNG Terminal slip and access channel prism. This plume may reach the existing navigation channel where currents would influence its shape up and downstream. Dredging at the eelgrass mitigation site is expected to be completed in one in-water work window and is not expected to extend beyond the dredge prism as it is a low energy part of the bay. Dredging is planned from October 1 through February 15 following ODFW's recommendation, and timing of these activities will minimize impact to MAMU forage/prey species.

Fuels or lubricants spilled from LNG carriers could decrease forage species abundance and quality. Many MAMU prey species are intertidal spawners, and are more susceptible to oil pollution than pelagic spawners (Carter and Kuletz 1995). However, fuels and lubricants are kept in relatively small quantities on LNG carriers and therefore spills are unlikely to result in impacts to forage species. Mitigation measures (SPCC plans) will further reduce potential effects of any spills on MAMU within the proximity of such an incident. For example, LNG carriers calling on the LNG Terminal would be required by the Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills. LNG carriers would also be required to obtain a vessel general permit from the EPA that would outline regulations for avoiding release of even small quantities of fuel or lubricants during normal operations such as washing the vessel deck. As a result, effects to MAMU prey species from accidental spills are expected to be insignificant and discountable.

Direct Effects – Terrestrial Nesting Analysis Area

MAMUs nesting within the terrestrial nesting analysis area could be directly affected by 1) removal of nest trees or potential nest trees during the breeding season (April 1 through September 15) and 2) human presence and noise disturbance during the breeding period. No direct effects to nesting MAMU are expected from construction or operation of the LNG Terminal. Analysis of potential direct effects to MAMU by the Pipeline project within the terrestrial nesting analysis area followed guidance provided by FWS included in the Revised Conservation Framework developed for the Project (see *Revised Conservation Framework for the Northern Spotted owl and Marbled Murrelet: Jordan Cove Energy and Pacific Connector Gas Pipeline Project*, FWS 2014c).

Nest Removal During Breeding Season

Removal of habitat during the breeding season within an occupied or presumed occupied stand could result in the potential death of nestlings if the nest tree is removed. Removing suitable nesting habitat outside of the entire breeding season (September 16 through March 31) would eliminate any direct impact to individual MAMUs or nestlings. PCGP met with FWS on June 5, 2008, to review and discuss the proposed action and construction schedule and identify areas where the project and schedule could be adjusted to avoid or further decrease the disturbance impacts to MAMUs while allowing for a constructible Pipeline project that considered 1) MAMU seasonal and daily timing restrictions, 2) safety of the construction crew, and 3) meeting the targeted in-service date within a two-year construction period. FWS provided a preference of activities associated with timber removal and construction, including the following specific to habitat removal, listed below in descending order of importance:

- Felling nest trees outside the entire breeding season.
- No removal of habitat within an occupied stand during the entire breeding season.
- No fragmentation of an occupied stand (i.e., clipping the edge of the stand is not as bad as dissecting through the middle).

PCGP moved and adjusted the Pipeline to avoid and/or minimize effects to MAMU, where feasible. Appendix V1 (Marbled Murrelet and Northern Spotted Owl Avoidance and Minimization Plan) identifies the additional measures that have been incorporated into the design of the Pipeline in relation to occupied MAMU stands or potentially suitable MAMU habitat. Maps within appendix V1 show the timing constraints that would be applied in relation to each MAMU stand for timber felling and Pipeline construction.

Also, considering the factors above, PCGP developed a timber removal and construction schedule that would minimize effects to MAMU, as well as ensure the safety of the timber removal and construction crew and meet the in-service date (see section 2.1.2.3). PCGP would remove forested habitat within 300 feet of an occupied stand, or presumed occupied stand outside of the entire breeding season to eliminate direct impact to individual MAMUs or nestlings. Timber would be removed beginning fourth quarter prior to initiating construction and, if necessary, continue the following fall after the breeding season. This includes habitat that would be removed or potentially removed from 37 MAMU stands (19 occupied and 18 presumed occupied stands) and 300-foot buffers of 59 MAMU stands (21 occupied stands and 38 presumed occupied stands). Habitat would also be removed within 0.25 mile of an NSO activity center outside of the breeding season (from October 1 through February 28); within the range of the MAMU, this includes forested habitat between MPs 37.33 and 37.86, MPs 53.74 and 54.04, and MPs 64.02 and 64.43. Elsewhere in the range of the MAMU, timber removal would precede construction and could occur during the breeding season; however, direct effects to MAMUs or nestlings would not be expected because suitable nesting habitat would have been removed outside of the breeding season.

Table 3.3.3-6 tabulates the number of occupied and presumed occupied stands by Murrelet Inland Zone that would have timber cleared within 300 feet of the MAMU Stand (i.e., the SHU) outside of the breeding season, including 37 MAMU stands that would have suitable habitat removed from the stand.

TABLE 3.3.3-6

Number of Occupied and Presumed Occupied Stands that Would Have Habitat Removed Outside of the Breeding Season, Including the 300-foot Buffer (i.e., the Suitable Habitat Unit)

	Number of MAMU Stands		
Status Of Marbled Murrelet (MAMU) Stand	**Stand**	**300-foot Buffer**	**Total**
Marbled Murrelet Inland Zone 1			
Occupied	16	18	18
Presumed Occupied	19	39	39
Total	**35**	**57**	**57**
Marbled Murrelet Inland Zone 2			
Occupied a/	2	2	2
Presumed Occupied	0	0	0
Total	**2**	**2**	**2**
Overall Total			
Occupied	18	20	20
Presumed Occupied	19	39	39
Total	**37**	**59**	**59**

a/ One occupied MAMU stand occurs in both Marbled Murrelet Inland Zones 1 and 2 but has been included in tabluations for Inland Zone 2.

No suitable MAMU nesting habitat would be removed during the construction of the LNG Terminal because no suitable nesting habitat exists within the LNG Terminal site; therefore, no direct effects to MAMUs would be result from the construction of the LNG Terminal.

Noise and Visual Effects

In the Revised Conservation Framework, FWS (2014c) provided guidance on determining potential impacts to NSO and MAMU from noise. This guidance included disturbance and disruption distances based on noise thresholds (as described in FWS 2003b and 2006a; discussed below), and prescribed associated impact levels (No, Low, Moderate, or High) based on Project timing and activity.

Disruption and Disturbance – Available Literature

Noise associated with timber clearing and other construction and operation activities associated with the proposed Pipeline could disturb nesting MAMUs and negatively affect productivity. The term "disruption" was alluded to in the ESA, under the definition of "harassment" (50 CFR 17.3) as:

> "an intentional or negligent act or omission which creates the likelihood of injury by annoying it (the organism) to such an extent as to significantly disrupt normal behavior patterns which include but are not limited to, breeding, feeding or sheltering."

The term "disturbance" was not included in the ESA but a reasonable working definition was provided by Leal (2006) and has been incorporated into this APDBA:

> "any potential auditory or visual stimuli or deviation from ambient/baseline conditions [that] an individual bird, at a given site, is likely to detect and potentially react to."

There is limited information on distances from noise and/or visual stimuli at which MAMUs react or flush from the nest, or the effect of such disturbance on productivity (FWS 2003b). Most data gathered for disturbance on MAMUs have been obtained from observations incidental to other research (e.g., Long and Ralph 1998). The sensitivity of an individual MAMU to noise and/or visual disturbance is likely related to levels of disturbance to which the bird is accustomed, including the level and proximity of the disturbance (Hamer and Nelson 1998) as well as the timing of disturbance (time of day, time of year, and time within breeding season). The available research and anecdotal accounts show that the effects of noise and vehicles on roads can elicit disturbance as well as disruption responses from MAMUs, including responses such as flushing, flight, and/or missed feedings of chicks in nests that would be to a level that could interfere with normal behavior patterns including but not limited to, breeding, feeding or sheltering. The following are brief summaries of available research and anecdotal accounts.

- No visible response to vehicles driving past MAMU nests 70 meters (230 feet) away from a paved, "well traveled park road" (Singer et al. 1995 in Long and Ralph 1998).
- MAMU in nests in Big Basin Redwoods State Park showed no response to passing cars during several days of observation in 1989 (Nelson, personal communication, in Long and Ralph 1998).
- MAMU nests 70 meters (230 feet) from lightly used logging road show little to no response when observers drove by in light trucks (Chinnici, personal communication, in Long and Ralph 1998).
- MAMU in nests across river from road with moderate traffic (30 cars/day) showed no reactions when vehicles passed (Nelson, personal communication, in Long and Ralph 1998).
- In a study comparing responses to four types of disturbance (automobiles, trucks, cars, humans), adult MAMU reacted least to trucks and automobiles on U.S. Highway 101 even though truck noise averaged 84 dB and auto noise averaged 72 dB, although one or more vehicles passing by the nest sometimes caused adults to abort a nest visit and return later; MAMU chicks showed only low response to cars/trucks (Hamer and Nelson 1998). The authors concluded that visual disturbances may be of much more concern to nesting birds than noise, which they note is not surprising given the fact they hunt prey solely by visual means.
- There is evidence of MAMU flushing from car doors/people talking within 32.8 yards. (FWS 2006a, 2014d), although Hébert and Golightly (2006) found that trail use does not appear to influence the behavior of MAMU adults or chicks on the nest.
- Field study to measure behavioral responses of MAMU adults and chicks to disturbance produced by trail users, proximity to paved highways, and experimental disturbances produced by maintenance activities (chainsaws) (Hébert and Golightly 2006):
  - Ambient sound at nest sites was less than 50 dB before and after exposure to chainsaw noise. Experimental noise was greater than 65 dB generated by chainsaws.
  - MAMU chicks and adults in nests exposed to significantly louder experimental noise than before or after trial.
  - Adult MAMU spent less time at rest during disturbance than before and after.
  - Adult MAMU spent more time with head raised during disturbance than before and after.

- MAMU chicks spent similar times at rest before, during, and after chainsaw noise trials.
- Controlled for temporal variations, hatching success at control nests (69 percent) was not significantly different than hatching success at experimental nests (exposed to chainsaw noise; 67 percent).
- Fledging success at control nests was 25 to 50 percent; fledging success at experimental nest did not show a statistically significantly difference.
- Overall, MAMU avoided nesting close to high volume roads (U.S. Highway 101).
- Concluded that in some instances vehicular traffic noise may have little or no effect on MAMU nesting success.

Available research suggests that MAMUs may be more sensitive to visual disturbances than to auditory disturbance conditioned by predators in the vicinity that may cause aborted or delayed feedings (Phifer 2003; Hamer and Nelson 1998; Bednarz and Hayden 1994). Human presence attracts corvids, which increases the predation risk at MAMU nest sites that are located near project activities. Studies from other bird species suggest that disturbance can affect productivity by causing nest abandonment, egg and hatchling mortality due to exposure and predation, longer periods of incubation, premature fledging or nest evacuation, depressed feeding rates of adults and offspring, reduced body mass or slower growth of nestlings, and avoidance of otherwise suitable habitat (Henson and Grant 1991; Rodgers and Smith 1995 as cited in BLM and Forest Service 2008). Additionally, increased vigilance or non-resting behaviors can increase energetic expenditures or decrease food deliveries such that energetic costs exceed energy supply (Hébert and Golightly 2006).

Auditory and Visual Disturbance - FWS Guidance

Based on analysis of published literature and anecdotal accounts of harassment of MAMUs, the FWS (2003b, 2006a, 2014c) established distances within which sound levels and visual disturbance for various activities may result in injury or harassment of MAMUs by disrupting the normal behavior pattern of individuals or breeding pairs. FWS determined that visual disturbances within 100 yards of MAMU nest sites could lead to increased predation of nests by corvids when humans are present during project-related activities and would constitute a disruption of the nest site (Phifer 2003).

FWS identified distances within which activities may “disrupt” nesting MAMUs (noise and/or visual disturbance). Disruption distances identify a distance from activities that FWS have determined would likely cause a MAMU to be distracted to such an extent as to substantially disrupt normal behavior and increase the likelihood of breeding season failure. Activities that occur beyond the disruption distances may “disturb” MAMU but the effects should be minimal and not result in harm or “disrupt” reproductive activities. Activities may disturb MAMU if the activities occur within 0.25 mile of MAMU; disturbance distances have often been applied as seasonal buffers to minimize impacts of projects to nesting MAMUs. FWS determined that activities occurring beyond these disturbance distances would not likely cause MAMUs to be distracted from their normal activity. This direction is consistant with guidance provided in the FWS Conservation Framework prepared for this Project (FWS 2014c).

Table 3.3.3-7 provides the threshold distances beyond which noise and visual disturbances are unlikely to result in disruption or disturbance to nesting MAMUs during the breeding season (April 1 through September 15), which are generally based on distances to which noise levels and/or human presence are expected to disrupt or disturb nesting MAMU. In addition to the temporal and spatial restrictions presented in table 3.3.3-7, FWS also recommends limiting Project-related disturbance to two hours after sunrise until two hours before sunset near occupied and presumed occupied stands. Adhering to this daily timing restriction (DTR) minimizes the potential to disrupt adult MAMUs delivering meals to chicks at dawn and dusk. Application of DTRs during the breeding season should minimize effects from project activities, and would result in no disturbance or disruption for most activities if applied in the late breeding period, as identified in table 3.3.3-7.

TABLE 3.3.3-7

Threshold Distances Beyond which Noise and Visual Disturbances are Unlikely to Result in Disruption or Disturbance to Nesting Marbled Murrelets during the Breeding Season a/

	Disruption Threshold Distances From Occupied or Presumed Occupied Stands			Disturbance Threshold Distance From Occupied or Presumed Occupied Stands		
Activity	MAMU Critical Breeding Season b/	MAMU Late Breeding Season — No DTRs b/, c/	MAMU Late Breeding Season — With DTRs b/, c/	MAMU Critical Breeding Season b/	MAMU Late Breeding Season — No DTRs b/, c/	MAMU Late Breeding Season — With DTRs b/, c/
Use of Existing Low Use Roads d/	35 yards (105 feet)	No Disruption Anticipated	No Disruption Anticipated	0.25 mile	0.25 mile	No Disturbance Anticipated
Use of Existing High Use Roads e/	No Disruption Anticipated	No Disruption Anticipated	No Disruption Anticipated	0.25 mile	0.25 mile	No Disturbance Anticipated
Chainsaws	100 yards (300 feet)	100 yards (300 feet)	No Disruption Anticipated	0.25 mile	0.25 mile	No Disturbance Anticipated
Heavy equipment f/	120 yards (360 feet)	120 yards (360 feet)	No Disruption Anticipated	0.25 mile	0.25 mile	No Disturbance Anticipated
Rock Ditching Equipment g/	120 yards (360 feet)	120 yards (360 feet)	No Disruption Anticipated	0.25 mile	0.25 mile	No Disturbance Anticipated
Blasting — more than 2 lbs with mitigation measures	120 yards (360 feet)	120 yards (360 feet)	120 yards (360 feet)	0.25 mile	0.25 mile	0.25 mile
Small Helicopter/Air planes	120 yards (360 feet)	120 yards (360 feet)	No Disruption Anticipated	0.25 mile	0.25 mile	No Disturbance Anticipated
Large/ Transport Helicopters with mitigation measures h/	240 yards (720 feet)	240 yards (720 feet)	240 yards (720 feet)	0.25 mile	0.25 mile	0.25 mile

a/ Sources: FWS 2003b; Michael Minor & Associates 2008 (appendix P); FWS 2014c; Phifer 2003.
b/ MAMU breeding period is from April 1-September 15; critical breeding period is considered from April 1-August 5; late breeding season is considered from August 6 – September 15.
c/ DTRs (Daily Timing Restrictions) – restricting activity to between 2 hours after sunrise until 2 hours before sunset.
d/ Existing Low Use Roads include federal roads designated as local/resource and private roads that appear to receive light traffic and periodic maintenance.
e/ Existing High Use Roads include federal roads that are designated as arterial and collector roads. Includes some federal roads local/resources roads that are paved or receive regular traffic/maintenance and are the primary access routes within checkerboard (federal/private) ownership. Also includes other private residential roads driveways or other roads that provide access to multiple rural residences.
f/ Heavy equipment includes: back trackhoes, side-booms, bulldozers, semi-trucks, pneumatic hammers.
g/ Rock Ditching Equipment includes: auger drill rig, mounted impact hammer, rock drill, and blasting (mitigated or less than 2 lbs).
h/ Transport helicopters proposed for use during construction of the Pipeline include: Boeing Chinook (CH-47) and Boeing Vertol 107-II (CH-46)

FWS (2003b and 2006a) reviewed available scientific literature on behavioral and physiological responses of different bird species to various noise sources. They determined that birds would likely detect noises that were 4 decibels or more above ambient noise levels. FWS (2006a) defined an “injury threshold” of 92 dBA, and a “tolerance threshold” of 82 dB for MAMUs and NSOs.

The tolerance threshold assumes that respective nest sites become "intolerable" to the species and harassment occurs due to the total sound level the species must endure. FWS (2006a) did recognize that a tolerance threshold of 92 dB for aircraft (e.g., helicopters) would be applicable due to the usually slow onset of aircraft noise approaching, but otherwise FWS (2006a) applied the threshold of 82 dB as a sound-related injury threshold level. Based on Delaney et al. (1999) and Brown (1990), FWS (2006a) subtracted the noise level that elicited a harassment-indicating behavior (flight or flushing) from the minimum ambient noise at the respective sites and deduced that action-generated noise levels that are 25 dB above ambient levels constitute the sound level threshold above which harassment is likely to occur. From that exercise, FWS (2006a) deduced that a noise level of 70 dB would be a disturbance threshold and noise greater than 70 dB would be disruptive.

FWS (2003b) did not analyze injury threshold distances for noise associated with blasting or large helicopters. Rather, a conservative assumption was used for blasting with charges of 2 pounds or less; for larger blasts (greater than 2 pounds) a conventional one-mile distance was considered due to the lack of dB information. During informal consultation with FWS (Smith et al. 2007; Wille et al. 2006), restricting the use of large helicopters to remove large timber and transport pipe to the construction right-of-way to a one-mile disturbance threshold distance was considered as well. However, FWS also suggested that if additional studies could demonstrate that use of larger blasts (greater than 2 pounds) and large helicopters attenuated to less than 92 dB, and preferably 70 dB (disturbance threshold versus 92 dB disruption threshold) within a mile, the report and additional data demonstrating this would be considered to reduce the disturbance threshold distances for those activities (Smith et al. 2007; Wille et al. 2006).

Blasting and Helicopter Noise Levels

PCGP prepared a noise report (see appendix P) that analyzes the distances at which conventional blasting required for trenching within rock substrate for construction and transport helicopters attenuates to 92 dB, the threshold for injury to individual MAMUs and is the sound level above which MAMU are likely to respond with behavior that indicate harassment (FWS 2006a). Under the worst case conditions, with common and appropriate mitigation measures applied to trench blasting operations (greater than 2 pounds of explosives), it is expected that blasting noise would attenuate to 92 dB within 200 feet of the source and to 70 dB within 1,025 feet of the blast source in soft rock. Large transport helicopters would attenuate to 92 dB within 700 feet. The greater distance for helicopter use is due to the directional aspects of blade slap noise that is directed toward the ground.

Mitigation for helicopter noise includes operational restrictions such as maintaining a high altitude and keeping away from noise sensitive areas whenever possible. Analyses for MAMUs in this APDBA consider the distances for larger blasts and large helicopters to be more conservative than what the noise report suggests. A disruption threshold distance for blasting greater than 92 dB has been used but with mitigation measures discussed in appendix P applied to be the same disruption distance expected for smaller blasts (less than 92 dB) – 120 yards or 360 feet – more conservative than the noise report describes, and the disturbance threshold distance associated with large blasts to be expected within 0.25 mile of blasting activity (see table 3.3.3-7). It is expected that these distances be considered throughout the entire breeding season (April 1 – September 15), regardless of the application of DTRs, because of the sudden onset of noise associated with blasting activities. A disruption threshold distance for large/transport helicopter use has been used with proposed mitigation techniques discussed in appendix P to be slightly farther than the report suggests, considering a disruption distance of 240 yards or 720 feet and a disturbance threshold distance of 0.25 mile (see table 3.3.3-7).

Even though FWS (2003b) provided some evidence suggesting that noise that builds in intensity, such as a helicopter approaching from a distance, may result in less risks and does not anticipate effects for smaller aircraft after the critical breeding period with DTRs applied, for analysis within this assessment, it is anticipated that similar to large blasts (greater than 2 pounds) use of large/transport helicopters may disrupt or disturb MAMUs throughout the entire breeding season (April 1–September 15), regardless of the application of DTRs. In a memorandum provided to Tetra Tech, contractor to FERC (FWS 2008h), FWS indicated that if noise level above 92 dB is recorded at 0.25 mile of the blasting activities, that blasting operations should cease until more effective mitigation measures can be employed.

Noise Evaluation Procedure

In the Revised Conservation Framework, FWS (2014c) provides the threshold distances beyond which noise and visual disturbances are unlikely to result in disruption or disturbance to nesting MAMUs during the breeding season (April 1 through September 15), which are generally based on distances to which noise levels and/or human presence are expected to disrupt or disturb nesting MAMU (see table 3.3.3-7). PCGP is aware of the temporal and spatial restrictions recommended by FWS (see table 3.3.3-7) and would adhere to them where feasible; however, due to construction constraints within the range of the MAMU and safety of construction crew, PCGP cannot adhere to all recommended restrictions. No suitable nesting MAMU habitat is within 0.25 mile of proposed construction of the LNG terminal and no disruption or disturbance to nesting MAMU is expected, including construction at the Kentuck Project site.

Disruption and Disturbance – Timber Clearing, Pipeline Construction, Existing Road Use

To avoid direct effects to MAMUs, chicks, or eggs within MAMU stands and adjacent habitat, PCGP would clear timber within MAMU Stands and a 300-foot buffer of MAMU stands outside of the entire breeding season (between September 16 and March 31): this includes at least 15.0 miles of forested habitat within 300 feet of 59 occupied and presumed occupied MAMU stands (tables 3.3.3-6 and 3.3.3-8). Timber removal is expected to begin the fourth quarter prior to construction, and if timber removal within 300 feet of MAMU stands is not completed prior to the MAMU breeding season (April 1), timber removal would continue the following fall outside of the breeding season (between September 16 and March 31). Noise, visual disturbance, and in some instances large helicopter use associated with timber removal within 300 feet of MAMU stands outside of the breeding season would be consistent with the temporal restrictions recommended by FWS to protect nesting MAMUs (see table 3.3.3-7) and would not be expected to disturb or disrupt MAMUs. However, to safely construct the Pipeline within two years, PCGP could not commit to removing timber within the entire 0.25-mile spatial buffer recommended by FWS outside of the breeding season; therefore, some disturbance would be expected from timber removal outside of the 300-foot buffer. An additional 15.1 miles of timber clearing (greater than 300 feet but within 0.25 mile of MAMU Stand) could occur during the MAMU breeding period within 0.25 mile of 25 occupied and 57 presumed occupied MAMU stands (see tables 3.3.3-8 and 3.3.3-9). As a result, acoustic and visual disturbances from timber removal could affect MAMU nesting and rearing activities.

After timber has been cleared, approximately 37.5 miles of construction activities along the Pipeline route could occur during the MAMU breeding period within 0.25 mile of 25 occupied and 57 presumed occupied MAMU stands (see tables 3.3.3-8 and 3.3.3-9), including mitigated blasting along the trenchline and across waterbodies, and use of large transport helicopters for pipe delivery (see table Q2 in appendix Q). As a result, acoustic and visual disturbances from construction of the Pipeline project could affect MAMU nesting and rearing activities.

PCGP has proposed to apply DTRs recommended by FWS for timber removal and construction activities that occur within 0.25 mile of a MAMU stand through the critical breeding period (April 1 through August 5), which would reduce direct effects from noise and visual disturbance. PCGP has indicated that DTRs would also be applied to large transport helicopters in the late breeding period (August 6 through September 15), if use of helicopters is necessary during that time period. Although timber removal and construction activities would likely occur within one breeding season in the proximity of each MAMU stand, PCGP conservatively assumes that each MAMU stand could experience effects from activities for 2 years.

Informal consultations with FWS (June 5, 2008 meeting; see NSO and MAMU Avoidance Plan, appendix V1) identified disturbance from travel on existing roads to be less of an impact than other actions associated with the construction, especially if farther than 35 yards (105 feet). In the Revised Conservation Framework, FWS (2014c) identified that use of existing low use roads within 35 yards (105 feet) of an active MAMU nest has the potential to disrupt normal behavior patterns and lead to harassment, whereas use of existing high use roads would not be expected to disrupt normal behavior at an active MAMU nest. However, utilization of high or low traffic use access roads would be expected to disturb MAMU up to 0.25 mile of the road (see table 3.3.3-7). For the purposes of this analysis, existing low use roads include federal roads designated as local/resource and private roads that appear to receive light traffic and periodic maintenance. Existing high use roads include federal roads that are designated as arterial and collector roads as well as some local/resources roads that are paved or receive regular traffic/maintenance and are the primary access routes within checkerboard (federal/private) ownership. Existing high use roads also include other private residential roads driveways or other roads that provide access to multiple rural residences.

TABLE 3.3.3-8

Total Miles Crossed by the Pipeline within the MAMU Stand, and the 300-foot and 0.25-mile Buffer of MAMU Stands

	Marbled Murrelet Habitat (miles crossed)				
Location of Project Activity	**Suitable**	**Recruitment**	**Capable**	**Not Capable**	**Total Miles Crossed**
Total MAMU Inland Zone 1					
MAMU Stand a/	4.9		0.1	<0.1	5.1
300-foot Buffer a/, b/		3.4	4.8	2.4	10.7
0.25-mile Buffer c/		3.7	10.1	3.4	17.1
MAMU Inland Zone 1 Total	**4.9**	**7.2**	**15.0**	**5.9**	**32.9**
MAMU Inland Zone 2					
MAMU Stand a/	0.9				0.9
300-foot Buffer a/, b/		0.3	0.5	<0.1	0.8
0.25-mile Buffer c/		0.8	0.1	1.1	1.9
MAMU Inland Zone 2 Total	**0.9**	**1.1**	**0.5**	**1.1**	**3.5**
Overall MAMU Range					
MAMU Stand a/	5.8		0.1	<0.1	6.0
300-foot Buffer a/, b/		3.7	5.3	2.4	11.4
0.25-mile Buffer c/		4.6	10.2	4.5	19.0
Overall Total MAMU Range	**5.8**	**8.3**	**15.5**	**6.9**	**36.4**

a/ Timber would be harvested outside of the entire breeding season (between September 16 and March 31); this includes habitat associated with 59 MAMU stands (see table 3.3.3-6).
b/ Miles provided for 300-foot buffer exclude the MAMU stand.
c/ Miles provided for 0.25-mile buffer exlude the MAMU stand and the 300-foot buffer.

Expected Disturbance Effects

Impact assessments were prepared following guidance from FWS's Revised Conservation Framework (FWS 2014c) for each MAMU stand analyzed within this APDBA (appendix Z1) that identify existing access roads within 0.25 mile of occupied or presumed occupied stands, including distance from roads, expected improvements within the stand or 0.25-mile buffer, and surface of existing roads, including maps of the particular stand. The impact assessments in appendix Z1 also identify the distance between a MAMU stand and proposed construction activities, including large helicopter use and blasting (>2 pounds explosives). Many of the MAMU stands occur in areas with higher existing disturbance (i.e., residential, commercial, and agricultural areas) and although noise associated with construction would be detectable, but often times not disruptive, PCGP has conservatively applied direction provided by FWS to determine possible effects to MAMU if nesting in the stand (see table 3.3.3-7).

Table Q-2 in appendix Q provides distances from actions and timing of those actions that are expected to occur within the occupied or presumed occupied stands during Pipeline project activities (timber clearing, construction activities, road use) and through the life of the Pipeline (i.e., maintenance and operation activities). Since nest locations within MAMU stands are not known, analyses in this APDBA have assumed that MAMUs are nesting along the closest edge to disturbance or existing road from the MAMU stand which is unlikely but, absent specific nest locations, is the most conservative approach. Additionally, table Q-2 in appendix Q provides the expected effect from noise and visual presence of construction activities (disruption, disturbance, no disturbance, or no effect) and rationale for each occupied or presumed occupied stand based on timing and distance from the activities for each proposed activity (based on disturbance distances from table 3.3.3-7).

Maps 1 through 10 in appendix Q show the locations of occupied and presumed occupied stands in relation to different Project components and identify spatial buffers (360 feet and 0.25-mile buffers) associated with a MAMU stand. The rationale for location of the proposed Pipeline within each known occupied stand and presumed occupied stand is provided in PCGP's *Marbled Murrelet and Northern Spotted Owl Avoidance and Minimization Plan* (see appendix V1).

Table 3.3.3-9 provides a summary of occupied and presumed occupied stands within the terrestrial nesting analysis area that may be affected by the Pipeline and is based on the timing of activities (summarized from table Q-2 in appendix Q). Forested stands that may provide suitable habitat for MAMU that have not had ground surveys conducted to date to determine presence of nesting structues have been presumed occupied for this analysis, resulting in a conservative estimate of potential effects. If stands are surveyed and no suitable nesting structures are present, then no disturbance effect would be expected. Table 3.3.3-9 provides a conservative estimate of the stands likely to be disturbed by activities associated within the proposed action, because PCGP does not expect the majority of presumed occupied stands on private lands to have suitable nesting habitat present based on the following:

1. on-the-ground surveys adjacent to those stands with no suitable nesting habitat identified,
2. location of those identified stands within narrow riparian buffers surrounded by clear-cuts and/or residences, and/or
3. proximity of presumed occupied stands greater than 3.0 miles from known occupied stands.

Additionally, activities would not occur simultaneously along the Pipeline route, and as a result some activities near MAMU stands may occur outside of the breeding period and/or within the latter part of the breeding season within the DTR timing window. Also, disturbance or disruption associated with construction activities would likely only occur in one year; however, PCGP cannot guarantee that activities would only occur in one year (there may be unforeseeable circumstances that result in two years of activities), therefore, PCGP has identified that disruption and disturbance activities could occur in both Years 1 and 2.

MAMU stands identified in the timber and removal/construction column could also experience effects during reclamation; however, reclamation activities within 0.25 mile of MAMU stands would occur outside of the MAMU breeding season (September 15 through March 31). Effects by reclamation to nesting MAMUs would not be expected.

The FWS (2014c) provided a method in the Revised Conservation Framework to categorize direct effects to MAMU stands within a disruption and/or disturbance distance (0.25 mile) of project activities, including use of access roads, into the following Disruption-Disturbance (D/D) Impact Categories: High Impact, Moderate Impact, Low Impact, Low Impact – no mitigation, and No Impact. The assessment considers the timing, types, and location of project-related activities in relation to MAMU stands that could result in disturbance or disruption of nesting MAMU to assist in determining a D/D Impact Category for each activity for each MAMU stand. In many instances a MAMU stand is provided more than one D/D Impact Category because of different project effects and different locations of effects on the MAMU stand (i.e., construction effects and proposed use of existing access roads).

The Revised Conservation Framework (FWS 2014c), guided individual assessments included in appendix Z1 for each MAMU stand (occupied and presumed occupied) to determine the amount of acres by D/D Impact Type; the resulting D/D Impact Category(ies) is also included for each stand in table Q2 in appendix Q. In May 2018, FWS reviewed the D/D impact categories provided for each MAMU stand and agreed with the categories provided by PCGP. Table MAMU-1 in the introduction to appendix Z1 summarizes the acres of MAMU stands (occupied and presumed occupied) within 0.25 mile of proposed activities that would be categorized as Moderate Impact, Low Impact, and No Impact. No MAMU stand was assigned a "High" category, because PCGP would adhere to DTRs during the critical breeding period for construction and timber removal activities that occur within 0.25 mile of MAMU stands.

Maintenance and Operation

No activities associated with general maintenance and operations of the Pipeline project are expected to affect occupied MAMU stands. Vegetation maintenance activities would occur only between August 1 and April 15 of any year (see appendix C); generally, outside of the critical breeding season. PCGP would apply DTRs during activities within 0.25 mile of MAMU stands during the late breeding season (August 5 through September 15) to ensure no effects to MAMU (see table 3.3.3-7); therefore, no disturbance is expected. Routine clearing of vegetation within the 30-foot permanent right-of-way would not occur more frequently than every 3 years. A 10-foot corridor centered over the pipeline would be maintained annually in an herbaceous state to facilitate periodic corrosion and leak surveys. PCGP would also require pilots conducting annual aerial inspection (small plane/helicopter) of the pipeline to adhere to the spatial restrictions recommended in the vicinity of occupied stands (no overflight within 1,300 feet agl during the critical breeding season (April 1 through August 5), resulting in no adverse effect from aerial pipeline inspection. However, some routine activities such as right-of-way inspection may require pipeline personnel to visit the right-of-way at any time; these visits along the right-of-way would be by a vehicle or via walking and would adhere to DTRs.

TABLE 3.3.3-9

Number of Occupied or Presumed Occupied Stands within the Marbled Murrelet Zones with
Expected Disturbances from Noise and/or Visuals Associated with Activities Proposed within 0.25 Mile of Stands a/

Status of Marbled Murrelet Stand	General Landowner b/	Total Number of Stands	Construction Activities and Road Use c/		Construction Activities Only d/		Road Use Only e/		
			Disruption	Disturbance	Disruption	Disturbance	Disruption	Disturbance	None f/
Marbled Murrelet Zone 1									
Occupied Stand	BLM	48	20	2	0	0	6	20	0
	Other	0	0	0	0	0	0	0	0
	Total	*48*	*20*	*2*	*0*	*0*	*6*	*20*	*0*
Presumed Occupied	BLM	79	19	7	1	0	2	48	2
	Other	38	22	4	2	0	2	8	0
	Total	*117*	**41**	**11**	**3**	*0*	**4**	**56**	*2*
Total MAMU Zone 1	**BLM**	**127**	39	9	1	**0**	8	68	**2**
	Other	**38**	22	4	2	**0**	2	8	**0**
	Total	**165**	**61**	**13**	**3**	**0**	**10**	**76**	**2**
Marbled Murrelet Zone 2									
Occupied Stand	BLM g/	3	2	0	0	1	0	0	0
	Other	0	0	0	0	0	0	0	0
	Total	*3*	*2*	*0*	*0*	*1*	*0*	*0*	*0*
Presumed Occupied	BLM	7	0	1	0	1	2	3	0
	Other	0	0	0	0	0	0	0	0
	Total	*7*	*0*	*1*	*0*	*1*	*2*	*3*	*0*
Total Murrelet Zone 2	**BLM**	**10**	**2**	**1**	**0**	**2**	**2**	**3**	**0**
	Other	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Total	**10**	**2**	**1**	**0**	**2**	**2**	**3**	**0**
Entire MAMU Range									
Occupied Stand	BLM	51	22	2	0	1	6	20	0
	Other	0	0	0	0	0	0	0	0
	Total	*51*	*22*	*2*	*0*	*1*	*6*	*20*	*0*
Presumed Occupied	BLM	86	19	8	1	1	4	51	2
	Other	38	22	4	2	0	2	8	0
	Total	*124*	**41**	**12**	**3**	*1*	**6**	**59**	*2*
Total MAMU Range	**BLM**	**137**	41	10	1	2	10	71	2
	Other	**38**	22	4	2	**0**	2	8	**0**
	Total	**175**	**63**	**14**	**3**	**2**	**12**	**79**	**2**

a/ Summarized from table Q-2 in appendix Q.; see appendix Z1 for D/D Impact Categories for each MAMU stand applying guidance provided by FWS (2014c) in the Revised Conservation Framework.

b/ BLM includes Coos Bay and Roseburg Districts; three presumed occupied stands with mixed landowner (BLM and private) in MAMU Inland Zone 1 have been included in this category. Other includes private and Bureau of Indian Affairs (BIA); one presumed occupied stand with mixed landowner (private and BIA) in MAMU Inland Zone 1 have been included in this category.

c/ Construction Activities (see d/) and Road use (see e/): both proposed activities occur within 0.25 mile of MAMU Stands

d/ Construction Activities Only: includes general construction activities, blasting (> 2lbs explosives), and large transport helicopter use; no proposed road use within 0.25 mile of MAMU Stands

e/ Road use only: does not include paved roads that are used regularly by the public (i.e., County Roads, State Highways). MAMU stands are included if the stand is within 0.25 mile of a proposed access road; no construction activities proposed within 0.25 mile of MAMU Stand

f/ None: construction and proposed road use > 0.25 mile of MAMU Stands but within 0.5 mile of critical habitat removal (see appendix Z-1).

g/ One occupied MAMU stand occurs in both Marbled Murrelet Inland Zones 1 and 2 but has been included in tabluations for Inland Zone 2.

Helicopter Rotor Wash

Strong winds can adversely affect MAMUs (FWS 1990) by directly removing habitat from windthrow that could fragment forests and increase edge effects (risk of predation, microclimatological changes). Wind can also cause direct mortality by blowing chicks out of nests (FWS 1992a). Helicopter drive rotors produce high velocity vortices (winds) that extend from the center of the helicopter outward in all directions. Vertical downwash of air (rotor wash) close enough to the ground produces surface winds that dissipate with distance away from the helicopter (sidewash). Induced winds caused by helicopter rotor wash may exceed hurricane force velocities that would be expected to adversely affect nesting MAMUs on a local level. Since induced rotor downwash and surface sidewash are functions of helicopter size, rotor surface area, helicopter weight, flight speed, and height above ground (Teske et al. 1997; Gordon et al. 2005), effects to nesting birds can be minimized or avoided by routing helicopter flight paths and staging locations far enough away from nests so that induced winds would not adversely affect nests or nestlings.

Maximum induced surface velocities produced by downwash and sidewash from various helicopters were measured in the field to determine the decay function of rotor-produced vortices near ground level (Teske et al. 1997). Field studies included measurements on three helicopter models that might be utilized during construction of the Pipeline: 1) the twin-rotor CH-47 (civilian variant is the Boeing HH-47 Chinook) with rotor diameter 59.1 feet, 2) the single rotor CH-54 with a rotor diameter of 72 feet (civilian variant is the Sikorsky S-64 Skycrane), and 3) the twin-rotor CH-46 (civilian variant Boeing Vertol 107) with a rotor diameter of 49.9 feet (Teske et al. 1997). Using parameters derived from the field trials, estimates of maximum induced surface velocities were made for each of the three helicopter models at varying heights above ground while flying at different ground speeds. In general, maximum induced surface velocities increase with rotor diameters, decrease with distance above ground, and decrease with faster ground speeds.

Results of modeling maximum induced surface velocities (model described in Teske et al. 1997) produced by a Chinook helicopter are shown in figure 3.3.3-4 for drop heights (heights above ground level at which the helicopter would discharge a payload of foam, water, or retardant during wild fire control) ranging from 10 to 320 feet while flying at ground speeds ranging from 5 to 25 mph. Included in figure 3.3.3-4 are four wind speed categories on the Beaufort Scale (NOAA 2015) which was developed to describe damage associated with wind forces ranging from calm to hurricane forces. On the Beaufort Scale, induced surface winds of 9 to 11 mph produced by rotor wash would be equivalent to a “gentle breeze” during which leaves and small twigs would be constantly moving and light flags would be extended. Wind velocities of 19 to 24 mph are classified as a “fresh breeze” (small trees in leaf would sway). Winds 39 to 46 mph are “gale” force strength: difficult to walk against, twigs and small branches blown off trees. Winds greater than 74 mph are classified as a hurricane.

Figure 3.3.3-5 shows the heights above ground that Chinook helicopters would produce maximum induced surface winds with velocities equivalent to a “fresh breeze” while traveling at ground speeds of 5, 10, 15, 20 or 25 mph. For example, if traveling at a ground speed of 5 mph, the Chinook would have to be approximately 185 feet above ground to produce a maximum induced surface velocity of 24 mph, equivalent to a “fresh breeze.” If traveling at ground speed of 25 mph, the Chinook could be 75 feet above ground and still induce a maximum surface velocity of 24 mph.

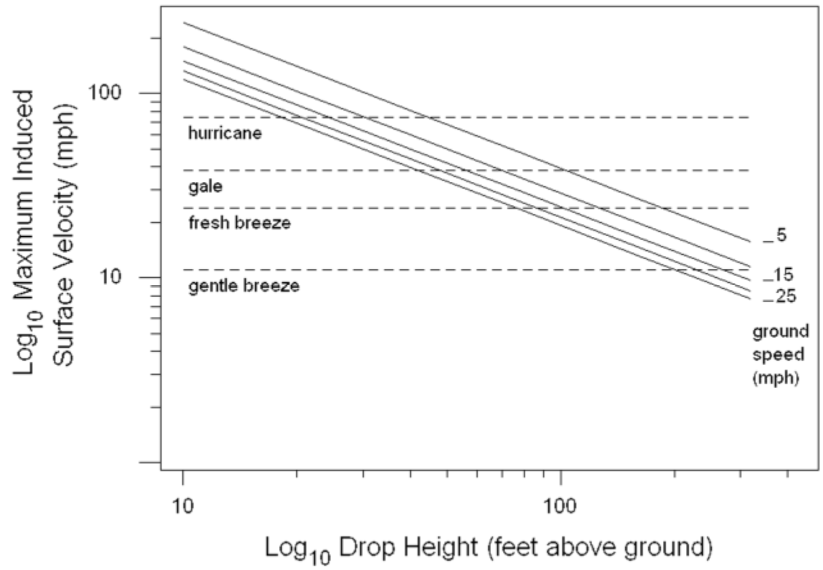


Figure 3.3.3-4 Modeled Maximum Surface Velocities Induced by Chinook C-47 Helicopters while Flying at Ground Speeds From 5 to 25 mph at Heights From 10 to 320 feet Above Ground. (Modeled from data in Teske et al. 1997)

In the Pipeline project area, wind speeds reported by the Western Regional Climate Center (2015) at the North Bend airport averaged 10.2 mph in June, 11.2 mph in July and 9.9 mph in August, the three months with highest average wind velocities during the period from 1996 to 2006. During the same period, winds in Roseburg averaged 5.0 mph in June, 5.2 mph in July, and 4.4 mph in August. These data indicate that winds as strong as a fresh breeze (19 to 24 mph) would be expected along the Oregon Coast and most likely inland during the period when MAMUs are nesting. It is assumed that induced winds the strength of a fresh breeze would not adversely affect young or nests.

Incoming or outgoing Chinook helicopters flying at 5 mph while 185 feet above a tree with a nest would most likely produce winds with velocities less than a fresh breeze at the tree top because there would be no resistance by the ground to induce maximum sidewash vortices.

Similar results were produced by the Boeing Vertol 107 (see figure 3.3-8) even though it is smaller than the Chinook (rotor diameter 49.9 feet compared to 59.1 feet). The Vertol 107, flying at a ground speed of 5 mph, would have to be approximately 200 feet above ground to produce a maximum induced surface velocity of 24 mph, equivalent to a fresh breeze. If traveling at ground speed of 25 mph, the Vertol 107 could be 82 feet above ground and still induce a maximum surface velocity of 24 mph. Overall, the Vertol 107 produces slightly greater maximum induced surface velocities than the Chinook CH-47 even though its maximum equipment weight is less than the Chinook.

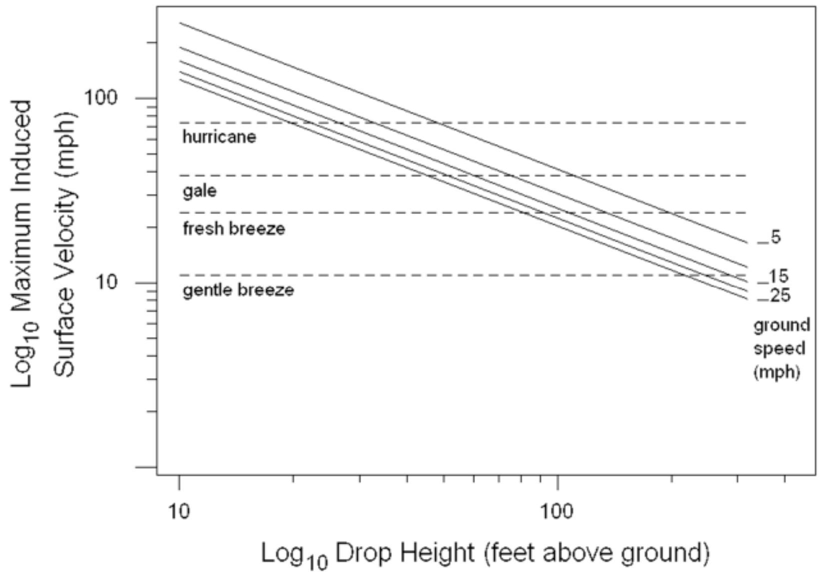


Figure 3.3.3-5 Modeled Maximum Surface Velocities Induced by Boeing Vertol 107 Helicopters while Flying at Ground Speeds From 5 to 25 mph at Heights From 10 to 320 feet Above Ground (Modeled from data in Teske et al. 1997)

The single rotor S-64 Skycrane has the largest rotor diameter (72 feet diameter) of the three models. As modeled in figure 3.3.3-6, the Skycrane would produce greater maximum induced surface velocities while flying at the same ground speeds and same drop heights as the other two helicopter models.

Flying at a ground speed of 5 mph, the Skycrane would have to be approximately 233 feet above ground to produce a maximum induced surface velocity of 24 mph, equivalent to a fresh breeze. The Chinook and Vertol 107 helicopters would induce similar maximum surface velocities flying at heights of 185 feet and 200 feet above ground, respectively. If traveling at ground speed of 25 mph, the Skycrane could be 95 feet above ground to induce a maximum surface velocity of 24 mph.

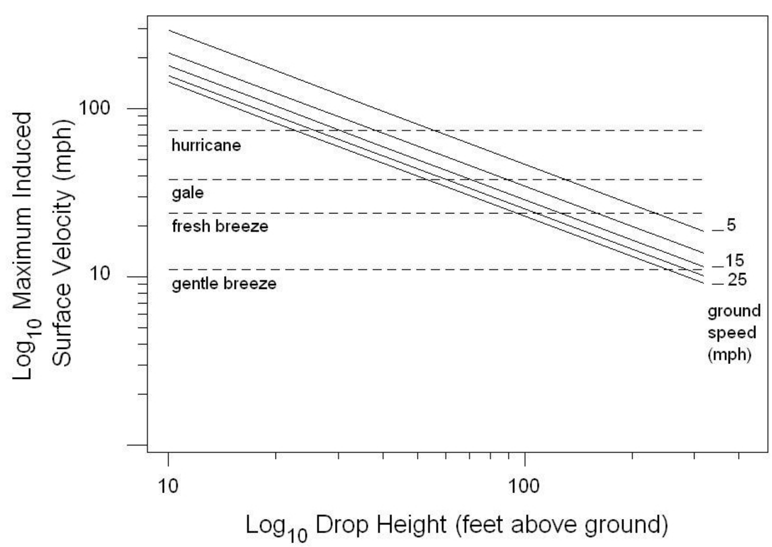


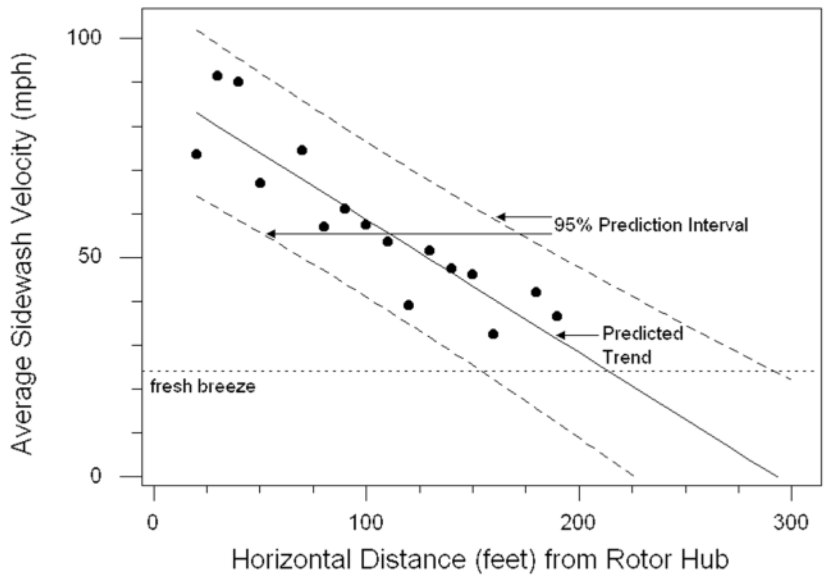
Figure 3.3.3-6 Modeled Maximum Surface Velocities Induced by Skycrane S-64 Helicopters while Flying at Ground Speeds From 5 to 25 mph at Heights From 10 to 320 feet Above Ground. (Modeled from data in Teske et al. 1997)

Actual downwash and sidewash vortices produced by Chinook CH-47 and Skycrane (CH-54) helicopters were measured during field tests (Leese and Knight 1974) while aircraft were hovering at 40-50 feet and 80-90 feet above ground level (agl) while under maximum loads of 36,000 pounds (CH-47) and 45,000 to 47,000 pounds (CH-54). The Vertol 107 (CH-46) was not included in the field tests.

With a 47,000-pound load, the single rotor CH-54 hovering at 40 feet agl produced a maximum sidewash velocity of 87 mph 50 feet away from the rotor hub; at 80 feet agl, the maximum sidewash was 74 mph, also measured at 50 feet from the hub though the gross weight was 45,000 pounds during that particular trial. Both maximum sidewash measurements were at heights of 0.3 feet above ground (Leese and Knight 1974). Under the specified load conditions, the CH-54 produced a sidewash of 11 mph 170 feet away from the rotor hub while hovering at 40 feet agl and a sidewash of 9 mph 150 feet away from the hub while hovering at 80 feet agl. Maximum sidewash velocities of 74 to 87 mph that were associated with the CH-54 helicopter while it was hovering, are within the range of hurricane force winds on the Beaufort Scale while winds of 9 to 11 mph produced by rotor sidewash would be described as a "gentle breeze." Sidewash velocities between 9 and 11 mph at distances 150 to 170 feet away from a CH-54 helicopter (Skycrane) would be unlikely to blow young MAMUs from their nests.

Downwash and sidewash velocities measured for the CH-47 helicopter (Chinook) were greater than 100 mph up to 70 feet horizontally from the rotor hub when it was hovering at 90 feet agl with maximum load of 36,000 pounds (Leese and Knight 1974). The twin rotor CH-47 produced sidewash velocities as high as 56 mph 190 feet away from the rotor hub when it was hovering at 90 feet agl. The Beaufort Scale classifies winds between 55 and 63 mph as a "storm," with trees uprooted and structural damage likely. The greater strength of winds produced by the CH-47 is likely due to the interaction of descending air produced by the two rotors (Fabey 2008); sidewash winds are generally strongest at 120 and 240 degrees (4 o'clock and 8 o'clock, respectively) relative to the helicopter's heading (data in Leese and Knight 1974).

Sidewash wind velocities produced by the CH-47 at various distances away from the rotor hub (Leese and Knight 1974) were used to predict the distance at which the helicopter would be far enough to avoid adversely affecting MAMU nests and young. The prediction is based on the sidewash wind velocities produced by the CH-47, averaged for wind measurements made 0.3 feet above ground at angles of 120 and 240 degrees while the helicopter was hovering 90 feet agl under a load of 36,000 pounds. The prediction is shown below in figure 3.3.3-7 in which a sidewash velocity of 0 mph would occur 293 feet away from the rotor hub. Due to the observed variation in sidewash winds at different distances away from the rotor hub (solid circles in figure 3.3.3-7), the upper 95 percent prediction interval on that predictive estimate of 0 mph at 293 feet from the hub would be 23.8 mph. A wind velocity of 23.8 mph is classified as a fresh breeze on the Beaufort Scale. One can be 95 percent certain that a stronger wind, potentially adversely affect nesting MAMUs, would not occur.



Source: Leese and Knight 1974

Figure 3.3.3-7 Average Sidewash Wind Velocities Produced by the CH-47 at Varying Horizontal Distances from the Rotor Hub While Hovering 90 feet agl Under a Load of 36,000 pounds. The observed averages (solid circles) were used to predict sidewash winds at distances out to 300 feet.

These estimates clearly suggest that greater distances would be required to avoid adverse effects to MAMUs if Chinook helicopters, rather than Skycranes, are employed for heavy lifting along remote sections of the construction right-of-way. Based on the similarities of maximum induced surface velocities between Chinook and Vertol 107 helicopters, sidewash velocities induced while hovering are likely to be similar as well. However, if known nest trees or stands can be avoided by at least 200 feet above tree tops by heavy-lifting helicopters in transit, and avoided horizontally by at least 300 feet while helicopters hover above staging sites, no adverse effects to the species from rotor downwash and induced sidewash would be expected.

Eight MAMU stands occur within 0.25 mile of proposed helicopter use, of which six occupied stands are within 300 feet of proposed helicopter use (C3073, C3090, C3094, C3095, R3035 [EAR 46.51_A], and R3051 [B14]). Helicopter use for timber extraction within 300 feet of a MAMU stand would occur outside of the entire breeding season (between September 16 and March 31); no adverse effects from rotor wash of large helicopters are expected during timber extraction. Adverse effects to MAMUs in the six stands identified above could occur from rotor wash of large helicopters during pipe delivery during construction of the proposed action, since activity could occur during the entire breeding season and may be within 200 feet above nest trees and horizontally within 300 feet of nest trees (the nest site is unknown within these stands but potential nest trees have been identified adjacent to the construction right-of-way and rotor wash could affect MAMU if present).

Burning and Smoke

Whether by prescribed burning as a habitat enhancement procedure or by burning slash, effects of smoke on MAMUs have not been studied. However, FWS et al. (2007) have declared (see Table 15, FWS et al. 2007) "that smoke can cause [NSO] adults to move off nest sites, therefore leaving eggs or young exposed to predation or resulting in lost feedings reducing the young's fitness." In the absence of reliable information, one would reasonably assume that the same effects apply to MAMUs.

According to BLM and Forest Service (2008, page 35), MAMUs "are potentially affected by fire control activities and drifting smoke during burning. The threshold distance for disturbance from smoke is 0.25 mile for MAMUs," which also would be subject to smoke-related disturbance during the critical breeding period (April 1 through August 5). PCGP would not conduct slash burning on any land during the critical breeding season within 0.25 mile of an occupied or presumed occupied MAMU stand. No direct effect to MAMUs due to slash burning is expected.

Indirect Effects – Terrestrial Nesting Analysis Area

A primary indirect effect to MAMUs would be removal of suitable nesting habitat, and could also include removal of recruitment or capable habitat. Removal of MAMU habitat would be a long-term impact to MAMUs and would be expected to last at least 5 years or more. Short-term impact is expected with the use of UCSAs and is likely to last from the initiation of timber clearing until 1 to 5 years after restoration/revegetation. Other indirect or secondary effects by the Pipeline could include increased human presence as a result of the requirements of the action itself (the workforce needed to construct or operate the Pipeline), increased recreation (including ORV use, hunting), and habitat degradation, including a reduction of those habitats that are capable of achieving higher quality habitat status but for the Pipeline's impacts within LSR, Riparian Reserves, or within MAMU SHUs (Comer 1982). No effects to MAMU habitat is expected from construction of the LNG Terminal; the following section is specific to construction fo the Pipeline.

Analysis of indirect effects to MAMU habitat by Pipeline construction and operation within the terrestrial nesting analysis area followed guidance provided by FWS included in the Revised Conservation Framework developed for the Project (see *Revised Conservation Framework for the Northern Spotted owl and Marbled Murrelet: Jordan Cove Energy and Pacific Connector Gas Pipeline Project*, FWS 2014c).

Focus of Effects Analyses

Indirect effects from construction of the Pipeline analyzed within this APDBA are considered within three habitat areas defined by FWS as an SHU (FWS 2014c), which include habitat that could play an important role in maintaining and expanding MAMU populations: 1) the MAMU Stand with known or presumed suitable nesting structures; 2) a 300-foot buffer around the MAMU stand that includes forested habitat to protect/provide a buffer to nesting MAMUs as described by the MAMU Recovery plan (FWS 1997); and 3) federally-designated critical habitat within a 0.5-mile buffer around a MAMU stand that is within 0.5 miles of critical habitat removal by the proposed action. The FWS (2008b, 2011b) recognize that forested habitat within 0.5 mile of an occupied stand is important to recruit additional nesting habitat for the MAMU in the future (e.g., coniferous forested stands greater than 60 years of age that are capable of becoming potential nesting habitat within 25 years; FWS 2014c; BLM 1995a, 1995b). Therefore, this latter defined area includes forested habitat proximal to the MAMU stand that could provide suitable nesting structures in the future for the MAMU and has been federally protected through critical habitat designation. Within the terrestrial nesting analysis area where MAMU stands are in close proximity of each other (i.e., less than 300 feet or adjacent), SHUs overlap. Therefore, analyses provided in this APDBA consider the SHUs within the terrestrial nesting analysis area collectively to eliminate duplication of acres of impact. Impacts to individual MAMU SHUs are included in appendix Z1. Figure 1 in appendix Z1 shows the MAMU SHUs in relation to the proposed action and Marbled Murrelet Inland Zones 1 and 2.

Nesting Habitat Removal/Modification

Long-Term Effects to Habitat. Removal of suitable nesting habitat by harvest of old-growth timber has been cited as the primary reason for the species' decline (FWS 1992a). Implementation of the NWFP and management of late successional reserves, and the designation of critical habitat were designed to increase the amount of late successional forest habitat available for the long term, thus increasing potential nesting habitat for MAMUs. The BLM RMPs (BLM 2016a and 2016b) also identify the importance of forested habitat within 0.25 mile of occupied MAMU stands and state that removal of habitat within occupied stands should not occur and other forested habitat within a 0.25-mile radius of any occupied stand should be protected for recruitment of nesting habitat for MAMUs (i.e., stands that are capable of becoming MAMU habitat). Since 2003, effects to MAMU suitable habitat have been minimal (BLM and Forest Service 2006). Suitable MAMU nesting habitat takes a long time to develop (more than 250 years on average); therefore, any removal of suitable habitat or recruitment habitat may affect the recovery of the MAMU since recent trends indicate that MAMUs may be declining (see section 3.3.3.1).

Based on MAMU habitat delineated for the Pipeline, construction of the Pipeline would remove approximately 806.45 acres of MAMU habitat, including 78.04 acres of "suitable habitat" removed from 37 MAMU stands (19 occupied MAMU stands and 18 presumed occupied stands; see tables 3.3.3-6 and 3.3.3-10). Removal of 78.04 acres of suitable MAMU habitat amounts to approximately 0.5 percent of the 14,310 acres of suitable habitat available in the terrestrial nesting analysis area (see table 3.3.3-11) and accounts for 0.09 percent of potential nesting habitat in Conservation Zones 3 and 4 in Oregon (approximately 867,219 acres of higher suitable nesting habitat; (Falxa and Raphael 2016). It is expected that recruitment habitat within SHUs, especially forested habitat greater than 60 years located on federally-managed lands, would provide potential nesting habitat for MAMUs in the future (BLM 1995a, 1995b; FWS 2008a, 2011b, 2014c). The removal of suitable habitat would indirectly affect MAMUs over the long term, for longer that the expected 40-year life of the Project.

Short-Term Effects to Habitat. Additionally, 157.13 acres of MAMU habitat (23.51 acres of suitable habitat) have been identified for use by the Pipeline project as UCSAs that may be used to store forest slash, stumps, and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration (see UCSA Column in table 3.3.3-10). Use of the UCSAs would be a short-term modification of understory species and would not affect the nesting habitat or characteristics.

Summary of Effects to Habitat. Table 3.3.3-10 below summarizes the amount of suitable habitat, recruitment habitat, and capable habitat that would be directly removed or used as UCSAs within and outside of SHUs within the range of the MAMU.

Table 3.3.3-10 (summarized from table Q-3 in appendix Q) also identifies 192.71 acres of MAMU habitat that occur within the designated 30-foot maintenance corridor (21.33 acres of suitable habitat, 75.65 acres of recruitment habitat, and 95.73 acres of capable habitat) within Marbled Murrelet Inland Zones 1 and 2. After construction of the Pipeline, a maximum of 613.74 acres of forested habitat within Marbled Murrelet Inland Zones 1 and 2 outside of the 30-foot maintenance corridor (see Suitable, Recruitment, and Capable in table 3.3.3-10, computed by subtracting areas in the 30-foot Corridor from areas in the Removed columns) would be replanted with trees. This acreage represents a maximum because replanting may not occur or be maintained on non-federal lands and federal lands slated for timber harvest. In areas where trees are planted and maintained as forested habitat, edge effects would decrease over time, although these areas would provide minimal benefit to MAMUs because it would take decades at a minimum to restore replanted forests to recruitment or suitable habitat conditions. Douglas-firs (12-inch seedlings in one-gallon containers or bare root) would be planted on dry sites and western hemlock (12-inch seedlings in one-gallon containers) would be planted on moist sites (see ECRP in appendix F). It is expected that 12-inch Douglas-firs and western hemlocks planted the year of or year after construction could be approximately 70 feet tall in 50 years (expected end of the Pipeline project life). During the first 30 years or so, coastal Douglas-fir are expected to grow at an average rate of 24 inches per year and may grow at a continuous rate of 6 to 9 inches per year to age 120 (McArdle et al. 1961; Hermann and Lavender 2004). Young, unthinned stands of Douglas-fir (38 to 70 years old) were documented between 115 and 154 feet tall while young, thinned stands (40 to 73 years old) were 121 to 151 feet tall (Tappeiner et al. 1997). Western hemlock are highly productive; trees in Oregon were 140 feet tall at 100 years old (an approximate height growth rate of 16-17 inches per year). MAMU habitat within the 30-foot corridor would remain in an early seral state, maintained free of vegetation greater than 6 feet in height, through the life of the project.

Figure 1 in appendix Q provides an overview of MAMU habitat (suitable, recruitment, and capable) within the proposed terrestrial nesting analysis area and includes known occupied and presumed occupied stands, designated critical habitat, and LSRs within Marbled Murrelet Zones 1 and 2 and Conservation Zones 3 and 4. Table 3.3.3-11 summarizes the amount of MAMU habitat affected by the Pipeline project within the terrestrial nesting analysis area pre- and post-action. The proposed action would remove the greatest percentage of available MAMU habitat within the terrestrial nesting analysis area on non-federal lands; however, only a small amount of habitat on non-federal lands is expected to provide suitable nesting structures, and a majority of capable or recruitment habitat is not expected to mature to provide suitable MAMU nesting structures based on review of timber harvest practices in Oregon (Zhou et al. 2005; Rasmussen et al. 2012). These studies noted that forest harvest practices on non-federal lands typically occur between 45 and 65 years of age.

TABLE 3.3.3-10

Summary of Marbled Murrelet Suitable, Recruitment, and Capable Habitat Impacted during Pipeline Project Construction and Operation (30-foot Corridor) within Marbled Murrelet Inland Zones 1 and 2, Recovery Plan Conservation Zones, and within/outside Marbled Murrelet SHUs by Landowner

			Suitable Habitat b/			Recruitment Habitat c/			Capable Habitat d/			Non-Capable Habitat e/			Total Acres		
			Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation
Conservation Zones	Land Owner	General Location a/	Removed f/ (acres)	UCSA g/ (acres)	30-foot Corridor h/ (acres)	Removed f/ (acres)	UCSA g/ (acres)	30-foot Corridor h/ (acres)	Removed f/ (acres)	UCSA g/ (acres)	30-foot Corridor h/ (acres)	Removed f/ (acres)	UCSA g/ (acres)	30-foot Corridor h/ (acres)	Removed f/ (acres)	UCSA g/ (acres)	30-foot Corridor h/ (acres)
Marbled Murrelet Inland Zone 1																	
Conservation Zone 3	Coos Bay BLM	Within SHUs	2.22	1.57	0.08	0.00		0.00	2.99	1.33	1.30	0.12	0.04	0.04	5.33	2.94	1.43
		Outside SHUs							3.84	0.89	1.03				3.84	0.89	1.03
		Subtotal	2.22	1.57	0.08	0.00		0.00	6.84	2.22	2.33	0.12	0.04	0.04	9.18	3.83	2.46
	State	Within SHUs													0.00	0.00	0.00
		Outside SHUs				0.18						103.35		3.92	103.53	0.00	3.92
		Subtotal				0.18						103.35		3.92	103.53	0.00	3.92
	Private / Other	Within SHUs	0.62		0.21	1.45		0.35	3.28		0.80	1.43		0.50	6.77	0.00	1.85
		Outside SHUs				7.08		1.05	56.12	1.39	12.59	47.45	0.03	7.70	110.65	1.41	21.35
		Subtotal	0.62		0.21	8.53		1.40	59.40	1.39	13.39	48.88	0.03	8.20	117.43	1.41	23.20
Total Conservation Zone 3		*Within SHUs*	*2.84*	*1.57*	*0.29*	*1.45*	*0.00*	*0.35*	*6.27*	*1.33*	*2.10*	*1.55*	*0.04*	*0.54*	*12.11*	*2.94*	*3.28*
		Outside SHUs	*0.00*	*0.00*	*0.00*	*7.26*	*0.00*	*1.05*	*59.96*	*2.27*	*13.62*	*150.80*	*0.03*	*11.62*	*218.02*	*2.30*	*26.30*
		Total	*2.84*	*1.57*	*0.29*	*8.71*	*0.00*	*1.40*	*66.23*	*3.61*	*15.72*	*152.35*	*0.06*	*12.17*	*230.13*	*5.24*	*29.58*
Conservation Zone 4	Coos Bay BLM	Within SHUs	45.24	12.74	13.14	30.63	7.08	8.58	37.58	8.71	7.14	17.12	0.50	5.21	130.58	29.03	34.07
		Outside SHUs				65.15	5.24	16.34	26.44	3.69	6.44	10.91	0.61	2.79	102.49	9.54	25.56
		Subtotal	45.24	12.74	13.14	95.78	12.32	24.91	64.02	12.40	13.58	28.03	1.11	8.00	233.06	38.57	59.63
	Roseburg BLM	Within SHUs	2.47		0.72	1.55		0.22	1.47		0.03	0.91		0.03	6.41	0.00	0.99
		Outside SHUs							0.03		0.00				0.03	0.00	0.00
		Subtotal	2.47		0.72	1.55		0.22	1.51		0.03	0.91		0.03	6.44	0.00	0.99
	State	Within SHUs													0.00	0.00	0.00
		Outside SHUs										6.23			6.23	0.00	0.00
		Subtotal										6.23			6.23	0.00	0.00
	Private / Other	Within SHUs	7.73	2.83	2.29	18.69	3.37	4.38	30.28	9.38	6.67	7.20	0.10	1.97	63.91	15.67	15.30
		Outside SHUs				23.33	3.87	4.07	201.84	28.96	44.74	127.76	0.93	14.45	352.93	33.76	63.25
		Subtotal	7.73	2.83	2.29	42.02	7.24	8.44	232.12	38.34	51.40	134.96	1.02	16.42	416.84	49.44	78.56
Total Conservation Zone 4		*Within SHUs*	*55.44*	*15.58*	*16.14*	*50.87*	*10.45*	*13.18*	*69.34*	*18.08*	*13.83*	*25.24*	*0.59*	*7.21*	*200.89*	*44.70*	*50.36*
		Outside SHUs	*0.00*	*0.00*	*0.00*	*88.48*	*9.11*	*20.40*	*228.31*	*32.65*	*51.17*	*144.90*	*1.54*	*17.24*	*461.68*	*43.30*	*88.82*
		Total	*55.44*	*15.58*	*16.14*	*139.35*	*19.56*	*33.58*	*297.65*	*50.74*	*65.01*	*170.14*	*2.14*	*24.45*	*662.58*	*88.01*	*139.18*
Outside Conservation Zones	Roseburg BLM	Within SHUs	4.20	1.64	0.99	1.47	0.02	0.41	8.02	0.14	2.35	2.04	0.12	0.56	15.72	1.92	4.30
		Outside SHUs				13.10		3.25	0.15		0.07	1.56		0.52	14.82	0.00	3.83
		Subtotal	4.20	1.64	0.99	14.57	0.02	3.66	8.17	0.14	2.42	3.60	0.12	1.07	30.54	1.92	8.14
	Private / Other	Within SHUs	2.40	0.00	0.75	0.44	0.00	0.18	3.51	0.89	0.90	2.34		0.52	8.69	0.89	2.34
		Outside SHUs				10.57		2.98	15.06	3.75	3.80	28.88	0.06	6.23	54.51	3.80	13.00
		Subtotal	2.40	0.00	0.75	11.01	0.00	3.16	18.57	4.64	4.70	31.22	0.06	6.74	63.20	4.69	15.35
Total Outside Conservation Zones		*Within SHUs*	*6.60*	*1.64*	*1.74*	*1.91*	*0.02*	*0.59*	*11.53*	*1.03*	*3.24*	*4.37*	*0.12*	*1.07*	*24.41*	*2.81*	*6.65*
		Outside SHUs	*0.00*	*0.00*	*0.00*	*23.67*	*0.00*	*6.23*	*15.21*	*3.75*	*3.87*	*30.45*	*0.06*	*6.74*	*69.33*	*3.80*	*16.84*
		Subtotal	*6.60*	*1.64*	*1.74*	*25.57*	*0.02*	*6.81*	*26.74*	*4.77*	*7.11*	*34.82*	*0.18*	*7.82*	*93.74*	*6.61*	*23.49*
Marbled Murrelet Inland Zone 1	Coos Bay BLM	Within SHUs	47.45	14.32	13.22	30.64	7.08	8.58	40.58	10.04	8.44	17.24	0.53	5.26	135.91	31.97	35.50
		Outside SHUs	0.00	0.00	0.00	65.15	5.24	16.34	30.28	4.57	7.46	10.91	0.61	2.79	106.33	10.43	26.59
		Subtotal	47.45	14.32	13.22	95.78	12.32	24.91	70.85	14.61	15.91	28.15	1.15	8.05	242.24	42.40	62.09
	Roseburg BLM	Within SHUs	6.67	1.64	1.71	3.02	0.02	0.63	9.49	0.14	2.37	2.95	0.12	0.58	22.13	1.92	5.29
		Outside SHUs	0.00	0.00	0.00	13.10	0.00	3.25	0.19	0.00	0.07	1.56	0.00	0.52	14.85	0.00	3.83
		Subtotal	6.67	1.64	1.71	16.12	0.02	3.88	9.68	0.14	2.44	4.51	0.12	1.10	36.98	1.92	9.13
	State	Within SHUs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Outside SHUs	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	109.58	0.00	3.92	109.76	0.00	3.92
		Subtotal	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	109.58	0.00	3.92	109.76	0.00	3.92
	Private / Other	Within SHUs	10.75	2.83	3.25	20.58	3.37	4.91	37.07	10.27	8.36	10.96	0.10	2.98	79.37	16.56	19.50
		Outside SHUs	0.00	0.00	0.00	40.98	3.87	8.09	273.02	34.10	61.13	204.10	1.01	28.38	518.10	38.98	97.61
		Subtotal	10.75	2.83	3.25	61.56	7.24	13.00	310.09	44.36	69.49	215.06	1.11	31.37	597.47	55.54	117.11
Total MAMU Inland Zone 1		*Within SHUs*	*64.88*	*18.80*	*18.18*	*54.24*	*10.47*	*14.11*	*87.14*	*20.44*	*19.17*	*31.15*	*0.75*	*8.82*	*237.41*	*50.46*	*60.29*
		Outside SHUs	*0.00*	*0.00*	*0.00*	*119.40*	*9.11*	*27.68*	*303.48*	*38.67*	*68.67*	*326.15*	*1.62*	*35.61*	*749.04*	*49.41*	*131.95*
		Total	*64.88*	*18.80*	*18.18*	*173.64*	*19.57*	*41.79*	*390.63*	*59.11*	*87.84*	*357.30*	*2.38*	*44.43*	*986.44*	*99.86*	*192.24*
Marbled Murrelet Inland Zone 2																	
Outside Conservation Zones	Roseburg BLM	Within SHUs	13.11	4.68	3.14							0.00			13.11	4.68	3.14
		Outside SHUs				18.27	1.83	4.90	0.17	0.21	0.04	3.61	0.06	0.91	22.05	2.09	5.85
		Subtotal	13.11	4.68	3.14	18.27	1.83	4.90	0.17	0.21	0.04	3.61	0.06	0.91	35.16	6.77	8.99
	Private / Other	Within SHUs	0.05	0.03	0.01	3.48	2.90	1.08	5.12	1.38	1.66	0.45	0.26	0.05	9.10	4.58	2.80
		Outside SHUs				111.54	39.78	27.88	25.57	8.83	6.20	314.47	4.70	32.82	451.58	53.31	66.89
		Subtotal	0.05	0.03	0.01	115.02	42.68	28.96	30.69	10.21	7.85	314.91	4.96	32.87	460.67	57.88	69.70

TABLE 3.3.3-10 (cont'd)

Summary of Marbled Murrelet Suitable, Recruitment, and Capable Habitat Impacted during Pipeline Project Construction and Operation (30-foot Corridor) within Marbled Murrelet Inland Zones 1 and 2, Recovery Plan Conservation Zones, and within/outside Marbled Murrelet SHUs by Landowner

			Suitable Habitat b/			**Recruitment Habitat c/**			**Capable Habitat d/**			**Non-Capable Habitat e/**			**Total Acres**		
			Construction		**Operation**	**Construction**		**Operation**	**Construction**		**Operation**	**Construction**		**Operation**	**Construction**		**Operation**
Conservation Zones	**Land Owner**	**General Location a/**	**Removed f/ (acres)**	**UCSA g/ (acres)**	**30-foot Corridor h/ (acres)**	**Removed f/ (acres)**	**UCSA g/ (acres)**	**30-foot Corridor h/ (acres)**	**Removed f/ (acres)**	**UCSA g/ (acres)**	**30-foot Corridor h/ (acres)**	**Removed f/ (acres)**	**UCSA g/ (acres)**	**30-foot Corridor h/ (acres)**	**Removed f/ (acres)**	**UCSA g/ (acres)**	**30-foot Corridor h/ (acres)**
Total Marbled Murrelet Zone2		*Within SHUs*	*13.16*	*4.71*	*3.15*	*3.48*	*2.90*	*1.08*	*5.12*	*1.38*	*1.66*	*0.45*	*0.26*	*0.05*	*22.21*	*9.26*	*5.94*
		Outside SHUs	*0.00*	*0.00*	*0.00*	*129.81*	*41.61*	*32.78*	*25.74*	*9.04*	*6.24*	*318.07*	*4.75*	*33.73*	*473.62*	*55.40*	*72.75*
		Total	*13.16*	*4.71*	*3.15*	*133.29*	*44.51*	*33.86*	*30.86*	*10.42*	*7.89*	*318.52*	*5.01*	*33.78*	*495.83*	*64.66*	*78.69*
Entire Marbled Murrelet Range																	
Entire Marbled Murrelet Range	Coos Bay BLM	*Within SHUs*	*47.45*	*14.32*	*13.22*	*30.64*	*7.08*	*8.58*	*40.58*	*10.04*	*8.44*	*17.24*	*0.53*	*5.26*	*135.91*	*31.97*	*35.50*
		Outside SHUs	*0.00*	*0.00*	*0.00*	*65.15*	*5.24*	*16.34*	*30.28*	*4.57*	*7.46*	*10.91*	*0.61*	*2.79*	*106.33*	*10.43*	*26.59*
		Subtotal	*47.45*	*14.32*	*13.22*	*95.78*	*12.32*	*24.91*	*70.85*	*14.61*	*15.91*	*28.15*	*1.15*	*8.05*	*242.24*	*42.40*	*62.09*
	Roseburg BLM	Within SHUs	19.79	6.33	4.85	3.02	0.02	0.63	9.49	0.14	2.37	2.95	0.12	0.58	35.24	6.60	8.43
		Outside SHUs	0.00	0.00	0.00	31.37	1.83	8.15	0.35	0.21	0.11	5.17	0.06	1.43	36.90	2.09	9.69
		Subtotal	19.79	6.33	4.85	34.39	1.84	8.78	9.85	0.35	2.48	8.12	0.18	2.01	72.14	8.70	18.12
	State	Within SHUs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		Outside SHUs	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	109.58	0.00	3.92	109.76	0.00	3.92
		Subtotal	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	109.58	0.00	3.92	109.76	0.00	3.92
	Private / Other	Within SHUs	10.80	2.86	3.27	24.06	6.27	5.98	42.19	11.65	10.02	11.41	0.36	3.03	88.47	21.14	22.30
		Outside SHUs	0.00	0.00	0.00	152.51	43.65	35.97	298.59	42.93	67.33	518.57	5.71	61.20	969.67	92.29	164.50
		Subtotal	10.80	2.86	3.27	176.58	49.92	41.95	340.78	54.58	77.35	529.98	6.06	64.24	1,058.14	113.43	186.80
Total Marbled Murrelet Range		*Within SHUs*	*78.04*	*23.51*	*21.33*	*57.72*	*13.37*	*15.19*	*92.26*	*21.82*	*20.83*	*31.60*	*1.01*	*8.88*	*259.62*	*59.71*	*66.23*
		Outside SHUs	*0.00*	*0.00*	*0.00*	*249.21*	*50.72*	*60.46*	*329.22*	*47.71*	*74.90*	*644.23*	*6.38*	*69.34*	*1,222.66*	*104.81*	*204.70*
		Subtotal	*78.04*	*23.51*	*21.33*	*306.93*	*64.09*	*75.65*	*421.48*	*69.53*	*95.73*	*675.82*	*7.39*	*78.21*	*1,482.28*	*164.52*	*270.93*

a/ General Location identifies areas within Marbled Murrelet SHUs – marbled murrelet stands – occupied and presumed occupied, and appropriate buffers and areas outside of Marbled Murrelet SHUs within the range of the marbled murrelet.
b/ Suitable Habitat: generally late-seral forested stands that provide or are presumed to provide nesting structures for marbled murrelet based on modeling and other available GIS data.
c/ Recruitment Habitat: forested land not currently suitable for marbled murrelet nesting that may be capable of becoming suitable marbled murrelet habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).
d/ Capable Habitat: forested land that has the capability of becoming suitable nesting marbled murrelet habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).
e/ Non-Capable habitat: not forested and not capable of becoming forest, or deciduous forest stands.
f/ Pipeline project components considered in calculation of habitat "Removed:" construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), and pipe storage yards.
g/ Acres identified as UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.
h/ Acres of habitat that would be maintained in an early seral / shrub state during the life of the project within the 30-foot maintenance corridor.

Summarized from table Q-3 in appendix Q, which also provides project effects by land allocation and within and outside of interior forest.

TABLE 3.3.3-11

Summary of Effects to Marbled Murrelet Habitat within Marbled Murrelet Zones 1 and 2 and
Recovery Plan Conservation Zones 3 and 4 within the Defined Terrestrial Nesting Action Area as a Result of the Proposed Project

Conservation Zone	Landowner a/	General Location	Total Acres within Analysis Area	Suitable Habitat b/ Pre-Action Acres	Suitable Removed Acres	Suitable Removed Percent	Suitable Post-Action Acres	Recruitment Habitat c/ Pre-Action Acres	Recruitment Removed Acres	Recruitment Removed Percent	Recruitment Post-Action Acres	Capable Habitat d/ Pre-Action Acres	Capable Removed Acres	Capable Removed Percent	Capable Post-Action Acres	Total MAMU Habitat Pre-Action Acres	Total MAMU Removed Acres	Total MAMU Removed Percent	Total MAMU Post-Action Acres
Marbled Murrelet Inland Zone 1																			
Conservation Zone 3	Federal	Within SHUs	84	43	2.22	5.2	41	14	0.00	0.0	14	27	2.99	11.1	24	83	5.21	6.3	78
		Outside of SHUs	479	0			0	4		0.0	4	275	3.84	1.4	271	279	3.84	1.4	275
		Total	563	43	2.22	5.2	41	18	0.00	0.0	18	302	6.84	2.3	295	363	9.06	2.5	354
	Non-Federal	Within SHUs	204	41	0.62	1.5	40	34	1.45	4.3	33	102	3.28	3.2	99	177	5.35	3.0	172
		Outside of SHUs	8,996	0	0.00		0	408	7.26	1.8	401	2,853	56.12	2.0	2,797	3,261	63.38	1.9	3,198
		Total	9,199	41	0.62	1.5	40	441	8.71	2.0	432	2,956	59.40	2.0	2,897	3,438	68.73	2.0	3,369
	Total Conservation Zone 3	Within SHUs	288	84	2.84	3.4	81	47	1.45	3.1	46	130	6.27	4.8	124	261	10.56	4.0	250
		Outside of SHUs	9,475	0	0.00		0	412	7.26	1.8	405	3,129	59.96	1.9	3,069	3,540	67.22	1.9	3,473
		Total	9,762	84	2.84	3.4	81	459	8.71	1.9	450	3,258	66.23	2.0	3,192	3,801	77.78	2.0	3,723
Conservation Zone 4	Federal	Within SHUs	18,588	11,557	47.71	0.4	11,509	3,154	32.18	1.0	3,122	3,735	39.06	1.0	3,696	18,446	118.95	0.6	18,327
		Outside of SHUs	8,412	13	0.00	0.0	13	5,407	65.15	1.2	5,342	2,889	26.47	0.9	2,863	8,309	91.61	1.1	8,217
		Total	27,000	11,570	47.71	0.4	11,522	8,562	97.32	1.1	8,465	6,624	65.53	1.0	6,558	26,756	210.56	0.8	26,545
	Non-Federal	Within SHUs	4,058	336	7.73	2.3	328	553	18.69	3.4	534	3,072	30.28	1.0	3,042	3,961	56.71	1.4	3,904
		Outside of SHUs	18,014	0	0.00		0	1,439	23.33	1.6	1,416	14,110	201.84	1.4	13,908	15,549	225.17	1.4	15,324
		Total	22,073	337	7.73	2.3	329	1,992	42.02	2.1	1,950	17,182	232.12	1.4	16,950	19,510	281.88	1.4	19,228
	Total Conservation Zone 4	Within SHUs	22,647	11,893	55.44	0.5	11,838	3,707	50.87	1.4	3,656	6,807	69.34	1.0	6,738	22,407	175.66	0.8	22,231
		Outside of SHUs	26,426	13	0.00	0.0	13	6,847	88.48	1.3	6,759	16,999	228.31	1.3	16,771	23,859	316.78	1.3	23,542
		Total	49,073	11,907	55.44	0.5	11,852	10,554	139.35	1.3	10,415	23,806	297.65	1.3	23,508	46,266	492.44	1.1	45,774
Outside Conservation Zones	Federal	Within SHUs	2,551	1,621	4.20	0.3	1,617	451	1.47	0.3	450	389	8.02	2.1	381	2,461	13.69	0.6	2,447
		Outside of SHUs	1,193	0			0	1,101	13.10	1.2	1,088	56	0.15	0.3	56	1,158	13.25	1.1	1,145
		Total	3,744	1,621	4.20	0.3	1,617	1,553	14.57	0.9	1,538	445	8.17	1.8	437	3,619	26.94	0.7	3,592
	Non-Federal	Within SHUs	694	66	2.40	3.6	64	135	0.44	0.3	135	405	3.51	0.9	401	606	6.35	1.0	600
		Outside of SHUs	3,226				0	666	10.57	1.6	655	1,839	15.06	0.8	1,824	2,506	25.63	1.0	2,480
		Total	3,920	66	2.40	3.6	64	801	11.01	1.4	790	2,244	18.57	0.8	2,225	3,111	31.98	1.0	3,079
	Total Outside Conservation Zone	Within SHUs	3,245	1,687	6.60	0.4	1,680	586	1.91	0.3	584	794	11.53	1.5	782	3,067	20.04	0.7	3,047
		Outside of SHUs	4,419	0	0.00		0	1,768	23.67	1.3	1,744	1,896	15.21	0.8	1,881	3,663	38.88	1.1	3,624
		Total	7,664	1,687	6.60	0.4	1,680	2,354	25.57	1.1	2,328	2,689	26.74	1.0	2,662	6,730	58.92	0.9	6,671
MAMU Inland Zone 1 Total	Federal	Within SHUs	21,223	13,220	54.13	0.4	13,166	3,619	33.65	0.9	3,585	4,151	50.07	1.2	4,101	20,991	137.85	0.7	20,853
		Outside of SHUs	10,084	13	0.00	0.0	13	6,513	78.24	1.2	6,435	3,220	30.47	0.9	3,190	9,746	108.71	1.1	9,637
		Total	31,307	13,234	54.13	0.4	13,180	10,132	111.90	1.1	10,020	7,371	80.53	1.1	7,290	30,737	246.56	0.8	30,490
	Non-Federal	Within SHUs	4,956	444	10.75	2.4	433	721	20.58	2.9	700	3,579	37.07	1.0	3,542	4,744	68.41	1.4	4,676
		Outside of SHUs	30,236	0	0.00		0	2,513	41.16	1.6	2,472	18,803	273.02	1.5	18,530	21,316	314.17	1.5	21,002
		Total	35,192	444	10.75	2.4	433	3,234	61.74	1.9	3,172	22,382	310.09	1.4	22,072	26,060	382.58	1.5	25,677
	Subtotal Marbled Murrelet Zone1	Within SHUs	26,179	13,664	64.88	0.5	13,599	4,340	54.24	1.2	4,286	7,730	87.14	1.1	7,643	25,735	206.26	0.8	25,529
		Outside of SHUs	40,320	13	0.00	0.0	13	9,026	119.40	1.3	8,907	22,023	303.48	1.4	21,720	31,062	422.88	1.4	30,639
		Total	66,500	13,678	64.88	0.5	13,613	13,366	173.64	1.3	13,192	29,753	390.63	1.3	29,362	56,797	629.14	1.1	56,168
Marbled Murrelet Inland Zone 2																			
Outside Conservation Zones	Federal	Within SHUs	789	641	13.11	2.0	628	23		0.0	23	100		0.0	100	764	13.11	1.7	751
		Outside of SHUs	1,095	6		0.0	6	767	18.27	2.4	749	229	0.17	0.1	229	1,002	18.44	1.8	984
		Total	1,884	647	13.11	2.0	634	790	18.27	2.3	772	329	0.17	0.1	329	1,766	31.55	1.8	1,734
	Non-Federal	Within SHUs	392	1	0.05	5.1	1	188	3.48	1.9	185	184	5.12	2.8	179	373	8.65	2.3	364
		Outside of SHUs	15,423	20		0.0	20	3,990	111.54	2.8	3,878	5,010	25.57	0.5	4,984	9,021	137.11	1.5	8,884
		Total	15,815	21	0.05	0.2	21	4,177	115.02	2.8	4,062	5,195	30.69	0.6	5,164	9,393	145.76	1.6	9,247
	Subtotal Marbled Murrelet Zone2	Within SHUs	1,182	641	13.16	2.1	628	211	3.48	1.6	208	284	5.12	1.8	279	1,136	21.76	1.9	1,114
		Outside of SHUs	16,518	26	0.00	0.0	26	4,757	129.81	2.7	4,627	5,239	25.74	0.5	5,213	10,023	155.55	1.6	9,867
		Total	17,699	668	13.16	2.0	655	4,968	133.29	2.7	4,835	5,524	30.86	0.6	5,493	11,159	177.31	1.6	10,982

TABLE 3.3.3-11

Summary of Effects to Marbled Murrelet Habitat within Marbled Murrelet Zones 1 and 2 and
Recovery Plan Conservation Zones 3 and 4 within the Defined Terrestrial Nesting Action Area as a Result of the Proposed Project

Conservation Zone	Landowner a/	General Location	Total Acres within Analysis Area	Suitable Habitat b/ Pre-Action Acres	Suitable Habitat b/ Removed Acres	Suitable Habitat b/ Removed Percent	Suitable Habitat b/ Post-Action Acres	Recruitment Habitat c/ Pre-Action Acres	Recruitment Habitat c/ Removed Acres	Recruitment Habitat c/ Removed Percent	Recruitment Habitat c/ Post-Action Acres	Capable Habitat d/ Pre-Action Acres	Capable Habitat d/ Removed Acres	Capable Habitat d/ Removed Percent	Capable Habitat d/ Post-Action Acres	Total MAMU Habitat Pre-Action Acres	Total MAMU Habitat Removed Acres	Total MAMU Habitat Removed Percent	Total MAMU Habitat Post-Action Acres
Total Marbled Murrelet Range																			
Total Marbled Murrelet Range	*Federal*	Within SHUs	22,012	13,861	67.24	0.5	13,794	3,642	33.65	0.9	3,608	4,251	50.07	1.2	4,201	21,754	150.96	0.7	21,603
		Outside of SHUs	11,179	19	0.00	0.0	19	7,280	96.52	1.3	7,183	3,449	30.63	0.9	3,418	10,748	127.15	1.2	10,621
		Total	**33,191**	**13,881**	67.24	0.5	13,814	**10,922**	130.17	1.2	10,792	**7,700**	80.70	1.0	7,619	**32,503**	278.11	0.9	32,225
	Non-Federal	Within SHUs	*5,349*	*444*	10.80	2.4	433	*909*	24.06	2.6	885	*3,764*	42.19	1.1	3,722	*5,117*	77.06	1.5	5,040
		Outside of SHUs	*45,659*	*20*	0.00	0.0	20	*6,503*	152.69	2.3	6,350	*23,813*	298.59	1.3	23,514	*30,337*	451.28	1.5	29,886
		Total	***51,008***	***465***	10.80	2.3	454	***7,412***	176.76	2.4	7,235	***27,577***	340.78	1.2	27,236	***35,453***	528.34	1.5	34,925
	Total Marbled Murrelet Range	***Within SHUs***	***27,361***	***14,306***	***78.04***	***0.5***	***14,228***	***4,551***	***57.72***	***1.3***	***4,493***	***8,015***	***92.26***	***1.2***	***7,923***	***26,871***	***228.02***	***0.8***	***26,643***
		Outside of SHUs	***56,838***	***40***	***0.00***	***0.0***	***40***	***13,783***	***249.21***	***1.8***	***13,534***	***27,262***	***329.22***	***1.2***	***26,933***	***41,085***	***578.43***	***1.4***	***40,507***
		Total	***84,199***	***14,345***	***78.04***	***0.5***	***14,267***	***18,334***	***306.93***	***1.7***	***18,027***	***35,277***	***421.48***	***1.2***	***34,856***	***67,956***	***806.45***	***1.2***	***67,150***

a/ Federal Landowners include Coos Bay BLM and Roseburg BLM Districts; Non-federal Landowners include Private and State.
b/ Suitable Habitat: generally late-seral forested stands that provide or are presumed to provide nesting structures for marbled murrelet based on modeling and other available GIS data.
c/ Recruitment Habitat: forested land not currently suitable for marbled murrelet nesting that may be capable of becoming suitable marbled murrelet habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).
d/ Capable Habitat: forested land that has the capability of becoming suitable nesting marbled murrelet habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).

Habitat Impact Categorization. PCGP used the Revised Conservation Framework (FWS 2014c) to guide categorizing effects to MAMU habitat within SHUs into Habitat Impact Categories (Severe, High, Moderate, and Low categories) based on the amount and type of MAMU Habitat removed, as well as the area from which the habitat is removed within the MAMU SHU (see MAMU habitat impact categorization for each MAMU stand in appendix Z1).

The Habitat Impact Category assigned to each MAMU SHU (appendix Z1 and table Q-1 in appendix Q) was applied to acres of MAMU habitat affected by the proposed action (summarized in table 3.3.3-10 from table Q-3 in appendix Q). Where MAMU SHUs overlapped, the higher impact category was considered. MAMU habitat affected outside of MAMU SHUs or within a MAMU SHU that were provided a "No Impact Category" in appendix Z1 are considered areas of "Low Impact," as well. Table MAMU-3 in the introduction to appendix Z1 provides a summary of MAMU habitat affected by Habitat Impact Category within and outside of interior forest.

Temporary Loss of Habitat – Noise and Human Presence

There is a potential for MAMU that may be present within 0.25 mile of Pipeline activities to be disturbed or disrupted from normal activities due to associated noise or human presence from Pipeline project activities, which could cause MAMU to temporarily avoid or flush from suitable nesting habitat (i.e., temporary habitat loss). Approximately 7,145 acres of suitable nesting habitat (occupied and presumed occupied MAMU stands) within the terrestrial nesting analysis area could occur within 0.25 mile of the Projectwhich could result in temporary loss of habitat due to noise and visual disturbance where construction activities, including existing road use (nonpublic) occur within 0.25 mile of suitable habitat within MAMU stands during the breeding season (April 1 through September 15; table 3.3.3-12). Construction activities within the range of the MAMU could occur during the breeding season for up to two years, with DTRs applied for timber removal and construction during the critical breeding season (April 1 through August 5) to minimize direct effects to MAMU. PCGP would continue to apply DTRs in the late breeding season for use of large transport helicopter, if use of large transport helicopters is still necessary, to further minimize disturbance and disruption effects. Proposed activities would not occur simultaneously within MAMU Inland Zones 1 and 2, and therefore, actual temporary, indirect habitat loss would be less than estimated within table 3.3.3-12, and potential direct effects to MAMU utilizing habitat would be short in duration.

TABLE 3.3.3-12

Amount (acres) of Suitable Nesting Habitat (a/) within 0.25 mile of Proposed Disturbance from Timber Removal and Construction, and Access Roads (b/) that could Directly Impact MAMU during the Entire Breeding Season (April 1 through September 15)

	Length of Pipeline / EARs within 0.25 mile of MAMU Stands		**Suitable Nesting Habitat (MAMU Stands) within 0.25 mile of Proposed Project Activities**			
Landowner	**Pipeline (miles)**	**Access Roads (miles)**	**Construction/ Timber Removal and Access Roads**	**Construction/ Timber Removal Only**	**Access Roads Only**	**Overall Total**
Marbled Murrelet Inland Zone 1						
Federal	14.8	61.9	1,895.31	332.02	4,299.40	6,526.73
Non-Federal	18.1	54.3	166.28	21.43	39.83	227.54
Total Zone 1	**32.9**	116.2	**2,061.59**	**353.45**	**4,339.22**	**6,754.27**
Marbled Murrelet Inland Zone 2						
Federal	0.9	1.9	133.63	213.76	42.50	389.89
Non-Federal	2.7	4.5	0.50	0.11	0.01	0.63
Total Zone 2	**3.5**	6.4	**134.13**	**213.87**	**42.52**	**390.52**
Overall Marbled Murrelet Range						
Federal	15.7	63.8	2,028.94	545.78	4,341.90	6,916.62
Non-Federal	20.7	58.9	166.78	21.55	39.84	228.17

Overall Total	**36.4**	**122.6**	**2,195.73**	**567.32**	**4,381.74**	**7,144.79**

a/ Acres of suitable habitat (MAMU Stands – occupied and presumed occupied, including non-capable and early regenerating habitat within BLM-delineated occupied stands) includes only the area of MAMU stands considered for analysis within this APDBA within 0.25 mile of proposed activities.
b/ Access Roads do not include roads currently identified as public access roads; only nonpublic access roads within 0.25 mile of MAMU stands (occupied and presumed occupied) that have been identified for use by the Pipeline project.

Table 3.3.3-12 identifies that approximately 7,145 acres of potentially suitable MAMU nesting habitat (occupied and presumed occupied stands) could become effectively unavailable on a temporary basis due to noise and/or human presence during Pipeline construction. This overestimates potential Pipeline project effects, because conservative assumptions are used by PCGP, as explained above. Additionally, BLM-delineated occupied stands include habitat not suitable for nesting (non-capable habitat and early seral forested habitat). If considering the occupancy index (see McShane et al. 2004), approximately 3,643.84 acres (51 percent of available suitable habitat in terrestrial nesting analysis area; 7,144.79 acres in table 3.3.3-12) is likely occupied and could be indirectly impacted. Use of existing access roads (nonpublic) could disrupt or disturb MAMU to the extent of expected nest failure during the breeding season (see discussion above in Direct Effects section).

Habitat Fragmentation

In addition to impact by surface disturbances, fragmentation of connected, contiguous habitats would occur. Fragmentation of MAMU habitat can reduce the amount and heterogeneous nature of the habitat, forest patch size, and amount of interior or core habitat, and can increase the amount of edge, isolate remaining habitat patches, and create "sink" habitats (FWS 2006c). The ecological consequences of these habitat changes to MAMUs can include effects on population viability and size, local or regional extinctions, displacement, fewer nesting attempts, failure to breed, reduced fecundity, reduced nest abundance, lower nest success, increased predation and parasitism rates, and reduced adult survival (FWS 2006c).

Habitat Edge. One manifestation of fragmentation is the amount of edge created through otherwise contiguous habitats. In the context of habitat fragmentation, edge is the portion of habitat (or ecosystem on a larger scale) "near its perimeter, where influences of the surroundings prevent development of interior environmental conditions" (page 38 in Forman 1995). As compared to interior habitats, edge habitats generally support different species composition, structure, and species' abundance (Forman and Godron 1986). For example, higher levels of flower and fruit production often occur along the edge (Forman 1995) and vertebrate species richness (bird and amphibian) has positively associated with edges in fragmented Douglas-fir forests (Rosenberg and Raphael 1986). Edges play a crucial role in controlling ecosystem interactions and landscape function, including the distribution of plants and animals, fire spread, vegetation structure, wildlife habitat conservation, and physical environments.

Research indicates that MAMUs within southern Oregon tend to nest in stands that are generally located away from high-contrast edge created from timber stand harvests and adjacent immature forests (Ripple et al. 2003; Meyer et al. 2002). In Canada, Zharikov et al. (2006) found MAMUs commonly nesting in stands near edges, although when edge increased in the nest stand, more nests failed (Zharikov et al. 2007). Nest failure observed by Zharikov et al. (2007) could be a result of increased risk of nest predation by corvids, since Raphael et al. (2011) and McShane et al. (2005) indicated that MAMU have reduced nest success along forested edges as a result of nest predation, predominantly by species of corvids. Alternatively, a study conducted in British Columbia found no evidence suggesting that nesting near forest edges, especially natural edges, reduced reproductive success in MAMUs (Bradley 2002). In addition, nests at edges of clearcuts, old-growth, and second-growth transitional forests were generally more successful than not successful. In that study, increased reproductive success at natural edges compared to interior forest stands was thought to be related to the ease of nest tree accessibility having a greater benefit to MAMUs than the risk of nest predation (Bradley 2002).

Increase in edge within SHUs from construction of the Pipeline may result in reduced nest success as a result of increased nest predation by corvids (Raphael et al 2011, McSchane et al. 2005; Meyer et al. 2002). Fragmentation of an SHU may also result in eventual abandonment of the stand. For example, Meyer et al. (2002) reported that fragmentation may result in increased predation on nests near forest edges, which could cause the birds to abandon small old-growth stands with high edge/area ratios. Meyer et al. (2002) determined that stands with large core areas over 50 to 100 meters from edge had higher occupancy and abundance than patches with little or no core area, and on average, occupied old-growth stands were 136 acres (55 hectares) in size. However, since the terrestrial nesting analysis area has already been subjected to extensive fragmentation by past land uses including transportation corridors, timber harvest and associated activities (i.e., road construction), and urban development, occupied and presumed occupied stands analyzed within this APDBA are generally smaller than 136 acres (see overall acres in the stand in table Q1 in appendix Q). To minimize further fragmentation to MAMU stands in the terrestrial analysis area from construction and operation of the Pipeline, PCGP routed the Pipeline in or adjacent to existing edge (forested or non-forested) or corridors. Within MAMU Inland Zone 1 and Zone 2 (MP 0.0 to MP 75.40), the Pipeline would be located within or parallel to existing corridors for approximately 30.5 miles (40 percent of proposed action in MAMU range; see table Q-4 in appendix Q), thus minimizing fragmentation within known or potential suitable MAMU nesting habitat. Table Q-4 in appendix Q identifies the location of MAMU Stands and associated SHU habitat areas in relation to existing rights-of-ways and corridors. However, additional fragmentation would occur within suitable nesting habitat (occupied and presumed occupied stands), as well as recruitment and capable habitat due to the Project.

Table 3.3.3-13 identifies 39 MAMU stands (occupied and presumed occupied) that overlap the Pipeline. The 39 affected stands range in size from 0.86 acre (presumed occupied stand on edge of right-of-way and uncapable habitat on private land) to 326.96 acres in an occupied stand, of which most stands (20 presumed occupied stands and 9 of 19 occupied stands) are currently smaller than 124 acres (table 3.3.3-13). With the exception of 14 MAMU stands (eight occupied and six presumed occupied), most suitable habitat that would be removed by construction of the Pipeline project either occurs on the edge of the MAMU stand or between the interface of the older occupied stand and an adjacent young, regenerating stand and/or existing access roads. Additionally, five presumed occupied stands occur on the extreme edge of the Pipeline project footprint and would not be expected to have suitable habitat or large trees removed from the stand and two other occupied MAMU stands would have in-road construction that would minimize or avoid removing potentially suitable nesting habitat (see underlined stands in table 3.3.3-13). Table 3.3.3-13 summarizes the length that each of the 39 MAMU stands is crossed by the proposed Pipeline, how much each stand is reduced in size, and the resulting habitat patches for the 14 stands bisected by the Pipeline.

The Pipeline would bisect eight occupied stands and six presumed occupied stands (see asterisk in table 3.3.3-13), although some stands identified with an asterisk would remove additional habitat adjacent to existing roads, essentially creating two lobes of the stand. Five of the MAMU stands that would be bisected are currently 136 acres or greater, and within those occupied stands, construction of the Pipeline would create habitat patches smaller than 136 acres (C1080, C3073, and R3051; see table 3.3.3-13). Although these stands would be reduced below 136 acres, a mean patch size that Meyer et al. (2002) indicated was generally occupied by MAMUs, most stands analyzed in the terrestrial nesting analysis area are below the 136 acres as a result of the currently fragmented landscape but still have observed MAMU nesting.

Table Q-1 in appendix Q, as well as the MAMU Impact Categorization for each MAMU Stand in appendix Z1 identifies the suitable, recruitment, and/or capable MAMU habitat that would be removed within the 300-foot Buffer of each MAMU Stand outside of the MAMU breeding season (see also maps of each MAMU Stand located within appendix Z1). The proposed Pipeline occurs in MAMU recovery plan Conservation Zones 3 and 4, of which the recommended management to aid in recovery includes maintaining designated occupied sites and minimizing loss of unoccupied but suitable habitat (FWS 1997). PCGP has adjusted the proposed route to minimize impact to MAMU stands by 1) rerouting the Pipeline to avoid occupied stands documented during 2007 and 2008 survey efforts, 2) incorporating minor alignment adjustments to reduce habitat removed in occupied stands, 3) modifying or moving temporary extra work areas, and 4) restricting the construction right-of-way to roads within occupied and presumed occupied stands. Approximately 78.04 acres of suitable habitat would be removed from occupied and presumed occupied stands, removing a total of 0.5 percent from available suitable habitat within the analysis area (14,345 acres; see table 3.3.3-11, above). Overall, 2.6 percent of MAMU habitat (suitable, recruitment, and capable) within delineated MAMU stands would be removed as a result of construction (see table 3.3.3-13).

TABLE 3.3.3-13

Suitable Nesting Habitat Removed from Occupied and Presumed Occupied Stands Affected by the Proposed Action

MSNO or Site ID a/	Status b/	Project Location (MP range in stand)	Landowner	Land Allocation c/	Overall Acres in the Stand	Length Crossed		Edge Created	Suitable Habitat Affected in MAMU Stand d/		Additional Description (see Maps in appendix Z1)
						Feet	Miles		Acres	Percent of Stand	
Marbled Murrelet Zone 1											
WC1A-C	Presumed (No Permission)	8.24R - 8.25R	Private	None	0.86	0	0	0	0.01	1.2	Stand adjacent to non-capable habitat (pasture); no trees within the presumed occupied stand would be removed.
WC1A-G	Presumed (No Permission)	8.79R-8.85R	Private	None	3.11	307.92	0.06	0	0.62	19.9	Habitat on edge of 100' powerline corridor and surrounded by recent clearcut (habitat previously considered a part of the presumed occupied stand) and early regenerating forest; ROW follows existing road ~ 50-100 feet from powerline corridor; would remove habitat either side of two-track road, generally reducing or removing all potential habitat in WC1A-G between road and powerline corridor; other permitted 'gray' habitat around stand determined "not suitable'; no new edge created.
C1027*	Occupied (Coos Bay BLM)	12.83BR - 13.17BR	Coos Bay BLM	LSR	43.40	153.18	0.03	2	2.22	5.1	ROW follows edge of one lobe of occupied stand following a two-track road between late seral and early seral forested habitat; ROW continues to follow road (EAR 13.15BR-13.66BR) between two lobes of occupied stand. Does not fragment stand but would increase fragmentation along existing access road, essentially creating two lobes (17.5 acres and 23.6 acres after construction).
C1042	Occupied (Coos Bay BLM)	13.17BR - 13.31BR 13.46BR - 13.58BR	Coos Bay BLM	LSR	76.61	1,006.33	0.19	1	1.55	2.0	ROW generally follows an existing road (EAR 13.15BR-13.66BR; BLM 26-12-4.1) through outer portion of northern lobe of the occupied stand and then skirts the outer edge of southern lobe of the occupied stand. ROW increases existing edge along road within the northern lobe of stand and creates a harder edge along southern lobe between early regen and late seral forest in the stand.
G102	Presumed (Ground Survey)	TEWA 13.79BR	Private	None	4.01	0	0	1	<0.01	<0.1	The ROW and TEWA are located on the edge of the presumed occupied stand and generally occur within existing roads and adjacent early seral habitat; it is not expected that suitable MAMU habitat would be removed from the delineated stand. The project would not fragment the stand but would create a hard edge.
C1040	Occupied (Coos Bay BLM)	13.46BR - 13.78BR	Coos Bay BLM	LSR	72.87	856.55	0.16	1	2.14	2.9	This occupied stand is adjacent to occupied stand C1042. The ROW follows existing Road (EAR 13.15BR-13.66BR, BLM 26-12-4.1) for approximately 1,290 feet on the north edge of the stand, between late seral and early regenerating forest. The ROW would not fragment the stand but would create a hard edge along the north edge of the stand between late seral habitat in the Stand and early regeneration forests.
BR 01	Presumed (Presence – 2015)	14.06BR - 14.15BR	Coos Bay BLM	Other	1.88	0.76	<0.01	1	0.64	34.0	Small stand adjacent to EAR 13.83BR-14.42BR (BLM 26-12-4.4) and surrounded by early seral forest. The ROW would follow the existing road on the edge of the stand. Does not fragment stand but would create a harder edge between stand and early seral forest. Although trees greater than 107 feet that could provide suitable habitat would be removed by the Project (LiDAR coverage), the stand would continue to provide potentially suitable nesting habitat including within at least four trees greater than 200 feet.
G109	Presumed (No Permission)	15.40BR-15.50BR	Private	None	3.17	384.37	0.07	1	1.00	31.5	The ROW removes habitat from eastern portion of small presumed occupied stand and would create a hard edge between early seral forest and the remaining late seral forest in the delineated stand. Based on LiDAR coverage, the Project could remove potentially suitable nesting habitat (trees > 107 feet); however, at least three additional trees greater than 107 feet within the delineated stand would remain.
BR 02A*	Presumed (Ground Survey)	16.44BR - 16.71BR	Coos Bay BLM / Private	LSR / None	81.94	1,456.47	0.28	2	3.78	4.6	ROW generally follows an existing access road (EAR 16.09BR-16.97BR, BLM 26-12-15.2) through the middle of the presumed occupied stand. The ROW generally occurs in smaller trees within the stand but would fragment the stand where it deviates from the existing road; two resulting lobes = 45.9 acres and 32.2 acres. The project would also increase fragmentation along the existing access road.
BR 03*	Presumed (Presence – 2015)	17.13BR - 17.56BR	Coos Bay BLM	LSR	70.29	2,263.56	0.43	2	4.78	6.8	ROW generally follows or parallels an existing road (EAR 16.97BR-18.14BR, Blue Ridge Road) through the stand and would remove forested habitat either side of road. Where the ROW deviates from the existing road, additional edge in the stand would be created; resulting two lobes = 50.85 acres and 14.09 acres. Stand is surrounded by clearcut and early seral forest.
BR 04	Presumed (Presence – 2015)	17.60BR-17.90BR	Coos Bay BLM	LSR	32.13	0	0	1	0.17	0.5	ROW parallels existing access road (EAR 16.97BR-18.14BR, Blue Ridge Road) and removes potential habitat within extreme point of finger-like lobe of presumed occupied stand. Project does not fragment stand but creates harder edge on the narrow stand finger between stand and early seral habitat that surrounds stand.
G120	Presumed (Presence – 2015)	18.86BR - 19.02BR	Coos Bay BLM	LSR	13.06	861.69	0.16	1	2.16	16.5	Stand consists of two lobes separated by existing access road (EAR 10.20BR-19.61BR, Blue Ridge Road). Project generally parallels Blue Ridge Road within the larger, eastern lobe of G120, where habitat is removed on the edge of the lobe between the road and the stand and creates a hard edge.
BR 05	Presumed (Presence – 2015)	19.02BR - 19.13BR 19.18BR - 19.25BR	Coos Bay BLM	LSR	51.00	0	0	1	0.87	1.7	Large stand consists of three lobes separated by Blue Ridge Road. ROW generally parallels Blue Ridge Road and removes habitat between early/mid-seral

TABLE 3.3.3-13

Suitable Nesting Habitat Removed from Occupied and Presumed Occupied Stands Affected by the Proposed Action

MSNO or Site ID a/	Status b/	Project Location (MP range in stand)	Landowner	Land Allocation c/	Overall Acres in the Stand	Length Crossed		Edge Created	Suitable Habitat Affected in MAMU Stand d/		Additional Description (see Maps in appendix Z1)
						Feet	Miles		Acres	Percent of Stand	
											forest and far eastern edge of two lobes of the presumed occupied stand. Project does not further fragment stand but creates harder edge from stand and access road and/or early/mid-seral forest.
BR 06	Presumed (Presence – 2015)	19.50BR - 19.62BR	Coos Bay BLM Bay	LSR	60.79	0	0	0	0.01	<0.1	Large stand consists of two lobes. ROW is generally located over 300 feet west of presumed occupied stand, but is adjacent to the southern edge of the stand for approximately 670 feet where the ROW follows existing access road (EAR 19.20BR-19.61BR, Blue Ridge Road). Although the ROW intersects the Stand at this location, it is not expected that the project would remove suitable nesting habitat – only early regenerating forest along the edge of the existing road.
G122*	Presumed (Presence – 2015)	19.63BR - 20.2BR	Coos Bay BLM	LSR	42.11	1,956.49	0.37	2	5.64	13.4	ROW divides stand for approximately 0.25 mile and then follows the edge of the stand, following an existing access road (EAR 19.88BR-20.05BR) for a portion. Project would fragment the stand and would also create a harder edge along the edge of the stand; resulting two lobes = 9.79 acres and 26.42 acres. Based on LiDAR coverage, the Project could remove potentially suitable nesting habitat (trees > 107 feet); however, the remaining portion of the stand would continue to provide potential nesting habitat (trees > 107 feet).
G128	Presumed (Presence – 2015)	22.69BR - 22.95BR	Coos Bay BLM	LSR	11.34	17.39	<0.01	1	0.25	2.2	ROW traverses the western edge of the presumed occupied stand. Project would not fragment stand but create a harder edge between early seral forest and delineated stand. Although project removes a small amount of habitat from the edge of the stand, it is not expected to remove the larger, potentially suitable trees.
G129	Presumed (Presence – 2015)	23.06BR - 23.08BR	Coos Bay BLM	LSR	1.42	0	0	0	<0.01	<0.1	ROW traverses the western edge of a small presumed occupied stand. Although the ROW is adjacent to the stand and just intersects the delineated stand, the project is not expected to remove suitable MAMU habitat.
G133*	Presumed (No Permission)	24.49BR - 24.5BR	Private	None	1.87	77.90	0.01	2	0.17	9.1	This presumed occupied stand incorporates potentially suitable habitat within a strip of habitat adjacent to an existing access road (EAR 24.50BR) and early regenerating forest. The ROW would bisect the stand in two lobes creating two additional edges; resulting lobes = 1.21 acres and 0.49 acre. Based on available LiDAR, no trees greater than 107 feet would be removed and potential nest trees would remain in the existing stand.
G134*	Presumed (No Permission)	24.58BR - 24.72BR	Private	None	12.84	736.65	0.14	2	1.62	12.6	The ROW bisects this presumed occupied stand that is adjacent and/or near early seral/clearcut forest; resulting two lobes = 5.02 acres and 6.20 acres. One existing road (EAR 24.72BR) traverses across the south eastern portion of the stand. Based on LiDAR coverage, the Project could remove potentially suitable nesting habitat (trees > 107 feet); however, the remaining portion of the stand would continue to provide potential nesting habitat (trees > 107 feet).
G38	Presumed (No Permission)	23.08-23.17	Private	None	3.80	292.75	0.06	1	0.46	12.1	Habitat 'mid-seral' as delineated; LiDAR indicated some taller trees; does not fragment stand but creates new edge - removes habitat from edge; however, contiguous with other older habitat around delineated stand; adjacent "gray habitat" determined not suitable.
C1080* (B02)	Occupied (PCGP – 2013)	27.14 - 27.47	Coos Bay BLM	LSR (PCGP-delineated)	135.87	1,761.62	0.33	2	3.99	2.9	Project would bisect stand - no other existing fragmentation; resulting two lobes = 15.58 acres and 116.30 acres; approximately 93 potential nest trees were identified in the vicinity of the Project, of which 75 would likely be removed during construction (R&A and SBS 2014).
C3098*	Occupied (PCGP – 2007)	32.04 - 32.47	Coos Bay BLM	LSR / CHU	128.40	2,294.41	0.43	2	4.98	3.9	Project would bisect stand increasing fragmentation of stand- existing road crosses stand; resulting two lobes = 106.95 acres and 16.47 acres; occupied behavior detected ~625 feet north of habitat removal; 5 potential nest trees were identified in the vicinity of the Project, of which 3 trees would likely be removed during construction (R&A and SBS 2014).
C3042	Occupied (Coos Bay BLM)	33.84-33.90	Coos Bay BLM	LSR	249.13	325.80	0.06	0	0.87	0.3	Habitat removed adjacent to regenerating forest from edge/small lobe of large stand; generally mid-seral even age forest - within groups of larger older trees outside of project area; 7 potential nest trees were identified within the vicinity of the Project, of which 1 potential nest tree could be removed during construction (R&A and SBS 2014).
C3075	Occupied (Coos Bay BLM)	33.76 - 33.86 33.94 - 34.00	Coos Bay BLM	LSR	43.36	195.77	0.04	0	1.19	2.7	Remove one lobe of delineated stand adjacent to roads and other stand (C3042); no habitat (large trees) would be removed from other lobe of stand - adjacent to regenerating forest; approximately 4 potential nest trees were identified within the vicinity of the Project that could be removed during construction (R&A and SBS 2014).
C3093	Occupied (PCGP – 2007)	35.12 - 35.24 35.34 - 35.79	Coos Bay BLM	LSR	326.96	1,215.34	0.23	0	2.01	0.6	Project travels along roads - in-road construction; approximately 5 potential nest trees were identified on edge of road in delineated stand (R&A and SBS 2014).
C3165 (B07)	Occupied (PCGP – 2013)	35.89 - 36.12	Coos Bay BLM	LSR	67.11	6.05	<0.01	0	0.05	0.1	Project follows road; habitat removed from stand would be immediately adjacent to an existing access road [Elk Creek Rd (BLM 28-11-29)]; 3 potential nest trees were identified on edge of road that could be removed during construction (R&A and

TABLE 3.3.3-13

Suitable Nesting Habitat Removed from Occupied and Presumed Occupied Stands Affected by the Proposed Action

MSNO or Site ID a/	Status b/	Project Location (MP range in stand)	Landowner	Land Allocation c/	Overall Acres in the Stand	Length Crossed Feet	Length Crossed Miles	Edge Created	Suitable Habitat Affected in MAMU Stand d/ Acres	Suitable Habitat Affected in MAMU Stand d/ Percent of Stand	Additional Description (see Maps in appendix Z1)
											SBS 2014).
C3073*	Occupied (Coos Bay BLM)	36.49 - 36.63 36.65 - 37.16	Coos Bay BLM	LSR	174.56	1,485.85	0.28	2	3.21	1.8	Project bisects narrow area of large delineated stand and follows existing road/regenerating forest along one lobe of stand and increases fragmentation in the stand; resulting two lobes = 119.64 acres and 51.70 acres; 22 potential nest trees were identified within the vicinity of the Project, of which 15 potential nest trees could be removed during construction (R&A and SBS 2014).
C3090*	Occupied (PCGP – 2007)	37.14 - 37.16 37.32 - 38.09	Coos Bay BLM	LSR	320.50	3,991.22	0.76	2	9.15	2.9	Project would bisect stand - no other existing fragmentation; resulting two lobes = 199.07 acres and 112.27 acres; 106 potential nest trees were identified within the vicinity of the Project, of which 72 potential nest trees could be removed during construction (R&A and SBS 2014).
C3094	Occupied (PCGP – 2007)	38.09-38.18	Coos Bay BLM	LSR	76.56	489.10	0.09	0	0.94	1.2	Habitat removed from southern edge of delineated occupied stand between recent clearcut and delineated stand – no additional edge created; in 2008 occupied behavior detected ~1,000 feet north of the proposed ROW.
C3095	Occupied (PCGP – 2007)	38.82-38.92	Coos Bay BLM	LSR	21.82	0	0	0	0.52	2.4	Pipeline travels along a road that currently divides the stand - in-road construction; any habitat removed would be along existing stand edges adjacent to Weaver Sitkum Tie Road (BLM 28-10-9.4).
G55	Presumed (No permission)	40.47 - 40.50; TEWA 40.37-N; north and south of ROW; two stands	Private	None	4.20	0	0	1	0.07	1.7	Habitat 'mid-seral' as delineated; LiDAR indicated some taller trees which was used to delineate "potential suitable habitat" in two areas; the Pipeline traverses between the two areas. Habitat is removed by TEWA from edge of smaller delineated lobe that is adjacent to existing access road (EAR 40.27-40.37, Weaver Sitkum Tie Road).
C3070	Occupied (Coos Bay BLM)	41.89-41.97	Coos Bay BLM	LSR/CHU	123.44	413.48	0.08	2	1.02	0.8	One of the three areas delineated for this stand is clipped by the Pipeline; 10 potential nest trees were identified within the vicinity of the Pipeline, of which 8 potential nest trees could be removed during construction (R&A and SBS 2014).
G58	Presumed (No Permission)	43.92 - 44.06	Private	None	4.29	393.43	0.07	0	0.67	15.6	ROW generally occurs in early regen adjacent to presumed occupied stand; ROW would remove the majority of potential suitable habitat on the eastern portion of the stand. Although the project would remove habitat from the edge of the stand, it is currently adjacent to early regenerating habitat and would not expect to increase edge effect.
C3092	Occupied (PCGP – 2007)	45.40-45.47	Coos Bay BLM	LSR	173.05	376.60	0.07	1	0.86	0.5	Habitat along a ridge of a very large stand would be removed; stand would not be fragmented; trees in the northern portion of stand do not provide suitable nesting structures; one hard edge created.
R3035* (EAR 46.51_A)	Occupied (PCGP – 2013)	46.90-47.10	Roseburg BLM	LSR/CHU	201.26	1,038.97	0.20	2	2.47	1.2	Pipeline would bisect stand - existing roads through stand; resulting two lobes = 188.31 acres and 10.46 acres; 31 potential nest trees were identified within the vicinity of the Pipeline, of which 24 potential nest trees could be removed during construction (R&A and SBS 2014).
ALTR-A*	Presumed (No Permission)	50.83 - 51.04	Private	None	14.17	1,093.17	0.21	2	2.40	16.9	Pipeline would bisect presumed occupied stand adjacent to R3036; resulting two lobes = 5.56 acres and 6.20 acres.
R3036* (ALTR-A)	Occupied (PCGP – 2013)	51.04-51.29	Roseburg BLM	LSR	41.58	1,346.14	0.25	2	2.94	7.1	Pipeline would bisect stand; resulting two lobes = 30.78 acres and 7.83 acres; 3 potential nest trees were identified within the vicinity of the Pipeline and could be removed during construction (R&A and SBS 2014) .
			Marbled Murrelet Zone 1 - Stands		**2,694.76**	***26,966.32***	***5.11***	***N/A***	**65.43**	2.4	
Marbled Murrelet Zone 2											
R3052 (B13)	Occupied (PCGP – 2014)	53.11 - 53.64 53.66 - 53.76 54.31 - 54.44	Roseburg BLM/Private	LSR/CHU	206.85	455.46	0.09	0	2.45	1.2	Pipeline is adjacent to stand and occurs within existing road and clearcut/regenerating forest north of stand; no new edge created; 15 potential nest trees were identified within the vicinity of the Pipeline, of which 14 could be removed during construction (R&A and SBS 2014).
R3051* (B14)	Occupied (PCGP – 2014)	60.85-61.66	Roseburg BLM	LSR	219.42	4,287.75	0.81	2	12.31	5.6	Pipeline would bisect stand along a ridgeline - no other existing fragmentation; resulting two lobes = 124.05 acres and 83.06 acres; 34 potential nest trees were identified within the vicinity of the Pipeline, of which 20 could be removed during construction (R&A and SBS 2014) along the ridgeline alignment.
			Marbled Murrelet Zone 2 - Stands		426.2	*4,575.88*	*0.87*	*N/A*	14.76	3.5	
			Total Marbled Murrelet Stands		**3,121.03**	**31,542.20**	**5.97**	**N/A**	**80.19**	**2.6**	

a/ Underlined MSNO or Site ID indicates that the project is not expected to remove suitable nesting habitat from the stand. Asterisk (*) indicates Pipeline would bisect stand and create at least two new edges.
b/ "Occupied" – areas/stands delineated that occupied marbled murrelet behavior has been documented. Stands have been provided by BLM Coos Bay and Roseburg districts (BLM 2017). ""Presumed" – these are areas that may provide suitable MAMU nesting habitat as determined through 1) LiDAR, 2) identified by Coos Bay and/or Roseburg BLM Districts, 3) suitable habitat modeling (Raphael 2015; habitat value 4), or 4) ground-truthed by SBS/PCGP..
c/ Land Allocation: LSR = late-successional reserves; CHU = Marbled Murrelet Critical Habitat Unit OR-06-d; Other = other BLM land use allocations except for LSR; None = marbled murrelet stand on Private or Native American lands and do not have BLM LUA or designated CHU.
d/ MAMU Habitat includes suitable, recruitment, and/or capable habitat affected in the MAMU Stand; non-capable habitat is not tallied. Overall, 78.04 acres of suitable habitat is removed from occupied and presumed occupied stands (see table 3.3.3-10).

PCGP surveyed 17 occupied and presumed occupied stands located on BLM lands in fall 2013 to identify potential nest trees that may occur within proximity of the proposed Pipeline (see R&A and SBS 2014). Trees with adequate nesting platform structures, as outlined in the Pacific Seabird Group protocol (Mack et al. 2003) were considered "potential nest trees" and included: 1) mature (with or without an old-growth component) and old-growth coniferous trees, or 2) younger coniferous trees that have platforms. A nesting platform consists of a relatively flat surface (at least 4 inches in diameter) that occurs at least 33 feet from the ground in the live crown of a coniferous tree and can include a wide bare branch, moss or lichen covered a branch, mistletoe, witches brooms, or other deformities (i.e., squirrel nests).

In October 2013, PCGP cruised/surveyed nine stands that would be affected by the Pipeline, where permitted, of which six stands would be bisected by the Pipeline. LiDAR was available for the stands located in Coos Bay, and based on height of trees (> 107 feet, > 200 feet), there are several potential nest trees within the stands, both within and outside of the right-of-way. Potential nest trees (large trees with deformities) were documented within the construction right-of-way.

Additional description in table 3.3.3-13 describes the potential nest trees that were identified within the proposed construction area, if any. Additional maps have been prepared and included in appendix Z1 for the 39 MAMU stands that would potentially have suitable habitat removed by construction. The maps include locations of potential nest trees located within the vicinity of the proposed Pipeline during survey efforts in fall 2013, and were available (23 of 37 MAMU stands), are produced with a LiDAR background that depicts the structure and height of the MAMU stand, where available. Based on these maps and the potential nest trees documented within the vicinity of the Pipeline right-of-way, it can be assumed that each stand contains trees outside of the Pipeline project area that could provide suitable nesting habitat (i.e., trees greater than 200 feet in height). Although PCGP would remove potential nesting trees, it is expected that the biological viability would remain intact after construction activities have occurred since remaining habitat in the stands adjacent to the Pipeline would continue to provide potentially suitable nesting structures that could be used by the MAMU. In close proximity to the coast (within 20 miles), only one potential nest tree within a stand is considered necessary to provide nesting habitat for MAMU, whereas further from the coast (greater than 20 miles), at least six potential nest trees within a forested stand is considered necessary to be suitable for nesting MAMU. PCGP will evaluate the following possible opportunities during the detailed design phase that would further reduce impact to MAMU nesting habitat and reduce fragmentation, in particular where the Pipeline traverses Blue Ridge: 1) in-road construction where the right-of-way occurs on an edge of a MAMU stand in an existing road, or 2) reduce the width of the construction right-of-way, similar to wetland minimization measures.

Interior Forest Habitat. Indirect effects from construction of the Pipeline are also expected within habitat adjacent to the construction right-of-way, including within interior forest that the MAMU relies on for nesting habitat. The conversion of large tracts of old-growth forest to small, isolated forest patches with large edge areas can create changes in microclimate, vegetation species, and predator-prey dynamics. In general, microclimates along edges differ from those in forest interiors. Two main physical factors affecting and creating an edge microclimate are sun and wind (Forman 1995; Chen et al. 1995; Harper et al. 2005). Compared to the forest interior, areas near edges receive more direct solar radiation during the day, lose more long-wave radiation at night, have lower humidity, and receive less short-wave radiation. Other physical factors affecting edge includes edge orientation (Chen et al. 1995). For example, the general orientation of the Pipeline project is from northwest to southeast. Therefore, edge effects would be most pronounced on the southwest-facing edges and weakest along the northeast-facing edges (see discussion in Chen et al. 1995). Harper et al. (2005) reported that the mean distance of edge influence could occur to approximately 100 meters (328 feet) and result, on average, in 1) increased tree mortality and damage, increased recruitment, increased growth rate, decreased canopy foliage, increased understory foliage, and increased seedling mortality; 2) decreased amounts of canopy trees, reduced canopy cover, increased abundance of snags and logs, increased understory tree density, increased herbaceous cover, and increased shrub cover; and 3) increased stand composition metrics such as species, exotics, individual species, and species diversity. In other younger coniferous forests or mixed forests with deciduous species, edge effects compared to interior forests have been much less pronounced (Heithecker and Halpern 2007; Harper and Macdonald 2002). The importance of interior forest habitat to MAMUs is unclear. Suitable nest trees may be present within interior forest but reproductive success may be lower than at forest edges if access to interior forest nest trees is problematic, decreasing site suitability (Bradley 2002).

To determine indirect effects to MAMU habitat (suitable, recruitment, capable) from construction of the Pipeline project, PCGP assessed effects to MAMU habitat within 100 meters (328 feet) of proposed habitat removal, including effects to interior forest. This distance has been recommended by FWS (2014c), and is similar to the 300 feet considered in discussions within the Habitat Quality subtask force to analyze effects to interior forests (2007 and 2008), and the 295 feet used as an edge assessment by Raphael et al. (2011) within the NWFP 15-Year Monitoring Report for nesting MAMU habitat. This assessment considers the indirect effects of the newly constructed right-of-way on MAMU habitat within 100 meters (328 feet) of habitat removal, including interior forest. To determine which tracts of forested land (late regenerating, mid-seral, late successional, and old-growth) should be considered interior forest, existing edges, such as wide-surface roads, large rivers, early seral forest, and nonforested habitat were buffered by 100 meters (328 feet), and forested habitat included in the buffered area was identified as forested habitat currently affected by existing edge (FWS 2014c). Smaller roads with existing canopy cover were buffered by 50 feet per direction of FWS (2014c). Forested habitat (late regenerating to old-growth forest) that was not included in buffered "currently affected" area was classified as "interior forest" and incorporated into an interior forest GIS layer created for analysis of the Pipeline project.

Table 3.3.3-14 identifies the distance that MAMU habitat is crossed by the proposed Pipeline within and outside of interior habitat, summarizes the acreage of MAMU habitat directly removed and indirectly affected within 100 meters (328 feet) of the Pipeline project (habitat removal) by Marbled Murrelet Inland Zones 1 and 2, landowner, and within and outside of SHUs (summarized from table Q-3 in appendix Q). Approximately 5,163 acres of MAMU habitat (656 acres of suitable habitat, 2,058 acres of recruitment habitat, and 2.449 acres of capable habitat) occur within 100 meters (328 feet) of habitat removal, of which 1,455 acres (28.2 percent) of interior MAMU habitat would be indirectly affected (364 acres of suitable habitat, 644 acres of recruitment habitat, and 447 acres of capable habitat; table 3.3.3-14). The majority of MAMU habitat indirectly affected occurs outside of SHUs: 3,762 acres (72.8 percent) of all MAMU habitat within 100 meters (328 feet) of habitat removal, which includes 840 acres of interior MAMU habitat and 2,922 acres of MAMU habitat currently affected by existing edge.

Table Q-3 in appendix Q identifies the acres of MAMU habitat affected 100 meters (328 feet) from habitat removal by Marbled Murrelet Inland Zone, Recovery Plan Conservation Zone, land allocations (critical habitat and LSR effects), and landowner within SHUs and interior forest. Effects to MAMU habitat adjacent to the construction right-of-way would decrease as the forested area (a maximum of approximately 483 acres; table 3.3.3-14) outside of the 30-foot maintenance corridor are replanted with trees and return to early regenerating stands, except for those habitats on non-federal or Matrix/Harvest Land Base lands where there is less certainty that replanting would occur or be maintained on the landscape. Additionally, if allowed to regrow, these areas would provide minimal benefit to MAMUs because it would take decades at a minimum to restore replanted forests to recruitment or suitable habitat conditions.

Based on table 3.3.3-14, it can be assumed that at least 15.1 miles of interior forest would experience fragmentation as a result of construction and operation of the Pipeline, creating at least 30.2 miles (15.1 miles x 2) of additional edge in approximately 53 miles of MAMU habitat crossed by the Pipeline; this considers interior forest crossed by the Pipeline within older regenerating forest to old-growth forest (see FWS 2014c). Additional fragmentation of approximately 10.3 miles within forest currently affected by existing disturbance ("other" forest in table 3.3.3-14) could occur since approximately 40 percent (30.5 miles) of the Pipeline within the range of MAMU occurs within or is adjacent to/parallels existing disturbance (see co-locate table Q-4 in appendix Q; 40.8 miles minus 30.5 miles), creating approximately 20.6 miles of additional edge in forest already affected by existing disturbance. In addition to MAMU habitat crossed and affected within the MAMU range, approximately 24.3 miles of non-capable habitat would be crossed and remove approximately 676 acres (see table Q-3 in appendix Q). Figure 3.3.3-8 below provides an example of how indirect effects to MAMU habitat, both within and outside of interior forest are considered within the range of the MAMU.

Predation and Edge

A long-held tenet of bird conservation is that habitat fragmentation with concomitant exposure of nests at habitat edges increases risks of nest predation and/or nest parasitism and ultimately affects species' population growth. While various reviews of available literature have supported that relationship (Paton 1994), other reviews have found no relationships or ambiguous associations between fragmentation and nest predation (Murcia 1995; Lahti 2001). A common theme among reviews is poor representation of studies with tested hypotheses on the edge-predator hypothesis (Chalfoun et al. 2002). Some of the disparate results among studies come from forest characteristics, predator species, and predated species which makes generalizations about effects of fragmentation difficult; in western forests, fragmentation may reduce the abundance of some nest predating species while increasing the abundance of others (Tewksbury et al. 1998).

Early studies of fragmentation effects on predation of MAMU nests yielded mixed results (Meyer and Miller 2002). In British Columbia, MAMU nests greater than 150 meters (492 feet) from the edge of fragmented nest stands did not fail because of nest predation (Manley and Nelson 1999 in Nelson 2005). Nelson and Hamer (1995) found that MAMU nest success was higher for nests greater than 50 meters (164 feet) from forest edge. However, an experimental study using artificial nests in Washington did not detect differences in nest predation within fragmented or continuous forest stands (Marzuluff and Restani 1999 cited in Meyer and Miller 2002).

More recent investigations have given new support for the relationship between fragmentation, edges, and predation on MAMU nests. Predation at experimental MAMU nests located at fragment edges and at forest interiors was recorded by cameras. Disturbances by avian predators (Steller's jay, *Cyanocitta stelleri*) were more frequent at hard edges (between old growth and clearcut forest) relative to interiors, but less frequent at soft edges (between old growth and regenerating forest). There were no edge effects at natural-edged sites associated with riparian forest (Malt and Lank 2007).

TABLE 3.3.3-14

Summary of Other Indirect Effects from Construction of the Proposed Action to Marbled Murrelet Habitat (Suitable, Recruitment, Capable), Including Interior Forest within and outside Marbled Murrelet SHUs by Landowner

			Suitable Habitat d/					Recruitment Habitat e/					Capable Habitat f/					Total MAMU Habitat				
				Construction			Operation		Construction			Operation		Construction			Operation	Miles Crossed	Construction			Operation
Landowner a/	General Location b/	Interior Forest c/	Miles Crossed	Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)	Miles Crossed	Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)	Miles Crossed	Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)		Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)
Marbled Murrelet Inland Zone 1																						
Conservation Zone 3																						
Federal	Within SHU	Interior		0.13	7.00	0.71				0.00			0.06	0.66	8.99	0.98	0.22	0.06	0.78	15.99	1.69	0.22
		Other	0.02	2.09	7.63	0.87	0.08		0.00	0.00		0.00	0.30	2.34	2.61	0.35	1.09	0.32	4.43	10.24	1.22	1.17
		Subtotal	0.02	2.22	14.63	1.57	0.08		0.00	0.00		0.00	0.36	2.99	11.60	1.33	1.30	0.38	5.21	26.23	2.91	1.38
	Outside SHU	Interior											0.10	1.39	10.18	0.37	0.37	0.10	1.39	10.18	0.37	0.37
		Other											0.18	2.46	12.34	0.51	0.65	0.18	2.46	12.34	0.51	0.65
		Subtotal											0.28	3.84	22.52	0.89	1.03	0.28	3.84	22.52	0.89	1.03
	Total	Interior	0.00	0.13	7.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.16	2.04	19.17	1.35	0.59	0.16	2.17	26.17	2.06	0.59
		Other	0.02	2.09	7.63	0.87	0.08	0.00	0.00	0.00	0.00	0.00	0.48	4.79	14.95	0.86	1.74	0.50	6.88	22.57	1.73	1.82
		Subtotal	0.02	2.22	14.63	1.57	0.08	0.00	0.00	0.00	0.00	0.00	0.65	6.84	34.12	2.22	2.33	0.66	9.06	48.75	3.79	2.41
Non-Federal	Within SHU	Interior																				0.00
		Other	0.06	0.62	5.22		0.21	0.10	1.45	7.66		0.35	0.22	3.28	16.06		0.80	0.38	5.35	28.94		1.35
		Subtotal	0.06	0.62	5.22		0.21	0.10	1.45	7.66		0.35	0.22	3.28	16.106		0.80	0.38	5.35	28.94		1.35
	Outside SHU	Interior						0.08	1.29	4.02		0.30	0.91	13.77	107.38		3.29	0.99	15.06	111.39		3.59
		Other						0.19	5.97	49.06		0.75	2.51	42.35	242.58	1.39	9.30	2.71	48.31	291.64	1.39	10.06
		Subtotal						0.27	7.26	53.07		1.05	3.42	56.12	349.96	1.39	12.59	3.69	63.38	403.03	1.39	13.64
	Total	Interior	0.00	0.00	0.00	0.00	0.00	0.08	1.29	4.02	0.00	0.30	0.91	13.77	107.38	0.00	3.29	4.07	15.06	111.39	0.00	3.59
		Other	0.06	0.62	5.22	0.00	0.21	0.29	7.42	56.72	0.00	1.10	2.73	45.62	258.64	1.39	10.10	3.08	53.66	320.58	1.39	11.41
		Subtotal	0.06	0.62	5.22	0.00	0.21	0.37	8.71	60.73	0.00	1.40	3.64	59.40	366.02	1.39	13.39	4.07	68.73	431.97	1.39	15.00
Total Conservation Zone 3	Within SHU	Interior	0.00	0.13	7.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.66	8.99	0.98	0.22	0.06	0.78	15.99	1.69	0.22
		Other	0.08	2.71	12.85	0.87	0.29	0.10	1.45	7.66	0.00	0.35	0.53	5.61	18.67	0.35	1.88	0.70	9.78	39.18	1.22	2.52
		Subtotal	0.08	2.84	19.85	1.57	0.29	0.10	1.45	7.66	0.00	0.35	0.58	6.27	27.66	1.33	2.10	0.76	10.56	55.17	2.91	2.74
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	0.08	1.29	4.02	0.00	0.30	1.01	15.16	117.56	0.37	3.67	1.09	16.45	121.58	0.37	3.96
		Other	0.00	0.00	0.00	0.00	0.00	0.19	5.97	49.06	0.00	0.75	2.69	44.80	254.92	1.90	9.95	2.88	50.77	303.97	1.90	10.71
		Subtotal	0.00	0.00	0.00	0.00	0.00	0.27	7.26	5307	0.00	1.05	3.70	59.96	372.48	2.27	13.62	3.97	67.22	425.55	2.27	14.67
	Total	Interior	0.00	0.13	7.00	0.71	0.00	0.08	1.29	4.02	0.00	0.30	1.07	15.82	126.55	1.35	3.89	4.23	17.24	137.57	2.06	4.18
		Other	0.08	2.71	12.85	0.87	0.29	0.29	7.42	56.72	0.00	1.10	3.22	50.42	273.58	2.25	11.83	3.58	60.55	343.15	3.12	13.23
		Subtotal	0.08	2.84	19.85	1.57	0.29	0.37	8.71	60.74	0.00	1.40	4.29	66.23	400.13	3.61	15.72	4.73	77.78	480.72	5.18	17.41
Marbled Murrelet Inland Zone 1																						
Conservation Zone 4																						
Federal	Within SHU	Interior	1.48	19.85	236.22	6.23	5.52	1.23	15.51	92.94	4.57	4.45	0.58	9.95	59.91	2.30	2.11	3.30	45.32	389.08	13.10	12.08
		Other	2.28	27.86	191.21	6.52	8.34	1.19	16.67	102.72	2.51	4.34	1.38	29.10	107.53	6.40	5.06	4.86	73.62	401.46	15.43	17.74
		Subtotal	3.77	47.71	427.43	12.74	13.85	2.42	32.18	195.67	7.08	8.80	1.97	39.06	167.44	8.71	7.17	8.15	118.95	790.54	28.53	29.82
	Outside SHU	Interior						1.17	18.16	148.30	1.15	4.28	0.38	5.66	59.43	0.55	1.36	1.55	23.82	207.72	1.69	5.64
		Other						3.31	46.99	259.83	4.09	12.06	1.38	20.81	126.21	3.14	5.08	4.70	67.80	386.05	7.23	17.13
		Subtotal						4.48	65.15	408.13	5.24	16.34	1.76	26.47	185.64	3.69	6.44	6.25	91.61	593.77	8.93	22.78
	Subtotal	Interior	1.48	19.85	236.22	6.23	5.52	2.40	33.67	241.24	5.72	8.74	0.96	15.61	119.34	2.85	3.47	4.85	69.14	596.80	14.79	17.72
		Other	2.28	27.86	191.21	6.52	8.34	4.50	63.66	362.56	6.60	16.40	2.77	49.91	233.74	9.55	10.13	9.55	141.42	787.51	22.67	34.87
		Subtotal	3.77	47.71	427.43	12.74	13.85	6.90	97.32	603.80	12.32	25.14	3.73	65.53	353.08	12.40	13.60	14.40	210.56	1,384.31	37.46	52.59
Non-Federal	Within SHU	Interior	0.16	2.74	36.97	0.95	0.60	0.24	4.64	27.37	1.45	0.89	0.19	3.41	38.28	1.84	0.69	0.60	10.79	102.62	4.25	2.19
		Other	0.47	4.99	29.27	1.88	1.69	0.95	14.05	38.25	1.92	3.48	1.63	26.88	130.27	7.54	5.97	3.05	45.92	197.79	11.33	11.14
		Subtotal	0.63	7.73	66.24	2.83	2.29	1.19	18.69	65.62	3.37	4.38	1.83	30.28	168.55	9.38	6.67	3.65	56.71	300.42	15.58	13.34
	Outside SHU	Interior						0.29	4.38	43.15	1.06	1.02	0.86	13.46	119.25	2.89	3.16	1.15	17.83	162.39	3.95	4.17
		Other						0.78	18.95	152.88	2.81	3.05	11.44	188.38	1,019.09	26.08	41.58	12.23	207.33	1,171.97	28.89	44.63
		Subtotal						1.07	23.33	196.03	3.87	4.07	12.30	201.84	1,138.33	28.96	44.74	13.37	225.17	1,334.36	32.83	48.80
	Total	Interior	0.16	2.74	36.97	0.95	0.60	0.53	9.02	70.52	2.52	1.91	1.05	16.86	157.53	4.73	3.85	1.75	28.63	265.01	8.19	6.37
		Other	0.47	4.99	29.27	1.88	1.69	1.73	33.00	191.13	4.72	6.53	13.08	215.26	1,149.36	33.62	47.55	15.28	253.25	1,369.76	40.22	55.77
		Subtotal	0.63	7.73	66.24	2.83	2.29	2.27	42.02	261.65	7.24	8.44	14.13	232.12	1,306.89	38.34	51.40	17.02	281.88	1,634.78	48.41	62.14
Total Conservation Zone 4	Within SHU	Interior	1.65	22.60	273.19	7.18	6.12	1.48	20.16	120.31	6.02	5.35	0.78	13.36	98.20	4.14	2.80	3.90	56.12	491.70	17.35	14.27
		Other	2.75	32.85	220.48	8.40	10.02	2.14	30.72	140.98	4.43	7.83	3.02	55.98	237.80	13.94	11.03	7.91	119.54	599.25	26.76	28.88
		Subtotal	4.40	55.44	493.67	15.58	16.14	3.62	50.87	261.29	10.45	13.18	3.79	69.34	335.99	18.08	13.83	11.81	175.66	1,090.95	44.11	43.15
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	1.46	22.53	191.44	2.21	5.30	1.24	19.12	178.67	3.43	4.52	2.69	41.65	370.12	5.64	9.82
		Other	0.00	0.00	0.00	0.00	0.00	4.10	65.94	412.72	6.90	15.11	12.83	209.19	1,145.30	29.22	46.66	16.93	275.13	1,558.02	36.12	61.76
		Subtotal	0.00	0.00	0.00	0.00	0.00	5.55	88.48	604.16	9.11	20.40	14.07	228.31	1,323.97	32.65	51.17	19.62	316.78	1,928.13	41.76	71.58
	Total	Interior	1.65	22.60	273.19	7.18	6.12	2.93	42.69	311.76	8.23	10.65	2.01	32.48	276.87	7.58	7.32	6.59	97.77	861.81	22.99	24.09

TABLE 3.3.3-14

Summary of Other Indirect Effects from Construction of the Proposed Action to Marbled Murrelet Habitat (Suitable, Recruitment, Capable), Including Interior Forest within and outside Marbled Murrelet SHUs by Landowner

Landowner a/	General Location b/	Interior Forest c/	Suitable Habitat d/ Miles Crossed	Suitable Habitat d/ Construction Removed g/ (acres)	Suitable Habitat d/ Construction Indirect i/ (acres)	Suitable Habitat d/ Construction UCSA j/ (acres)	Suitable Habitat d/ Operation 30-foot Corridor k/ (acres)	Recruitment Habitat e/ Miles Crossed	Recruitment Habitat e/ Construction Removed g/ (acres)	Recruitment Habitat e/ Construction Indirect i/ (acres)	Recruitment Habitat e/ Construction UCSA j/ (acres)	Recruitment Habitat e/ Operation 30-foot Corridor k/ (acres)	Capable Habitat f/ Miles Crossed	Capable Habitat f/ Construction Removed g/ (acres)	Capable Habitat f/ Construction Indirect i/ (acres)	Capable Habitat f/ Construction UCSA j/ (acres)	Capable Habitat f/ Operation 30-foot Corridor k/ (acres)	Total MAMU Habitat Miles Crossed	Total MAMU Habitat Construction Removed g/ (acres)	Total MAMU Habitat Construction Indirect i/ (acres)	Total MAMU Habitat Construction UCSA j/ (acres)	Total MAMU Habitat Operation 30-foot Corridor k/ (acres)
		Other	2.75	32.85	220.48	8.40	10.02	6.24	96.66	553.69	11.33	22.93	15.84	265.17	1,383.10	43.16	57.69	24.83	394.67	2,157.27	62.89	90.64
		Subtotal	4.40	55.44	493.67	15.58	16.14	9.17	139.35	865.45	19.56	33.58	17.86	297.65	1,659.97	50.74	65.01	31.43	492.44	3,019.08	85.87	114.73
Marbled Murrelet Inland Zone 1																						
No Recovery Conservation Zone																						
Federal	Within SHU	Interior	0.19	2.24	14.07		0.70	0.09	1.17	6.20		0.34	0.01	0.08	2.22		0.02	0.29	3.49	22.49		1.07
		Other	0.08	1.96	31.02	1.64	0.29	0.02	0.30	2.22	0.02	0.06	0.63	7.94	34.48	0.14	2.32	0.72	10.20	67.71	1.80	2.68
		Subtotal	0.27	4.20	45.08	1.64	0.99	0.11	1.47	8.42	0.02	0.41	0.63	8.02	36.70	0.14	2.35	1.02	13.69	90.21	1.80	3.75
	Outside SHU	Interior						0.06	1.30	21.29		0.22		0.00	0.01			0.06	1.30	21.29		0.22
		Other						0.82	11.80	40.13		3.03	0.02	0.15	0.66		0.07	0.84	11.95	40.80		3.10
		Subtotal						0.88	13.10	61.42		3.25	0.02	0.15	0.67		0.07	0.90	13.25	62.09		3.32
	Subtotal	Interior	0.19	2.24	14.07	0.00	0.70	0.15	2.47	27.49	0.00	0.56	0.01	0.08	2.23	0.00	0.02	0.35	4.79	43.79	0.00	1.28
		Other	0.08	1.96	31.02	1.64	0.29	0.84	12.10	42.36	0.02	3.10	0.65	8.09	35.14	0.14	2.39	1.56	22.15	108.51	1.80	5.78
		Subtotal	0.27	4.20	45.08	1.64	0.99	0.99	14.57	69.85	0.02	3.66	0.65	8.17	37.37	0.14	2.42	1.92	26.94	152.30	1.80	7.06
Non-Federal	Within SHU	Interior	0.10	1.27	4.53		0.38	0.00	0.01	2.46		0.00						0.10	1.28	7.00		0.38
		Other	0.10	1.13	7.09	0.00	0.37	0.05	0.43	5.40	0.00	0.18	0.25	3.51	16.89	0.89	0.90	0.40	5.07	29.37	0.89	1.45
		Subtotal	0.21	2.40	11.62	0.00	0.75	0.05	0.44	7.87	0.00	0.18	0.25	3.51	16.89	0.89	0.90	0.50	6.35	36.37	0.89	1.83
	Outside SHU	Interior						0.24	3.35	27.95		0.89	0.09	1.21	4.95		0.32	0.33	4.56	32.90		1.21
		Other						0.57	7.22	95.82		2.09	0.96	13.85	99.51	3.75	3.48	1.53	21.07	195.34	3.75	5.57
		Subtotal						0.81	10.57	123.77		2.98	1.05	15.06	104.46	3.75	3.80	1.86	25.63	228.24	3.75	6.78
	Subtotal	Interior	0.10	1.27	4.53	0.00	0.38	0.25	3.36	30.42	0.00	0.89	0.09	1.21	4.95	0.00	0.32	0.44	5.84	39.90	0.00	1.59
		Other	0.10	1.13	7.09	0.00	0.37	0.62	7.64	101.23	0.00	2.26	1.20	17.36	116.40	4.64	4.38	1.92	26.14	224.71	4.64	7.02
		Subtotal	0.21	2.40	11.62	0.00	0.75	0.86	11.01	131.64	0.00	3.16	1.29	18.57	121.35	4.64	4.70	2.36	31.98	264.61	4.64	8.60
Total MAMU Zone 1 - No Conservation Recovery Zone	Within SHU	Interior	0.30	3.50	18.60	0.00	1.08	0.10	1.18	8.67	0.00	0.35	0.01	0.08	2.22	0.00	0.02	0.40	4.77	29.49	0.00	1.45
		Other	0.18	3.09	38.10	1.64	0.66	0.07	0.73	7.63	0.02	0.24	0.87	11.45	51.37	1.03	3.22	1.12	15.27	97.09	2.69	4.13
		Subtotal	0.48	6.60	56.70	1.64	1.74	0.16	1.91	16.29	0.02	0.59	0.88	11.53	53.59	1.03	3.24	1.52	20.04	126.58	2.69	5.57
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	0.30	4.65	49.24	0.00	1.11	0.09	1.21	4.96	0.00	0.32	0.39	5.86	54.20	0.00	1.42
		Other	0.00	0.00	0.00	0.00	0.00	1.39	19.02	135.95	0.00	5.12	0.98	14.00	100.17	3.75	3.55	2.36	33.02	236.14	3.75	8.67
		Subtotal	0.00	0.00	0.00	0.00	0.00	1.69	23.67	185.19	0.00	6.23	1.07	15.21	105.13	3.75	3.87	2.76	38.88	290.33	3.75	10.10
	Total	Interior	0.30	3.50	18.60	0.00	1.08	0.40	5.83	57.91	0.00	1.45	0.09	1.29	7.18	0.00	0.34	0.79	10.63	83.69	0.00	2.87
		Other	0.18	3.09	38.10	1.64	0.66	1.45	19.74	143.58	0.02	5.36	1.85	25.45	151.54	4.77	6.77	3.48	48.29	333.22	6.43	12.80
		Subtotal	0.48	6.60	56.70	1.64	1.74	1.85	25.57	201.49	0.02	6.81	1.94	26.74	158.72	4.77	7.11	4.28	58.92	416.91	6.43	15.67
TOTAL Marbled Murrelet Inland Zone 1																						
Federal	Within SHU	Interior	1.68	22.22	257.29	6.93	6.22	1.33	16.69	99.15	4.57	4.80	0.65	10.69	71.12	3.29	2.35	3.65	49.60	427.56	14.79	13.36
		Other	2.38	31.91	229.85	9.03	8.71	1.21	16.97	104.95	2.53	4.41	2.31	39.37	144.61	6.89	8.47	5.90	88.25	479.41	18.45	21.58
		Subtotal	4.06	54.13	487.14	15.96	14.93	2.53	33.65	204.09	7.10	9.21	2.96	50.07	215.74	10.17	10.81	9.55	137.85	906.97	33.24	34.95
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	1.23	19.45	169.59	1.15	4.50	0.48	7.05	69.61	0.92	1.74	1.71	26.50	239.20	2.06	6.23
		Other	0.00	0.00	0.00	0.00	0.00	4.13	58.79	299.97	4.09	15.09	1.58	23.42	139.21	3.66	5.80	5.72	82.21	439.18	7.75	20.89
		Subtotal	0.00	0.00	0.00	0.00	0.00	5.36	78.24	469.55	5.24	19.59	2.06	30.47	208.83	4.57	7.53	7.43	108.71	678.38	9.81	27.12
	Subtotal	Interior	1.68	22.22	257.29	6.93	6.22	2.56	36.14	268.73	5.72	9.30	1.13	17.74	140.74	4.20	4.08	5.36	76.10	666.76	16.85	19.60
		Other	2.38	31.91	229.85	9.03	8.71	5.34	75.76	404.92	6.62	19.50	3.90	62.79	283.83	10.55	14.27	11.62	170.46	918.59	26.19	42.47
		Subtotal	4.06	54.13	487.14	15.96	14.93	7.90	111.90	673.65	12.33	28.79	5.03	80.53	424.57	14.75	18.35	16.98	246.56	1,585.35	43.05	62.07
Non-Federal	Within SHU	Interior	0.27	4.01	41.50	0.95	0.98	0.25	4.65	29.84	1.45	0.90	0.19	3.41	38.28	1.84	0.69	0.70	12.07	109.62	4.25	2.57
		Other	0.63	6.74	41.58	1.88	2.27	1.10	15.93	51.32	1.92	4.01	2.10	33.67	163.22	8.43	7.66	3.82	56.34	256.10	12.22	13.94
		Subtotal	0.89	10.75	83.08	2.83	3.25	1.34	20.58	81.15	3.37	4.91	2.29	37.07	201.50	10.27	8.36	4.53	68.41	365.72	16.47	16.52
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	0.61	9.02	75.11	1.06	2.20	1.85	28.44	231.58	2.89	6.77	2.46	37.46	306.69	3.95	8.97
		Other	0.00	0.00	0.00	0.00	0.00	1.54	32.13	297.76	2.81	5.89	14.92	244.58	1,361.18	31.21	54.36	16.46	276.71	1,658.95	34.02	60.25
		Subtotal	0.00	0.00	0.00	0.00	0.00	2.16	41.16	372.87	3.87	8.09	16.77	273.02	1,592.75	34.10	61.13	18.92	314.17	1,965.63	37.97	69.22
	Subtotal	Interior	0.27	4.01	41.50	0.95	0.98	0.86	13.68	104.95	2.52	3.10	2.04	31.84	269.86	4.73	7.46	6.25	49.53	416.31	8.19	11.54
		Other	0.63	6.74	41.58	1.88	2.27	2.64	48.06	349.08	4.72	9.90	17.02	278.25	1,524.39	39.64	62.03	20.28	333.05	1,915.05	46.24	74.20
		Subtotal	0.89	10.75	83.08	2.83	3.25	3.50	61.74	454.02	7.24	13.00	19.06	310.09	1,794.25	44.36	69.49	23.45	382.58	2,331.36	54.44	85.74
Total MAMU Inland Zone 1	Within SHU	Interior	1.94	26.23	298.79	7.89	7.20	1.57	21.34	129.98	6.02	5.70	0.84	14.10	109.41	5.13	3.04	4.36	61.67	537.18	19.04	15.94
		Other	3.01	38.65	271.43	10.91	10.98	2.30	32.90	156.26	4.44	8.42	4.41	73.04	307.83	15.32	16.13	9.73	144.59	735.52	30.67	35.53
		Subtotal	4.95	64.88	570.22	18.80	18.18	3.87	54.24	85.25	10.47	14.11	5.25	87.14	417.24	20.44	19.17	14.08	206.26	72.69	49.70	51.46
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	1.84	28.47	244.70	2.21	6.70	2.33	35.49	301.19	3.80	8.50	4.18	63.96	545.89	6.01	15.20
		Other	0.00	0.00	0.00	0.00	0.00	5.68	90.93	597.73	6.90	20.98	16.50	268.00	1,500.39	34.87	60.16	22.17	358.92	2,098.13	41.77	81.14
		Subtotal	0.00	0.00	0.00	0.00	0.00	7.52	119.40	842.43	9.11	27.68	18.83	303.48	1,801.58	38.67	68.67	26.35	422.88	2,644.02	47.78	96.35

TABLE 3.3.3-14

Summary of Other Indirect Effects from Construction of the Proposed Action to Marbled Murrelet Habitat (Suitable, Recruitment, Capable), Including Interior Forest within and outside Marbled Murrelet SHUs by Landowner

			Suitable Habitat d/					Recruitment Habitat e/					Capable Habitat f/					Total MAMU Habitat				
				Construction			Operation		Construction			Operation		Construction			Operation	Miles Crossed	Construction			Operation
Landowner a/	General Location b/	Interior Forest c/	Miles Crossed	Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)	Miles Crossed	Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)	Miles Crossed	Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)		Removed g/ (acres)	Indirect i/ (acres)	UCSA j/ (acres)	30-foot Corridor k/ (acres)
		Interior	1.94	26.23	298.79	7.89	7.20	3.41	49.81	373.68	8.23	12.40	3.18	49.59	410.60	8.93	11.55	11.61	125.63	1,083.07	25.05	31.14
	Total	Other	3.01	38.65	271.43	10.91	10.98	7.98	123.82	753.99	11.34	29.40	20.91	341.04	1,808.22	50.19	76.29	31.90	503.51	2,833.64	72.44	116.67
		Subtotal	4.95	64.88	570.22	18.80	18.18	11.39	173.64	1,127.67	19.57	41.79	24.09	390.63	2,218.82	59.11	87.84	40.43	629.14	3,916.71	97.48	147.81
Marbled Murrelet Inland Zone 2 (No Recovery Conservation Zone)																						
Federal	Within SHU	Interior	0.80	12.30	64.87	4.46	2.91											0.80	12.30	64.87	4.46	2.91
		Other	0.06	0.81	20.83	0.22	0.23			0.12					5.80			0.06	0.81	26.75	0.22	0.23
		Subtotal	0.86	13.11	85.69	4.68	3.14			0.12					5.80			0.86	13.11	91.62	4.68	3.14
	Outside SHU	Interior						0.92	12.82	81.57	1.42	3.35		0.01	0.45	0.02		0.92	12.83	82.02	1.43	3.35
		Other						0.43	5.45	25.57	0.41	1.55	0.01	0.16	2.50	0.19	0.04	0.44	5.61	28.07	0.60	1.59
		Subtotal						1.35	18.27	107.14	1.83	4.90	0.01	0.17	2.95	0.21	0.04	1.36	18.44	110.09	2.04	4.94
	Subtotal	Interior	0.80	12.30	64.87	4.46	2.91	0.92	12.82	81.57	1.42	3.35	0.00	0.01	0.45	0.02	0.00	1.72	25.13	146.89	5.89	6.26
		Other	0.06	0.81	20.83	0.22	0.23	0.43	5.45	25.70	0.41	1.55	0.01	0.16	8.30	0.19	0.04	0.50	6.42	54.83	0.83	1.82
		Total	0.86	13.11	85.69	4.68	3.14	1.35	18.27	107.26	1.83	4.90	0.01	0.17	8.76	0.21	0.04	2.22	31.55	201.71	6.72	8.08
Non-Federal	Within SHU	Interior	0.00	0.02	0.11	0.02	0.00	0.18	2.31	8.39	2.26	0.65	0.18	2.08	3.87		0.66	0.36	4.42	12.37	2.28	1.32
		Other	0.00	0.03	0.16	0.01	0.01	0.13	1.17	7.22	0.65	0.43	0.28	3.04	9.04	1.38	0.99	0.41	4.23	16.42	2.04	1.43
		Subtotal	0.00	0.05	0.27	0.03	0.01	0.31	3.48	15.61	2.90	1.08	0.46	5.12	12.91	1.38	1.66	0.77	8.65	28.79	4.32	2.75
	Outside SHU	Interior						1.20	16.27	180.24	7.66	4.39	0.18	2.92	32.34	1.27	0.67	1.38	19.19	212.58	8.94	5.06
		Other						6.50	95.27	626.97	32.12	23.48	1.53	22.65	175.96	7.55	5.53	8.03	117.92	802.93	39.67	29.02
		Subtotal						7.70	111.54	807.21	39.78	27.88	1.71	25.57	208.30	8.83	6.20	9.41	137.11	1,015.51	48.61	34.08
	Subtotal	Interior	0.00	0.02	0.11	0.02	0.00	1.38	18.58	188.63	9.92	5.05	0.36	5.00	36.22	1.27	1.33	1.74	23.61	224.95	11.21	6.37
		Other	0.00	0.03	0.16	0.01	0.01	6.63	96.44	634.18	32.77	23.91	1.80	25.69	185.00	8.94	6.53	8.44	122.15	819.34	41.71	30.45
		Total	0.00	0.05	0.27	0.03	0.01	8.01	115.02	822.82	42.68	28.96	2.17	30.69	221.21	10.21	7.85	10.18	145.76	1,044.30	52.93	36.82
Subtotal Marbled Murrelet Zone2	Within SHU	Interior	0.80	12.33	64.97	4.48	2.91	0.18	2.31	8.39	2.26	0.65	0.18	2.08	3.87	0.00	0.66	1.16	16.72	77.24	6.73	4.22
		Other	0.07	0.84	20.99	0.24	0.24	0.13	1.17	7.34	0.65	0.43	0.28	3.04	14.84	1.38	0.99	0.47	5.04	43.17	2.26	1.66
		Subtotal	0.87	13.16	85.96	4.71	3.15	0.31	3.48	15.73	2.90	1.08	0.46	5.12	18.71	1.38	1.66	1.63	21.76	120.41	9.00	5.89
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	2.12	29.09	261.81	9.08	7.75	0.18	2.93	32.80	1.29	0.67	2.31	32.02	294.60	10.37	8.41
		Other	0.00	0.00	0.00	0.00	0.00	6.93	100.72	652.54	32.53	25.03	1.54	22.81	178.46	7.74	5.57	8.47	123.53	831.00	40.28	30.60
		Subtotal	0.00	0.00	0.00	0.00	0.00	9.05	129.81	914.35	41.61	32.78	1.72	25.74	211.25	9.04	6.24	10.77	155.55	1,125.60	50.65	39.02
	Subtotal	Interior	0.80	12.33	64.97	4.48	2.91	2.30	31.40	270.20	11.33	8.40	0.36	5.01	36.67	1.29	1.33	3.47	48.74	371.84	17.10	12.64
		Other	0.07	0.84	20.99	0.24	0.24	7.06	101.89	659.88	33.18	25.46	1.81	25.85	193.30	9.13	6.56	8.94	128.58	874.17	42.54	32.27
		Total	0.87	13.16	85.96	4.71	3.15	9.36	133.29	930.08	44.51	33.86	2.18	30.86	229.97	10.42	7.89	12.40	177.31	1,246.01	59.64	44.90
Total Marbled Murrelet Range																						
Federal	Within SHU	Interior	2.48	34.52	322.15	11.39	9.13	1.33	16.69	99.15	4.57	4.80	0.65	10.69	71.12	3.29	2.35	4.45	61.90	492.42	19.25	16.27
		Other	2.45	32.72	250.68	9.25	8.94	1.21	16.97	105.07	2.53	4.41	2.31	39.37	150.42	6.89	8.47	5.97	89.06	506.17	18.67	21.81
		Subtotal	4.92	67.24	572.83	20.64	18.07	2.53	33.65	204.22	7.10	9.21	2.96	50.07	221.54	10.17	10.81	10.42	150.96	998.59	37.92	38.09
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	2.15	32.27	251.15	2.56	7.85	0.48	7.06	70.07	0.94	1.74	2.63	39.33	321.22	3.50	9.59
		Other	0.00	0.00	0.00	0.00	0.00	4.56	64.25	325.54	4.51	16.64	1.59	23.58	141.71	3.85	5.84	6.15	87.82	467.25	8.35	22.48
		Subtotal	0.00	0.00	0.00	0.00	0.00	6.71	96.52	576.69	7.07	24.49	2.08	30.63	211.78	4.78	7.57	8.79	127.15	788.47	11.85	32.06
	Subtotal	Interior	2.48	34.52	322.15	11.39	9.13	3.48	48.96	350.30	7.13	12.65	1.13	17.75	141.19	4.22	4.08	7.09	101.23	813.65	22.74	25.86
		Other	2.45	32.72	250.68	9.25	8.94	5.77	81.21	430.61	7.03	21.05	3.91	62.95	292.13	10.74	14.30	12.12	176.88	973.42	27.02	44.29
		Total	4.92	67.24	572.83	20.64	18.07	9.24	130.17	780.91	14.16	33.70	5.04	80.70	433.32	14.96	18.39	19.20	278.11	1,787.06	49.77	70.15
Non-Federal	Within SHU	Interior	0.27	4.04	41.61	0.97	0.98	0.42	6.97	38.23	3.71	1.55	0.37	5.49	42.16	1.84	1.36	1.07	16.49	121.99	6.52	3.89
		Other	0.63	6.77	41.74	1.89	2.28	1.22	17.10	58.53	2.56	4.43	2.38	36.70	172.26	9.81	8.66	4.23	60.57	272.52	14.26	15.38
		Subtotal	0.90	10.80	83.35	2.86	3.27	1.65	24.06	96.76	6.27	5.98	2.75	42.19	214.41	11.65	10.02	5.30	77.06	394.51	20.78	19.27
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	1.81	25.29	255.35	8.73	6.59	2.03	31.36	263.92	4.16	7.44	3.85	56.65	519.27	12.89	14.03
		Other	0.00	0.00	0.00	0.00	0.00	8.05	127.40	924.73	34.93	29.38	16.44	267.23	1,537.14	38.77	59.89	24.49	394.63	2,461.87	73.69	89.27
		Subtotal	0.00	0.00	0.00	0.00	0.00	9.86	152.69	1,180.08	43.65	35.97	18.48	298.59	1,801.05	42.93	67.33	28.34	451.28	2,981.14	86.58	103.30
	Subtotal	Interior	0.27	4.04	41.61	0.97	0.98	2.24	32.25	293.58	12.43	8.15	2.41	36.85	306.08	6.00	8.79	7.99	73.14	641.26	19.41	17.92
		Other	0.63	6.77	41.74	1.89	2.28	9.27	144.50	983.26	37.49	33.81	18.82	303.93	1,709.39	48.58	68.55	28.72	455.20	2,734.39	87.95	104.65
		Total	0.90	10.80	83.35	2.86	3.27	11.51	176.76	1,276.84	49.92	41.95	21.23	340.78	2,015.47	54.58	77.35	33.63	528.34	3,375.65	107.36	122.56
Total Marbled Murrelet Range	Within SHU	Interior	2.74	38.56	363.76	12.36	10.11	1.75	23.65	99.15	8.28	6.35	1.02	16.18	113.28	5.13	3.70	5.52	78.39	614.42	25.77	20.16
		Other	3.08	39.49	292.42	11.14	11.22	2.43	34.07	105.07	5.09	8.84	4.69	76.08	322.67	16.70	17.13	10.20	149.63	778.69	32.93	37.19
		Subtotal	5.82	78.04	656.18	23.51	21.33	4.18	57.72	204.22	13.37	15.19	5.71	92.26	435.95	21.82	20.83	15.71	228.02	1,393.10	58.70	57.35
	Outside SHU	Interior	0.00	0.00	0.00	0.00	0.00	3.97	57.56	251.15	11.29	14.45	2.52	38.42	333.99	5.10	9.17	6.48	95.98	840.49	16.38	23.62
		Other	0.00	0.00	0.00	0.00	0.00	12.60	191.65	325.54	39.43	46.01	18.04	290.81	1,678.85	42.61	65.73	30.64	482.46	2,929.12	82.05	111.75
		Subtotal	0.00	0.00	0.00	0.00	0.00	16.57	249.21	576.69	50.72	60.46	20.55	329.22	2,012.83	47.71	74.90	37.12	578.43	3,769.62	98.43	135.36

TABLE 3.3.3-14

Summary of Other Indirect Effects from Construction of the Proposed Action to Marbled Murrelet Habitat (Suitable, Recruitment, Capable), Including Interior Forest within and outside Marbled Murrelet SHUs by Landowner

			Suitable Habitat d/					**Recruitment Habitat e/**					**Capable Habitat f/**					**Total MAMU Habitat**				
				Construction			**Operation**		**Construction**			**Operation**		**Construction**			**Operation**	**Miles Crossed**	**Construction**			**Operation**
Landowner a/	**General Location b/**	**Interior Forest c/**	**Miles Crossed**	**Removed g/ (acres)**	**Indirect i/ (acres)**	**UCSA j/ (acres)**	**30-foot Corridor k/ (acres)**	**Miles Crossed**	**Removed g/ (acres)**	**Indirect i/ (acres)**	**UCSA j/ (acres)**	**30-foot Corridor k/ (acres)**	**Miles Crossed**	**Removed g/ (acres)**	**Indirect i/ (acres)**	**UCSA j/ (acres)**	**30-foot Corridor k/ (acres)**		**Removed g/ (acres)**	**Indirect i/ (acres)**	**UCSA j/ (acres)**	**30-foot Corridor k/ (acres)**
		Interior	2.74	38.56	363.76	12.36	10.11	5.72	81.21	643.88	19.57	20.80	3.54	54.60	447.27	10.22	12.87	15.08	174.37	1,454.91	42.15	43.78
	Subtotal	Other	3.08	39.49	292.42	11.14	11.22	15.04	225.72	1,413.87	44.52	54.86	22.73	366.88	2,001.52	59.31	82.86	40.84	632.09	3,707.81	114.98	148.94
		Total	5.82	78.04	656.18	23.51	21.33	20.75	306.93	2,057.75	64.09	75.65	26.27	421.48	2,448.79	69.53	95.73	52.84	806.45	5,162.72	157.13	192.71

a/ Landowner: Federal includes Coos Bay and Roseburg BLM Districts; Non-federal includes State and Private lands.
b/ General Location identifies areas within Marbled Murrelet SHUs—occupied and presumed occupied—and areas outside of Marbled Murrelet SHUs but within the range of the marbled murrelet.
c/ Interior Forest: forested habitat farther than 100 meters (328 feet) from existing disturbance (i.e., wide-surface roads, existing corridors) or adjacent land use/vegetation type (i.e., agriculture, non-forest, early regenerating forest), and/or farther than 50 feet from smaller roads with existing canopy cover (FWS 2014c). Other Forest Type includes forested habitat that is currently affected by existing disturbance or adjacent land use/vegetation types within 100 meters (328 feet) of disturbance
d/ Suitable Habitat: generally late-seral forested stands that provide or are presumed to provide nesting structures for marbled murrelet based on modeling and other available GIS data.
e/ Recruitment Habitat: forested land not currently suitable for marbled murrelet nesting that may be capable of becoming suitable marbled murrelet habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).
f/ Capable Habitat: forested land that has the capability of becoming suitable nesting marbled murrelet habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).
g/ Total Habitat: only includes forested MAMU habitat
h/ Pipeline project components considered in calculation of habitat "Removed:" construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, and rock source and disposal site.
i/ Acres identified as UCSAs have been incorporated into the 100-meter indirect effects. Indirect Effects considers habitat within 100-meters (328 feet) of habitat removal as measured from the edge of habitat removal/edge of right-of-way/TEWA.
j/ UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.
k/ 30-foot-wide Maintenance Corridor would be kept in a shrub/sapling state for the life of the project; all other habitat outside of the 30-foot maintenance corridor would be revegetated, except for those habitats on non-federal or matrix lands where there is less certainty that replanting would occur or be maintained on the landscape.
Note: Table summarized from table Q-3 in appendix Q, which includes effects by general landowner, by Conservation Zones 3 and 4 and Marbled Murrelet Inland Zones 1 and 2. Habitat effects are also broken out marbled murrelet habitat type and within and outside of marbled murrelet SHUs (occupied and presumed).

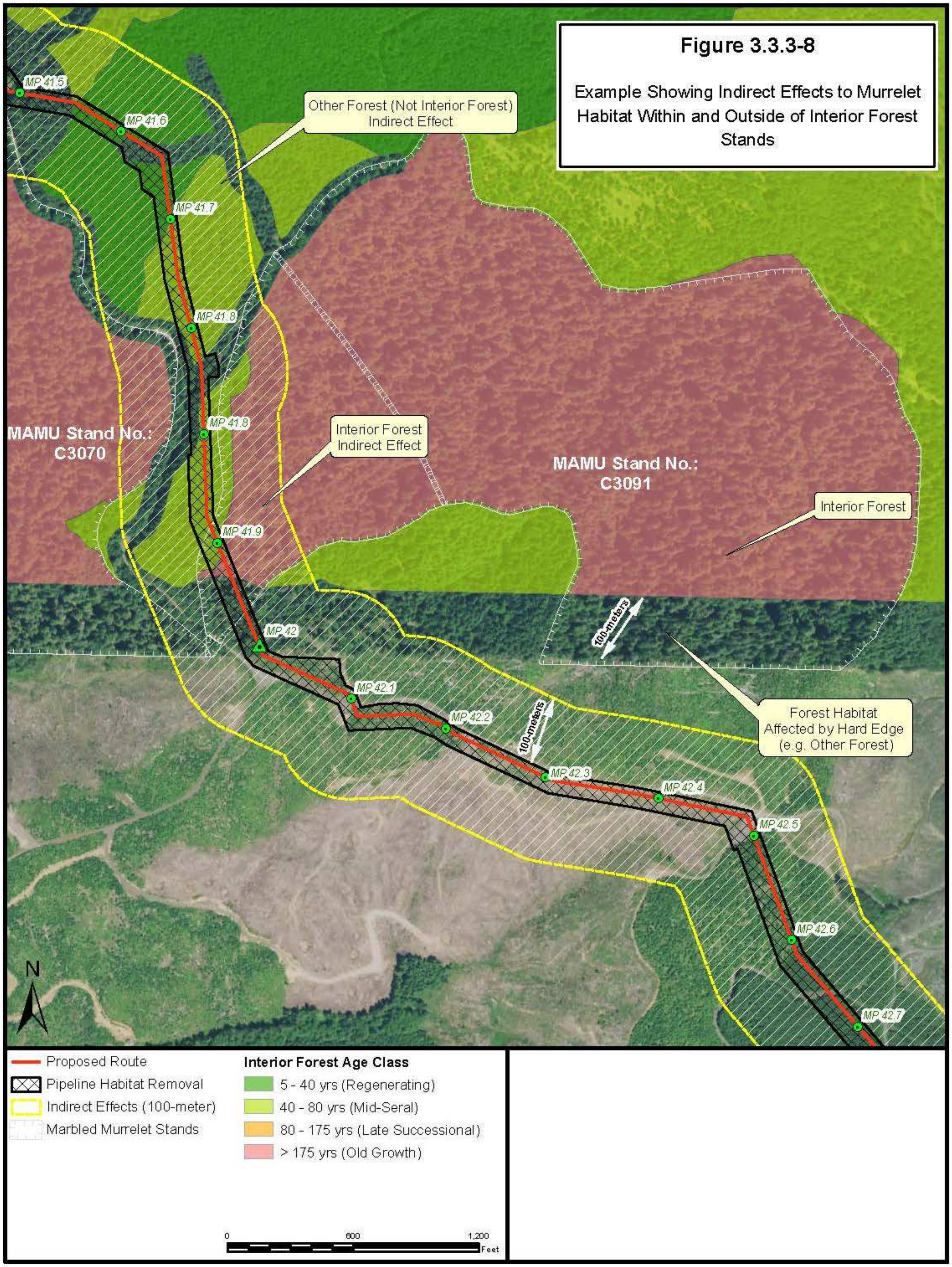
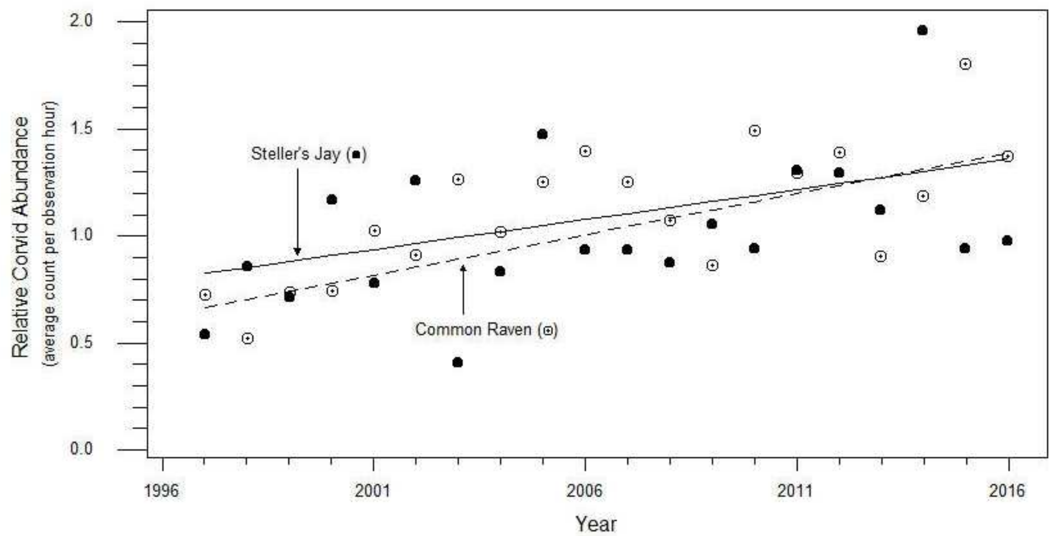


Figure 3.3.3-8
Example Showing Indirect Effects to Murrelet Habitat Within and Outside of Interior Forest Stands
Other Forest (Not Interior Forest) Indirect Effect
Interior Forest Indirect Effect
Interior Forest
Forest Habitat Affected by Hard Edge (e.g. Other Forest)
MAMU Stand No.: C3070
MAMU Stand No.: C3091
100-meters
100-meters
MP 41.5
MP 41.6
MP 41.7
MP 41.8
MP 41.8
MP 41.9
MP 42
MP 42.1
MP 42.2
MP 42.3
MP 42.4
MP 42.5
MP 42.6
MP 42.7
N
Proposed Route
Pipeline Habitat Removal
Indirect Effects (100-meter)
Marbled Murrelet Stands
Interior Forest Age Class
5 - 40 yrs (Regenerating)
40 - 80 yrs (Mid-Seral)
80 - 175 yrs (Late Successional)
> 175 yrs (Old Growth)
0
600
1,200
Feet

Nest disturbance probability at hard edges was 2.5 times that of interior sites, but soft edges had less than half the disturbance probability of interiors (Malt and Lank 2009). The study also showed that the negative effects of fragmentation decrease over time as managed forests regenerate, changing edge characteristics from hard to soft contrasts with older forest stands. Further, the study found Steller's jay to be the dominant avian predator of simulated nests and abundance of Steller's jay increased across the landscape as old-growth forest cover declined (Malt and Lank 2009). That study and another by Marzluff et al. (2004) demonstrated that Steller's jays prefer fragmented habitat and high contrast edges, often sites associated with residential sites and campgrounds, locations where jays are more likely to successfully forage and fledge young. Study results reported by Malt and Lank (2009) suggested that larger areas of habitat would lessen negative effects of hard edges, including surrounding or embedding small reserves of suitable MAMU nesting habitat within a protective matrix of surrounding regenerating forest that would reduce predation risks to nesting MAMUs as well as to the conservation of other old-growth associated bird species (Malt and Lank 2009). However in Oregon, Luginbuhl et al. (2001) found that predator densities and rates of nest predation are higher in areas with a variety of tree ages, so nest success is reduced in areas intermixed with young trees or brush habitat (Raphael 2006).

In addition to Steller's jay, common ravens (Corvus corax) have been observed preying on MAMU nestings and eggs (Nelson and Hamer 1995; Peery and Henry 2010). Statistically significant increasing regional trends of corvids within the Pipeline vicinity, specifically Steller's jay and common ravens which have been observed during the National Audubon Society CBCs since the early 1990s (see figure 3.3.3-9) and have likely contributed to existing but undocumented nest predation of MAMUs and other bird species (see Liebezeit and George 2002 for a comprehensive review of corvid predation). Population viability modeling of MAMUs in central California included various nest predation rates by corvids (Peery and Henry 2010). With only a 40 percent reduction in predation, the extinction risk was dramatically reduced from 96 percent to 5 percent over 100 years and a 60 percent reduction resulted in a stable MAMU population with assumed modest proportion of breeders, renesting rates, and corvid predation rates. The modeled population viability analysis revealed that nest predation would only need to be reduced by 40 percent to produce a stable population if corvid management was coupled with a modest increase in after-hatch-year survival rate (Peery and Henry 2010). Corvid control resulted in greater gains in MAMU population size when the maximum number of breeders was allowed to increase over time, similar to what would be expected if the amount of old-growth nesting habitat increased over time (Perry and Henry 2010). The authors and others (Liebezeit and George 2002) advocate evaluating local corvid populations, local conditions that may subsidize artificially high population levels (e.g., food, garbage), and MAMU nest site vulnerability to develop a corvid management plan that may or may not include lethal removal if an immediate short-term solution to predation is required (e.g., Liebezeit and George 2002).



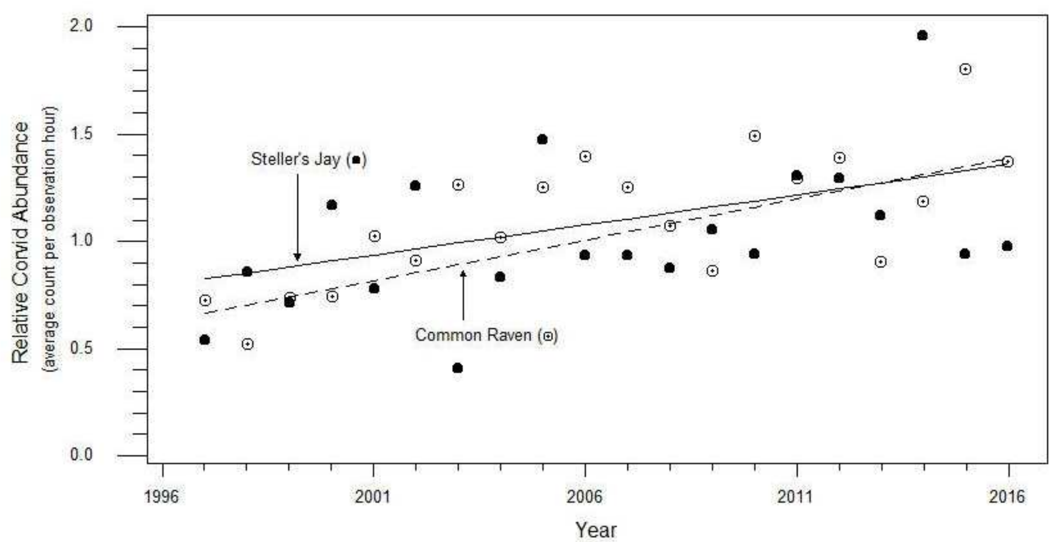


Figure 3.3.3-9 Relative Abundance for Two Species of Corvids Surveyed During the National Audubon Society Christmas Bird Counts within the Pipeline Vicinity, 1997 through 2016, with Significant Increasing Trends (Steller's Jay, P<0.05; Common Raven, <0.001).

Creation of a 30-foot shrub/grass utility corridor could increase current corvid densities and result in reduced nest success, although, where feasible, revegetation (tree planting) outside of the 30-foot maintenance corridor on certain federal lands and non-federal lands and subsequent regrowth may reduce the effects of a hard edge and minimize predation on nesting MAMU. Food enticements associated with human presence during construction activities could also increase predator populations within the vicinity of the Pipeline. All trash, food waste, and other items attractive to ravens, jays, magpies, and other corvids would be picked up and removed from the construction areas on a daily basis to minimize potential predation of MAMU nestlings.

Critical Habitat/Late Successional Reserves

The FWS (1996, 2011b) determined the physical and biological habitat features associated with the terrestrial environment that support nesting, roosting, and other normal behaviors essential to the conservation of the MAMU. Within areas essential for successful MAMU nesting, FWS utilized the following physical and biological habitat features to identify critical habitat: PCE 1 – individual trees with potential nest platforms (comparable to suitable habitat within this APDBA); and PCE 2 – forest lands of at least one half site-potential tree height, within 0.5 mile of individual trees/suitable habitat stand that are recruitment or capable habitat (within a MAMU Group/SHU). Within this analysis, PCE 2 is comparable to recruitment habitat delineated (FWS 2013g).

A variety of ongoing or proposed activities that disturb or remove physical and biological habitat features may adversely affect, remove or modify MAMU critical habitat. Such activities include, but are not limited to: 1) forest management activities that greatly reduce stand canopy closure, appreciably alter the stand structure, or reduce the availability of nesting sites; 2) land disturbance activities such as mining, sand and gravel extraction, and road building; and 3) harvest of certain types of commercial forest products (e.g., moss).

Those activities have the following effects on the PCEs of MAMU critical habitat:

1. Removal or degradation of individual trees with potential nesting platforms, or the nest platforms themselves, that results in a substantial decrease in the value of the trees for future nesting use. Moss may be an important component of nesting platforms in some areas.
2. Removal or degradation of trees adjacent to trees with potential nesting platforms that provide habitat elements essential to the suitability of the potential nest tree or platform, such as trees providing cover from weather or predators.
3. Removal or degradation of forested areas with a canopy height of at least one-half the site-potential tree height and regardless of contiguity, within 0.5 mile of individual trees containing potential nest platforms. This includes removal or degradation of trees currently unsuitable for nesting that contribute to the integrity of the potential nest area (e.g., trees that contribute to the canopy of the forested area). These trees provide the canopy and stand conditions important for MAMU nesting (FWS 1996).

The proposed Pipeline crosses one federally designated CHU (OR-06-d) five times for a total of 2.14 miles, although not all habitat within designated critical habitat is forested MAMU habitat (i.e., "non-capable" in table Q-3 in appendix Q; see table 3.3.3-15). Additionally five rock source and disposal sites occur within critical habitat: Signal Tree Road Quarry (Section 3, MP 45.86), Signal Tree Road Quarry (Section 15, MP 47.00), Weaver Road Quarry Sites 1 and 2 (MP 47.00), and Signal Tree Road Quarry (Section 35, MP 47.00). These are existing quarries and although GIS indicates the quarries provide recruitment (0.97 acre) and capable (4.90 acres) MAMU habitat, no forested habitat would be removed within these sites. Overall, construction of the Pipeline project would remove 4.33 acres of suitable MAMU nesting habitat (PCE-1) and 11.77 acres of recruitment (PCE-2) within CHU OR-06-d (see table 3.3.3-15), all within MAMU SHUs. Additionally, approximately 1.64 acres of suitable habitat (PCE-1), and 0.95 acre of recruitment habitat within CHU OR-06-d have been identified for use by the Pipeline project as UCSAs that may be used to store forest slash, stumps, and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration (see UCSA Column, table 3.3.3-15).

Use of the UCSAs would be a short-term disturbance of understory vegetation within suitable and potentially suitable habitat and would not affect potential nesting stand structures or characteristics. After construction, approximately 19.44 acres of MAMU habitat within CHU OR-06-d outside of the 30-foot maintenance corridor would be replanted with tree species and effects of edge would decrease over time. A detailed table of CHU OR-06-d affected by the Pipeline within and outside of MAMU SHUs and interior forest is provided in appendix Q (table Q-3); non-capable habitat that is affected in designated critical habitat can be reviewed in table Q-2, appendix Q.

Designated critical habitat only occurs within MAMU Inland Zone 1. Approximately half (54.1 percent) of forested habitat within CHU OR-06-d affected by the proposed action overlaps with BLM RMP designated late successional reserves (LSRs) in Coos Bay and Roseburg BLM Districts (see table Q-3 in appendix Q). The Pipeline project would remove approximately 176.5 acres of MAMU habitat (65.37 acres of suitable, 55.93 acres of recruitment, and 55.19 acres of capable habitat) within LSRs, of which 100.61 acres of forested habitat within LSRs would be replanted with trees outside of the 30-foot maintenance corridor which would reduce the effects of edge over time (see table 3.3.3-16). Table 3.3.3-16 identifies the MAMU habitat that would be affected within LSRs from construction. A detailed table of LSRs affected by the Pipeline project within and outside of MAMU SHUs and interior forest, as well as non-capable habitat that is affected and occurs in LSRs is provided in table Q-6 in appendix Q. Table Q-3 in appendix Q provides the acres of MAMU habitat affected within Marbled Murrelet Inland Zones 1 and 2 and Recovery Plan Conservation Zones 3 and 4, including landowner, and identifies the area that FWS-designated CHU OR-06-d overlaps with LSRs within and outside of MAMU SHUs.

Within Murrelet Inland Zones 1 and 2 where federal land is checker-boarded, PCGP considered locations of LSRs, occupied MAMU stands, and/or late successional / old-growth forest when routing the Pipeline and tried to avoid those tracts of lands if another constructible route was feasible to minimize impacts to MAMU habitat (see MAMU and NSO Avoidance Plan). Minimizing effects to LSRs also minimizes effects to MAMU designated critical habitat since overlap of MAMU CHU OR-06-d and LSRs occurs. Table 3.3.3-17 summarizes the location of the Pipeline project and MAMU habitat affected in relation to MAMU designated CHU OR-06-d.

In addition to direct loss of critical habitat and effects to PCEs due to construction, the Pipeline project's indirect effects to MAMU that were discussed above (fragmentation, edge, and effects to interior forest) indirectly affect designated critical habitats and PCEs. Edge effects and effects to interior forest may induce changes to forest characteristics later in time and would indirectly affect PCEs. Such effects may induce changes at individual nest trees and/or trees with potential nest platforms (PCE-1). Long-term effects on edges and interiors of recruitment habitat (PCE-2) are less well defined and over time, edge effects would diminish as edges evolve from "hard" to "soft" after revegetation occurs in the construction right-of-way, and in particular, trees are planted outside of the 30-foot maintenance corridor (see for example, Peery and Henry 2010).

TABLE 3.3.3-15

Summary of Marbled Murrelet Critical Habitat Unit OR-06d that would be Affected during Construction and Operation of the Proposed Action by Recovery Plan Conservation Zones and Landowner

		PCE1 / Suitable Habitat a/					PCE2 / Recruitment Habitat b/					PCE2 / Capable Habitat c/					Total Acres				
			Construction			Operation		Construction			Operation		Construction			Operation		Construction			Operation
Land Owner	**Land Owner**	**Miles Crossed**	**Removed d/ (acres)**	**Indirect e/ (acres)**	**UCSA f/ (acres)**	**30-foot Corridor g/ (acres)**	**Miles Crossed**	**Removed d/ (acres)**	**Indirect e/ (acres)**	**UCSA f/ (acres)**	**30-foot Corridor g/ (acres)**	**Miles Crossed**	**Removed d/ (acres)**	**Indirect e/ (acres)**	**UCSA f/ (acres)**	**30-foot Corridor g/ (acres)**	**Miles Crossed**	**Removed d/ (acres)**	**Indirect e/ (acres)**	**UCSA f/ (acres)**	**30-foot Corridor g/ (acres)**
Marbled Murrelet Inland Zone 1																					
Conservation Zone 4	BLM - Coos Bay	0.08	1.02	32.88	0	0.47	0.70	8.78	59.27	0.93	4.14	0.15	5.76	20.64	0	0.97	0.93	15.57	112.79	0.93	5.59
	BLM - Roseburg	0.19	2.43	18.90	0	1.17	0.06	1.52	21.38	0	0.36	0	1.44	8.67	0	0.01	0.25	5.39	48.95	0	1.54
Total Conservation Zone 4		**0.27**	3.45	51.78	0	1.64	0.76	10.30	80.64	0.93	4.50	0.15	7.20	29.31	0	0.98	**1.19**	20.95	161.73	0.93	7.12
Outside Conservation Zones	BLM - Roseburg	0.02	0.88	22.91	1.64	0.09	0.11	1.47	8.40	0.02	0.68	0.62	7.89	36.38	0.14	3.85	0.75	10.24	67.69	1.80	4.62
Total Critical Habitat		**0.29**	**4.33**	**74.69**	**1.64**	**1.74**	**0.87**	**11.77**	**89.04**	**0.95**	**5.18**	**0.77**	**15.09**	**65.69**	**0.14**	**4.83**	**1.94**	**31.19**	**229.42**	**2.73**	**11.75**

a/ PCE1/Suitable Habitat: individual trees with potential nest platforms, including supporting trees delineated as occupied or suitable (comparable to suitable habitat)
b/ PCE2/Recruitment Habitat: forest lands of at least one half site-potential tree height, within 0.5 miles of individual trees/suitable habitat stand that are recruitment or capable habitat (comparable to recruitment habitat) not currently suitable for marbled murrelet nesting that may be capable of becoming suitable marbled murrelet habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).
c/ PCE2/Capable Habitat: forested land that has the capability of becoming suitable nesting marbled murrelet habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).
d/ Pipeline project components considered in calculation of habitat "Removed:" construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, and rock source and disposal sites.
e/ Acres identified as UCSAs have been incorporated into the 100-meter indirect effects. Indirect Effects considers habitat within 100 meters (328 feet) of habitat removal as measured from the edge of habitat removal/edge of right-of-way/TEWA.
f/ UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.
g/ 30-foot-wide Maintenance Corridor would be kept in a shrub/sapling state for the life of the project.

Summarized from table Q-5 in appendix Q.

TABLE 3.3.3-16

Summary of MAMU Habitat within Late Successional Reserves within Marbled Murrelet Inland Zones 1 and 2 and Recovery Plan Conservation Zones that Would Be Affected by Construction and Operation of the Proposed Action

Recovery Plan Conservation Zone	Land Owner	Suitable Habitat a/					Recruitment Habitat b/					Capable Habitat c/					Total Acres				
			Construction			Operation		Construction			Operation		Construction			Operation		Construction			Operation
		Miles Crossed	Removed d/ (acres)	Indirect e/ (acres)	UCSA f/ (acres)	30-foot Corridor g/ (acres)	Miles Crossed	Removed d/ (acres)	Indirect e/ (acres)	UCSA f/ (acres)	30-foot Corridor g/ (acres)	Miles Crossed	Removed d/ (acres)	Indirect e/ (acres)	UCSA f/ (acres)	30-foot Corridor g/ (acres)	Miles Crossed	Removed d/ (acres)	Indirect e/ (acres)	UCSA f/ (acres)	30-foot Corridor g/ (acres)
Marbled Murrelet Inland Zone 1																					
Conservation Zone 3	BLM - Coos Bay	0.02	2.22	14.61	1.57	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	2.22	14.61	1.57	0.22
Total Conservation Zone 3		**0.02**	**2.22**	**14.61**	1.57	**0.22**	**0.00**	**0.00**	**0.00**	0.00	**0.00**	**0.00**	**0.00**	**0.00**	0.00	**0.00**	**0.02**	**2.22**	**14.61**	1.57	**0.22**
Conservation Zone 4	BLM - Coos Bay	3.51	43.40	366.65	12.23	21.65	3.64	50.74	295.34	8.41	22.26	2.90	47.00	187.92	8.36	17.32	10.04	141.15	849.91	29.00	61.23
	BLM - Roseburg	0.20	2.46	18.28	0.00	1.19	0.06	0.40	0.30	0.00	0.33	0.00	0.15	0.96	0.00	0.01	0.25	3.02	19.55	0.00	1.54
Total Conservation Zone 4		3.70	45.87	384.93	12.23	22.84	3.69	51.14	295.64	8.41	22.59	2.90	47.16	188.88	8.36	17.33	10.30	144.17	869.45	29.00	62.76
Outside Recovery Zone	BLM - Roseburg	0.27	4.17	41.88	1.64	1.63	0.11	1.47	8.42	0.02	0.68	0.63	8.03	32.46	0.14	3.91	1.02	13.67	82.76	1.80	6.23
Total MAMU Inland Zone 1		**4.00**	**52.25**	**441.43**	15.45	**24.70**	**3.81**	**52.61**	**304.06**	8.42	**23.27**	**3.53**	**55.19**	**221.33**	8.50	**21.25**	**11.33**	**160.06**	**966.82**	32.38	**69.21**
Marbled Murrelet Inland Zone 2																					
Outside Recovery Zone	BLM - Roseburg	0.86	13.11	83.78	4.68	5.22	0.24	3.32	26.66	26.66	1.44	0.00	0.00	5.11	0.00	0.00	1.10	16.43	115.55	4.69	6.67
Total Marbled Murrelet Range																					
Total Marbled Murrelet Range	BLM - Coos Bay	3.53	45.62	381.26	13.80	21.87	3.64	50.74	295.34	8.41	22.26	2.90	47.00	187.92	8.36	17.32	10.06	143.37	864.52	30.57	61.45
	BLM - Roseburg	1.33	19.74	143.94	6.32	8.04	0.41	5.19	35.38	26.68	2.45	0.63	8.18	38.53	0.14	3.92	2.37	33.12	217.86	6.49	14.44
Total Marbled Murrelet Range		**4.85**	**65.37**	**525.20**	20.12	**29.91**	**4.04**	**55.93**	**330.72**	35.09	**24.71**	**3.53**	**55.19**	**226.45**	8.50	**21.24**	**12.44**	**176.49**	**1082.37**	37.06	**75.88**

a/ Suitable Habitat: generally late-seral forested stands that provide or are presumed to provide nesting structures for marbled murrelet based on modeling and other available GIS data.
b/ Recruitment Habitat: forested land not currently suitable for marbled murrelet nesting that may be capable of becoming suitable marbled murrelet habitat within the next 25 years (FWS 2006c; BLM 1995a, 1995b); generally forested stands 60 years or greater (FWS 2014c).
c/ Capable Habitat: forested land that has the capability of becoming suitable nesting marbled murrelet habitat, generally includes forest stand age 0 to 60 years (FWS 2014c).
d/ Pipeline Project components considered in calculation of habitat "Removed:" construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, and rock source and disposal sites.
e/ Acres identified as UCSAs have been incorporated into the 100-meter indirect effects. Indirect Effects considers habitat within 100 meters (328 feet) of habitat removal as measured from the edge of habitat removal/edge of right-of-way/TEWA.
f/ UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.
g/ 30-foot-wide Maintenance Corridor would be kept in a shrub/sapling state for the life of the project; all other habitat outside of the 30-foot maintenance corridor would be revegetated, except for those habitats on non-federal or matrix lands where there is less certainty that replanting would occur or be maintained on the landscape.

Summarized from table Q-7 in appendix Q. Non-Capable habitat (not forested and not capable of becoming suitable habitat, or deciduous forest) that occurs in LSRs is included in table Q-7 in appendix Q.

TABLE 3.3.3-17

Summary of Habitat Affected in Marbled Murrelet Designated Critical Habitat Unit OR-06-d from the Proposed Action

Critical Habitat Unit	Land Ownership	Land Use Allocation	Total acres of PCE1 that would be removed a/	Total Acres of PCE2/Recruitment removed b/	Total Acres of PCE2/Capable c/	Length of Pipeline through CHU (miles)	Additional Comments
OR-06-d	Coos Bay BLM	LSR / Harvest Land Base	1.02	5.3	2.27	0.67	1st crossing (MPs 41.44-42.01): Pipeline routed through mostly regenerating (capable) and mid-seral (recruitment) forest, with a portion crossing through the edge of an old-growth/occupied (suitable) stand; crosses corner of critical habitat section. Follows or occurs within an existing road for a small portion.
		Harvest Land Base / Riparian Reserve	0.0	3.50	0.0	0.32	2nd crossing (MPs 43.20-43.50): route mostly parallels a road through regenerating (capable) forest.
			0.0	0.0	3.49	N/A	Rock Sources (Signal Tree Road Quarry Section 35 – MP 47.00, Weaver Road Quarry Site 1 and 2 – MP 47.00): within previously disturbed quarries.
OR-06-d	Roseburg BLM	LSR / Harvest Land Base	2.43	0.55	0.04	0.26	3rd crossing (MPs 46.91-47.17) – Weaver Ridge reroute: crosses mosaic of old-growth (suitable) and regenerating (capable) forest; parallels a road for approximately 0.06 mile.
		LSR	0.0	1.32	3.04	0.33	4th crossing (MPs 52.61-52.94): crosses mid-seral (recruitment) and regenerating (capable) forest; crosses corner of critical habitat section.
			0.88	0.15	4.90	0.59	5th crossing (MPs 53.10-53.70): generally follows a road between regenerating (capable) and late successional (suitable) stands.
			0.0	0.97	1.40	N/A	Rock Sources (Signal Tree Road Quarry Section 15 – MP 47.00, Signal Tree Road Quarry Section 3 – MP 45.86): within previously disturbed quarries - no recruitment habitat would be removed.

a/ PCE 1 = suitable habitat
b/ PCE 2 = recruitment habitat
c/ PCE 2 = capable habitat, which includes early mid-seral forest, as well as clearcut and regenerating coniferous forest.

Long-term effects from removal of interior forest within critical habitat, LSRs, and unmapped LSRs by the Pipeline could occur from clearing MAMU habitat. Tables 3.3.3-15 and 3.3.3-16 identify the distance that MAMU habitat is crossed by the Pipeline within and outside of interior habitat, and summarize the acreage of MAMU habitat directly removed and indirectly affected within 100 meters (328 feet) of the Pipeline project (habitat removal) by Marbled Murrelet Inland Zones 1 and 2, and landowner within CHUs and NWFP LSRs and unmapped LSRs, respectively. Tables Q-5 and Q-6 in appendix Q provide detailed effects to MAMU Habitat within CHU OR-06-d and LSRs, respectively, including MAMU habitat affected within and outside of MAMU SHUs and interior forest. Most indirect effects to forested habitat within 100 meters (328 feet) of habitat removal occur in MAMU habitat that has been previously affected by existing edge, such as roads, waterbodies, early seral forest, and nonforested habitat.

Cumulative Effects

Habitat removal and construction disturbance from the Pipeline are expected to be complete one year before the in-service date due to the longer construction period for the LNG Terminal, access channel, and slip (figure 2.1.1-1). Consequently, the foreseeable future required for cumulative effects analysis would actually occur before implementation of the proposed action, not after its implementation, which is more often the case.

Cumulative effects to MAMUs would be generated by timber harvesting and other sources of habitat losses on non-federal lands in the foreseeable future. Areas of MAMU habitat-capable land have been monitored as a component of the NWFP. Habitat-capable lands are capable of supporting forest structure with the potential to provide MAMU nesting habitat (Raphael et al. 2016). In Oregon, the evaluation of habitat-capable land was limited to Marbled Murrelet Zone 1 (of the NWFP) and did not include any analysis of habitat within Marbled Murrelet Zone 2.

In 2017, there were 465 acres of suitable habitat and 7,411 acres of recruitment habitat on non-federal lands within the terrestrial nesting analysis area (see table 3.3.3-2 in section 3.3.3.2, above). Recruitment habitat and suitable habitat, used here, are considered equivalent to habitat Class 3 (moderately high likelihood of suitability) and habitat Class 4 (highest likelihood of suitability), respectively. Those two habitat classes were included in modeling changes in MAMU habitat availability from 1996 (baseline conditions) to 2012 (Raphael et al. 2015).

Within Marbled Murrelet Zone 1, which coincides with the Coast Range physiographic province, there were 254.3 thousand acres of Class 3 and Class 4 habitats in 1993; by 2012 there were 198.3 thousand acres in those habitat classes on non-federal lands (see Table 2-7 in Raphael et al. 2016). There was a net loss of 56.0 thousand acres of Class 3 and Class 4 habitats (-22.0 percent), declining by 22.0 percent during the 19-year period (Table 2-10 in Raphael et al. 2011), and used here as an annual loss of suitable and recruitment habitats at 1.16 percent per year. That rate of decline on non-federal lands is assumed to be constant over time within the terrestrial nesting analysis area. Areas of suitable and recruitment habitats present in 2017 would be expected to decline at that annual rate; therefore, within 2020, there would be 449 acres of suitable habitat and 7,153 acres of recruitment habitat expected within the analysis area on non-federal land in 2020.

The Pipeline would remove 10.75 acres of suitable habitat and 61.74 acres of recruitment habitat on non-federal (state and private) lands in Marbled Murrelet Zone 1 (see table 3.3.3-10 in section 3.3.3.3, above). The amount of suitable habitat removed in Marbled Murrelet Zone 1 would be 2.51 percent of the suitable habitat remaining on non-federal lands (429 acres) in the analysis area by 2020 and represents less than 0.01 percent of higher quality suitable habitat available on non-federal lands in Oregon (approximately 221,131 acres; Falxa and Raphael 2016). Likewise, the amount of recruitment habitat removed would be 1.98 percent of the habitat remaining on non-federal lands (3,121 acres) in the analysis area by 2020. When compared to the estimated amount of suitable and recruitment habitat on non-federal land within the analysis area, the Pipeline project would affect a total of 72.49 acres within Marbled Murrelet Zone 1, which would be 2.04 percent of the total suitable and recruitment habitat available within Marbled Murrelet Zone 1 within the foreseeable future in 2020.

Although Raphael et al. (2016) limited their evaluation of habitat-capable land to Marbled Murrelet Zone 1 (of the NWFP), the same analysis was included, as described above, for Zone 2 using the annual loss of 1.16 percent, which is included in table 3.3.3-18.

Cumulative effects to MAMUs could also occur within the marine and estuarine analysis areas from fuel spills and disturbance, including underwater noise. NMFS (2008a) reports that chronic small-scale discharges of oil into oceans greatly exceed the volume released by major spills (Clark 1997). Fuel or lubricants spilled from the 120 LNG carriers transiting the marine analysis area could adversely affect foraging MAMUs, especially in combination with other small spills or accidental releases. On board mitigation measures, including the SPCC plans would minimize potential inadvardent spills. However, as discussed above for blue whales, the background rate of spills off the Oregon coast by fishing carriers, recreation carriers, and other carrier types is generally low, a frequency that would be expected to continue.

As discussed above in section 3.2.1.3 for blue whales, ship traffic at the Port has declined in the past two decades and is not expected to increase significantly relative to historical levels. . Therefore, the foreseeable cumulative effect of 120 LNG carriers per year would exceed current carrier-related disturbance, including disturbance from underwater noise and avoidance of ships, to foraging MAMUs in the Coos Bay estuary and nearshore habitats in the vicinity of the Coos Bay channel in the marine analysis area.

TABLE 3.3.3-18

Estimates for Losses of Marbled Murrelet Suitable and Recruitment Habitat on Non-Federal Land within the Terrestrial Nesting Analysis Area by 2020, with Pipeline Project-Related Effects on Non-Federal Land Compared to Cumulative Effects

Marbled Murrelet Inland Zone	Marbled Murrelet Habitat Areas on Non-Federal Land in Analysis Area in 2017 a/			Loss of Marbled Murrelet Habitat Between 1993 and 2012 b/		Marbled Murrelet Habitat on Non-federal Land in Analysis Area Expected in 2020			Marbled Murrelet Habitat Removed by the Project on Non-federal Land in Analysis Area c/			Percent of Marbled Murrelet Habitat in Analysis Area Expected in 2020 to be Affected by the Project		
	Suitable Habitat (acres)	Recruitment Habitat (acres)	Total Habitat (acres)	Percent Change from 1993	Percent Change per Year	Suitable Habitat (acres)	Recruitment Habitat (acres)	Total Habitat (acres)	Suitable Habitat (acres)	Recruitment Habitat (acres)	Total Habitat (acres)	Suitable Habitat	Recruitment Habitat	Total Habitat
Zone 1	419	3,257	3,676	-22.0%	-1.16%	404	3,144	3,548	10.75	61.74	72.49	2.66%	1.96%	2.04%
Zone 2	21	4,177	4,198			20	4,032	4,052	0.05	115.02	115.07	0.25%	2.85%	2.84%
Overall Total	440	7,434	7,874			424	7,176	7,600	10.80	176.76	187.56	2.54%	2.46%	2.47%

a/ Data from table 3.3.3-2 in section 3.3.3.2.
b/ Percent loss in Marbled Murrelet Zone 1 on Non-Federal Land from Table 2-10 in Raphael et al. (2016).
c/ Data from table 3.3.3-10 in section 3.3.3.3.

3.3.3.4 Conservation Measures

PCGP and JCEP have implemented or proposed conservation measures including avoidance, minimization, and rehabilitation/restoration, as described below.

Avoidance, Minimization, and Rehabilitation / Restoration

Conservation measures have been proposed by PCGP and JCEP to minimize construction and operations impact to the terrestrial nesting analysis area. Those measures have been compiled in table 2C in appendix N. Specific conservation measures that would benefit MAMUs include those that:

- avoid timber clearing during the breeding and nesting season;
- apply DTRs for construction activities within 0.25 mile of occupied or presumed occupied stands during the critical breeding season (April 1 through August 5);
- route the Pipeline through existing disturbance or previously disturbed forested lands to minimize impact to higher quality MAMU habitat;
- minimize removal of forest by incorporating UCSAs into the project design;
- utilize two-year construction window to minimize the overall TEWAs;
- flag large diameter trees on edges of construction right-of-way or temporary work areas where feasible to save from clearing, as outlined in the Plan of Development's Leave Tree Protection Plan;
- ensure that all trash, food waste, and other items attractive to crows, jays, and other corvids would be contained and removed from the construction areas on a daily basis to minimize potential predation on MAMU nestlings;
- use logging methods that would minimize damage to adjacent trees when clearing the right-of-way to reduce potential infestation from forest pathogens and insects; and
- minimize potential for establishment of invasive vegetation and establish control of noxious weeds.

Conservation measures have been proposed by JCEP to minimize construction and operation impacts to foraging marbled murrelets in the marine and estuarine analysis areas. Measures to reduce ship speeds once inside the Coos Bay navigation channel to between 4 to 6 knots and within the marine analysis area when pods or large assemblages of cetaceans are observed near an underway ship would provide protection to MAMU as well. Those measures have been compiled in tables 2A and 2B in appendix N. Specific conservation measure that would benefit MAMUs include:

- The contractor will develop and implement a turbidity monitoring and management plan (TMMP) that describes measures to reduce and monitor turbidity impacts resulting from dredging activities. Water quality monitoring will be performed during active in-water work operations in Coos Bay to ensure compliance with federal and state water quality standards.
- JCEP has prepared a Spill Prevention, Control, and Countermeasure (SPCC) Plan for both construction and operational phases of the LNG Terminal to minimize the potential for accidental releases of hazardous materials and to establish proper protocol concerning minimization, containment, remediation, and reporting of any releases that occur.

- All in-water work associated with the LNG Terminal will be conducted during the ODFW-approved in-water work window for Coos Bay (October 1 to February 15) unless otherwise approved by the appropriate agencies.
- Whenever feasible, a vibratory hammer will be used during in-water piling installation. If not feasible, an appropriately sized drop or impact hammer will be used to complete the job following the manufacturers' recommendations to drive the piling. If an impact hammer is used to drive or proof steel piling within fish-bearing waters, then sound attenuation devices would be used to effectively dampen sound in accordance with the guidance in NMFS' and USFWS' Impact Pile Driving Sound Attenuation Specifications, Western Washington Fish and Wildlife Office, Revised October 13, 2006, which is the standard NMFS applies in Oregon.
- Vibratory equipment will be used during installation of land-based sheet pile. Pre-drilling of sheet pile for the Slip and MOF and for pipe pile within a 30 meter setback will also be completed. Installation of piles will use an appropriately sized impact hammer.

Plans included in the appendices of PCGP's POD would also minimize effects to MAMU habitat and/or nesting MAMUs. The *Leave Tree Protection Plan* describes the preconstruction surveys that would be completed to clearly mark the boundaries of the Pipeline project's certificated working limits, and procedures to identify individual trees within and along the edges of the certificated work limits that can be conserved or left standing, as well as BMPs that would be employed to minimize damage to trees within UCSAs and protect trees not removed from the construction right-of-way (see appendix P to the POD, available upon request). An *Integrated Pest Management Plan* (see appendix N to the POD, available upon request) describes BMPs to address the control of noxious weeds, invasive plants, forest pathogens, and soil pests, as well as describes measures to minimize the potential spread of invasive species and potential adverse effects of control treatments. The *Blasting Plan* and *Air Noise and Fugitive Dust Plan* (see Appendices C and B to the POD, respectively – available upon request) provide mitigation measures and monitoring plans to minimize noise effects to nesting MAMUs during construction of the Pipeline project.

PCGP prepared an *Avoidance and Minimization Plan for MAMU and NSO* (see appendix V1) that identifies the additional measures that have been incorporated into the project design to reduce impacts to both MAMUs and NSOs. This avoidance plan was developed through consultations with the FWS and the cooperating agencies (Interagency Habitat Quality Subgroup-Micro Siting Working Group, June 4, 2008). Application of measures outlined in the plan would minimize potential impacts to suitable MAMU habitat by 1) converting TEWAs to UCSAs to reduce the amount of suitable habitat removed by the Pipeline project, 2) moving TEWAs to avoid impacts to suitable habitat within occupied or presumed occupied stands, and 3) moving the alignment to avoid MAMU occupied or presumed occupied stands. A "Standard Rules Set" was developed during the meeting to further minimize effects to MAMU, and this Standard Rules Set would be implemented prior to or concurrent with tree felling. The Standard Rules Set measures include:

- identify potential nest trees that would be allowed to remain standing within TEWAs or edge of right-of-way;
- identify TEWAs to be reduced in size or eliminated to reduce removal of suitable habitat;

- identify any additional minor route adjustments that would not alter constructability but further reduce removal of suitable habitat;
- identify any previously unknown nest tree discovered and assure that it is properly protected by applying the appropriate seasonal limitations or daily timing restrictions associated with similar locations along the alignment; and
- EIs would be supported by qualified biologists to identify potential nest trees.

To avoid direct effects to MAMU, PCGP would remove timber outside of the entire MAMU breeding season (after September 15 but before March 31) within 300 feet of MAMU stands to ensure that trees with active MAMU nests and chicks are not felled. Additionally, to minimize disturbance within forested areas, PCGP has designated nearly 165 acres (see table 3.3.3-10) of UCSAs within Marbled Murrelet Inland Zones 1 and 2 that would not be cleared of trees but be used to store forest slash, stumps, and dead and downed log materials during construction that would be scattered across the right-of-way after construction and during restoration. The UCSAs would be used for construction of the Pipeline project while not requiring removal of trees or understory vegetation, as well as allow the maintenance of suitable or potentially suitable and recruitment habitat function.

Construction of the Pipeline would occur within Marbled Murrelet Inland Zones 1 and 2, including within MAMU occupied stands during the entire breeding season. Construction would occur after timber has been felled outside of the breeding season and would adhere to daily timing restrictions (DTRs, activity limited to 2 hours after sunrise and 2 hours before sunset) within 0.25 mile of MAMU stands (occupied and presumed occupied) at least through the critical breeding season to minimize risk of disturbance to adult MAMUs entering and leaving the stand, as well as possible dispersal of juveniles. DTRs would continue to be applied to large transport helicopter use in the late breeding season within 0.25 mile of a MAMU stand if helicopter use is necessary.

Within known occupied stands, PCGP has proposed the route within existing roads that traverse the stand or situated the right-of-way within existing edge (i.e., within clearcut or regenerating forest adjacent to a stand) to avoid or minimize habitat removal from the stand, where feasible. In other areas, PCGP has rerouted the Original 2007 Route (FERC 2009) to avoid removing habitat and further fragmenting suitable MAMU stands – occupied and presumed occupied (surveyed/no survey). Also, to minimize impacts to MAMU stands and suitable nesting habitat, PCGP has incorporated minor alignment adjustments or TEWA modifications into the Pipeline project. Other major and minor route alternatives that further minimize effects to MAMUs and habitat have been considered and included in the Pipeline route, which are discussed in the *Marbled Murrelet and Northern Spotted Owl Avoidance and Minimization Plan* (appendix V1 to this APDBA).

When PCGP acquires survey access in stands identified to have potential nesting habitat (presumed occupied stands), where survey permission has been denied, PCGP would evaluate the stands for trees with suitable nesting structures. If suitable nesting structures are identified and time permits for 2-year protocol surveys prior to beginning the proposed Project, PCGP may survey those stands for occupied MAMU behavior. If protocol surveys are not conducted, PCGP will continue to presume occupancy and apply conservation measures to those presumed occupied stands. When additional information on the status of these presumed occupied MAMU stands is acquired, PCGP would advise the FWS of their updated status, including whether they are determined to have suitable nesting structures, determined to be occupied or unlikely occupied, or determined to not be suitable habitat for nesting MAMUs.

During construction, PCGP would ensure that the construction contracts include stipulations ensuring that all trash, food waste, debris, and other items attractive to crows, jays, and other corvids would be picked up and removed from the construction areas on a daily basis year round to minimize potential predation of MAMU nestlings. PCGP's EIs would be responsible for overseeing that the construction contractor is adequately following these stipulations.

PCGP has also proposed measures to rectify, repair, rehabilitate, and otherwise reduce impact to forested habitats once construction of the Pipeline is complete. Those measures have been compiled in table 3C in appendix N. Specific conservation measures that would benefit MAMUs include those that:

- replant conifer species outside of the 30-foot-wide maintenance corridor after construction, where allowable, which would contribute to the reestablishment of native vegetation and soften the edge effect created from construction of the Pipeline project if the area is allowed to revegetate;
- contribute to forest habitat structural diversity (e.g., snags and downed timber); and
- minimize potential for increased human use of the reclaimed construction right-of-way and intrusion into undisturbed habitats.

Following construction, affected forested lands (the construction right-of-way and TEWAs outside of the 30-foot maintenance right-of-way) would be replanted and allowed to return to the pre-construction condition where possible, with tree species in the approximate proportion to those species removed. This replanting would occur on certain federal lands and non-federal lands on a case- by-case basis. Replanted trees may also be harvested from non-federal lands or federal lands slated for timber harvest. Tree establishment would be allowed to occur up to 15 feet on either side of the centerline. Over the short term, replanting a maximum of approximately 1,211 acres on the edge of the 30-foot maintenance corridor within the range of the MAMU would provide a soft edge to adjacent forested habitat and minimize effects of edge, as well as reduce predator presence (see table 3.3.3-10). However, if allowed to regrow, these areas would provide minimal benefit to MAMUs because it would take decades to restore replanted forests to recruitment or suitable habitat conditions. Over the long term (200 to 250 years to become MAMU suitable nesting habitat), revegetated areas outside of the 30-foot maintenance corridor may achieve tree structural characteristics comparable to trees that would be removed, had they not been affected.

3.3.3.5 Determination of Effects

Species

The Project **may affect** MAMUs because:

- suitable habitat is available within the terrestrial nesting analysis area;
- MAMUs have been located within the terrestrial nesting analysis area during survey efforts for the proposed action and
- MAMUs are expected to forage offshore in the marine analysis area, and within Coos Bay in the estuarine analysis area.

The Project is **likely to adversely affect** MAMUs because:

- disturbance associated with Pipeline project activities and construction of Kentuck Mitigation Site would occur within the critical breeding season and within 0.25 mile of known MAMU stands. Proposed actions which generate noise above local ambient levels might disturb or disrupt MAMUs and interfere with essential nesting behaviors.
  - 82 MAMU stands (25 occupied and 57 presumed occupied) are within 0.25 mile of the proposed construction right-of-way that could be constructed during the breeding season.
  - 168 MAMU stands (50 occupied and 118 presumed occupied) are within 0.25 mile of proposed access roads that could be used during the breeding season.
- blasting activities (>2 pounds explosives) may occur within 0.25 mile of MAMU stands between April 1 and September 30.
- helicopter use within 0.25 mile of eight occupied MAMU stands during the breeding period (between April 1 and September 15) could occur and disturb MAMU adults and nestlings, as well as potentially blow nestlings out of the nest tree within six occupied MAMU Stands from rotor wash.
- the proposed Pipeline would remove and modify potential suitable nesting habitat and recruitment habitat within the range of the MAMU, which does not support the recovery of the species. Approximately 78 acres of suitable MAMU habitat would be removed, or approximately 0.5 percent of the 14,310 acres of suitable habitat available in the terrestrial nesting analysis area.

Critical Habitat

A **may affect** determination is warranted for MAMU critical habitat because:

- the Pipeline crosses designated MAMU critical habitat, and
- the Pipeline would result in habitat impacts within designated critical habitat area.

A **likely to adversely affect** determination is warranted for MAMU critical habitat because:

- the proposed action could remove or degrade individual trees with potential nesting platforms or the nest platforms themselves, resulting in a decrease in the value of the trees for future nesting use (PCE-1, or suitable or potentially suitable habitat); and
- the proposed action could remove or degrade trees adjacent to trees with potential nesting platforms that provide habitat elements essential to the suitability of the potential nest tree or platform, such as providing cover from weather or predators (PCE-2, or recruitment/capable habitat).

3.3.4 Northern Spotted Owl

3.3.4.1 Species Account and Critical Habitat

Status

The NSO was listed by the FWS as threatened on June 26, 1990 (FWS 1990), including populations in Oregon. Declining populations due to loss and adverse modification of suitable habitat from timber harvest and natural catastrophes (wild fire, windthrow), as well as inadequate regulatory mechanisms to protect the owl or its habitat (FWS 1990) were the basis for the listing decision.

Threats

As of 1990 when NSO was listed as threatened by the FWS, an estimated 60 percent of suitable NSO habitat present in the Pacific Northwest in 1800 had been eliminated with 90 percent of all remaining suitable habitat occurring on public lands (less than 5 percent of old-growth habitats occurred on private, state, or tribal lands in 1990). At the time of listing, FWS (1990) indicated that given the current trends, remaining unprotected NSO habitat could be eliminated in 10 to 30 years Although timber harvest on federal lands has been greatly reduced since NSO habitat has been protected through designated critical habitat (FWS 1992c), as well as additional habitat protection from the Forest Service and the Bureau of Land Management through the Northwest Forest Plan (NWFP), Further, at the time of listing, the quality of 50 percent of total remaining NSO habitats across the range of the NSO was judged to be affected by reduction of individual stand size, fragmentation, and edge effects so that successful NSO reproduction was at risk (FWS 1990). Continued logging practices were chiefly responsible for the loss and degradation of habitat, and public forest lands that are intensively managed for timber production generally are not able to achieve old-growth characteristics, which may require 200 years to develop (FWS 1990). Although timber harvest on federal lands has been greatly reduced since implementation of the NWFP in 1994, documented loss of NSO habitat on federal lands has contined, mostly as a result of wildfies (Davis et al 2016); from 1993 through NSO habitat on feeral lands has decreased by 1.5 percent range wide (approximately 135,700 acres; Davis et al 2016). Residual habitat loss and continued timber harvest on private lands across the range of NSO continues to threaten this species (FWS 2011c, Davis et al. 2011). Past NSO habitat loss and current NSO habitat loss are still considered pressing threats to the NSO (FWS 2011d).

Natural events and logging create a fragmented landscape that is utilized less by NSO than more intact landscapes (FWS 1990). Further, fragmentation reduces potential metapopulation dynamic interactions between NSO-inhabited patches (extinction, colonization within patches), resulting in potential adverse genetic effects (FWS 1990). High levels of fragmentation, particularly fragmentation found on BLM lands interspersed with private lands forming a "checkerboard," adversely affect adult survivorship and fecundity (FWS 1990), which are the major drivers influencing population growth.

In addition to the relationship of habitat quality and quantity to NSO population declines, in 1990, barred owls were recognized as a potential threat to NSO due to their aggressiveness and potential to displace NSO through competitive interactions (FWS 1990); however, by 2006, FWS (2007c) recognized that competition from barred owls was a significant "pressing" threat to NSO throughout its range. Threats from barred owls had developed within the context of habitat loss and diminished distribution of habitat by past logging activities and other catastrophic disturbances, as well as ongoing habitat losses from timber harvest, albeit reduced harvest levels since implementation of the NWFP (FWS 2007c, 2008c; Dugger et al. 2016). Hazards to NSO from barred owl include competition for resources and displacement from suitable habitat (Kelley et al. 2003; Kelley and Forsman 2004) and to a lesser degree than thought in the 1990 listing, hybridization with NSOs (Courtney et al. 2004; Kelley and Forsman 2004). Dugger et al. (2016) report that barred owls have negatively affected spotted owl populations, primarily by decreasing apparent survival and increasing local territory extinction rates.

Another threat to NSO populations is loss of habitat from wildfires, especially within forests that demonstrate succession toward climax communities in the absence of fires (FWS 2011c; Courtney et al. 2004). In drier portions of the NSO range, such as the Eastern Oregon Cascades and Klamath Mountains provinces, wildfire has become more of a threat (FWS 2011c, 2004b). Davis et al. (2016) report 85,900 acres of non-reserved lands in the northern spotted owl range had burned since 1993, which represents approximately 48.8 percent of habitat loss reported since 1993. Climate change is expected to increase the risk of large, high-intensity wildfire in the Pacific northwest (Dugger et al. 2016).

Other potential threats to the NSO and its habitat include West Nile virus and tree diseases, respectively (FWS 2004b; FWS 2006d, 2011c). West Nile Virus has the potential to reduce population numbers beyond what was anticipated from other causes, although to date, no mortality of NSO has been recorded from the West Nile virus (Lint 2005). The revised northern spotted owl recovery plan did not consider West Nile virus as a significant threat to spotted owls (FWS 2011c). At this time, no avian diseases, including West Nile Virus, are significantly affecting spotted owls (FWS 2011c).

Species Recovery

1992 Draft Recovery Plan (FWS 1992b)

The 1992 Draft Recovery Plan for the Northern Spotted Owl considered threats to NSO populations within the proposed project area to include: low and declining populations, loss and fragmentation of habitat, poor population connectivity within each province and with adjacent provinces, and high levels of predators. As a result of these threats, the 1992 Draft Recovery Plan established 196 designated conservation areas (DCAs), of which 56 were considered category 1 DCAs (having the potential to support at least 20 NSO pairs), and the other 140 were considered category 2 DCAs (potential to support 1 to 19 NSO pairs). DCAs were derived from concepts presented by Thomas et al. (1990) in "A Conservation Strategy for the Northern Spotted Owl" that focused on the establishment of large habitat blocks that could support self-sustaining populations of 15 to 20 pairs and protected lands for dispersal of juveniles.

2008 Final Recovery Plan (FWS 2008c)

In April 2007, the FWS released a NSO draft recovery plan for public review, identifying criteria and actions needed to stop NSO decline, reduce threats, and return the species to a stable, well-distributed population in Washington, Oregon, and California over the next 30 years (FWS 2007c). In May 2008, FWS approved the Final Recovery Plan for the Northern Spotted Owl. The recovery plan recommended specific actions that address the threats to the NSO, including threats posed by barred owls, as well as actions to maintain habitat for the recovery and long-term survival of the NSO including dry-forest landscape management strategies. The recovery plan built off strategies set forth in the 1992 Draft Recovery Plan for NSO (FWS 1992b) and the NWFP (Forest Service and BLM 1994), using a network of Managed Owl Conservation Areas (MOCAs) on federal lands and Conservation Support Areas (CSAs) on federal and non-federal lands where recovery actions and criteria would be targeted. MOCAs are larger tracts of lands within non-fire-dominated provinces that are expected to support a stable number of breeding pairs of NSOs over time and allow for movement of NSOs across the network. Within the drier forests of the Eastern Cascades Province, the recovery plan did not identify MOCAs or CSAs since it is expected that the rate of loss of older forests to stand-replacing wildfires would continue or increase in the coming years as the climate changes (Westerling et al. 2006 in FWS 2008c). Rather, the recovery plan recommended treatments to older forests to reduce risks of fires and insect outbreaks even though the strategy could have short-term impacts on NSO habitat, but would achieve the long-term goal of creating more sustainable NSO habitat.

2011 Revised Final Recovery Plan (FWS 2011c)

The 2008 Northern Spotted Owl Recovery Plan was revised in 2011, which continues to address threats of barred owl and habitat loss, and integrates an adaptive management approach to achieve results focusing on the most important actions for recovery, including maintaining and restoring high value habitat for the recovery and long-term survival of the NSO. Recovery criteria have been identified to serve as objective, measureable guidelines to assist in determining if the NSO has recovered and may be delisted, which include: 1) stable population trend, 2) adequate population distribution, and 3) continued maintenance and recruitment of spotted owl habitat. Thirty-three recovery actions were included to guide activities needed to accomplish the four recovery criteria. In some instances, recovery actions are specific to physiographic provinces, which have been identified as recovery units within the 2011 Revised Recovery Plan to assist managers in measuring the objectives of the recovery criteria.

The 2011 Revised Recovery Plan discontinued the recommendation of DCAs, MOCA networks, and CSAs included in previous NSO recovery plans; rather, these areas were considered in revised critical habitat designation in 2012 (FWS 2011c).

Life History, Habitat Requirements, and Distribution

The NSO is a medium-sized owl that occurs in coniferous or mixed coniferous-hardwood forests from southwestern British Columbia through western Washington, Oregon, and northern California south to San Francisco Bay (FWS 1990). Although NSO habitat is variable over its range, to support NSO reproduction, a home range requires appropriate amounts of nesting, roosting, and foraging (NRF) habitat arrayed so that nesting pairs can survive, obtain resources, and breed successfully. NSOs primarily occur in old-growth and mature forests because these habitat types provide the structure and characteristics required for nesting, but they may also inhabit younger forests with the appropriate structural, vegetation, and prey characteristics, including:

- moderate to high canopy cover (60 to 80 percent);
- multi-layered, multi-species canopy dominated by large overstory trees (greater than 30 inches dbh;
- a high incidence of large trees with various deformities,
- numerous large snags;
- large accumulations of fallen trees and other woody debris on the ground; and
- sufficient open space below the canopy to fly (FWS 1990).

High canopy closure is important to help NSOs thermoregulate and reduce potential predation (FWS 1990 and 2007c). Dispersing NSOs, whether adults moving between blocks of suitable NRF habitat (generally 15 miles for females and 9 miles for males; Forsman et al. 2002), or juveniles dispersing from natal areas (a range of 0.3 to 69 miles; Forsman et al. 2002), utilize a wider array of forest types and structures including more open and fragmented habitat. Although forest attributes needed for successful dispersal have not been thoroughly evaluated, they generally consist of conifer and mixed mature conifer-hardwood habitats with canopy cover greater than or equal to 40 percent and conifer trees averaging at least 11 inches dbh (FWS 1992b). Dispersal habitat may occur in NRF habitat, but it lacks the optimal structural characteristics needed for nesting.

Foraging and dispersal habitats may be in younger, more open and fragmented forests than those associated with nesting and roosting (FWS 1992b). Foraging habitat may also be consistent with areas that NSO prey is found. Northern spotted owls are primarily nocturnal, foraging between dusk and dawn, with peak activity occurring two hours after sunset and two hours prior to sunrise (Delaney et al. 1999; Forsman et al. 1984). NSO feed primarily on small mammals, especially northern flying squirrels and woodrats in southwestern Oregon (citations in Anthony et al. 2006).

Northern spotted owls have been reported to occur in the following forest types: Douglas-fir and western hemlock in the coastal forests of Washington and Oregon, Pacific silver fir on the west slope of the Cascades in Washington and Oregon, mixed conifer stands including Douglas-fir, grand fir, and ponderosa pine on the east slope of the Cascades, dry Douglas-fir and mixed conifer in southern interior Oregon, and Douglas-fir, mixed-conifer, and coastal redwood or mixed conifer-hardwood habitat types in California (FWS 1992b; Forsman et al. 1984). The NSO has been reported in a variety of elevations, from 70 feet on the Olympic Peninsula in Washington to more than 6,000 feet in California (FWS 1990).

NSOs are territorial and remain on their home range throughout the year. As a result, NSO have large home ranges that provide all the habitat components and prey necessary for the survival and successful reproduction of a territorial pair. Home ranges vary in size by physiographic province, forest type, and heterogeneity but generally increase in size from south to north where habitat quality decreases and/or becomes more fragmented (Courtney et al. 2004; FWS 1990, 1992b; Forsman et al. 1984). Courtney et al. (2004) determined that the home range size of NSOs appeared to be influenced by a variety of factors including proportion of mature and old-growth forest within the home range, forest fragmentation, and the availability of dominant prey species (larger home ranges where flying squirrels dominated the diet compared to smaller home ranges where wood rats dominated the diet). Within the Pipeline project area, NSO home ranges typically encompass an area within the following radii around the nest site: 1.5 miles within Coast Range Physiographic Province, 1.3 miles within Klamath Mountains Physiographic Province, and 1.2 miles within East and West Cascades Physiographic Provinces from a nest or roost site (FWS 1992c). Home ranges within the Coast Range physiographic province are much larger where a lot of fragmentation from urban development, timber harvesting, and transmission corridors has occurred (Courtney et al. 2004).

Home ranges contain three distinct use areas: 1) the nest patch, which research has shown to be an important attribute for site selection by NSOs and includes approximately 70 acres of usually contiguous forest (300-meter radius around an activity center; FWS et al. 2008), 2) the core area, which is used most intensively by a nesting pair and varies considerably in size across the geographic range, but on average encompasses approximately 500 acres around the nest site (1/2 mile radius around the activity center), and is generally made up of mostly mature/old-growth forest (FWS 2007c; Courtney et al. 2004), and 3) the remainder of the home range which is used for foraging and roosting and is essential to the year-round survival of the resident pair (FWS 2007c).

NSOs are relatively long-lived. They are sexually mature at the age of 1, but rarely breed until they are 2 to 5 years of age. Females will lay one to four eggs per clutch, with an average of two eggs. However, most NSOs do not nest every year (FWS 2011c). Fecundity in NSOs appears to follow a biennial cycle of high fecundity in even-numbered years and low fecundity in odd-numbered years; however, it is not known what causes the synchronization across the range of the NSO (Dugger et al. 2016). Nesting and fledging varies with latitude and elevation (FWS 1990), although, courtship usually occurs in February or March and eggs are laid in late March or April. Although juveniles flege in late May or June, parental care continues into September when natal dispersal may begin (FWS 2011).

Population Status

Demographic data collected from 11 study areas throughout the range of the northern spotted owl in Washington, California, and Oregon have been used to monitor NSO populations in their geographical range from 1985 through 2013, of which five sites occur in Oregon (Anthony et al. 2006; Dugger et al. 2016). The primary objectives of these studies were to estimate fecundity, apparent survival, and annual population rate of change, and to determine if there were any temporal trends in these population parameters. Recently, studies have also been reporting barred owl activity and its potential effects on the spotted owl population (Dugger et al. 2016). Three of the study sites in Oregon, Tyee, Klamath, and southern Oregon Cascades (South Cascades), are located within and/or adjacent to the Pipeline: Klamath and South Cascades study areas are located in Douglas County (approximately MP 94.13 to MP 98.9) and in Jackson and Klamath counties (approximately MP 153.87 to MP 172.25), and the Tyee study site is located north of the Pipeline. Forests on these study sites were mostly characterized by mixtures of Douglas-fir and western hemlock or by mixed-conifer associations of Douglas-fir, grand fir, western white pine, and ponderosa pine (Anthony et al. 2006; Dugger et al. 2016).

Estimates of fecundity, apparent survival rates, and population change for five study sites within Oregon are included in table 3.3.4-1 (Dugger et al. 2016). Within Oregon, apparent adult survival rates are declining on all but the Oregon Coast Range and Klamath study areas; most annual rates of decline have been increasing. Decreased local extinction rates of NSOs were attributed to barred owl presence in all 11 study areas. In Oregon, increased fecundity was associated with higher annual estimates of the amount of suitable habitat. Overall, demographic declines in study sites were attributed to the increased numbers of barred owls and loss of habitat (Forsman et al. 2011; Davis et al. 2011; Dugger et al. 2016).

In 2009, a barred owl removal pilot program was initiated in the Green Diamond Resources (GDR) study area in California where barred owls were removed from a portion of the study area to assess the effectiveness of this program on northern spotted owl survival and population change. Based on the study to-date, removal of barred owls has had a positive effect on northern spotted owl survival and rate of population change, at least at a localized scale (Dugger et al. 2016). Annual rate of decline in all study areas (excluding the GDR treatment area) indicated an average rate of decline of 3.8 percent per year.

Barred owl presence has increased significantly within each NSO demographic study area in Oregon (Dugger 2016; Lesmeister and Reid 2016; Lesmeister 2016; Dugger 2015; Hollen 2015). In 2013, FWS (2013e) released an Environmental Impact Statement (EIS) for the experimental removal of barred owls in four study areas including the Klamath study area in the Pipeline project area to determine if removal of barred owls can improve localized populations trends of spotted owls (FWS 2013e). Experimental removals following a before-after-control-impact (BACI) experimental design were initiated in 2015 on three demographic study areas in Oregon and Washington with at least 20 years of pre-treatment demographic data on spotted owls (Wiens et al. 2017). The first 21 months (March 2015 – December 2016) of the planned 5-year experiment has removed 643 individual barred owls outside of the breeding season; treatments are expected to continue through 2020 in the Klamath study area, and through 2019 within the Cle Elum and Coast Ranges study areas. A preliminary analysis of the demographic response of spotted owls to experimental removal of barred owls in Oregon and Washington is scheduled to occur after a full 3 years of removal has been completed by March 2018/2019.

TABLE 3.3.4-1

Estimates of Fecundity, Apparent Survival Rates and Population Change for the Five Northern Spotted Owl Demographic Study Sites on Federally-Managed Lands in Oregon from 1985-2013 [1]

Study Area	Land-ownership	Fecundity [2] %	Fecundity [2] Trend	Apparent Survival [2] %	Apparent Survival [2] Trend	Population Rate of Change (λ)	Population Trend	Overall Trend
Coast Range Physiographic Province								
Oregon Coast Range [3]	Mixed	22.3	Declining	86.1	No Trend	0.949	Decrease	Declining
Tyee [3]	Mixed	26.3	Declining	85.8	Declining	0.976	Decrease	Declining
Klamath Mountains Physiographic Province								
Klamath [3]	Mixed	33.5	Declining	84.8	No Trend	0.972	Decrease	Declining
West and East Cascades Physiographic Provinces								
H.J. Andrews [4]	Federal	28.8	Declining	87.0	Declining	0.965	Decrease	Declining
South Cascades [5]	Federal	32.3	gNo Trend [6]	85.1	Declining	0.963	No Trend [6]	Declining

[1] Source: adapted from Dugger et al. 2016.
[2] Provides rates for adults greater than 3 years.
[3] Trends based on data collected between 1990 – 2013
[4] Trends based on data collected between 1988 – 2013
[5] Trends based on data collected between 1991 – 2013
Although study sites appeared stationary throughout the study period (1985-2013), data through 2015 for this study area suggests that fecundity and populations are declining (Dugger 2016).

Critical Habitat

Critical habitat for the NSO was originally designated on January 15, 1992 and included approximately 6.9 million acres in California, Oregon, and Washington, of which 3.3 million acres occurred in Oregon (FWS 1992c). The 1992 designation was revised in 2008 (FWS 2008e), and more recently in 2012 (FWS 2012d). The 2012 final rule (FWS 2012d) designates approximately 9.6 million acres within 11 CHUs and 60 critical habitat subunits in California, Oregon, and Washington. Eight CHU and 58 subunits are identified in Oregon on a little more than 4.5 million acres. The FWS (2012d) relied on recovery criteria set forth in the 2011 Recovery Plan for the NSO (FWS 2011c) to ensure that designated CHUs met the following criteria: 1) ensures sufficient habitat to support stable, healthy populations across the range and within each CHU, 2) ensures distribution of NSO populations across the range of habitat conditions used by the species, and 3) incorporates uncertainty, including potential effects of barred owls, climate change, and wildfire disturbance risk.

The FWS (1992c) determined that the physical and biological habitat features, the primary constituent elements (PCEs) that are essential for the recovery of the spotted owl are forested lands used or potentially used for nesting, roosting, foraging, and dispersal; more specificity to PCEs was provided in the revised critical habitat rule in 2012. Based on more current information on the life history, biology, and ecology of the species, the revised PCEs are (FWS 2012d):

- PCE 1: Forest types that may be in early-, mid-, or late-seral stages and that support NSOs across its geographical range, primarily: Sitka spruce, western hemlock, grand fir, Pacific silver fir, Douglas-fir, white fir, Shasta red fir, redwood/Douglas-fir (in coastal California and southwestern Oregon), and the moist end of the ponderosa pine coniferous forest zones. This PCE must occur in concert with at least one of the following PCEs.
- PCE 2: Forested habitat (see PCE1) that provides for nesting and roosting, and could provide for foraging. Nesting and roosting habitat provides structural features for nesting, protection from adverse weather conditions, and cover to reduce predation risks for adults and young. Across the owl's range, habitat requirements are nearly identical and are associated with a high incidence of large trees with various deformities (large cavities, broken tops, mistletoe infections) or large snags suitable for nest placement. Patches of nesting habitat, in combination with roosting habitat, must be sufficiently large and contiguous to maintain NSO core areas and home ranges, and must be proximate to foraging habitat.
- PCE 3: Habitat that provides for foraging, which varies widely across the NSO range. It can consist of nesting and roosting habitat, and provide for dispersal, but its primary function is to provide a food supply for survival and reproduction. Foraging habitat is closely tied to the prey base and in some cases can include more open and fragmented forests, especially in the southern portion of the owl's range. NSO feed primarily on small mammals, especially northern flying squirrels and wood rats in southwestern Oregon (citations in Anthony et al. 2006).
- PCE 4: Habitat that supports dispersal of spotted owls, which could provide NRF habitat, but could also be composed of other forest types between larger blocks of NRF habitat. Dispersal habitat must, at a minimum, provide stands with adequate tree size and canopy cover to provide protection from avian predators and at least minimal foraging opportunities. It is essential to maintaining genetic and demographic connections among populations across the range of the species.

Because not all life history functions require all the PCEs, not all critical habitat would contain all four PCEs described above. Some CHUs contain all PCEs and support multiple life processes, while other units contain only one or two (FWS 2012d). All CHUs have had or have presence of NSO.

Activities that disturb or remove the PCEs within designated CHUs might adversely modify the owls' critical habitat. These activities could include actions that would reduce the canopy closure of a timber stand, reduce the average dbh of trees in the stand, appreciably modify the multi-layered stand structure, reduce the availability of nesting structures and sites, reduce the suitability of the landscape to provide for safe movement, or reduce the abundance or availability of prey species (FWS 1992c).

<u>NWFP Late Successional Reserves</u>

Additional habitat protection for the NSO was established when the Forest Service and BLM adopted the NWFP in 1994. The NWFP (Forest Service and BLM 1994) was designed to protect habitat for NSO and other species associated with late-successional forests while allowing a reduced amount of commercial logging on federal lands. Large amounts of federal land within the range of NSO were allocated for riparian and late successional reserves; the primary objective for these lands was to maintain or restore habitat for NSO and other fish and wildlife species. Riparian Reserves and other NWFP land use allocations provide connectivity between LSRs and federally designated critical habitat. Additionally the NWFP states that sites currently occupied by MAMUs, and KOAC (100-acre areas identified by BLM and Forest Service) that are within Matrix lands are considered "unmapped LSRs" and managed as LSRs by the NWFP.

In August 2016, the BLM issued two Records of Decision and Approved Resource Management Plans (RMPs) for Southwestern Oregon and Northwestern and Coastal Oregon (BLM 2016a and 2016b). These 2016 RMPs supersede the NWFP on BLM-managed lands. The new 2016 RMPs have similar land allocations to those in the NWFP that continue to contribute to the conservation of northern spotted owl habitat within BLM-administered lands, including LSRs and riparian reserves. The NWFP still applies to lands managed by the Forest Service and is still in effect on the three National Forests crossed by the Proposed Route. A good portion of the federally designated critical habitat overlaps with LSR land allocations; however, some lands do not and therefore LSRs afford additional habitat protection for listed species.

3.3.4.2 Environmental Baseline

Provincial Analysis Area

The proposed action is located within four Physiographic Provinces: Oregon Coast Range, Oregon Klamath Mountains, West Oregon Cascades, and East Oregon Cascades. NSO home ranges vary across provinces as a result of habitat heterogeneity and type, and prey availability (Courtney et al. 2004), and are generally larger on the west coast of Oregon and become smaller in eastern Oregon. Described below are two components of the action area within which Project-related activities could affect NSOs—one for habitat removal or modification that relate to NSO home ranges and a second for disturbance/disruption of NSO during the breeding season. The two components have been combined together to consider all components of the provincial analysis area (see figure 3.3.4-1).

Habitat Removal or Modification

The habitat removal or modification analysis area applies to all proposed action components that have the potential to remove or modify habitat, including construction of the Pipeline and aboveground facilities; no NSO habitat occurs at the LNG Terminal site (LBJ Enterprises 2006; SHN 2013c). The provincial analysis area also includes a 100-meter (328-foot) wide buffer along the edge of the area of habitat impact (e.g., edge of right-of-way or edge of new roadway corridor). In addition to the 100-meter buffer, the provincial analysis area includes any NSO Home Range with an activity center located between the outer edge of the 100-meter (328-foot) wide buffer of the proposed action components out to the distance equal to the applicable NSO physiographic home range radius: 1.5 miles, 1.3 miles, or 1.2 miles of the proposed Project.

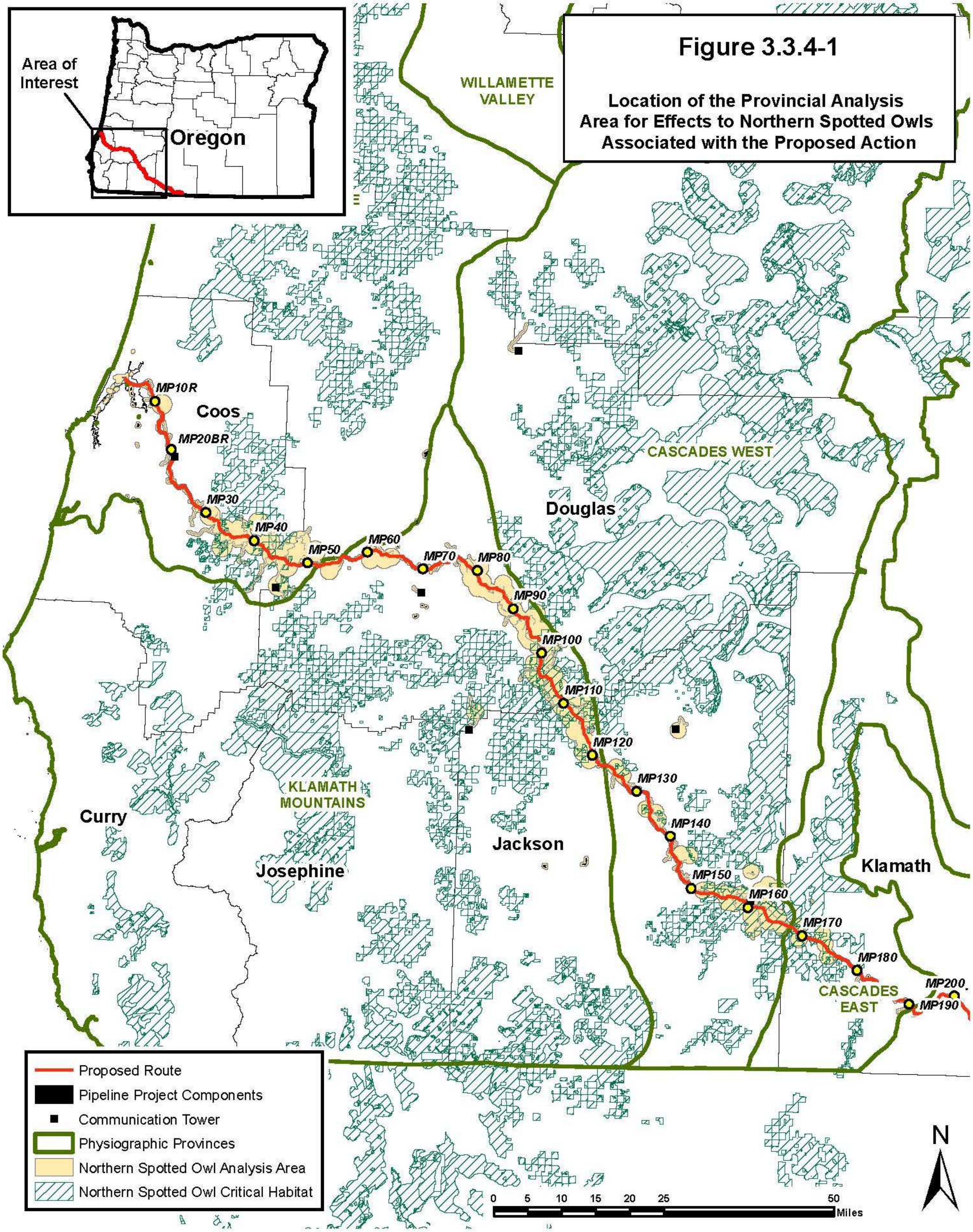


Figure 3.3.4-1
Location of the Provincial Analysis Area for Effects to Northern Spotted Owls Associated with the Proposed Action
Area of Interest
Oregon
WILLAMETTE VALLEY
CASCADES WEST
KLAMATH MOUNTAINS
CASCADES EAST
Coos
Douglas
Curry
Josephine
Jackson
Klamath
MP10R
MP20BR
MP30
MP40
MP50
MP60
MP70
MP80
MP90
MP100
MP110
MP120
MP130
MP140
MP150
MP160
MP170
MP180
MP190
MP200
Proposed Route
Pipeline Project Components
Communication Tower
Physiographic Provinces
Northern Spotted Owl Analysis Area
Northern Spotted Owl Critical Habitat
0 5 10 15 20 25 50 Miles
N

Disturbance/Disruption

Harassment that could occur from proposed construction, including blasting (greater than 2 pounds) and/or large transport helicopter use by the proposed action has been analyzed within a 0.25-mile radius of the proposed activity. A 0.25-mile analysis area would be considered for construction and timber removal activities, as well as existing access roads that have been identified for access to the proposed action (excluding paved roads used regularly by the public – County Roads and State Highways) to account for potential disturbance from noise generated from traffic or road improvements.

Species Presence

NSO populations consist of resident owls (adult and subadult) that defend a territory vocally, and non-territorial owls (adult, subadult, and juvenile owls) that generally move through habitats in search of vacant territories or available mates and rarely vocalize. Surveys to determine if potential suitable NSO habitat is occupied are accomplished by imitating NSO calls to elicit a response, generally from the territorial owls. This is usually more effective at night, as NSOs would defend their territory more readily at night (Hobbs et al. 2004; Courtney et al. 2004; Forsman 1983). Generally sites identified at night would be visited the following day to determine status (i.e., pair, nesting, resident single). Reproduction information for territorial owls is obtained by feeding an individual adult owl live mice to determine if it is a member of a nesting pair or not, based on the owl's behavior (Lint 2001; FWS 1992d). FWS (2012i) recommends conducting at least six visits a year for two years prior to a proposed action to determine site occupancy and potential reproductive success, although the survey protocol for NSOs suggests that this information can be gathered during six visits to a site in one year if the only disturbance expected from a project is noise.

Northern spotted owls are known to occur within the vicinity of the Pipeline (ORBIC 2017a) and designated critical habitat for the species is present in each county crossed by the Pipeline (FWS 2012d) see Critical Habitat Units ORC-6, KLE-1, KLE-2, KLE-3, KLE-4, KLE-5, and ECS-1). Additionally, the Pipeline will pass through BLM and Forest Service LSRs in Coos Bay, Roseburg, and Medford BLM Districts, and through LSR units RO 223 on Umpqua NF and RO 227 on Rogue River-Siskiyou NF.

To determine species presence and/or absence within the provincial analysis area, GIS data of historical and current NSO locations were obtained from BLM Districts and National Forests crossed by the Pipeline, as well as from the demographic studies occurring within the Pipeline project area (BLM 2006, 2012, and 2017; Forest Service 2006, 2012, 2017a, 2017b, and 2017c; FWS 2008d). Additionally, PCGP contracted SBS (Eagle Point, Oregon) to conduct 2 years of surveys in 2007 and 2008 to determine species presence within the proposed construction right-of-way. Taking a conservative approach for purposes of this APDBA, all owl sites (known, best location, and PCGP assumed) are analyzed as if occupied and reproductive.

PCGP Spotted Owl Surveys (2007 and 2008)

To determine nesting NSO presence and/or absence, as well as nesting status (if possible) within the analysis area, NSO surveys were conducted by PCGP between March 15 and August 31 in 2007 and 2008 as defined by the *Protocol for Surveying Proposed Management Activities that May Impact Northern Spotted Owls* (FWS 1992d); NSO absence data could be considered accurate for two breeding seasons following complete survey efforts. Surveys were conducted by SBS and were carried out within suitable NRF habitat and outside of ongoing NSO demographic and monitoring survey efforts. In general, surveys were conducted within 0.5 mile of the proposed construction right-of-way where suitable NRF habitat would be removed by the Project. Otherwise, surveys were conducted within 0.25 mile of the proposed construction right-of-way if suitable NRF habitat was present, but would not be removed (as advised by Smith et al. 2007). In areas that were identified as requiring blasting and/or timber removal and construction by helicopter, surveys within suitable NSO habitat were conducted 1 mile from the proposed alignment in 2008 (Smith et al. 2007; Wille et al. 2006).

The 0.25-mile disturbance and the 0.5-mile habitat alteration survey areas followed the 1992 FWS two-year survey protocol (three visits per year) in 2007 and 2008. Surveys conducted out to 1 mile from potential blasting (greater than 2 pounds) and/or large transport helicopter disturbance areas in 2008 followed the 1992 one-year survey protocol (six visits per year). Surveys conducted within the Project area took extra precautions to reduce negative effects of barred owls on NSO, following guidance provided by the FWS in March 2007, which dictate that if a barred owl responds to a NSO call, stop calling for the NSO. This guidance is similar to the direction provided in the 2012 revised and updated survey protocol (FWS 2012i). To further reduce NSO harassment from multiple survey efforts, PCGP did not conduct surveys where other survey efforts by agency biologists were ongoing, including demographic and monitoring studies in the Roseburg BLM District (approximately MP 46.8 through MP 100.7), South Cascades demographic study conducted in Jackson and Klamath counties (MP 155.2 through MP 170.7), and a NSO monitoring study area in Lakeview BLM District.

Within the defined survey area for 2007, approximately 28,774 acres were identified as suitable NRF habitat and were organized into 61 separate survey areas. Of that acreage, 8,562 acres identified were located on private lands but permission to survey was granted on only 3,713 acres (access was denied for 4,849 acres). Overall, 83 percent or approximately 23,925 acres were surveyed in 2007 following the 1992 two-year survey protocol. In 2008, an additional 32,221 acres were identified as potential suitable NRF habitat within 1 mile of areas that may require blasting (greater than 2 pounds) and large transport helicopter use. Of the 58,652 acres identified as suitable NRF habitat, permission to survey was granted for 47,679 acres (81 percent), and these were surveyed in 2008. New habitat identified in 2008 followed the 1992 one-year survey protocol.

NSO surveys conducted in 2007 detected NSO 115 times in 29 of the 61 survey areas. Twelve NSO pairs and one resident single (located at least three times on separate survey visits) were detected. No nest sites were located in 2007; however, at one site fledglings were observed with their parents, suggesting a nest location in the vicinity. During 2008 surveys, NSO were detected 190 times and were found in 26 of the 54 survey areas established. NSO pairs were detected at 20 locations and two nests were located. Resident singles were identified at six sites. Approximate activity centers were drawn around the pairs and resident singles documented in 2007 and/or 2008 based on detection date and time, the age and sex of owls observed, the owls' behavior, and occasionally the habitat of a detection location. Seven NSO pairs documented within the survey area were assumed to be NSO activity sites previously documented and/or monitored by other agencies, and seven pairs were incorporated as new activity sites within agency management areas considering activity documented during 2007 and/or 2008 survey results. NSO pairs or resident singles that were not associated with previous known NSO activity centers or were not incorporated by agencies as new activity sites are considered Pipeline project "best location" activity centers for analysis within this APDBA.

Although survey design was not intended to locate or census barred owls, this species was documented 36 times in 14 survey areas in 2007, and 115 times in 14 survey areas in 2008, including 8 pairs.

For full description and information on NSO surveys and detections, see the 2007–2008 Northern Spotted Owl Survey Report (available upon request).

PCGP Spotted Owl Surveys (2015)

Protocol surveys were initiated along the Blue Ridge route in 2015 following the revised 2012 survey protocol – two years of surveys, six visits each year (FWS 2012i). No NSO were documented; however, barred owls were documented 19 times, including three pairs. The presence of barred owls detected during survey efforts decreases the likelihood that NSO are nesting along the Blue Ridge portion of the Proposed Route. To-date, only one year of survey effort has occurred in this portion of the Pipeline project.

Northern Spotted Owl Activity Sites Considered for Analysis

Initially in 2008, PCGP received a Northern Spotted Owl Occupancy Map (NSOOM) from FWS that included both historical and recent NSO sites provided by BLM Districts and National Forests within the proposed Project area that were combined with survey data collected for the Pipeline by SBS in 2007/2008. Additionally, the NSOOM provided areas of potential NSO nests sites modeled or "predicted" to occur on the landscape based on current NSO occupancy and available NSO habitat (see appendix 1 in appendix A of Trapper Timber Sale Biological Opinion). Agency biologists reviewed the data and revised NSO activity centers considered for the Pipeline based on local knowledge prior to providing the final data to PCGP. The objective of the collaborative process was to generate a clean but complete NSO map that could be used for analyses purposes for the proposed Pipeline. Some areas where owl activity was less certain, such as where resident single or pair activity was identified by SBS that may be associated with other known activity sites but not enough information was available (i.e., no band color collected), were included for analysis (i.e., Pipeline project best location sites). If an agency-provided alternate nest site was closer to the Pipeline route, the alternate site was considered rather than the site with the most recent activity for a more conservative analysis. By using this conservative approach, the analysis reflects a "worst case scenario" and likely results in an overestimation of potential impacts to the NSO.

The 2008 NSOOM was revised in 2013 and again in 2014 as part of the previous iteration of the Pipeline project, and subsequently revised in 2017 to account for new data and new direction by agencies since 2008 for the Pipeline. To revise previous NSOOM and account for new data and new survey efforts since 2008, PCGP requested and obtained new NSO data from each of the BLM Districts and National Forests crossed by the Pipeline, including demographic study data (Forest Service 2017a, 2017b, 2017c; BLM 2017) Using the same methodology that was applied to the 2008 NSOOM, a revised NSOOM was created for this APDBA. The NSOOM methodology is intended to facilitate a reasonable, but conservative basis for estimating potentially occupied NSO habitat within the proposed analysis area, especially where surveys have not been conducted or not completed as required by the survey protocol, or barred owl presence may have negatively affected the response of NSOs during calling surveys.

In June 2013, the use of the Owl Estimation Model (OEM) that produced "predicted" owls provided in the 2008 NSOOM was challenged in federal district court. As a result of this challenge, FWS, BLM, and Forest Service requested that the use of "predicted owls" utilizing the OEM no longer be used by PCGP. PCGP had used the predicted owl sites and had previously included 18 possible NSO activity centers to produce a more conservative analysis for habitat effects and disturbance disruption effects by the Project. As a result of the recent court activity and agency requests, PCGP removed 18 predicted owls created using the OEM that had been previously included in the 2008 NSOOM. In order for PCGP to continue with a conservative analysis approach for spotted owls (similar to PCGP's approach for MAMUs – presumed occupied stands), PCGP identified nine areas (referred to hereafter as "PCGP assumed sites") within 1.2 to 1.5 miles of proposed Project disturbance (Cascades to Coast Range physiographic province home range radii distances) that could potentially support NSO pairs. PCGP assumed sites were established in areas that were either surveyed in 2007/2008 with NSO presence but no pair or resident single determined, or an area that could support a NSO pair based on suitable habitat available in an assumed nest patch/core area that is located farther than the average "nearest neighbor" distance from a known or best location NSO site, as reported by FWS et al. (2008) for each physiographic province crossed (see Table 5 in FWS et al. 2008: more than 2,084 meters [6,837 feet] in Coast Range; more than 2,078 meters [6,817 feet] in Klamath Mountains; more than 2,333 meters [7,654 feet] in West Cascades; and more than 2,446 meters [8,024 feet] in East Cascades).

PCGP took into consideration the general habitat characteristics of known NSO sites in the vicinity of potential "assumed" locations to review the current status of available NRF within known home ranges, since available NRF habitat within a potential PCGP assumed site often did not meet the FWS-recommended NRF threshold of more than 40 percent and more than 50 percent NRF in the home range and core area, respectively. Past predicted owl sites previously analyzed were also reviewed for consideration because PCGP survey efforts had targeted those areas. In five instances, PCGP assumed sites were established in the vicinity of previously "mapped" / "predicted" owl sites based on survey efforts or the amount of available high quality NRF habitat that was also contiguous, interior forest. PCGP assumed sites have been placed in contiguous high NRF/NRF habitat at least 100 meters (328 feet) from the edge of a forested stand resulting in the site being placed in interior forest. These areas are PCGP assumed NSO sites and have been provided a site ID (i.e. PCGP A-8) No PCGP assumed sites were established between MPs 0.00 and 32.47 because this area consists of checkerboard BLM/private land ownership where commercial timber harvest is prevalent and surveys conducted within this MP range for the Pipeline in areas of higher quality NRF habitat did not document NSO. Three of the PCGP-assumed sites established in 2014 were replaced by known or historic owl sites provided by BLM or Forest Service in 2017 that were in close proximity to the PCGP-assumed sites.

Sites considered for analysis within this APDBA are either 1) known pairs or resident singles provided by BLM and Forest Service (historic or current), 2) best location (pair documented by PCGP survey efforts in 2007/2008 but nest site not located, or 3) PCGP-assumed (site analyzed where no pair has been documented, but available NRF habitat present could provide habitat for nesting or future nesting NSO). Approximately 105 northern spotted owl home ranges – known current/historic (84), best location (15), and PCGP-assumed (6) occur within the vicinity of the proposed Pipeline, including existing access roads (excluding paved, public roads) identified for use for construction and operation of the Pipeline, pipe yards, and rock storage areas, of which 97 home ranges will be affected by construction of the proposed Pipeline, and 78 home ranges will be crossed by proposed access roads. Table 3.3.4-2 provides a summary of NSO home ranges, core areas, and nest patches (known, best location, or PCGP assumed) that intersect the proposed Pipeline and/or proposed access roads within each physiographic province. Table Q-7 in appendix Q provides additional details for each NSO Home Range included in the provincial analysis area, including available NSO habitat (high NRF, NRF, dispersal only, and capable) within each Home Range pre-action.

TABLE 3.3.4-2

Summary of Known, Best Location, or PCGP-Assumed
NSO Home Ranges, Core Areas, and Nest Patches Crossed by the Pipeline Project, including Access Roads

NSO Status	Number of NSO Activity Centers	Number of Home Ranges Crossed		Number of Core Areas Crossed		Number of Nest Patches Crossed	
		Habitat Affected a/	Access Roads b/	Habitat Affected a/	Access Roads b/	Habitat Affected a/	Access Roads b/
Coast Range Physiographic Province – 1.5 mile home range radius							
Known Sites	14	11	14	5	12	1	11
Best Location Sites d/	0	0	0	0	0	0	0
PCGP Assumed Sites e/	3	3	3	2	3	0	3
Total	***17***	***14***	***17***	***7***	***15***	***1***	***14***
Klamath Mountains Physiographic Province – 1.3 mile home range radius							
Known Sites	39	38	27	15	15	1	12
Best Location Sites c/	10	10	9	5	6	3	5
PCGP Assumed Sites d/	3	2	2	1	2	1	2
Total	***52***	***50***	***38***	***21***	***23***	***5***	***19***
West Cascades Physiographic Province – 1.2 mile home range radius							
Known Sites	26	24	19	9	13	2	12
Best Location Sites c/	5	5	4	2	3	0	2
PCGP Assumed Sites d/	0	0	0	0	0	0	0
Total	***31***	***29***	***23***	***11***	***16***	***2***	***14***
East Cascades Physiographic Province – 1.2 mile home range radius							
Known Sites	5	4	0	1	0	1	0
Best Location Sites c/	0	0	0	0	0	0	0
PCGP Assumed Sites d/	0	0	0	0	0	0	0
Total	***5***	***4***	***0***	***1***	***0***	***1***	***0***
All Physiographic Provinces Crossed							
Known Sites	84	77	60	30	40	5	35
Best Location Sites c/	15	15	13	7	9	3	7
PCGP Assumed Sites d/	6	5	5	3	5	1	5
Total	**105**	**97**	**78**	**40**	**54**	**9**	**47**

a/ Habitat Affected considers all proposed disturbance, including uncleared storage areas (UCSAs), pipeyards, rock sources, and PARs/TARs.
b/ Access roads considered does not include paved roads that are used regularly by the public (i.e., County Roads, State Highways). Home ranges are included if the activity center is within 0.25 mile of a proposed access road.
c/ Best Location Sites – areas identified with pair activity during PCGP survey efforts in 2007 and/or 2008 but the nest was not located; SBS and local agency biologists determined best potential nest site based on survey data and available habitat.
d/ PCGP Assumed Sites - area identified by PCGP that may provide habitat for NSO pair.

FWS et al. (2008) consider core areas with 50 percent or greater NRF habitat and home ranges with at least 40 percent NRF habitat to be necessary to maintain NSO life history function. Based on FWS et al. (2008) guidelines 39 of 97 spotted owl sites identified that will have habitat removed by the Proposed Route are above the threshold of available NRF habitat within both their core area (greater than 50 percent) and home range (greater than 40 percent): 32 known NSO sites and 7 best location sites. The remaining 58 spotted owl activity centers (45 known, 8 best location, and 5 PCGP assumed) are below NRF thresholds for the core area and/or home range (table 3.3.4-3).

Table 3.3.4-3 provides a summary of the current habitat condition by Physiographic Province and owl status (known, best location, or PCGP assumed) of the 97 NSO sites within the provincial analysis area that will have habitat affected by the Proposed Route. Note that calculations of habitat conditions for each owl site in table 3.3.4-3 considered suitable habitat located on both federal and non-federal lands. The amount of NRF habitat currently available for each NSO within each habitat type (nest patch, core area, and home range) can be reviewed in table Q-7 in appendix Q. Amount of NRF habitat in table Q-7 in appendix Q is specific to each habitat type in its entirety;

acres provided for the home range include acres that also occur within the core area and nest patch, and acres included in the core area also include acres within the nest patch. Table Q-7 in appendix Q provides the amount of suitable habitat for each individual owl in federal and non-federal lands, regardless of overlap with adjacent home ranges and the habitat condition determined pre-action for each NSO home range. A description of how NSO habitat was determined is addressed in the Habitat section below.

TABLE 3.3.4-3

Number of NSO Home Ranges, by Physiographic Province and Habitat Condition that Would Have NSO Habitat Removed by the Proposed Route [1]

Suitable NRF Habitat Condition within Owl Home Ranges [2]	Owl Status [3]	Physiographic Province: Coast Range	Klamath Mountains	West Cascades	East Cascades	Total
Home Range > 40%	Known	1	17	11	3	32
AND	Best Location	0	3	4	0	7
Core Area > 50%	PCGP-assumed	0	0	0	0	0
(Above Threshold)	*Total*	*1*	*20*	*15*	*3*	39
Home Range > 40%	Known	0	4	5	0	9
AND	Best Location	0	1	0	0	1
Core Area < 50%	PCGP-assumed	0	1	0	0	1
(Below Threshold)	*Total*	*0*	*6*	*5*	*0*	11
Home Range < 40%	Known	2	6	1	0	9
AND	Best Location	0	1	0	0	1
Core Area > 50%	PCGP-assumed	0	0	0	0	0
(Below Threshold)	*Total*	*2*	*7*	*1*	*0*	10
Home Range < 40%	Known	8	11	7	1	27
AND	Best Location	0	5	1	0	6
Core Area < 50%	PCGP-assumed	3	1	0	0	4
(Below Threshold)	*Total*	*11*	*17*	*8*	*1*	37
Overall Total	Known	11	38	24	4	77
	Best Location	0	10	5	0	15
	PCGP-assumed	3	2	0	0	5
	Total	14	50	29	4	97

[1] For detailed suitable NRF habitat available for each individual northern spotted owl and its habitat type (nest patch, core area, home range), refer to suitable habitat acres in table Q-7 in appendix Q.
[2] FWS et al. (2008) consider core areas with 50 percent or greater suitable NRF habitat and home ranges with at least 40 percent suitable NRF habitat to be necessary to maintain NSO life history function.
[3] Owl Status: 1) Known sites represent pairs or resident singles - historic or current; 2) Best Location are sites documented during survey efforts for the Pipeline project but nest site was not located; and 3) PCGP-assumed sites are areas identified by PCGP that may provide habitat for NSO pair.

PCGP requested guidance from FWS in November 2012 to determine what additional surveys for NSO should be conducted for the proposed action, considering the survey protocol was revised in February 2010 (see FWS 2010h) and finalized in January 2012 (see FWS 2012i), and surveys for the Pipeline project were conducted in 2007 and 2008 following the 1992 survey protocol. FWS (McCorkle 2012; appendix S – ROC) stated that additional full protocol NSO surveys across the entire project were not necessary, but recommended pre-construction "spot check" surveys with at least three site visits occurring prior to construction to confirm occupancy status, and to inform additional opportunities to fine-tune timing or distance buffers around active NSO activity centers. PCGP would conduct "spot check" surveys one year prior to scheduled timber removal in NRF habitat that is within 0.25 mile of the construction right-of-way to detect spotted owls that may have recently established territories in the project area or are utilizing another site for nesting (see "spot check" surveys in the revised NSO survey protocol; FWS 2012i). Surveys would target NRF habitat within home ranges analyzed for the Pipeline project, as well as additional NRF habitat outside of NSO home ranges that was included in previous survey efforts for the Pipeline (2007, 2008, and 2015 survey efforts) and may be capable of supporting a single or pair of territorial

NSO. Surveys would not occur where annual monitoring survey efforts are on-going in the proposed action area to minimize NSO harassment.

Habitat

FWS identified four categories of NSO habitat that should be used to assess impacts to spotted owls and habitat for the proposed action (2014c): highly suitable NRF (high NRF), NRF, dispersal habitat, and capable habitat. High NRF is considered habitat that is characterized by large trees (greater than 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species (FWS 2014c). Other habitat definitions include (FWS; 2012d, 2014c; North et al. 1999): 1) NRF that consists of conifer-dominated stands older than 80 years, and are multi-storied in structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, high basal area (greater than 240 square feet/acre), high diversity of different diameters of trees, high incidence of large live trees with various deformities (e.g., large cavities, broken tops, mistletoe infections), sufficient snags and down wood, and sufficient open space below the canopy for NSO to fly but does not meet the definition of High NRF; 2) dispersal habitat is composed of conifer and mixed mature conifer-hardwood habitats with a canopy cover greater than or equal to 40 percent in moist forests and greater than 30 percent in dry forests, conifer trees greater than or equal to 11 inches average diameter-breast-at-height, and sufficient open space below the canopy to fly; and 3) capable habitat that is forested habitat that could provide NSO suitable NRF in the future (including recently harvested stands – i.e., clearcut) but currently does not provide the structures described above for NSO High NRF, NRF, or dispersal habitat. Non-capable habitat has been defined as areas that will never provide habitat for NRF or dispersal habitat, such as agriculture fields, grasslands, rivers, rock outcroppings, roads, etc. (FWS 2006d), as well as forested areas that are non-capable largely because of the natural expression of vegetation patterns resulting from edaphic, topographic, and climatic constraints; such areas may include serpentine dominated soils or dry, south-facing slopes, and could also include oak woodlands.

In the analysis conducted for the previously proposed project (FERC 2009), PCGP used the BioMapper Habitat Model created by the Forest Service Northwest Research Station and used in the 10-year Monitoring Report (see Lint 2005) per recommendations by FWS and Forest Service, as the foundation to determine suitable habitat within the project area. Davis et al. (2011) determined that the BioMapper model overestimated owl habitat suitability in portions of the range, including pine-dominated forests of the eastern Cascades, and young stands in the Coast Range and western Cascades. Since the previous analysis (FERC 2009), improved NSO habitat models have been developed to monitor status and trends of the NSO populations and habitat within the past 15 and 20 years in the NWFP area and were introduced in the 15-year and 20-year NWFP NSO habitat monitoring documents; the habitat suitability models represent NSO habitat as of 2006 and 2012 in Oregon, respectively (see Davis et al. 2011 and 2016). In 2012, FWS and Forest Service suggested that PCGP use these models developed for the 15-year NWFP NSO habitat monitoring efforts to assist in categorizing NSO habitat (high NRF, NRF, dispersal, and capable habitat; see FWS 2014c) within the proposed action project area, rather than the BioMapper model. The updated model used in the 20-year NWFP NSO habitat monitoring effort has been used for developing NSO habitat for this APDBA.

In addition to the updated GIS NSO habitat models developed for the 20-year NWFP monitoring documents (Davis et al. 2016), PCGP received agency-specific NSO habitat GIS data from National Forests crossed by the Pipeline [Umpqua (Forest Service 2017a), Rogue River – Siskiyou

(Forest Service 2017b), and Fremont-Winema (Forest Service 2017c)] and BLM Districts crossed by the Pipeline (Coos Bay, Roseburg, Medford, and Lakeview [BLM 2017a]). In order to standardize the available GIS data throughout the provinicial analysis area, and create a NSO habitat GIS file with the four recommended NSO habitat categories for for this BAAPDBA (see FWS 2014c), PCGP used the available GIS NSO Habitat files in conjuction with the vegetation GIS coverage that was delineated for the Pipeline. The vegetation GIS coverage for the Pipeline was delineated at a finer scale using 2016 aerial photography, and available agency data (i.e., BLM FOI coverage, late successional Gradient Nearest Neighbor coverage) to classify age of forest, generally within 300 meters (984 feet) of the proposed action and particularly in the affected area, and has been reviewed by local agency biologists; forested habitat was classified by type and age classes (clear-cut – 0 to 5 years, regenerating forest—5 to 40 years, mid-seral—40 to 80 years, late successional—80 to 175 years, and old-growth—greater than 175 years; see discussion in Vegetation, Section 3.3.1.1 in PCGP's FERC Certificate application).

NSO habitat was initially delineated using the vegetation GIS file created by PCGP for the proposed action using age classes and forest type: clearcut and regenerating forest was considered "capable;" mid-seral coniferous and mixed forest lands, as well as deciduous forests were considered "dispersal only;" and late successional coniferous and old-growth forest were considered NRF habitat. Next, the seven NSO habitat coverages obtained from the National Forests and BLM Districts crossed by the Pipeline were used to further refine NSO habitat classification, and expand the PCGP NSO habitat coverage beyond the vegetation GIS file delineated for the Pipeline. Where NSO habitat categories differed between the NSO habitat identified from the vegetion GIS file, or from other agency data, PCGP conservatively used the higher habitat category (i.e., an area that was identified as NRF, dispersal, and non-capable was categorized as NRF), especially outside of the finely delineated vegetation GIS file created for the Pipeline project. Within closer vicinity of the Pipeline, NSO habitat was generally classified using the vegetation GIS file created for the proposed action since forested vegetation on the ground had been updated from 2016 aerial photography to consider recent clearcuts and the 2015 Stouts Creek fire; available agency NSO habitat data often did not reflect changes in forested habitat since 2015 or earlier.

The 2012 nesting/roosting model created for the 20-year NWFP Habitat monitoring provided a pixelated coverage that identified areas of highly suitable, suitable, marginal, and unsuitable habitat throughout the NWFP area. The pixelated areas identified as "highly suitable" were used to classify areas of "high NRF" in the NSO habitat file where the previous steps using the vegetation GIS and agency data determined NSO habitat to be NRF. Further, unclassified NSO habitat within the provincial analysis area was classified using areas identified in the 2012 nesting/roosting model ("suitable" areas were used to classify NSO habitat as NRF and "highly suitable" areas were used to classify high NRF), and previously modeled habitat from the 2015 FERC BA.

Within the resulting modeled areas for the provincial analysis area, 2016 aerial photography was used to delineate obviously young stands (i.e., clearcuts or early regenerating forest) and identify the habitat as capable (in many instances high NRF and NRF modeled from available data and the 2012 NWFP model were located in clearcuts). In 2015, Stouts Creek fire burned through a large quantity of high quality NSO habitat in the provinicial analysis area in Klamath Mountain physiographic provice; the modeled habitat and agency GIS data often identified this area as providing NRF and high NRF habitat. PCGP consulted with FWS (Stone, 2017), Forest Service

(Hadwen, 2017) and BLM (McGraw, 2017) to determine how to proceed with classifying NSO habitat in the affected area. Based on direction received from the agencies, PCGP conservatively classified NSO habitat in the area affected by the fire as follows:

- areas that had been clearcut or burned to the ground were considered capable habitat;
- mid-seral to late successional habitat that that had standing trees but had burned to some degree (trees brown in patches, based on visually reviewing 2016 aerial photography) continued to be considered their modeled NSO habitat type – diserpsal, NRF, high NRF; and
- areas that were charred from a high intensity burn, but still had trees standing (contiguous stand of black, standing trees) were considered NRF, but not high NRF if the 2012 NWFP model identified that area as high NRF. Agencies indicated that these areas would be considered areas for NSO foraging and/or roosting, but to include the habitat in the "NRF" category, as defined in the FWS Conservation Framework document (FWS 2014c). In the NSO GIS file, this NSO habitat type is classified as "post-fire NRF" and is incorporated in subsequent tables to identify the NRF habitat that is likely standing dead trees. Post-fire NRF is a term used in the Roseburg BLM District NSO habitat GIS file provided to PCGP.

The resulting NSO Habitat file described above provides a good, but conservative approximation of the NSO habitat (high NRF, NRF, dispersal only, and capable) within the proposed action area that would be affected by construction of the Pipeline. The model was used to determine the amount of high NRF, NRF, dispersal, and capable habitat within the Physiographic analysis area by Physiographic Province and jurisdiction (see table 3.3.4-4). Figures 2, 3, and 4 in appendix Q provide an overview of NSO habitat within the Project analysis area in relation to spotted owl home ranges, NSO critical habitat, and NWFP LSRs. Table Q-7 in appendix Q identifies the amount of NSO Habitat (high NRF, NRF, dispersal only, and capable habitat) available within each NSO Home Range.

Both federal and non-federal land occurs within the defined provincial analysis area, and based on acres of high NRF and NRF habitat available within each (see table 3.3.4-4), it is apparent that federally-managed lands provide substantially more suitable NRF habitat than non-federal lands. Therefore, it can be expected that non-federal land within the provincial analysis area plays a minor role in supporting NSOs and aiding in their recovery. Overall, approximately 52 percent of federal lands within the provincial analysis area provide suitable NRF (including High NRF) habitat; this is greater than the 40 percent NRF habitat threshold per home range that FWS et al. (2007) consider necessary to maintain NSO life history function. Also note, the majority of available NRF occurs within NSO home ranges. If physiographic provinces are reviewed individually, less than 40 percent of federal and non-federal lands together provide suitable NRF within each physiographic province; however, federal lands within individual physiographic province (except for the Coast Range) collectively consist of more than 40 percent NRF habitat which is above the recommended threshold. On all lands (federal and nonfederal), the Coast Range provides 18.1 percent NRF; Klamath Mountains, 37.5 percent NRF; West Cascades, 37.8 percent NRF; East Cascades, 32.6 percent NRF.

TABLE 3.3.4-4

Summary of NSO Suitable Nesting, Roosting, and Foraging, Dispersal, and Capable Habitat Available within the Provincial Analysis Area by Physiographic Province

Landowner a/	General Location	Total Acres within Analysis Area b/	High NRF Habitat c/		NRF Habitat d/		Dispersal Habitat Only e/		Capable Habitat f/		Total NSO Habitat	
			Acres Available	Percent	Acres Available	Percent	Acres Available	Percent	Acres Available	Percent	Acres Available	Percent
Coast Range Physiographic Province												
Federal	Home Range	27,022	7,761	28.7%	4,433	16.4%	8,314	30.8%	6,372	23.6%	26,880	99.5%
	Outside Home Range	10,422	1,151	11.0%	1,543	14.8%	4,399	42.2%	2,835	27.2%	9,928	95.3%
	Subtotal	**37,443**	8,913	**23.8%**	**5,975**	**16.0%**	**12,713**	**34.0%**	**9,207**	**24.6%**	**36,808**	**98.3%**
Non-Federal	Home Range	34,894	432	1.2%	975	2.8%	3,208	9.2%	27,732	79.5%	32,348	92.7%
	Outside Home Range	19,959	92	0.5%	309	1.5%	1,976	9.9%	9,126	45.7%	11,502	57.6%
	Subtotal	**54,853**	524	**1.0%**	**1,284**	**2.3%**	**5,184**	**9.5%**	**36,858**	**67.2%**	**43,850**	**79.9%**
Coast Range Total	Home Range	61,916	8,194	13.2%	5,408	8.7%	11,522	18.6%	34,103	55.1%	59,228	95.7%
	Outside Home Range	30,381	1,243	4.1%	1,851	6.1%	6,375	21.0%	11,961	39.4%	21,430	70.5%
	Subtotal	**92,297**	**9,437**	**10.2%**	**7,260**	**7.9%**	**17,897**	**19.4%**	**46,064**	**49.9%**	**80,658**	**87.4%**
Klamath Mountains Physiographic Province												
Federal	Home Range	53,344	16,798	31.5%	14,570 (4,110)	27.3%	13,226	24.8%	7,851	14.7%	52,445	98.3%
	Outside Home Range	3,707	899	24.3%	841 (142)	22.7%	1,238	33.4%	553	14.9%	3,531	95.3%
	Subtotal	**57,051**	**17,697**	**31.0%**	**15,411 (4,252)**	**27.0%**	**14,464**	**25.4%**	**8,404**	**14.7%**	**55,976**	**98.1%**
Non-Federal	Home Range	55,276	5,841	10.6%	7,798 (120)	14.1%	7,169	13.0%	27,642	50.0%	48,450	87.7%
	Outside Home Range	16,383	666	4.1%	847 (31)	5.2%	3,263	19.9%	4,603	28.1%	9,380	57.3%
	Subtotal	**71,660**	**6,508**	**9.1%**	**8,645 (151)**	**12.1%**	**10,432**	**14.6%**	**32,244**	**45.0%**	**57,829**	**80.7%**
Klamath Mountains Total	Home Range	108,621	22,639	20.8%	22,368 (4,230)	20.6%	20,395	18.8%	35,492	32.7%	100,895	92.9%
	Outside Home Range	20,091	1,565	7.8%	1,688 (173)	8.4%	4,501	22.4%	5,156	25.7%	12,910	64.3%
	Subtotal	**128,711**	**24,204**	**18.8%**	**24,056 (4,404**	**18.7%**	**24,896**	**19.3%**	**40,649**	**31.6%**	**113,805**	**88.4%**
West Cascades Physiographic Province												
Federal	Home Range	47,770	9,270	19.4%	14,757	30.9%	15,357	32.1%	5,293	11.1%	44,677	93.5%
	Outside Home Range	4,032	212	5.3%	2,001	49.6%	796	19.7%	331	8.2%	3,341	82.9%
	Subtotal	**51,802**	**9,482**	**18.3%**	**16,758**	**32.4%**	**16,153**	**31.2%**	**5,624**	**10.9%**	**48,018**	**92.7%**
Non-Federal	Home Range	15,111	616	4.1%	1,712	11.3%	3,336	22.1%	7,806	51.7%	13,470	89.1%
	Outside Home Range	9,936	78	0.8%	422	4.2%	1,619	16.3%	4,397	44.3%	6,516	65.6%
	Subtotal	**25,047**	**694**	**2.8%**	**2,134**	**8.5%**	**4,955**	**19.8%**	**12,203**	**48.7%**	**19,986**	**79.8%**
West Cascades Total	Home Range	62,881	9,886	15.7%	16,469	26.2%	18,693	29.7%	13,099	20.8%	58,147	92.5%
	Outside Home Range	13,968	290	2.1%	2,423	17.3%	2,416	17.3%	4,728	33.8%	9,856	70.6%
	Subtotal	**76,850**	**10,176**	**13.2%**	**18,892**	**24.6%**	**21,108**	**27.5%**	**17,827**	**23.2%**	**68,003**	**88.5%**
East Cascades Physiographic Province												
Federal	Home Range	10,955	1,402	12.8%	5,503	50.2%	1,678	15.3%	2,247	20.5%	10,830	98.9%
	Outside Home Range	1,094	43	3.9%	480	43.9%	249	22.8%	154	14.1%	927	84.7%

TABLE 3.3.4-4

Summary of NSO Suitable Nesting, Roosting, and Foraging, Dispersal, and Capable Habitat Available within the Provincial Analysis Area by Physiographic Province

Landowner a/	General Location	Total Acres within Analysis Area b/	High NRF Habitat c/		NRF Habitat d/		Dispersal Habitat Only e/		Capable Habitat f/		Total NSO Habitat	
			Acres Available	Percent	Acres Available	Percent	Acres Available	Percent	Acres Available	Percent	Acres Available	Percent
	Subtotal	**12,049**	**1,445**	**12.0%**	**5,984**	**49.7%**	**1,928**	**16.0%**	**2,401**	**19.9%**	**11,757**	**97.6%**
Non-Federal	Home Range	3,530	12	0.3%	297	8.4%	203	5.8%	2,523	71.5%	3,034	85.9%
	Outside Home Range	8,306	0	0.0%	49	0.6%	601	7.2%	6,146	74.0%	6,797	81.8%
	Subtotal	**11,836**	**12**	**0.1%**	**345**	**2.9%**	**804**	**6.8%**	**8,670**	**73.3%**	**9,831**	**83.1%**
East Cascades Total	Home Range	14,486	1,414	9.8%	5,800	40.0%	1,881	13.0%	4,770	32.9%	13,864	95.7%
	Outside Home Range	9,399	43	0.5%	529	5.6%	850	9.0%	6,301	67.0%	7,723	82.2%
	Subtotal	**23,885**	**1,457**	**6.1%**	**6,329**	**26.5%**	**2,731**	**11.4%**	**11,070**	**46.3%**	**21,588**	**90.4%**
All Physiographic Provinces												
Federal	Home Range	139,092	35,231	25.3%	39,263 (4,110)	28.2%	38,576	27.7%	21,762	15.6%	134,832	96.9%
	Outside Home Range	19,255	2,305	12.0%	4,864 (142)	25.3%	6,682	34.7%	3,874	20.1%	17,726	92.1%
	Subtotal	**158,347**	**37,536**	**23.7%**	**44,128 (4,252)**	**27.9%**	**45,258**	**28.6%**	**25,636**	**16.2%**	**152,558**	**96.3%**
Non-Federal	Home Range	108,811	6,902	6.3%	10,782 (120)	9.9%	13,916	12.8%	65,702	60.4%	97,302	89.4%
	Outside Home Range	54,584	836	1.5%	1,627 (31)	3.0%	7,460	13.7%	24,272	44.5%	34,194	62.6%
	Subtotal	**163,396**	**7,738**	**4.7%**	**12,409 (151)**	**7.6%**	**21,375**	**13.1%**	**89,974**	**55.1%**	**131,496**	**80.5%**
Overall Total	Home Range	247,903	42,133	17.0%	50,045 (4,230)	20.2%	52,491	21.2%	87,465	35.3%	232,134	93.6%
	Outside Home Range	73,839	3,141	4.3%	6,491 (173)	8.8%	14,141	19.2%	28,146	38.1%	51,920	70.3%
	Subtotal	**321,742**	**45,274**	**14.1%**	**56,536 (4,404)**	**17.6%**	**66,633**	**20.7%**	**115,611**	**35.9%**	**284,054**	**88.3%**

a/ Landowner is summarized by Federal (BLM Districts and National Forests) and Non-Federal (Private, State, Corps of Engineers, and Bureau of Indian Affairs Land).

b/ Total acres available within the entire analysis area, including non-capable habitat, is not identified in this table.

c/ High NRF (FWS 2014c): forested habitat characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species. Generally includes late successional and old-growth forest (greater than 80 years).

d/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., "post-fire NRF").

e/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.

f/ Capable Habitat (FWS 2014c: habitat that is forested or could become forested (i.e., including recently harvested timberlands) that do not provide dispersal or NRF characteristics

Discussion at the Task Force - ESA Consultation Subgroup meeting on April 2, 2008, indicated that NSO dispersal habitat could be considered adequate, or sufficient to support dispersing NSO, if at least 50 percent of the analysis area (in the Project's case, the defined provincial analysis area) consists of dispersal habitat. Within the provincial analysis area, dispersal habitat comprises dispersal-only habitat, as well as high NRF and NRF. Calculating the overall high NRF, NRF, and dispersal habitat from table 3.3.4-4, approximately 168,443 acres (52.4 percent) of dispersal habitat are available within the provincial analysis area. Overall, the provincial analysis area provides sufficient levels of dispersal habitat to support dispersing NSO (greater than 50 percent). Using the same method to calculate the available dispersal habitat within each physiographic province, the following acres of dispersal habitat are available within each province: 34,594 acres (37.5 percent) in the Coast Range, 73,156 acres (56.8 percent) in Klamath Mountains, 50,176 acres (65.3 percent) in West Cascades, and 10,517 acres (44.0 percent) in East Cascades. Two of the physiographic provinces within the provincial analysis area - Klamath Mountains and West Cascades physiographic provinces - provide adequate levels of dispersal habitat (greater than 50 percent).

Critical Habitat

Four federally-designated CHUs occur within the provincial analysis area (FWS 2012d): Oregon Coast Ranges – OCR (Unit 2) totaling 859,864 acres and six subunits, East Cascades South – ECS (Unit 8) totaling 368,381 acres and three subunits, Klamath West – KLW (Unit 9) totaling 1,197,389 acres and nine subunits, and Klamath East – KLE (Unit 10) totaling 1,052,731 acres and seven subunits. Eight subunits occur within the provincial analysis area (OCR-6, ECS-1, KLW-1, KLE-1, KLE-2, KLE-3, KLE-4, and KLE-5). All subunits are expected to function primarily for demographic support to the overall population, as well as connectivity between subunits and CHUs. Special management consideration or protection required for each subunit is to address threats from current and past timber harvest and competition from barred owls, as well as losses due to wildfire and the effects on vegetation from fire exclusion (with the exception of OCR-6).

- OCR (Unit 2): forest is dominated by western hemlock, Sitka spruce, and Douglas-fir. NSO nesting habitat tends to be limited to stands providing very large trees with cavities or deformities because Douglas-fir dwarf mistletoe is unusual in this region. Woodrats comprise an increasing proportion of the diet. One subunit occurs in the provincial analysis area: OCR-6.
  - OCR-6: consists of approximately 81,900 acres in Coos and Douglas Counties, Oregon and comprises lands managed by the BLM. 97 percent of the area was used by NSO at the time of listing.
- KLW (Unit 9): forest is a highly diverse mix of mesic forest communities such as Pacific Douglas-fir, Douglas-fir tanoak, and mixed evergreen forest interspersed with more xeric forest types; tanoak is a dominant factor. Douglas-fir dwarf mistletoe is uncommon and seldom used for nesting platforms by NSO. Prey is diverse, but dominated by woodrats and flying squirrels. One subunit occurs in the provincial analysis area but would not be affected by the Pipeline project: KLW-1.
  - KLW-1: consists of approximately 147,326 acres in Douglas, Josephine, Curry, and Coos Counties, Oregon and managed by the State of Oregon and BLM. 96 percent of the area was used by NSO at the time of listing.

- KLE (Unit 10): forest is a mixed-conifer/evergreen hardwood forest type and grades into the western hemlock forest. High summer temperatures and a mosaic of open forest conditions and Oregon white oak woodlands influence NSO distribution in this region. Dwarf mistletoe provides an important component of nesting habitat, enabling NSO to occasionally nest within stands of relatively younger, small trees. Five subunits occur in the provincial analysis area: KLE-1, KLE-2, KLE-3, KLE-4, and KLE-5.
  - KLE-1: consists of 242, 338 acres in Jackson and Douglas Counties, Oregon and managed by Forest Service and BLM; 84 percent of the area was used by NSO at the time of listing.
  - KLE-2: consists of 101,942 acres in Josephine and Douglas Counties, Oregon and is managed by BLM and the Forest Service; 92 percent of the area was used by NSO at the time of listing.
  - KLE-3: consists of 111,410 acres in Jackson, Josephine, and Douglas Counties, Oregon and is managed by Forest Service and BLM; 97 percent of the area was used by NSO at the time of listing.
  - KLE-4: consists of 254,442 acres in Jackson, Klamath, and Douglas Counties, Oregon and is managed by the Forest Service and BLM; 81 percent of the area was used by NSO at the time of listing.
  - KLE-5: consists of 38,283 acres in Jackson County, Oregon and is managed by the BLM and Forest Service; 86 percent of the area was used by NSO at the time of listing.
- ECS (Unit 8): ponderosa pine is dominant at mid-to-lower elevations, with a narrow band of Douglas-fir and white fir at middle elevations providing the majority of NSO habitat. Dwarf mistletoe provides an important component of nesting habitat, enabling NSO to nest within stands of relatively younger smaller trees. One subunit occurs in the provincial analysis area: ECS-1.
  - ECS-1: consists of approximately 127,801 acres in Klamath, Jackson, and Douglas Counties, Oregon and comprises lands managed by the BLM and Forest Service; 78 percent of the area was used by NSO at the time of listing.

The current status of NSO habitat (high NRF, NRF, dispersal only, and capable, as determined through the process for the Pipeline project identified in the "Habitat" sub-section above) within designated CHUs and subunits located in the Project analysis area is shown in table 3.3.4-5. The baseline information shows that not all designated critical habitat is currently functioning as suitable NRF habitat. However, table 3.3.4-5 also provides the number of NSO that are known to occur in the CHUs located in the analysis area (based on NSO activity centers provided to PCGP by FWS, BLM, and Forest Service). Given that suitable habitat acres within all affected CHUs currently support NRF habitat at levels that are adequate to support pairs of nesting NSOs, these CHUs are considered to be functional with respect to their recovery roles.

Of the 84 known, 15 best location, and 6 PCGP assumed NSO activity centers within the analysis area, 59 activity sites occur in Critical Habitat Units (48 known, 8 best location, 3 PCGP assumed). Table 3.3.4-6 summarizes the number of activity sites analyzed within this APDBA that occur within each critical habitat subunit, and the condition of the home range (see table Q-7 in appendix Q). More than half the activity centers (39 of 59) have suitable NSO habitat above the recommended level of 50 percent suitable NRF habitat in the core area and 40 percent suitable NRF habitat in the home range to support nesting and NSO survival.

TABLE 3.3.4-5

Summary of NSO High NRF, NRF, Dispersal Only, and Capable Habitat in Critical Habitat Subunits Available within the Provincial Analysis Area

CHU and Subunit	Total Acres in CHU	Total Acres in Analysis Area	% Subunit within Analysis Area	Number of Known Owls a/	High NRF in CHU b/		NRF in CHU c/		Dispersal Only in CHU d/		Capable in CHU e/		Total NSO Habitat in CHU f/	
					Acres	Percent Total g/	Acres	Percent Total g/	Acres	Percent Total h/	Acres	Percent Total g/	Acres	Percent Total g/
Oregon Coast Range CHU (Unit 2 - 859,864 acres)														
OCR-6	81,900	11,906	14.5	52	4,104	5.0	2,453	3.0	2,511	3.1	2,795	3.4	11,863	14.5
Klamath West CHU (Unit 9 - 1,197,389 acres)														
KLW-1	147,326	622	0.4	120	23	0.0	36	0.0	464	0.3	10	0.0	533	0.4
Klamath East CHU (Unit 10 - 1,052,731 acres)														
KLE-1	242,338	25,140	10.4	112	9,492	3.9	6,163 (2,337)	2.5	7,614	3.1	1,590	0.7	24,860	10.3
KLE-2	101,942	7,013	6.9	85	2,401	2.4	2,582 (1,529)	2.5	1,038	1.0	970	1.0	6,991	6.9
KLE-3	111,410	6,293	5.6	75	1,484	1.3	2,478	2.2	1,521	1.4	693	0.6	6,175	5.5
KLE-4	254,442	29,737	11.7	161	6,776	2.7	8,537	3.4	10,430	4.1	3,048	1.2	28,790	11.3
KLE-5	38,283	3,428	9.0	32	334	0.9	1,628	4.3	528	1.4	713	1.9	3,204	8.4
Total Unit 10	**748,415**	**71,611**	**9.6**	**348**	**20,486**	**2.7**	**21,389 (3,866)**	**2.9**	**21,131**	**2.8**	**7,014**	**0.9**	**70,020**	**9.4**
East Cascades South CHU (Unit 8 - 368,381 acres)														
ECS-1	127,801	9,058	7.1	16	1,106	0.9	4,560	3.6	1,354	1.1	1,885	1.5	8,905	7.0
Total CHU (3,478365 acres)														
Overall CHU Total	**1,105,442**	**93,197**	**8.4**	**535**	**25,718**	**2.3**	**28,439 (3,866)**	**2.6**	**25,460**	**2.3**	**11,704**	**1.1**	**91,321**	**8.3**

a/ Number of Known Owls in entire CHU Subunit: known owl sites obtained from known owl locations provided by BLM (2017a), Forest Service (2017), and FWS (2008d) and 2007/2008 surveys conducted by PCGP.

b/ High NRF (FWS 2014c): forested habitat that is characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species.

c/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., “post-fire NRF”).

d/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.

e/ Capable Habitat (FWS 2014c): habitat that is forested or could become forested (i.e., recently harvested timberlands) that do not provide dispersal or NRF characteristics.

f/ Total NSO Habitat within CHU Subunits that occur within the provincial analysis area; does not include non-capable habitat.

g/ Percent total: percent of habitat available in entire critical habitat unit, not just the provincial analysis area.

TABLE 3.3.4-6

Summary of Northern Spotted Owl Activity Centers Analyzed that
Occur within Northern Spotted Owl Critical Habitat Units, Including Condition of the NSO Activity Center

CHU and Subunit	Owl Status	Condition of high NRF/NRF in Activity Center: > 50% NRF in Core Area, > 40% NRF in Home Range	< 50% NRF in Core Area, > 40% NRF in Home Range	> 50% NRF in Core Area, < 40% NRF in Home Range	< 50% NRF in Core Area, < 40% NRF in Home Range	Total Activity Centers
Oregon Coast Range CHU (Unit 2)						
OCR-6	Known	1	0	1	5	7
	Best Location	0	0	0	0	0
	PCGP Assumed	0	0	0	1	1
	Total	**1**	**0**	**1**	**6**	**8**
Klamath East CHU (Unit 10)						
KLE-1	Known	11	1	0	0	12
	Best Location	2	0	0	0	2
	PCGP Assumed	0	1	1	0	2
	Total	**13**	**2**	**1**	**0**	**16**
KLE-2	Known	3	1	0	0	4
	Best Location	1	0	0	0	1
	Total	**4**	**1**	**0**	**0**	**5**
KLE-3	Known	3	1	0	0	4
KLE-4	Known	9	2	0	1	12
	Best Location	4	0	0	1	5
	Total	**13**	**2**	**0**	**2**	**17**
KLE-5	Known	1	0	1	2	4
East Cascades South CHU (Unit 8)						
ECS-1	Known	4	0	0	1	5
	Total	4	0	0	1	5
Overall CHU Subunits						
Overall CHU Subunits	Known	32	5	2	9	48
	Best Location	7	0	0	1	8
	PCGP Assumed	0	1	1	1	3
	Total	**39**	**6**	**3**	**11**	**59**

Late Successional Reserves

BLM and Forest Service LSRs occur within the provincial analysis area. LSRs on Forest Service lands are provided an LSR unit identified within the NWFP (Forest Service and BLM 1994): RO 223 is a large LSR unit and occurs within Umpqua NF, and RO 227 occurs within Rogue River National Forest and Winema National Forest and is generally contiguous. Additionally, approximately 568 acres of unmapped LSRs on National Forest Service lands associated with known NSO activity centers (KOAC) occur within the provincial analysis area. Table 3.3.4-7 includes a summary of NSO habitat that occurs within LSRs (and respective LSR units on National Forest Service lands) within the provincial analysis area by BLM District and National Forest, as well as NSO habitat within unmapped LSRs.

Much of the LSRs (and unmapped LSRs) within the provincial analysis area overlap the FWS designated CHUs for NSO. The overlap of LSRs with federally designated NSO critical habitat affords a greater degree of protection to the NSO and its critical habitat as the protections for LSRs are automatically imposed on those LSR acres that are found within a CHU. Thus, NSOs located within these land allocations also benefit from increased protection.

TABLE 3.3.4-7

Summary of High NRF, NRF, Dispersal, and Capable Habitat Available within LSRs and Forest Service Unmapped LSRs by Physiographic Province and Landowner within the Provincial Analysis Area

Landowner	Total Acres within Analysis Area	LSR Type a/	High NRF Habitat b/		NRF Habitat c/		Dispersal Habitat Only d/		Capable Habitat e/		Total NSO Habitat f/	
			Acres Available	Percent g/	Acres Available	Percent g/	Acres Available	Percent g/	Acres Available	Percent g/	Acres Available	Percent g/
Coast Range Physiographic Province												
Coos Bay BLM	15,839	LSR	6,780	42.8	3,637	23.0	3,166	20.0	2,121	13.4	15,705	99.2
Roseburg BLM	37	LSR	25	67.6	12	32.4		0.0		0.0	37	100.0
Coast Range Total	**15,876**	**TOTAL**	**6,806**	42.9	**3,649**	23.0	**3,166**	19.9	**2,121**	13.4	**15,742**	99.2
Klamath Mountains Physiographic Province												
Roseburg BLM	173	LSR	102	59.0	65 (29)	37.6	0	0.0	5	2.9	172	99.4
Medford BLM	8	LSR	3	37.5	5	62.5		0.0		0.0	8	100.0
Umpqua N.F.	12,100	LSR RO223	4,640	38.3	3,599 (2,287)	29.7	3,162	26.1	582	4.8	11,982	99.0
	677	Unmapped LSR	442	65.3	97	14.3	121	17.9	17	2.5	676	99.9
	12,309	LSR Units	4,753	38.6	3,677 (2,317)	29.9	3,168	25.7	592	4.8	12,190	99.0
Klamath Mountains Total	682	Unmapped LSRs	442	64.8	97	14.2	121	17.7	21	3.1	681	99.9
	12,991	**TOTAL**	**5,195**	40.0	**3,774 (2,317)**	29.1	**3,289**	25.3	**613**	4.7	**12,871**	99.1
West Cascades Physiographic Province												
Medford BLM	48	LSR	18	37.5	21	43.8	7	14.6	2	4.2	48	100.0
Rogue River N.F.	30,438	LSR RO227	6,974	22.9	7,904	26.0	10,888	35.8	2,945	9.7	28,712	94.3
(Fish Lake)	112	Unmapped LSR	34	30.4	59	52.7	19	17.0	0	0.0	112	100.0
	31,080	LSR Units	7,086	22.8	8,147	26.2	11,079	35.6	2,994	9.6	29,306	94.3
West Cascades Total	112	Unmapped LSRs	34	30.4	59	52.7	19	17.0	0	0.0	112	100.0
	31,192	**TOTAL**	**7,121**	22.8	**8,205**	26.3	**11,098**	35.6	**2,994**	9.6	**29,418**	94.3
East Cascades Physiographic Province												
Rogue River N.F.	1,187	LSR RO227	188	15.8	492	41.4	385	32.4	89	7.5	1,154	97.2
Winema N.F.	1,820	LSR RO227	193	10.6	896	49.2	364	20.0	270	14.8	1,722	94.6
(Lake of the Woods)	229	Unmapped LSR	91	39.7	138	60.3		0.0	0	0.0	229	100.0
	3,145	LSR Units	386	12.3	1,459	46.4	805	25.6	363	11.5	3,014	95.8
East Cascades Total	229	Unmapped LSRs	91	39.7	138	60.3		0.0	0	0.0	229	100.0
	3,374	**TOTAL**	**478**	14.2	**1,597**	47.3	**805**	23.9	**363**	10.8	**3,243**	96.1
All Physiographic Provinces												
	62,414	LSR Units	19,031	30.5	16,934 (2,317)	27.1	18,219	29.2	6,072	9.7	60,256	96.5
Overall Total	1,023	Unmapped LSRs	568	55.5	293	28.6	140	13.7	21	2.1	1,022	99.9
	63,437	***TOTAL***	**19,599**	30.9	**17,227 (2,317)**	27.2	**18,359**	28.9	**6,093**	9.6	**61,278**	96.6

a/ Unmapped LSRs consider MAMU occupied stands and Known Owl Activity Centers (KOAC) on NWFP Matrix lands on Forest Service-Managed lands.
b/ High NRF (FWS 2014c): forested habitat that is characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species.
c/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., “post-fire NRF”).
d/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.
e/ Capable Habitat (FWS 2014c): habitat that is forested or could become forested (i.e., recently harvested timberlands) that do not provide dispersal or NRF characteristics.
f/ Total NSO Habitat within NWFP LSRs and unmapped LSRs that occur within the provincial analysis area; does not include non-capable habitat.
g/ Percent total: percent of habitat available in LSR units withint the provincial analysis area.

3.3.4.3 Effects of the Proposed Action

Effects of the proposed action include direct and indirect effects within the provincial analysis area, as described below. Analysis of potential direct and indirect effects to NSO by the Pipeline project within the provincial analysis was guided by the Revised Conservation Framework developed for the Project (see *Revised Conservation Framework for the Northern Spotted owl and Marbled Murrelet: Jordan Cove Energy and Pacific Connector Gas Pipeline Project*, FWS 2014c).

Direct Effects

Potential Project-related effects to NSOs that could be caused by the action and occur at the same time and place, including the following within the provincial analysis area: 1) removal of a known nest tree during the breeding season (March 1 through September 30), and 2) human and noise disturbance due to right-of-way clearing, construction, and road use during the breeding period, including noise due to blasting and helicopter support during construction, and smoke from burning slash. These effects would extend over the short term.

Habitat Removal During Breeding Season

Removal of habitat during the breeding season within a nest patch could result in the potential death of nestlings if the nest tree is felled. Removing habitat outside of the entire breeding season (outside of March 1 through September 30) would eliminate any direct impact to individual NSOs or nestlings. Because habitat removal within 0.25 mile of an activity center within the Pipeline route, including subsequent NSO activity centers detected within 0.25 mile of the Pipeline prior to construction, would occur outside of the entire breeding season (outside of March 1 through September 30), no direct effect to NSOs through habitat removal is expected. Maps within appendix V1 show the timing constraints that would be applied in relation to NSO activity centers for timber felling (and Pipeline construction).

Noise and Visual

In their Revised Conservation Framework, FWS (2014c) provided guidance on determining Project impacts to NSO from noise. This guidance included disturbance and disruption distances based on noise thresholds (as described in FWS 2003b and 2006a; discussed below), and prescribed associated impact levels (No, Low, Moderate, or High) based on Project timing and activity.

Disruption and Disturbance – Available Literature

NSOs could be directly affected by noise and disturbance related to proximate human-related activities associated with timber removal, construction, and operation and maintenance of the Pipeline that could result in diminished reproductive success and survival (if behavior response to construction makes them more vulnerable to injury). Disturbance (both visual and noise) would include use of chainsaws and heavy equipment during vegetation clearing and construction, explosives to trench through rock, helicopters and/or small aircraft to inspect the pipeline once per year during the life of the Pipeline, and brush control (i.e., mowing and cutting) within the 30-foot maintenance right-of-way every three to five years for the life of the Pipeline. The term "disruption" was alluded to in the ESA, under the definition of "harassment" (50 CFR 17.3) as:

"an intentional or negligent act or omission which creates the likelihood of injury by annoying it (the organism) to such an extent as to significantly disrupt normal behavior patterns which include but are not limited to, breeding, feeding or sheltering."

The term "disturbance" was not included in the ESA but a reasonable working definition was provided by Leal (2006) and has been incorporated into this APDBA:

"any potential auditory or visual stimuli or deviation from ambient/baseline conditions [that] an individual bird, at a given site, is likely to detect and potentially react to."

Reactions of NSOs from human presence and excessive noise levels in the immediate vicinity of owls could include the following if project activities occur during the breeding season: 1) flushing from the nest site, which would leave eggs or young exposed to predation; 2) causing juveniles to prematurely fledge, which would increase juveniles' risk of predation; 3) interrupting foraging activities, which would result in the reduced fitness or even mortality of an individual; and/or 4) disrupting roosting activities which would cause a NSO to be displaced and possibly relocate. In the Northern Spotted Owl Status Review, none of these types of disturbance were considered a threat to the species (Courtney et al. 2004). However, at the individual level, based on anecdotal information and effects to other bird species (Wesemann and Rowe 1987; Delaney et al. 1999; Delaney and Grubb 2001; Swarthout and Steidl 2001; FWS 2003b; FWS 2005d), disturbance to NSOs could occur.

Disturbance to owls would be expected to be inversely related to stimulus distance and positively related to noise level, similar to results reported for bald eagles (Grubb and King 1991), gyrfalcon (Platt 1977), and other raptors (Awbrey and Bowles 1990). Therefore, for a significant disruption of NSO behavior to occur as a result of disturbance caused by an action, the disturbance and the NSO must be in close proximity to one another (FWS 2003b; FWS 2005d). Human presence on the ground is not expected to cause a significant disruption of behavior because NSOs do not seem to be startled by human presence (FWS 2005d); however, increased human presence in an area that previously had minimal human presence may be an indirect effect of the proposed Project.

NSOs disturbed at a roost site are presumably capable of moving away from disturbance without a substantial disruption of behavior. Since NSOs are primarily nocturnal predators, projects that occur during the day are not likely to disrupt foraging behavior and the potential for effects is mainly associated with breeding behavior at an active nest site.

In the late breeding period, potential effects from Pipeline project activities decline because juvenile NSOs are increasingly more capable of moving as the nesting season progresses. Once capable of sustained flight, young owls are presumably able to distance themselves from disturbance and minimize their risk of predation. To ensure that more than 86 percent of juvenile NSOs in the Oregon Western Cascades Physiographic Province are able to move away from disturbances without increasing their risk of predation or harm, the critical nesting period is considered to be March 1 through July 15. This is based on fledge data (Turner 1999) and includes an additional two weeks to allow for development of flight skills. After July 15, most fledgling NSOs are assumed to be capable of sustained flight and can move away from harmful disturbances. The critical breeding period for the Oregon Western Cascades Physiographic Province is applied to the entire provincial analysis area (March 1 through July 15), even though research has provided data that indicate NSOs fledge earlier in other Physiographic Provinces within the analysis area.

The available research and anecdotal accounts show that the effects of noise from a variety of sources can elicit disturbance as well as disruption responses from spotted owl subspecies (including MSO, NSO, and California spotted owls [CSO]), including responses such as flushing or flight that would be construed as interference with normal behavior patterns including but not limited to, breeding, feeding, or sheltering. The following are brief summaries of available spotted owl research:

- All NSO foraged adjacent to roads and appeared undisturbed by the occasional passage of vehicles on narrow secondary gravel forest roads (Forsman et al. 1984).
- Male NSOs within 0.25 mile of a major logging road or timber harvest had higher fecal corticosterone levels indicating that the NSO was more stressed than males farther away; no differences found for females related to distance from roads or timber harvest (Wasser et al. 1997).
- Proximity to roads (paved, improved surface, any type) was not correlated with fecal corticosterone in CSO (Tempel and Gutiérrez 2004).
- CSO exposure to chainsaw noise did not result in a detectable increase in fecal corticosterone level; CSO can tolerate low-intensity human sound in their environment without eliciting a physiological stress response (Tempel and Gutiérrez 2003).
- MSO nest occupancy less than 1 mile from firing sites was higher than nest occupancy more than 1 mile away; MSO not affected by explosives but were affected by hikers (Hathcock et al. 2010).
- MSO response to military aircraft overflights (noise levels 78, 92 and 95 dB during sequential exposures) ranged from none to sudden head turning; behaviors during flights were no different than pre- and post-flight periods (Johnson and Reynolds 2002).
- Relationships of NSO baseline physiology, nutritional stress, and reproductive success to exposures to high and low levels of routine OHV traffic (Hayward et al. 2011).
  - Male NSO showed high fecal glucocorticoid (GC) response to OHV trials during incubation period, indicating a higher level of stress.
  - Male NSO 164 to 2,625 feet (50 to 800 meters) from loud roads showed lower fecal GC response to motorcycle trials than males 164 to 2,625 feet (50 to 800 meters) from quiet roads in July (fledging period).
  - Female NSO with good nutrition but no young showed high fecal GC response to OHV trials.
  - Female NSO with 2 young and poor nutrition showed low fecal GS response to OHV trials.
  - NSO close to roads had better nutrition but levels of fecal GC were not related to proximity to roads or noise.
  - NSO within 328 feet (100 meters) of quiet roads fledged more young than NSO farther from roads; NSO within 328 feet (100 meters) of noisy roads fledged fewer young.

These studies to date show a mixed spotted owl response to noise. The majority of these studies focus on short-term measures of fecal steroids and do not necessarily account for potential longer term effects of noise over a breeding season. However, Hayward et al. (2011) did measure the effects on reproductive success of OHV traffic and found that that proximity to busy roads resulted in lower reproduction, which by definition is a measure of disruption. The literature summarized above indicates that while in the short term responses to noise may not be measureable, over a breeding season noise from roads has the potential to result in disruption.

Auditory and Visual Disturbance – FWS Guidance

FWS (2003b, 2006a) indicated that the disturbance behaviors noted above may occur when 1) the project-generated sound level substantially exceeds existing ambient noise levels by 20 to 25 dB; 2) when the total sound level (project and ambient noise levels combined) exceeds 90 dB; or 3) when the visual proximity of human disturbance occurs within 130 feet of an active nest site. FWS concluded that noise and human presence can result in a significant disruption of breeding, feeding, and/or sheltering behavior of NSOs such that it creates the potential for injury to the individuals (i.e., incidental take in the form of harassment).

FWS (2006a) established distances within which sound levels and visual disturbance for various activities may result in injury or harassment of NSOs by significantly disrupting the normal behavior pattern of individuals or breeding pairs. Table 3.3.4-8 (Disruption Threshold Distance) provides the distances at which FWS (2003b, 2006a, and 2014c) indicate that NSOs could be disrupted or "harassed" by certain activities during the critical breeding period and late breeding period. Within the Revised Conservation Framework, FWS (2014c) provided distances from a project boundary within which NSOs could potentially be distracted, or "disturbed" from their normal activity. Those distances are often applied as seasonal buffers to minimize impacts of projects on nesting NSOs (Disturbance Threshold Distance; table 3.3.4-8).

TABLE 3.3.4-8

Threshold Distances where Noise and Visual Disturbances are Unlikely to Occur to Nesting Northern Spotted Owls during the Breeding Season a/

	Disruption Threshold Distances From NSO Activity Centers		Disturbance Threshold Distance From NSO Activity Centers	
Activity	NSO Critical Breeding Season b/	NSO Late Breeding Season b/	NSO Critical Breeding Season b/	NSO Late Breeding Season b/
Use of Existing Low Use Roads c/	35 yards (105 feet)	No Disruption Anticipated	0.25 mile	No Disturbance Anticipated
Use of Existing High Use Roads d/	No Disruption Anticipated	No Disruption Anticipated	0.25 mile	No Disturbance Anticipated
Chainsaws	45 yards (135 feet)	No Disruption Anticipated	0.25 mile	No Disturbance Anticipated
Heavy equipment e/	35 yards (105 feet)	No Disruption Anticipated	0.25 mile	No Disturbance Anticipated
Rock ditching equipment f/	120 yards (360 feet)	No Disruption Anticipated	0.25 mile	No Disturbance Anticipated
Blasting – more than 2 pounds with mitigation measures	120 yards (360 feet)	120 yards (360 feet)	0.25 mile	0.25 mile
Small Helicopter/Airplanes	120 yards (360 feet)	No Disruption Anticipated	0.25 mile	No Disturbance Anticipated
Large/Transport Helicopters with mitigation measures g/	240 yards (720 feet)	240 yards (720 feet)	0.25 mile	0.25 mile

a/ Sources: FWS 2003b, 2006a, 2014c; Michael Minor & Associates 2008 (see appendix P).
b/ Northern Spotted Owl breeding period is from March 1-September 30; critical breeding period is considered from March 1-July 15; late breeding season is considered from July 16-September 30.
c/ Existing Low Use Roads include federal roads designated as local/resource and private roads that appear to receive light traffic and periodic maintenance.
d/ Existing High Use Roads include federal roads that are designated as arterial and collector roads. Includes some federal roads local/resources roads that are paved or receive regular traffic/maintenance and are the primary access routes within checkerboard (federal/private) ownership. Also includes other private residential roads driveways or other roads that provide access to multiple rural residences.
e/ Heavy equipment includes: back trackhoes, side-booms, bulldozers, semi-trucks, pneumatic hammers.

TABLE 3.3.4-8 Threshold Distances where Noise and Visual Disturbances are Unlikely to Occur to Nesting Northern Spotted Owls during the Breeding Season a/				
	Disruption Threshold Distances From NSO Activity Centers		**Disturbance Threshold Distance From NSO Activity Centers**	
Activity	**NSO Critical Breeding Season b/**	**NSO Late Breeding Season b/**	**NSO Critical Breeding Season b/**	**NSO Late Breeding Season b/**
f/ Rock ditching equipment includes: auger drill rig, mounted impact hammer (hoe ram), rock drill, and blasting (mitigated or less than 2 lbs.				
g/ Transport helicopters proposed for this Project include: Boeing Chinook (CH-47) and Boeing Vertol 107-II (CH-46)				

FWS (2003b, 2006a) reviewed available scientific literature on behavioral and physiological responses of different bird species to various noise sources. They determined that birds would likely detect noises that were ≥4 decibels or more above ambient noise levels. FWS (2006a) defined an "injury threshold" of 92 dBA, and a "tolerance threshold" of 82 dB for NSOs and MAMUs. The tolerance threshold assumes that respective nest sites become "intolerable" to the species and harassment occurs due to the total sound level the species must endure. FWS (2006a) did recognize that a tolerance threshold of 92 dB for aircraft (e.g., helicopters) would be applicable due to the usually slow onset of aircraft noise approaching, but otherwise FWS (2006a) applied the threshold of 82 dB as a sound-related injury threshold level. Based on Delaney et al. (1999) and Brown (1990), FWS (2006a) subtracted the noise level that elicited a harassment-indicating behavior (flight or flushing) from the minimum ambient noise at the respective sites and deduced that action-generated noise levels that are 25 dB above ambient levels would constitute the sound level threshold above which harassment is likely to occur (FWS 2006a). From that exercise, FWS (2006a) deduced that a noise level of 70 dB would be a disturbance threshold and noise ≥70 dB would be disruptive.

The FWS typically considers the disturbance threshold for general noise-generating activities within a 0.25-mile radius (125-acre area) of the activity during the critical breeding season (March 1 to July 15). For louder disturbance activities such as open air blasting using more than a 2 pound charge or large aircraft, FWS generally applies a 1.0-mile radius (2,176-acre area) around NSO sites during the entire breeding season (March 1 to September 30) to minimize disturbance to nesting NSO (FWS 2003b; Smith et al. 2007; Wille et al. 2006). However, FWS suggested that if additional studies could demonstrate that use of larger blasts (greater than 2 pounds) and large helicopters with mitigation measures proposed for the Project attenuated to less than 92 dB, and preferably below 70 dB (disturbance threshold versus 92 dB disruption threshold) within a mile, to provide a report and additional data would be considered to reduce the threshold distances for those activities (Smith et al. 2007; Wille et al. 2006).

Blasting and Helicopter Noise Levels

PCGP prepared a report (see appendix P) that analyzes the distances at which conventional blasting required for trenching within rock substrate for construction and transport helicopters attenuate to 92 dB. Appendix P shows empirical noise data evaluations for trench blasting and heavy transport helicopters and was used to determine the distances for which noise levels remain below 92 dB during construction activities with appropriate mitigation measures applied. Under the worst-case conditions with common and appropriate mitigation measures applied to trench blasting operations, it is expected that blasting noise would attenuate to 92 dB within 200 feet of the source, and to 70 dB within 1,025 feet of the blast source in soft rock. Likewise, large transport helicopters would attenuate to 92 dB within 700 feet. The greater distance for helicopter use is due to the directional aspects of blade slap noise that is directed toward the ground.

Mitigation for helicopter noise includes operational restrictions, such as maintaining a high altitude and flight paths away from noise sensitive areas whenever possible. Analyses for NSOs in this APDBA consider the distances for larger blasts and large helicopters to be more conservative than what the noise report suggests. A disruption threshold distance for blasting greater than 92 dB has been used but with mitigation measures applied to be the same disruption distance expected for smaller blasts (less than 92 dB)—120 yards or 360 feet—more conservative than the noise report describes, and the disturbance threshold distance associated with large blasts to be expected within 0.25 mile of blasting activity (see table 3.3.4-8). It is expected that these distances be considered throughout the entire breeding season (March 1–September 30) because of the sudden onset of noise associated with blasting activities. A disruption threshold distance for large/transport helicopter use has been used with proposed mitigation to be slightly farther than the report suggests, considering disruption distance of 240 yards (720 feet) and a disturbance threshold distance of 0.25 mile (1,320 feet) (see table 3.3.4-8).

Even though FWS (2003b) provided some evidence suggesting that noise that builds gradually, such as a helicopter approaching from a distance, may result in less risk, and even though FWS does not anticipate effects from smaller aircraft use after the critical breeding period, it is anticipated that use of large/transport helicopters may disrupt or disturb NSOs throughout the entire breeding season (March 1 – September 30) and therefore the analysis within this assessment makes the same assumption. In a memorandum provided to Tetra Tech (September 16, 2008), FWS indicated that if noise levels above 92 dB are recorded at 0.25 mile of the blasting activities, that blasting operations should cease until more effective mitigation measures can be employed.

Disruption and Disturbance – Timber Clearing, Pipeline Construction, Existing Road Use

Approximately 7.7 miles of timber clearing and construction would occur within 0.25 mile of 12 NSO activity centers (nine known sites, two best location sites, and one PCGP assumed site. PCGP proposes to clear timber within 0.25 mile of NSO activity centers between October 1 and February 28, outside of the NSO breeding season (March 1 through September 30); therefore, noise, visual disturbance, and in some instances large helicopter use would not be expected to disturb or disrupt NSO breeding activities at these 12 activity centers (see Habitat Removal during Breeding Season, above). However, due to construction constraints and safety of construction crew, PCGP has indicated they would need to construct and install the pipe within 0.25 mile of activity centers during the breeding season. To minimize disturbance, though, PCGP would construct within 0.25 mile of activity centers after the critical breeding season (after July 15).

With the exception of large transport helicopter activities to deliver pipe to inaccessible areas that could occur within 0.25 mile of three NSO activity centers (2317B, PCGP 095.3, and assumed PCGP A-3) and/or potential blasting activities (greater than 2 pounds of explosives) that could occur within 0.25 mile of five additional NSO activity centers (four known sites and one best location sites), acoustic and visual disturbances from the proposed action are not expected to disrupt NSO nesting and rearing activities because they would occur after the critical breeding season (see table 3.3.4-8). Therefore, activities from Pipeline construction during the late breeding period (July 16 through September 30) could disrupt or disturb NSO at 10 NSO activity centers within 0.25 mile of the Pipeline right-of-way, and construction activities off the right-of-way would occur during the entire breeding season and could disturb NSO at two known activity centers (0071 and 4052A) located within 0.25 of Pipeline project components, if NSO are present (see table 3.3.4-9). Table Q-8 in appendix Q provides distances from proposed project activities (timber clearing, construction activities, road use, operations/maintenance) and timing of those actions, including large transport helicopter use and blasting more than 2 pounds of explosives that are expected to occur within 0.25 mile of known, best location, and PCGP assumed NSO sites. Additionally, table Q-8 in appendix Q provides the expected direct effect (disruption, disturbance, no effect) and rationale for each known, best location, and PCGP assumed NSO site based on timing and distance from the Project activities for each proposed activity (based on disturbance distances from table 3.3.4-8).

TABLE 3.3.4-9

Number of Northern Spotted Owl Sites within each Physiographic Province with
Expected Disturbances from Noise and/or Visuals Associated with Activities Proposed within 0.25 mile of Activity Centers a/

Status of Northern Spotted Owl Site	Total Number of Owl Sites	Construction Activities and Road Use b/		Construction Activities Only c/		Road Use Only d/		None e/
		Disruption	Disturbance	Disruption	Disturbance	Disruption	Disturbance	
Coast Range Physiographic Province								
Known Site	14	0	0	1	0	0	6	7
Best Location	0	0	0	0	0	0	0	0
PCGP Assumed	3	0	0	0	0	0	1	2
Coast Range Total	17	0	0	1	0	0	7	9
Klamath Mountains Physiographic Province								
Known Site	39	0	3	0	0	1	7	28
Best Location	10	0	1	1	0	1 f/	2	5
PCGP Assumed	3	0	1	0	0	0	1	1
Klamath Mountains Total	52	0	5	1	0	2	10	34
West Cascades Physiographic Province								
Known Site	26	0	2	0	2	0	10	12
Best Location	5	0	0	0	0	0	2	3
PCGP Assumed	0	0	0	0	0	0	0	0
West Cascades Total	31	0	2	0	2	0	12	15
East Cascades Physiographic Province								
Known Site	5	0	0	0	1	0	0	4
Best Location	0	0	0	0	0	0	0	0
PCGP Assumed	0	0	0	0	0	0	0	0
East Cascades Total	5	0	0	0	1	0	0	4
Total Physiographic Provinces								
Known Site	84	0	5	1	3	1	23	51
Best Location	15	0	1	1	0	1 f/	4	8
PCGP Assumed	6	0	1	0	0	0	2	3
Overall Total	**105**	**0**	**7**	**2**	**3**	**2**	**29**	**62**

a/ Summarized from table Q-8 in appendix Q; see appendix Z2 for D/D Impact Categories for each NSO activity center applying guidance provided by FWS (2014c) in the Revised Conservation Framework.
b/ Construction Activities and Road use: both proposed activities occur within 0.25 mile of NSO activity center
c/ Construction Activities Only: includes general construction activities, blasting (> 2 lbs explosives), and/or large transport helicopter use; no proposed road use within 0.25 mile of NSO activity centers
d/ Road use only: includes non-public roads that will be used by for the Pipeline project; no construction activities proposed within 0.25 mile of NSO activity centers.
e/ None: construction and proposed road use > 0.25 mile of NSO activity center
f/ Best location site PCGP 090.2 is also located within 0.25 mile of Pipeline construction but no large transport or mitigated blasting (> 2lbs explosives) would occur; no disturbance or disruption would be expected since construction could occur during the late breeding season.

Informal consultations with FWS (June 5, 2008, meeting; see NSO and MAMU Avoidance Plan, appendix V1) identified disturbance from travel on existing roads to be less of an impact than other actions associated with the proposed Project, especially if farther than 35 yards (105 feet) from an NSO activity center. Based on the Revised Conservation Framework (FWS 2014c) that includes guidance provided by FWS, as well as available scientific literature, use of existing high use roads may be detectable by NSO within 0.25 mile but it is not expected that use of every existing high-use road would disturb nesting NSOs and use of existing high-use roads would not substantially disrupt normal behavior patterns and lead to harassment under the ESA. However, use of existing low-use roads has the potential to disrupt normal behavior patterns during the breeding season (March 1 through September 30) and lead to harassment under the ESA within 35 yards of an activity center. Use of public, high-volume access roads (i.e., State highways and county roads) are not expected to disturb NSO.

For the purposes of this analysis, existing low-use roads include federal roads designated as local/resource and private roads that appear to receive light traffic and periodic maintenance. Existing high-use roads include federal roads that are designated as arterial and collector roads as well as some local/resources roads that are paved or receive regular traffic/maintenance and are the primary access routes within checkerboard (federal/private) ownership. Existing high-use roads also include other private residential roads driveways or other roads that provide access to multiple rural residences. Use of existing low volume access roads would potentially disrupt NSO at two activity centers within 35 yards of the access roads and would potentially disturb NSO at 36 activity centers located within 0.25 mile, including seven activity centers that would experience disturbance from Pipeline construction during the late breeding season, if present.

Expected Disturbance Effects

Impact assessments were prepared following guidance from FWS's Revised Conservation Framework (FWS 2014c) for each NSO activity center analyzed within this APDBA (see appendix Z2) that identify how far a NSO activity center is in relation to proposed construction activities, including large transport helicopter use and blasting (greater than 2 pounds of explosives). The impact assessments in appendix Z2 also identify existing access roads by high or low traffic use within 0.25 mile of known, PCGP assumed, or best location NSO sites, including distance from the access road(s) and expected road improvements within the nest patch or 0.25-mile buffer of the activity site. Each NSO activity center has a series of maps with the analysis that show the NSO home range in relation to the proposed actions and include a 0.25-mile spatial buffer around each activity center (see appendix Z2); maps in appendix V1 identify the seasonal constraints that would be applied to minimize impact to NSO during timber felling and Pipeline construction. Additionally, maps 1 through 39 in appendix Q show the locations of NSO activity centers in relation to different Project components and identify spatial buffers (360 feet, 720 feet, and 0.25-mile buffers) associated with a NSO activity site.

Table 3.3.4-9 summarizes the effects (disruption, disturbance, no effect) to known, best location, or PCGP assumed NSO sites located within 0.25 mile of proposed project activities, including use of access roads within the provincial analysis area affected by the proposed Project based on the timing of activities and distance from proposed activity to NSO activity center (summarized from table Q-8 in appendix Q and described in appendix Z2).

The FWS (2014c) provided a method in the Revised Conservation Framework to categorize direct effects to NSO pairs within a disruption and/or disturbance distance (0.25 mile) of project activities, including use of access roads, into the following Disruption-Disturbance (D/D) Impact Categories: High Impact, Moderate Impact, Low Impact, Low Impact – no mitigation, and No Impact. The assessment considers the timing, types, and location of Project-related activities in relation to NSO activity centers that could result in disturbance or disruption of NSO to assist in determining a D/D Impact Category for each Project activity for each NSO activity center.

Using the Revised Conservation Framework (FWS 2014c) as guidance, PCGP determined the D/D Impact Category for each NSO activity center within 0.25 mile of proposed project activities in appendix Z2, and included a list of factors considered when determining if an activity would be considered a disruption, a disturbance, or have no effect on each NSO activity center. In many instances an NSO activity center could experience disturbance from more than one proposed activity (e.g., construction effects and proposed use of existing access roads; see D/D Impact Categorization in appendix Z2). In May 2018, FWS reviewed the D/D impact categories provided for each NSO activity center and agreed with the categories provided by PCGP. The resulting D/D Impact Category is included for each NSO activity center in table Q-8 in appendix Q, and within appendix Z2.

Table NSO-1 in the introduction to appendix Z2 summarizes the number of NSO activity centers by D/D Impact Category and status of NSO activity center. No NSO activity center was assigned a "High" category because within 0.25 mile of an NSO activity center, PCGP would remove timber outside of the entire breeding period and construct outside the critical breeding period (March 1 to July 15).

Temporary Habitat Loss Due to Disturbance

There is a potential for NSO present within 0.25 mile of Pipeline activities to be disturbed or disrupted from normal activities due to associated noise from Pipeline project activities, which could cause NSO to temporarily avoid or move away from habitat within 0.25 mile of Pipeline project activities (i.e., temporary habitat loss). Approximately 16,051 acres of suitable NRF habitat (high NRF and NRF) within the provincial analysis area occur within 0.25 mile of the proposed action, of which 12,687 acres occur within NSO home ranges analyzed within this APDBA that could result in temporary loss of habitat due to associated noise disturbance from construction and pipelay activities within the NSO breeding season (March 1 through September 30; table 3.3.4-10). Within 0.25 mile of NSO activity centers, timber removal would occur outside of the entire breeding season beginning in October and continuing through February and continue the following year outside of the NSO breeding season, if necessary (see table Q-9 in appendix Q for specific timing within individual owl home ranges), so direct effects to NSO would not occur. Timber removal and construction activities could occur during the entire NSO breeding season when beyond 0.25 mile of NSO activity centers. Activity would not occur simultaneously within the 192.1 miles of the proposed Pipeline project within the range of the NSO, and therefore, any temporary habitat loss would be less than estimated in table 3.3.4-10, and potential effects to NSO utilizing habitat would be short in duration. PCGP would conduct additional "spot-check" surveys within the NSO provincial analysis area one year prior to scheduled timber removal/construction in NRF habitat that is within 0.25 mile of the construction right-of-way to detect, if possible, spotted owls that may have recently established territories in the Pipeline project area and adjust the schedule, if necessary, further minimizing direct effects to NSO during the breeding season.

TABLE 3.3.4-10

Amount (acres) of Nesting, Roosting, and Foraging Habitat (acres) within 0.25 mile of Pipeline Project Activities that Could Directly Impact NSO during the Breeding Season (March 1 through September 30)

Physiographic Province	Miles of Proposed Pipeline	Suitable NRF within 0.25 mile of Proposed Activities a/	Suitable NRF within 0.25 mile of Proposed Activities within NSO Home Ranges a/	Percent of NRF Habitat within NSO Home Ranges
Coast Range	53.0	2,522	1,664	66.0
Klamath Mountains	71.0 (1.8)	7,022 (805)	6,405 (805)	91.2
West Cascades	45.0	5,309	3,977	74.9
East Cascades	23.1	1,199	641	53.5
Total	**192.1 (1.8)**	**16,051 (805)**	**12,687 (805)**	**79.0**

a/ Suitable NRF Habitat includes both high NRF and NRF habitat within 0.25 mile of proposed habitat removal. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., "post-fire NRF").

Helicopter Rotor Wash

Strong winds can adversely affect NSOs (FWS 1990) by directly removing habitat from windthrow that could fragment forests and increase edge effects (risk of predation, microclimatological changes). Wind can also cause direct mortality by blowing chicks out of nests (FWS 1992b). Helicopter drive rotors produce high velocity vortices (winds) that extend from the center of the helicopter outward in all directions. Vertical downwash of air (rotor wash) close enough to the ground produces surface winds that dissipate as they move away from the helicopter (sidewash). Induced winds caused by helicopter rotor wash may exceed hurricane force velocities and would be expected to adversely affect nesting NSOs in the area. Induced rotor downwash and surface sidewash are functions of helicopter size, rotor surface area, helicopter weight, flight speed and height above ground (Teske et al. 1997; Gordon et al. 2005), effects to nesting birds can be minimized or avoided by routing helicopter flight paths and staging locations far enough away from nests so that locally induced winds would not adversely affect nests or nestlings.

Maximum induced surface velocities produced by downwash and sidewash from various helicopters were measured in the field to determine the decay function of rotor-produced vortices near ground level (Teske et al. 1997). Field studies included measurements on three helicopter models that might be utilized during construction of the Pipeline: 1) the twin-rotor CH-47 (civilian variant is the Boeing HH-47 Chinook) with rotor diameter 59.1 feet, 2) the single rotor CH-54 with a rotor diameter of 72 feet (civilian variant is the Sikorsky S-64 Skycrane), and 3) the twin-rotor CH-46 (civilian variant Boeing Vertol 107) with rotor diameter of 49.9 feet (Teske et al. 1997). Using parameters derived from the field trials, estimates of maximum induced surface velocities were made for each of the three helicopter models at varying heights above ground while flying at different ground speeds. In general, maximum induced surface velocities increase with rotor diameters, decrease with distance above ground, and decrease with faster ground speeds.

Results of modeling maximum induced surface velocities (model described in Teske et al. 1997) produced by a Chinook helicopter are shown in figure 3.3-4-2 for drop heights (heights above ground level at which the helicopter would discharge a payload of foam, water, or retardant during wild fire control) ranging from 10 to 320 feet while flying at ground speeds ranging from 5 to 25 miles per hour (mph). Included in figure 3.3.4-2 are four wind speed categories on the Beaufort Scale (NOAA 2015) which was developed to describe damage associated with wind forces ranging from calm to hurricane forces. On the Beaufort Scale, induced surface winds of 9 to 11 mph produced by rotor wash would be equivalent to a "gentle breeze" during which leaves and small twigs would be constantly moving and light flags would be extended. Wind velocities of 19 to 24 mph are classified as a "fresh breeze" (small trees in leaf would sway). Winds 39 to 46 mph are "gale" force strength—difficult to walk against, while twigs and small branches would be blown off trees—and winds greater than 74 mph are classified as a "hurricane."

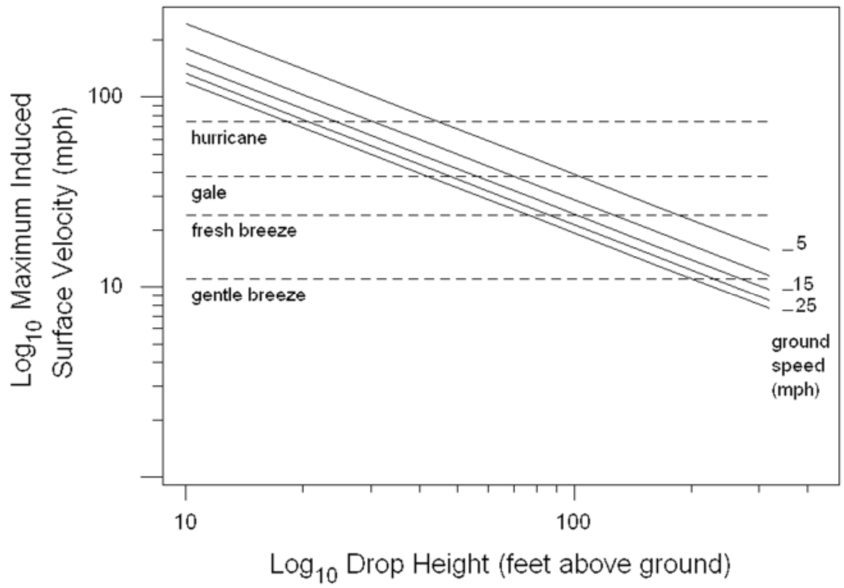


Figure 3.3.4-2 Modeled Maximum Surface Velocities Induced by Chinook C-47 Helicopters while Flying at Ground Speeds From 5 to 25 mph at Heights from 10 to 320 feet Above Ground. (Modeled from data in Teske et al. 1997)

Figure 3.3.4-2 shows the heights above ground that Chinook helicopters would produce maximum induced surface winds with velocities equivalent to a "fresh breeze" while traveling at ground speeds of 5, 10, 15, 20 or 25 mph. For example, if traveling at a ground speed of 5 mph, the Chinook would have to be approximately 185 feet above ground to produce a maximum induced surface velocity of 24 mph, equivalent to a "fresh breeze." If traveling at ground speed of 25 mph, the Chinook could be 75 feet above ground and still induce a maximum surface velocity of 24 mph.

In the project area, wind speeds reported by the Western Regional Climate Center (2015) at the North Bend airport averaged 10.2 mph in June, 11.2 mph in July and 9.9 mph in August, the three months with highest average wind velocities during the period from 1996 to 2006. During the same period, winds in Roseburg averaged 5.0 mph in June, 5.2 mph in July, and 4.4 mph in August. These data indicate that winds as strong as a fresh breeze (19 to 24 mph) would be expected along the Oregon Coast and most likely inland during the period when NSOs are nesting. It is assumed that induced winds the strength of a fresh breeze would not adversely affect young or nests. Incoming or outgoing Chinook helicopters flying at 5 mph while 185 feet above a tree with a nest would most likely produce winds with velocities less than a fresh breeze at the tree top because there would be no resistance by the ground to induce maximum sidewash vortices.

Similar results were produced by the Boeing Vertol 107 (see figure 3.3.4-3) even though it is smaller than the Chinook (rotor diameter 49.9 feet compared to 59.1 feet). The Vertol 107, flying at a ground speed of 5 mph, would have to be approximately 200 feet above ground to produce a maximum induced surface velocity of 24 mph, equivalent to a fresh breeze. If traveling at a ground speed of 25 mph, the Vertol 107 could be 82 feet above ground and still induce a maximum surface velocity of 24 mph. Overall, the Vertol 107 produces slightly greater maximum induced surface velocities than the Chinook CH-47 even though its maximum equipment weight is less than the Chinook.

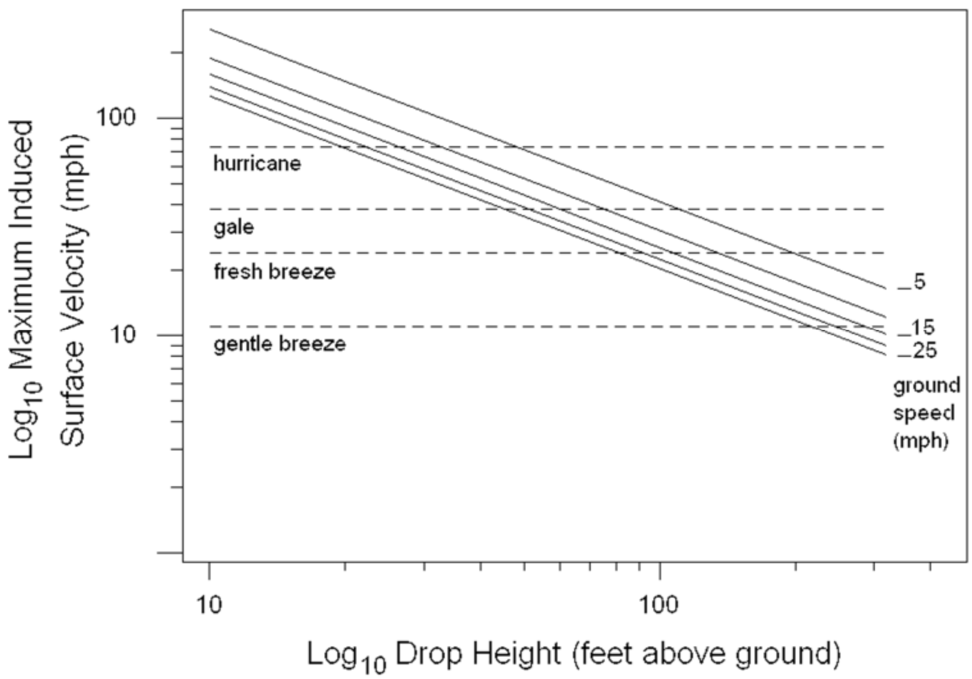


Figure 3.3.4-3 Modeled Maximum Surface Velocities Induced by Boeing Vertol 107 Helicopters while Flying at Ground Speeds From 5 to 25 mph at Heights From 10 to 320 feet Above Ground (Modeled from data in Teske et al. 1997)

The single rotor S-64 Skycrane has the largest rotor diameter (72 feet diameter) of the three models. As modeled in figure 3.3.4-4, the Skycrane would produce greater maximum induced surface velocities while flying at the same ground speeds and same drop heights as the other two helicopter models.

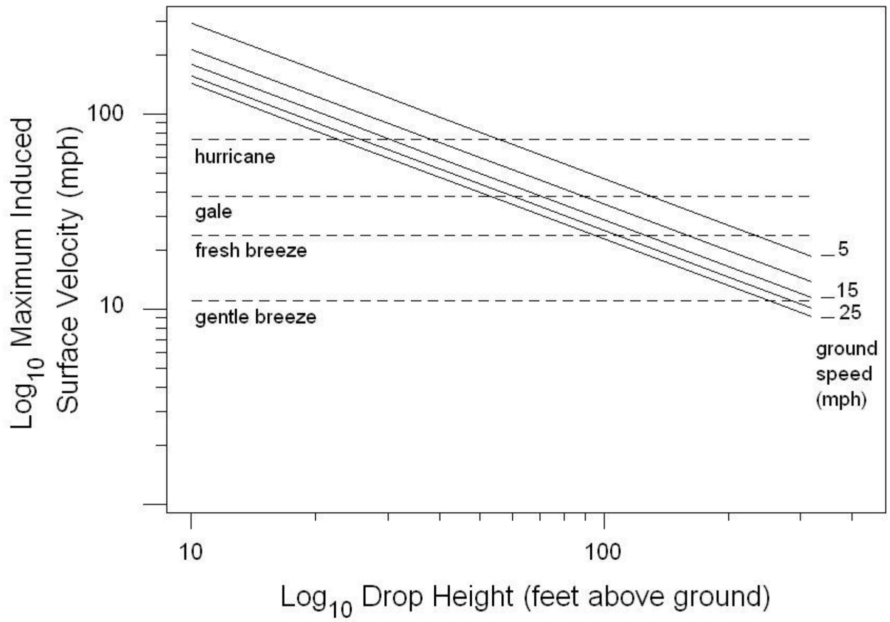


Figure 3.3.4-4 Modeled Maximum Surface Velocities Induced by Skycrane S-64 Helicopters while Flying at Ground Speeds From 5 to 25 mph at Heights From 10 to 320 feet Above Ground. (Modeled from data in Teske et al. 1997)

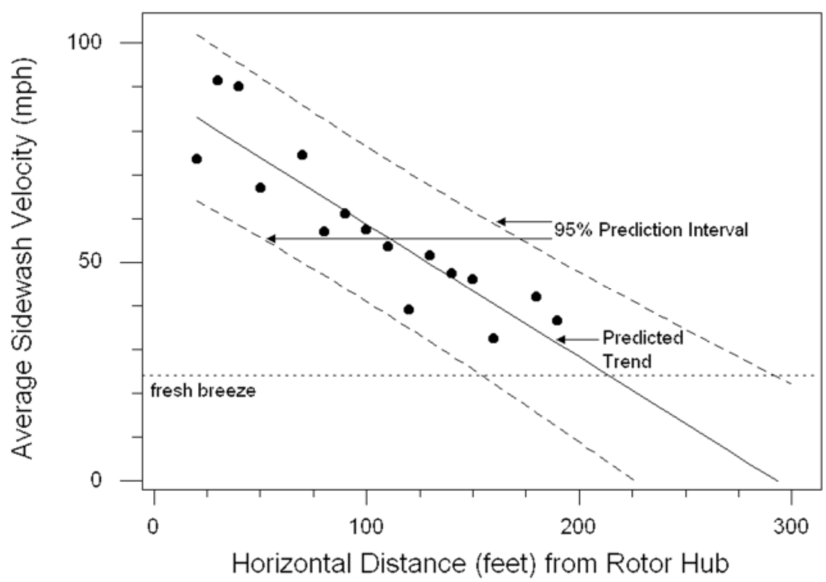
Flying at a ground speed of 5 mph, the Skycrane would have to be approximately 233 feet above ground to produce a maximum induced surface velocity of 24 mph, equivalent to a fresh breeze. The Chinook and Vertol 107 helicopters would induce similar maximum surface velocities flying at heights of 185 feet and 200 feet above ground, respectively. If traveling at ground speed of 25 mph, the Skycrane could be 95 feet above ground to induce a maximum surface velocity of 24 mph.

Actual downwash and sidewash vortices produced by Chinook CH-47 and Skycrane (CH-54) helicopters were measured during field tests (Leese and Knight 1974) while aircraft were hovering at 40–50 feet and 80–90 feet agl while under maximum loads of 36,000 pounds (CH-47) and 45,000 to 47,000 pounds (CH-54). The Vertol 107 (CH-46) was not included in the field tests.

With a 47,000-pound load, the single rotor CH-54 hovering at 40 feet agl produced a maximum sidewash velocity of 87 mph 50 feet away from the rotor hub. At 80 feet agl, the maximum sidewash was 74 mph, also measured at 50 feet from the hub though the gross weight was 45,000 pounds during that particular trial. Both maximum sidewash measurements were at heights of 0.3 feet above ground (Leese and Knight 1974). Under the specified load conditions, the CH-54 produced a sidewash of 11 mph 170 feet away from the rotor hub while hovering at 40 feet agl and a sidewash of 9 mph 150 feet away from the hub while hovering at 80 feet agl. Maximum sidewash velocities of 74–87 mph that were associated with the CH-54 helicopter while it was hovering, are within the range of hurricane force winds on the Beaufort Scale while winds of 9–11 mph produced by rotor sidewash would be described as a "gentle breeze." Sidewash velocities between 9 and 11 mph at distances 150 to 170 feet away from a CH-54 helicopter (Skycrane) would not create a risk of young NSOs being blown out of nests.

Downwash and sidewash velocities measured for the CH-47 helicopter (Chinook) were greater than 100 mph up to 70 feet horizontally from the rotor hub when it was hovering at 90 feet agl with maximum load of 36,000 pounds (Leese and Knight 1974). The twin rotor CH-47 produced sidewash velocities as high as 56 mph 190 feet away from the rotor hub when it was hovering 90 feet agl. The Beaufort Scale classifies winds between 55 and 63 mph as a "storm", with trees uprooted and structural damage likely. The strength of winds produced by the CH-47 is likely due to the interaction of descending air produced by the two rotors (Fabey 2008); sidewash winds are generally strongest at 120 and 240 degrees (4 o'clock and 8 o'clock, respectively) relative to the helicopter's heading (data in Leese and Knight 1974).

Sidewash wind velocities produced by the CH-47 at various distances away from the rotor hub (Leese and Knight 1974) were used to predict the distance at which the helicopter would be far enough away from adversely affecting NSO nests and young. The prediction is based on the sidewash wind velocities produced by the CH-47 averaged for wind measurements made 0.3 feet above ground at angles of 120 and 240 degrees while the helicopter was hovering 90 feet agl under a load of 36,000 pounds. The prediction is shown below in figure 3.3.4-5 in which a sidewash velocity of 0 mph would occur 293 feet away from the rotor hub. Due to the observed variation in sidewash winds at different distances away from the rotor hub (solid circles in figure 3.3.4-5), the upper 95 percent prediction interval on that predictive estimate of 0 mph at 293 feet from the hub would be 23.8 mph. A wind velocity of 23.8 mph is classified as a fresh breeze on the Beaufort Scale. One would be 95 percent certain that a stronger wind would not occur which could potentially adversely affect nesting NSOs.



Source: Leese and Knight 1974

Figure 3.3.4-5 Average Sidewash Wind Velocities Produced by the CH-47 at Varying Horizontal Distances from the Rotor Hub While Hovering 90 feet agl Under a Load of 36,000 pounds. The Observed Averages (solid circles) were used to Predict Sidewash Winds at Distances Out to 300 feet.

These estimates clearly suggest that greater distances would be required to avoid adverse effects to NSOs if Chinook helicopters, rather than Skycranes, are employed for heavy lifting along remote sections of the Pipeline construction right-of-way. Based on the similarities of maximum induced surface velocities between Chinook and Vertol 107 helicopters, sidewash velocities induced while hovering are likely to be similar as well. However, if known NSO activity centers can be avoided by at least 200 feet above tree tops by heavy-lifting helicopters in transit and avoided horizontally by at least 300 feet while helicopters hover above staging sites, no adverse effects to the species would be expected due to rotor downwash and induced sidewash.

Three activity centers occur within 0.25 mile of proposed helicopter use (known 2317B, best location site PCGP 095.3, and assumed PCGP A-3), of which two sites (2317B and PCGP 095.3) could have helicopter activity within their nest patch (see table Q-8 in appendix Q, and individual NSO impact assessments, appendix Z2). Helicopter use for timber extraction within 0.25 mile of an NSO activity center would occur outside of the entire breeding season (between October 1 and February 28); no adverse effects from rotor wash of large helicopters are expected during timber extraction. Helicopter activity could occur within two nest patches (2317B and PCGP 095.3) and adverse effects could occur from rotor wash of large helicopters during pipe delivery for construction of the proposed action if the activities occur within 200 feet above nest trees and horizontally within 300 feet of nest trees; however, the activity centerscenter analyzed for both NSO sites are located further than 300 feet, but the nest site is unknown for PCGP 095.3 (best location site). Helicopter use would only occur after the critical breeding season (after July 15), minimizing risk to NSO.

Burning and Smoke

Effects on NSOs from smoke, whether by prescribed burning as a habitat enhancement procedure or by burning slash have not been studied. However, FWS et al. (2007) have declared (see Table 15 in, FWS et al. 2007) that "smoke can cause [spotted owl] adults to move off nest sites, therefore leaving eggs or young exposed to predation or resulting in lost feedings reducing the young's fitness."

According to BLM and Forest Service (2008, page 34), NSOs "are potentially affected by fire control activities and drifting smoke during burning. The threshold distance for disturbance from smoke is 0.25 mile for spotted owls," which would be subject to smoke-related disturbance during the critical breeding period (March 1 to July 15). PCGP would not conduct slash burning during the critical breeding season within 0.25 mile of an occupied NSO activity center. No direct effect to NSOs due to slash burning is expected.

Maintenance and Operations

No activities associated with general maintenance and operations of the proposed action are expected to affect NSO sites. Vegetation maintenance activities within the operational right-of-way would occur only between August 1 and April 15 of any year (see appendix C). To further reduce impacts to nesting NSOs, PCGP would conduct vegetation maintenance activities within the operational right-of-way after the entire breeding season within known, best location, and PCGP assumed nest patches and after the critical breeding season within 0.25 mile of NSO activity centers. Routine clearing of vegetation within the 30-foot operational right-of-way would not occur more frequently than every 3 years. A 10-foot corridor centered over the pipeline may be maintained annually in an herbaceous state to facilitate periodic corrosion and leak surveys. PCGP would also require pilots conducting annual aerial inspection (small plane/helicopter) of the pipeline to adhere to the spatial restrictions recommended in the vicinity of known, best location, or PCGP assumed sites (no overflight within 1,300 feet of ground level during the critical breeding season [March 1 through July 15]); therefore, no effects from aerial pipeline inspection would be expected.

Indirect Effects

Habitat loss and modification, whether to nesting, roosting or foraging habitats, due to forest clear-cutting has been the primary factor causing declines of the NSO (FWS 1992b). Habitat losses and habitat fragmentation have indirect impacts that can affect survival and reproduction of NSOs. Short-term impact is expected with UCSAs and is likely to last from the initiation of use until 1 to 5 years afterward. Long-term impact to NSOs and NSO habitat is expected to last at least 5 years or more.

Other indirect effects to NSOs that are often related to habitat loss or modification are increased predation, increased competition, and effects to prey utilized by NSOs. Other indirect effects to NSOs also include increased edge and decreased interior forest habitats, as well as reduction of those habitats that are capable of achieving higher quality habitat status but for the Project's impacts within LSR, Riparian Reserves, or within NSO home ranges. In addition, secondary effects (Comer 1982) due to an increased human population base are expected as a consequence of the action (i.e., the need for ancillary goods, services, recreational opportunities resulting from the Project). Potential indirect or secondary effects by the proposed Pipeline project include increased recreation demand (including off-road vehicle use), increased habitat conversion, and habitat degradation by human intrusion and encroachment (Comer 1982).

To determine potential indirect effects to known, best location, and PCGP-assumed owl home ranges within the provincial analysis area, 14 NSO groups (note that WC-L and EC-M are in the same group) were created that included all known, best location, and PCGP assumed owls whose home ranges overlapped. Table 3.3.4-11 summarizes the number of owls by status (known, best location, and PCGP assumed) and physiographic province that occur within each owl group. The number of owls included in each group varied from one to 45 NSO activity centers (see table Q-7 in appendix Q for specific information on each NSO site included in each owl group). Owl groups have been used to identify the area of habitat being affected within and outside of NSO home ranges in the project area.

Analysis of indirect effects to NSO habitat by Pipeline construction and operation within the physiographic analysis area followed guidance provided by FWS included in the Revised Conservation Framework developed for the Project (see *Revised Conservation Framework for the Northern Spotted owl and Marbled Murrelet: Jordan Cove Energy and Pacific Connector Gas Pipeline Project*, FWS 2014c).

Habitat Removal and Modification

The decline of NSOs has been linked to the removal and degradation of available suitable NRF habitat. Appropriate vegetation and structural components are necessary to maintain suitable habitat, and the removal of these components can potentially have adverse effects on NSO populations. These effects could include displacement from traditional nesting areas, increased concentration of NSOs into smaller, fragmented areas of suitable habitat, and diminished reproductive success (FWS 2011c).

In the provincial analysis area, NSO habitat needs and home ranges vary based on physiographic provinces and forest type. In the Coast Range Physiographic Province (MP 0.00 to MP 51.74), the home range is assumed to be circular with a radius of 1.5 miles. Within the Klamath Mountains Physiographic Province (MP 51.74 to MP 122.67), the home range radius is 1.3 miles, and in the West Cascades (MP 122.67 to MP 167.76) and East Cascade Physiographic Provinces (MP 167.76 to MP 190.64) the home range radius is 1.2 miles (FWS 1992d). Although differences exist in natural stand characteristics that influence provincial home range size, habitat loss and forest fragmentation caused by timber harvest effectively reduce habitat quality in the home range. A reduction in the amount of suitable habitat reduces NSO abundance and nesting success (Bart and Forsman 1992; Bart 1995), and recent studies have indicated that NSOs' home ranges are substantially larger in more heavily fragmented stands (Courtney et al. 2004).

TABLE 3.3.4-11

Summary of the Number of Northern Spotted Owls Included in each Owl Group
by Owl Status (known, best location, PCGP assumed) and Physiographic Province a/

		Number of Northern Spotted Owl Sites within each Group			
NSO Group	**Project Location**	**Known b/**	**Best Location b/**	**PCGP Assumed b/**	**Total**
Coast Range Physiographic Province					
CR-A	MP 9.35R-12.52R	1	0	0	1
CR-B	MP 29.15-48.60	12	0	3	15
CR-C	EAR 46.51; Kenyon Mountain (Signal Tree) CT	1	0	0	1
	Total Coast Range	*14*	*0*	*3*	*17*
Klamath Mountains Physiographic Province					
KM-D	MP 52.55 – 55.30	2	0	0	2
KM-E	MP 58.95 – 65.66	2	2	0	4
KM-F	MP 76.99 – 121.39	34	8	3	45
KM-G	Starveout Creek Road; Starveout Creek CT	1	0	0	1
	Total Klamath Mountains	*39*	*10*	*3*	*52*
West Cascades Physiographic Province					
WC-H	MP 123.17 – 127.27	2	0	0	2
WC-I	Flounce Rock CT	1	0	0	1
WC-J	MP 132.83 – 137.43	3	0	0	3
WC-K	MP 143.02-144.63	2	0	0	2
WC-L	Rock Source/Disposal (log storage)	1	0	0	1
WC-M	MP 150.51-167.71	17	5	0	22
	Total West Cascades	*26*	*5*	*0*	*31*
East Cascades Physiographic Province					
EC-M (part of group WC-L)	MP 167.71 – 170.70	2	0	0	2
EC-N	MP 172.35 – 175.99	3	0	0	3
	Total East Cascades	*5*	*0*	*0*	*5*
Overall Total within Provincial Analysis Area		**84**	**15**	**6**	**105**

a/ Summarized from table Q-7 in appendix Q.
b/ Owl status: known (provided by BLM Districts, Forest Service, or FWS within the project area), PCGP assumed (area identifed by PCGP that may provide habitat for NSO activity center), best location (no nest located during PCGP survey efforts but survey results determined best potential site for nest).

Effects to Habitat. The Pipeline would affect NSOs over the long-term by habitat removal and modifications. Table 3.3.4-12 summarizes effects to NSO habitat from construction and operation (30-foot maintenance corridor) of the proposed Pipeline by physiographic province, land owner, and Project component (see table Q-9 in appendix Q for detailed information on habitat impact including amount removed/modified from CHUs, LSRs, and interior forest, by landowner within and outside of NSO groups). Habitat cleared outside of the 30-foot-wide operational right-of-way would be revegetated after construction where possible, although non-federal and Matrix or Harvest-land based lands may be harvested before they reach dispersal or NRF characteristics and thus would provide minimal benefit to NSO.

In total, construction of the Pipeline would remove approximately 517 acres of suitable NRF habitat (high NRF and NRF which include 26 acres of "post-fire NRF" removed) (see table 3.3.4-

12; table Q-9 in appendix Q), of which approximately 134 acres (includes 7 acres of "post-fire NRF") would be within the 30-foot operational easement and maintained free of forested vegetation for the life of the Pipeline (table 3.3.4-12; table Q-9 in appendix Q). A maximum of approximately 383 acres of suitable NRF habitat cleared outside the 30-foot operational right-of-way (including 19 acres of "post-fire NRF") would be revegetated, at least on federal land, and considered capable of becoming NRF habitat in approximately 80 years, although some of it may become functional foraging or roosting habitat prior to 80 years. However, replanted or naturally seeded trees may be harvested from non-federal lands or federal lands slated for timber harvest (i.e., Matrix or Harvest-based lands) before becoming NRF habitat. Removal of 517 acres of NRF habitat across the four physiographic provinces crossed represents approximately 0.5 percent of the 101,810 acres of suitable NRF/high NRF habitat in the provincial analysis area (see table 3.3.4-4, above) or less than 0.01 percent of the 5,091,800 acres available within Oregon (Davis et al 2016). Additionally, 214 acres of suitable NRF habitat (including 37 acres of "post-fire NRF") have been identified for use by the proposed project as UCSAs, which would not have vegetation removed but may be used to store forest slash, stumps, and dead and downed log materials between existing trees during construction and before they are scattered across the right-of-way after construction during restoration (see table 3.3.4-12; table Q-9 in appendix Q). Use of the UCSAs would be a short-term modification of suitable NRF habitat, and habitat function should be maintained following construction.

Discussion at the Task Force–ESA Consultation Subgroup meeting on April 2, 2008, indicated that NSO dispersal habitat could be considered adequate, or sufficient to support dispersing NSO, if at least 50 percent of the analysis area (in the Project's case, the defined provincial analysis area) consisted of dispersal habitat. Table 3.3.4-4 shows the amount of dispersal habitat available (High NRF, NRF, and Dispersal Only habitat) and its percentage for each physiographic province, and overall, within the defined provincial analysis area. Approximately 1,158 acres of dispersal habitat (high NRF, NRF, and dispersal only habitat) would be removed by the Proposed Action, which represents approximately 0.7 percent of all total available dispersal habitat (168,443 acres) within the provincial analysis area (see high NRF, NRF, and dispersal only habitat in table 3.3.4-4). After construction of the Pipeline project, approximately 167,285 acres (52.0 percent) of dispersal habitat would be available within the provinicial analysis area and would continue to provide sufficient habitat to support NSO dispersal.

Two physiographic provinces currently provide more than 50 percent available dispersal habitat – Klamath Mountains (56.8 percent) and West Cascades (65.3 percent). Removal of 515.95 acres of dispersal habitat from the Klamath Mountains Physiographic Province and 287.09 acres of dispersal habitat from the West Cascades Physiographic Province would still provide more than 50 percent dispersal habitat for both physiographic provinces within the defined provincial analysis area (approximately 72,604 acres or 56 percent in the Klamath Mountains Physiographic Province and 49,889 acres or 65 percent available in the West Cascades Physiographic Province). Removal of dispersal habitat in two physiographic provinces currently with less than 50 percent available dispersal habitat – Coast Range (37.5 percent) and East Cascades (44.0 percent) – would further reduce the amount of dispersal habitat available within those provinces: approximately 34,363 acres (37.2 percent) of dispersal habitat would remain in the Coast Range province after removal of 231.42 acres, and approximately 10,394 acres (43.5 percent) of dispersal habitat would remain in the East Cascades province after removal of 123.13 acres. Removal of dispersal habitat would not be in one locale, but would be removed along 192.1 miles of proposed Pipeline in the range of the NSO. After the Pipeline project is completed, neither the temporary 95-foot-wide construction right-of-way and associated temporary extra work areas or the permanent 30-foot-wide operational right-of-way would impede the movement of juveniles and adults.

Construction and permanent effects to habitat that is not currently NRF habitat, but is capable of becoming suitable NRF habitat (capable habitat) are also included in table 3.3.4-12. Approximately 919 acres of NSO capable habitat would be removed by construction of the proposed Project, of which 216 acres would remain in a permanent herbaceous/shrub state within the 30-foot operational right-of-way for the life of the Pipeline. Approximately 632 acres of capable habitat removed on private lands is not expected to mature to provide suitable NRF or high NRF habitat for NSO based on review of research on timber harvest practices in Oregon (Zhou et al. 2005; Rasmussen et al. 2012). These studies noted that forest harvest practices on non-federal lands typically occur between 45 and 65 years of age.

The majority of NRF habitat (high NRF and NRF) removed by the Pipeline project (approximately 386 acres) occurs within known, best location, or PCGP assumed home ranges of NSOs within the analysis area (see NSO Groups in table 3.3.4-11) and could affect NSO over the long term; this is approximately 75 percent of all suitable NRF habitat removed or modified by the proposed Project (517 acres total) within the range of the NSO. Table Q-10 in appendix Q provides a summary of suitable, dispersal, and capable habitat affected by the proposed Project within NSO groups by nest patch, core area, and home range. Suitable but unoccupied habitat removed outside of known, best location, or PCGP assumed home ranges may reduce the physical, geographical, and/or demographic connectivity between habitat and population reserves.

Davis et al. (2011) observed increased extinction rates of spotted owls in response to decreased amounts of old forest within the core area and higher colonization rates when old-forest habitat was less fragmented in the Southern Cascades Study Area, which is situated within the project area on federal lands (see Population Status section, above). The proposed action would affect NSO high NRF and NRF habitat within approximately 40 core areas (30 known sites, seven best location sites, and three PCGP assumed sites, see talleys in table 3.3.4-14) mostly within the Klamath Mountains Physiographic Province (21 core areas affected, see table 3.3.4-13), potentially increasing habitat abandonment and/or barred owl competition and encroachment (see Davis et al. 2011). Table Q-7 in appendix Q identifies the location and distance of each spotted owl site center from construction of the Pipeline, as well as identifies the current condition of each spotted owl nest site and the amount of habitat removed from the nest patch, core area, and home range for each NSO activity center, where applicable. It would be expected that spotted owl sites with less habitat available within their core area (i.e., Habitat Condition 2 or 4 in table Q-7 in appendix Q) would be affected more by habitat removal within their core area including: three PCGP assumed sites, four best location sites, and 13 known spotted owl sites (table 3.3.4-14).

TABLE 3.3.4-12

Indirect Effects (acres) to NSO Habitat by Land Ownership from Construction and Operation of the Proposed Action within the Range of the NSO

		High NRF b/			NRF c/			Dispersal Only d/			Capable e/			Non-Capable f/			Total Acres		
		Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation
Land Owner	General Location a/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/
Coast Range Physiographic Province																			
BLM - Coos Bay	NSO Groups	15.44	4.26	4.88	7.82	1.08	2.41	34.90	6.85	8.41	32.36	2.63	5.71	14.86	0.13	4.57	105.38	14.96	25.98
	Outside NSO Groups	4.29	1.04	1.22	21.35	7.14	5.44	60.20	6.60	15.79	37.72	11.65	10.18	13.29	1.01	3.48	136.85	27.44	36.10
	Total	19.73	5.29	6.10	29.18	8.22	7.85	95.11	13.46	24.20	70.08	14.28	15.89	28.15	1.15	8.05	242.24	42.40	62.09
BLM - Roseburg	NSO Groups	1.23		0.38	1.81		0.56	5.40		1.08	1.64		0.09	1.17		0.06	11.27	0.00	2.18
	Outside NSO Groups				2.93		0.93	9.33		2.39				0.64		0.25	12.90	0.00	3.57
	Total	1.23		0.38	4.75		1.48	14.73		3.48	1.64		0.09	1.81		0.31	24.17	0.00	5.75
State	NSO Groups													0.04		0.02	0.04	0.00	0.02
	Outside NSO Groups							0.18						105.94		3.90	106.12	0.00	3.90
	Total							0.18						105.98		3.92	106.16	0.00	3.92
Private / Other	NSO Groups	0.17	0.00	0.08	1.85	0.00	0.44	20.93	3.15	3.07	169.85	22.96	38.14	59.28	0.44	13.46	252.08	26.55	55.18
	Outside NSO Groups	0.56	0.07	0.15	5.81	1.20	1.54	37.19	4.74	9.04	133.71	18.56	29.71	236.78	0.65	16.76	414.04	25.21	57.20
	Total	0.73	0.07	0.23	7.66	1.20	1.98	58.12	7.89	12.11	303.56	41.52	67.85	296.06	1.08	30.22	666.12	51.76	112.38
Coast Range Subtotal	*NSO Groups*	16.85	4.26	5.34	11.49	1.08	3.41	61.24	10.01	12.56	203.85	25.59	43.94	75.36	0.57	18.11	368.78	41.51	83.35
	Outside NSO Groups	4.85	1.10	1.37	30.10	8.33	7.90	106.90	11.34	27.22	171.43	30.21	39.89	356.64	1.66	24.39	669.91	52.65	100.78
	Total	21.70	5.36	6.71	41.58	9.41	11.31	168.14	21.35	39.79	375.28	55.80	83.83	432.00	2.23	42.49	1,038.69	94.15	184.13
Klamath Mountains Physiographic Province																			
BLM - Roseburg	NSO Groups	33.12	28.00	8.67	48.08 (12.96)	41.05 (15.10)	11.05 (3.20)	20.31	10.68	4.07	45.36	22.62	9.27	18.11	2.67	4.50	164.98	105.01	37.56
	Outside NSO Groups	4.41	0.10	1.18	5.52	0.84	1.39	6.47	0.01	1.56		0.00		3.91	1.08	1.04	20.30	2.04	5.16
	Total	37.53	28.10	9.84	53.60 (12.96)	41.90 (15.10)	12.45 (3.20)	26.78	10.69	5.62	45.36	22.62	9.27	22.02	3.75	5.54	185.28	107.05	42.72
BLM - Medford	NSO Groups	9.30	5.29	2.78	15.43	3.76	3.38	17.95	5.46	3.84	2.45	0.63	0.88	6.22	1.09	1.37	51.36	16.23	12.26
	Outside NSO Groups	0.01		0.00	1.74	0.29	0.36	5.33	1.64	1.84	0.00			0.30		0.10	7.38	1.93	2.30
	Total	9.31	5.29	2.78	17.18	4.05	3.75	23.28	7.10	5.68	2.46	0.63	0.88	6.51	1.09	1.47	58.74	18.16	14.56
Umpqua N.F.	NSO Groups	41.36	9.82	11.37	36.88 (12.63)	24.21 (22.15)	9.06 (3.40)	30.37	7.59	6.04	35.22	0.07	10.19	25.45	0.41	2.64	169.28	42.10	39.30
	Outside NSO Groups																0.00	0.00	
	Total	41.36	9.82	11.37	36.88 (12.63)	24.21 (22.15)	9.06 (3.40)	30.37	7.59	6.04	35.22	0.07	10.19	25.45	0.41	2.64	169.28	42.10	39.30
State	NSO Groups																0.00	0.00	
	Outside NSO Groups													3.60			3.60	0.00	
	Total													3.60			3.60	0.00	
Private / Other	NSO Groups	6.60	9.03	0.99	23.67 (0.12)	17.48 (0.11)	4.94	110.76	87.40	28.43	160.10	126.16	37.01	158.80	14.27	29.97	459.93	254.35	101.34
	Outside NSO Groups	0.94	0.42	0.05	7.30	1.04	0.99	90.39	17.65	22.91	17.42	12.43	4.37	365.44	5.71	29.72	481.50	37.24	58.04
	Total	7.54	9.45	1.04	30.97 (0.12)	18.52 (0.11)	5.93	201.16	105.05	51.34	177.53	138.59	41.38	524.24	19.98	59.69	941.43	291.59	159.38
Klamath Mountains Subtotal	*NSO Groups*	90.38	52.14	23.81	124.07 (25.72)	86.51 (37.36)	28.44 (6.61)	179.39	111.12	42.39	243.13	149.48	57.35	208.57	18.43	38.48	845.55	417.69	190.46
	Outside NSO Groups	5.35	0.52	1.23	14.56	2.17	2.75	102.19	19.30	26.31	17.43	12.43	4.37	373.24	6.79	30.85	512.78	41.21	65.50
	Total	95.74	52.67	25.04	138.63 (25.72)	88.68 (37.36)	31.18 (6.61)	281.58	130.42	68.69	260.56	161.91	61.72	581.82	25.22	69.33	1,358.33	458.90	255.97
West Cascades Physiographic Province																			
BLM - Medford	NSO Groups	1.20	0.44	0.35	27.61	4.68	6.34	18.85	0.92	4.08	24.98	0.44	5.29	28.87	0.14	5.65	101.51	6.61	21.71
	Outside NSO Groups				35.76	5.51	8.62	4.55	1.19	1.17	1.00	0.68	0.36	37.68	2.14	8.68	78.99	9.52	18.84
	Total	1.20	0.44	0.35	63.37	10.19	14.96	23.40	2.11	5.25	25.98	1.12	5.65	66.54	2.28	14.34	180.50	16.14	40.55
Rogue River N.F.	NSO Groups	29.46	12.54	9.08	46.61	22.32	13.33	17.17	7.33	5.46	77.85	23.56	17.78	37.97	2.95	3.18	209.07	68.71	48.84
	Outside NSO Groups																0.00	0.00	
	Total	29.46	12.54	9.08	46.61	22.32	13.33	17.17	7.33	5.46	77.85	23.56	17.78	37.97	2.95	3.18	209.07	68.71	48.84
State	NSO Groups							2.06		0.36				0.62		0.19	2.68	0.00	0.55
	Outside NSO Groups							0.15		0.05				0.15		0.05	0.30	0.00	0.10
	Total							2.21		0.41				0.77		0.23	2.98	0.00	0.64
Private / Other	NSO Groups	0.91	0.45	0.38	6.68	2.59	1.60	33.11	3.29	7.80	48.77	8.51	11.12	31.20	1.34	7.59	120.67	16.18	28.49
	Outside NSO Groups		0.02		13.18	2.41	3.56	49.78	2.04	12.29	10.89	1.61	3.15	118.94	1.17	25.87	192.79	7.26	44.88
	Total	0.91	0.47	0.38	19.86	5.00	5.16	82.89	5.33	20.09	59.66	10.13	14.27	150.14	2.51	33.47	313.46	23.44	73.37
West Cascades Subtotal	*NSO Groups*	31.57	13.43	9.81	80.90	29.59	21.27	71.19	11.54	17.71	151.60	32.52	34.19	98.66	4.43	16.62	433.93	91.50	99.59
	Outside NSO Groups	0.00	0.02	0.00	48.94	7.92	12.18	54.48	3.23	13.51	11.89	2.29	3.52	156.76	3.32	34.61	272.08	16.78	63.81
	Total	31.57	13.46	9.81	129.84	37.51	33.45	125.68	14.77	31.22	163.49	34.81	37.71	255.42	7.74	51.22	706.00	108.29	163.40
East Cascades Physiographic Province																			
BLM -	NSO Groups																0.00	0.00	

TABLE 3.3.4-12

Indirect Effects (acres) to NSO Habitat by Land Ownership from Construction and Operation of the Proposed Action within the Range of the NSO

		High NRF b/			NRF c/			Dispersal Only d/			Capable e/			Non-Capable f/			Total Acres		
		Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation
Land Owner	**General Location a/**	**Removed g/**	**UCSA h/**	**30-foot Corridor i/**	**Removed g/**	**UCSA h/**	**30-foot Corridor i/**	**Removed g/**	**UCSA h/**	**30-foot Corridor i/**	**Removed g/**	**UCSA h/**	**30-foot Corridor i/**	**Removed g/**	**UCSA h/**	**30-foot Corridor i/**	**Removed g/**	**UCSA h/**	**30-foot Corridor i/**
Lakeview	Outside NSO Groups				13.01		3.50	0.00						1.81		0.27	14.82	0.00	3.77
	Total				13.01		3.50	0.00						1.81		0.27	14.82	0.00	3.77
Rogue River N.F.	NSO Groups	1.12	0.54	0.40	0.99	0.11	0.35				0.90	0.15	0.30				3.00	0.80	1.05
	Outside NSO Groups																0.00	0.00	
	Total	1.12	0.54	0.40	0.99	0.11	0.35				0.90	0.15	0.30				3.00	0.80	1.05
Fremont - Winema N.F.	NSO Groups	3.72	0.25	1.14	24.54	3.63	6.95	2.78	0.92	0.84	27.22	4.32	7.42	2.59	0.05	0.37	60.86	9.18	16.71
	Outside NSO Groups	1.71	0.26	0.49	11.13	1.93	3.17	5.04	0.17	1.24	0.32	0.01	0.12	1.60	0.01	0.28	19.80	2.39	5.30
	Total	5.43	0.52	1.63	35.67	5.57	10.11	7.82	1.09	2.08	27.54	4.33	7.54	4.19	0.07	0.65	80.66	11.57	22.01
Private / Other	NSO Groups				0.35	0.02	0.09	2.09		0.49	20.43	2.28	5.13	3.74	0.00	1.01	26.61	2.31	6.73
	Outside NSO Groups				1.15	0.01	0.35	55.49		15.83	70.58	0.38	20.05	68.44	0.05	14.38	195.66	0.44	50.61
	Total				1.49	0.03	0.45	57.59		16.32	91.01	2.66	25.17	72.17	0.05	15.39	222.27	2.74	57.34
East Cascades Subtotal	*NSO Groups*	4.84	0.79	1.54	25.88	3.77	7.39	4.88	0.92	1.33	48.55	6.75	12.84	6.33	0.05	1.39	90.47	12.28	24.49
	Outside NSO Groups	1.71	0.26	0.49	25.29	1.94	7.02	60.54	0.17	17.07	70.90	0.39	20.17	71.85	0.06	14.93	230.29	2.82	59.68
	Total	6.55	1.05	2.03	51.16	5.71	14.41	65.42	1.09	18.40	119.45	7.14	33.01	78.18	0.12	16.32	320.75	15.11	84.17
Total Northern Spotted Owl Range																			
BLM	NSO Groups	60.30	37.99	17.06	100.77 (12.96)	50.57 (15.10)	23.75 (3.20)	97.42	23.90	21.49	106.79	26.32	21.24	69.23	4.03	16.16	434.51	142.81	99.69
	Outside NSO Groups	8.70	1.14	2.39	80.32	13.79	20.25	85.88	9.44	22.74	38.72	12.33	10.54	57.62	4.24	13.81	271.25	40.93	69.75
	Total	69.00	39.13	19.45	181.09 (12.96)	64.35 (15.10)	44.00 (3.20)	183.31	33.34	44.24	145.51	38.65	31.78	126.85	8.27	29.97	705.75	183.75	169.44
Forest Service	NSO Groups	75.66	23.15	21.99	109.03 (12.63)	50.28 (22.15)	29.69 (3.40)	50.32	15.84	12.34	141.19	28.10	35.69	66.01	3.41	6.19	442.21	120.78	105.90
	Outside NSO Groups	1.71	0.26	0.49	11.13	1.93	3.17	5.04	0.17	1.24	0.32	0.01	0.12	1.60	0.01	0.28	19.80	2.39	5.30
	Total	77.37	23.42	22.48	120.16 (12.63)	52.21 (22.15)	32.85 (3.40)	55.36	16.01	13.58	141.51	28.11	35.81	67.61	3.42	6.47	462.01	123.17	111.20
State	NSO Groups	0.00	0.00	0.00	0.00	0.00	0.00	2.06	0.00	0.36	0.00	0.00	0.00	0.67	0.00	0.20	2.72	0.00	0.56
	Outside NSO Groups	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.05	0.00	0.00	0.00	109.69	0.00	3.95	110.02	0.00	4.00
	Total	0.00	0.00	0.00	0.00	0.00	0.00	2.39	0.00	0.41	0.00	0.00	0.00	110.35	0.00	4.15	112.74	0.00	4.56
Private / Other	NSO Groups	7.68	9.48	1.45	32.54 (0.12)	20.10 (0.11)	7.08	166.90	93.84	39.79	399.15	159.92	91.39	253.01	16.05	52.04	859.28	299.38	191.74
	Outside NSO Groups	1.50	0.51	0.20	27.43	4.65	6.44	232.86	24.43	60.07	232.61	32.98	57.28	789.59	7.58	86.73	1,283.99	70.14	210.73
	Total	9.18	9.99	1.65	59.98 (0.12)	24.74 (0.11)	13.52	399.76	118.27	99.86	631.76	192.89	148.67	1,042.61	23.63	138.77	2,143.28	369.53	402.46
Total Northern Spotted Owl Range	NSO Groups	143.64	70.62	40.49	242.34 (25.72)	120.94 (37.36)	60.51 (6.61)	316.70	133.59	73.99	647.13	214.34	148.32	388.91	23.48	74.59	1,738.72	562.98	397.90
	Outside NSO Groups	11.91	1.91	3.09	118.88	20.37	29.86	324.11	34.04	84.11	271.65	45.32	67.94	958.50	11.83	104.77	1,685.06	113.46	289.77
	Total	155.55	72.54	43.59	361.22 (25.72)	141.31 (37.36)	90.36 (6.61)	640.81	167.63	158.10	918.78	259.66	216.26	1,347.42	35.31	179.36	3,423.78	676.44	687.67

a/ General Location identifies areas within Northern Spotted Owl Groups (areas within NSO home ranges; see table Q-10 in appendix Q) and areas outside of NSO groups (outside of NSO home ranges).
b/ High NRF (FWS 2014c: forested habitat that is characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species.
c/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., “post-fire NRF”).
d/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.
e/ Capable Habitat (FWS 2014c): habitat that is forested or could become forested (i.e., recently harvested timberlands) that do not provide dispersal or NRF characteristics.
f/ Noncapable Habitat: not forested and not capable of becoming forested.
g/ Project components considered in calculation of habitat “Removed”: construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, rock source/disposal sites, and hydrostatic test locations.
h UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.
i/ 30-foot Maintenance Corridor would be kept in a shrub/sapling state for the life of the project; all other habitat outside of the 30-foot maintenance corridor would be revegetated, except for those habitats on non-federal or matrix lands where there is less certainty that replanting would occur or be maintained on the landscape.

Note: More detailed information on BLM Districts and National Forests impacted, as well as critical habitat, NWFP late successional reserves, is located in table Q-9 in appendix Q.

TABLE 3.3.4-13

Effects (acres) to Northern Spotted Owl (NSO) Habitat in each NSO Habitat Type by Owl Groups Impacted by Construction of the Proposed Pipeline Project within the Range of the NSO

NSO Habitat Type	Number of Habitat Types Crossed by the Project within each Province	High NRF Habitat b/			NRF Habitat c/			Dispersal Only Habitat d/			Capable Habitat e/			Non-Capable Habitat f/			Total		
		Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation	Construction		Operation
		Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/	Removed g/	UCSA h/	30-foot Corridor i/
Coast Range Physiographic Province																			
Home Range b/	14	7.11	0.42	2.44	3.66	1.08	1.18	46.33	6.08	9.41	161.40	15.44	35.75	66.64	0.25	14.78	285.15	23.27	63.56
Core Area	7	4.97	1.32	1.48	7.82	0.00	2.23	14.90	3.92	3.15	42.45	10.15	8.19	8.71	0.32	3.32	78.85	15.71	18.38
Nest Patch	1	4.77	2.52	1.42													4.77	2.52	1.42
Overall Coast Range Total	*N/A*	16.85	4.26	5.34	11.49	1.08	3.41	61.24	10.01	12.56	203.85	25.59	43.94	75.36	0.57	18.11	368.78	41.51	83.35
Klamath Mountains Physiographic Province																			
Home Range	50	55.34	38.82	14.70	80.25 (18.03)	56.35 (22.94)	17.88 (4.42)	153.81	95.23	37.76	175.82	100.92	42.56	155.21	13.41	28.25	620.43	304.73	141.15
Core Area	21	31.75	12.00	8.26	42.43 (7.11)	27.20 (12.77)	10.05 (1.97)	23.85	15.53	4.08	61.09	45.29	13.22	51.92	4.92	10.07	211.03	104.95	45.68
Nest Patch	5	3.29	1.31	0.85	1.39 (0.58)	2.96 (1.64)	0.50 (0.22)	1.73	0.37	0.55	6.23	3.26	1.57	1.44	0.11	0.16	14.09	8.02	3.63
Overall Klamath Mountains Total	*N/A*	90.38	52.14	23.81	124.07 (25.72)	86.51 (37.36)	28.44 (6.61)	179.39	111.12	42.39	243.13	149.48	57.35	208.57	18.43	38.48	845.55	417.69	190.46
West Cascades Physiographic Province																			
Home Range	29	18.14	8.40	5.63	64.46	22.81	16.69	55.43	8.66	13.62	116.26	23.00	26.09	79.02	3.05	13.08	333.30	65.92	75.11
Core Area	11	11.00	4.56	3.45	16.32	6.78	4.58	13.51	2.27	3.40	32.47	9.51	7.59	19.33	1.35	3.39	92.63	24.47	22.41
Nest Patch	2	2.43	0.47	0.72	0.13		0.00	2.25	0.61	0.68	2.87	0.01	0.51	0.31	0.02	0.14	7.99	1.12	2.07
Overall West Cascades Total	*N/A*	31.57	13.43	9.81	80.90	29.59	21.27	71.19	11.54	17.71	151.60	32.52	34.19	98.66	4.43	16.62	433.93	91.50	99.59
East Cascades Physiographic Province																			
Home Range	4	2.64	0.79	0.78	22.41	3.77	6.42	4.88	0.92	1.33	42.92	6.24	11.20	5.77	0.05	1.29	78.61	11.77	21.01
Core Area	1	2.04		0.68	3.45		0.97				5.63	0.51	1.65	0.55	0.00	0.09	11.68	0.51	3.39
Nest Patch	1	0.16		0.09	0.02		0.00										0.18	0.00	0.09
Overall East Cascades Total	*N/A*	4.84	0.79	1.54	25.88	3.77	7.39	4.88	0.92	1.33	48.55	6.75	12.84	6.33	0.05	1.39	90.47	12.28	24.49
Overall NSO Range																			
Home Range	97	83.23	48.43	23.54	170.77 (18.03)	84.01 (22.94)	42.17 (4.42)	260.45	110.89	62.12	496.39	145.60	115.58	306.65	16.76	57.41	1,317.50	405.68	300.83
Core Area	40	49.76	17.88	13.87	70.02 (7.11)	33.98 (12.77)	17.83 (1.97)	52.26	21.72	10.63	141.64	65.46	30.65	80.52	6.60	16.87	394.20	145.64	89.86
Nest Patch	9	10.65	4.31	3.08	1.54 (0.58)	2.96 (1.64)	0.51 (0.22)	3.99	0.98	1.23	9.10	3.27	2.08	1.74	0.13	0.30	27.02	11.66	7.21
Overall Physiographic Province Total	**N/A**	143.64	70.62	40.49	242.34 (25.72)	120.94 (37.36)	60.51 (6.61)	316.70	133.59	73.99	647.13	214.34	148.32	388.91	23.48	74.59	1,738.72	562.98	397.90

a/ Nest patch: includes an area that is 300 meters (984 feet) from the site center (70 acres occur within a nest patch).
Core area: generally 502 acres occur within a core area.
Home range: generally 4,525 acres, 3,398 acres, and 2,895 acres occur within the Oregon Coast Range, Klamath Mountains, and Cascades NSO home ranges, respectively.

b/ High NRF (FWS 2014c): forested habitat that is characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species.

c/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., "post-fire NRF").

d/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.

e/ Capable Habitat (FWS 2014c): habitat that is forested or could become forested (i.e., recently harvested timberlands) that do not provide dispersal or NRF characteristics.

f/ Noncapable Habitat: not forested and not capable of becoming forested.

g/ Project components considered in calculation of habitat "Removed": construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, rock source/disposal, and hydrostatic test locations.

h/ UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.

i/ 30-foot Maintenance Corridor would be kept in a shrub/sapling state for the life of the project; all other habitat outside of the 30-foot maintenance corridor would be revegetated, except for those habitats on non-federal or matrix lands where there is less certainty that replanting would occur or be maintained on the landscape.

NOTE: Summarized from table Q-10 in appendix Q.

TABLE 3.3.4-14

Number of NSO Home Ranges, by Physiographic Province and Habitat Condition that Would Have NSO Habitat Removed by the Proposed Project a/

Suitable NRF Habitat Condition within Owl Home Ranges b/	Owl Status c/	Coast Range			Klamath Mountains			West Cascades			East Cascades			Overall Total		
		Home Range	Core Area	Nest Patch	Home Range	Core Area	Nest Patch	Home Range	Core Area	Nest Patch	Home Range	Core Area	Nest Patch	Home Range	Core Area	Nest Patch
Home Range > 40%	Known	1	1	0	17	5	1	11	6	2	3	0	0	32	12	3
AND	Best Location	0	0	0	3	0	0	4	2	0	0	0	0	7	2	0
Core Area > 50%	PCGP Assumed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(*Above Threshhold)*	*Total*	*1*	*1*	*0*	*20*	*5*	*1*	*15*	*8*	*2*	*3*	*0*	*0*	39	14	3
Home Range > 40%	Known	0	0	0	4	1	0	5	2	0	0	0	0	9	3	0
AND	Best Location	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Core Area < 50%	PCGP Assumed	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
(Below Threshold)	*Total*	*0*	*0*	*0*	*5*	*1*	*0*	*5*	*2*	*0*	*0*	*0*	*0*	10	3	0
Home Range < 40%	Known	2	2	1	6	3	0	1	0	0	0	0	0	9	5	1
AND	Best Location	0	0	0	1	1	1	0	0	0	0	0	0	1	1	1
Core Area > 50%	PCGP Assumed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Below Threshold)	*Total*	*2*	*2*	*1*	*7*	*4*	*1*	*1*	*0*	*0*	*0*	*0*	*0*	10	6	2
Home Range < 40%	Known	8	2	0	11	6	0	7	1	0	1	1	1	27	10	1
AND	Best Location	0	0	0	6	4	2	1	0	0	0	0	0	7	4	2
Core Area < 50%	PCGP Assumed	3	2	0	1	1	0	0	0	0	0	0	0	4	3	0
(Below Threshold)	*Total*	*11*	*4*	*0*	*18*	*11*	*2*	*8*	*1*	*0*	*1*	*1*	*1*	38	17	3
Overall Total	Known	11	5	1	38	15	1	24	9	2	4	1	1	77	30	5
	Best Location	0	0	0	10	5	3	5	2	0	0	0	0	15	7	3
	PCGP Assumed	3	2	0	2	1	0	0	0	0	0	0	0	5	3	0
	Total	14	7	1	50	21	4	29	11	2	4	1	1	97	40	8

a/ For detailed NRF/High NRF habitat available for each NSO and its habitat type (nest patch, core area, home range), refer to "pre-action" suitable habitat acres in table Q-7 in appendix Q.

b/ FWS et al. (2008) consider core areas with 50 percent or greater suitable NRF habitat and home ranges with at least 40 percent suitable NRF habitat to be necessary to maintain NSO life history function. Habitat condition for each NSO affected is summarized from table Q-7 in appendix Q.

c/ Owl Status: 1) Known sites represent NSO activity sites provided by BLM and Forest Service biologists within the provincial analysis area; 2) Best Location sites represent pairs or resident singles documented by PCGP during surveys in 2007 and 2008 with no nest site/activity center located, and; 3) PCGP assumed sites respresents an area identifed by PCGP that may provide habitat for NSO pair.

Habitat Impact Categorization. PCGP used the Revised Conservation Framework (FWS 2014c) to guide categorizing effects to NSO habitat within home ranges into Habitat Impact Categories (Severe, High, Moderate, and Low categories), considering the amount and type of NSO Habitat removed, as well as where the NSO habitat is affected within an NSO home range, core area, and/or nest patch (see NSO habitat impact categorization for each NSO home range in appendix Z2). No NSO home range was provided a "Severe Impact" category because PCGP would not remove a known nest site or activity center or cause a NSO home range to become nonfunctional (loss of the territory).

The Habitat Impact Category assigned to each NSO home range (appendix Z2, table Q-7 in appendix Q) was then applied to acres of NSO habitat affected by the Pipeline project (summarized in table 3.3.4-12 from table Q-9 in appendix Q). Where home ranges overlapped, the higher impact category was considered. NSO habitat affected outside of NSO home ranges or within NSO home ranges that were provided a "No Impact Category" in appendix Z2 are considered areas of "Low Impact". Table NSO-3 in the introduction to appendix Z2 provides a summary of NSO habitat affected by Habitat Impact Category within and outside of interior forest.

<u>Known, Best Location, or PCGP Assumed Owl Sites</u>

There are 105 known, best location, or PCGP assumed owl home ranges that overlap the proposed Project. Of these, 8 NSO home ranges would not have habitat removed or modified because they are only intersected by existing roads to be used to access the right-of-way or are within 100 meters (328 feet) of habitat removal. The effects of habitat changes to the other 97 known, best location, or PCGP assumed NSO activity centers within the provincial analysis area as a result of the proposed action were evaluated at three scales: the nest patch, the core area, and the home range. The pre-action and post-action habitat conditions are provided in table Q-7 in appendix Q for each NSO home range; the amount of NSO habitat is specific to each habitat type in its entirety; acres provided for the home range include acres that also occur within the core area and nest patch, and acres included in the core area also include acres within the nest patch. Also, the amount of suitable NRF habitat removed within each owl habitat type does not consider overlap with neighboring owl sites.

Table 3.3.4-14 summarizes the number of NSO activity centers and acres of NSO habitat by physiographic province that would have NSO habitat removed from their nest patch, core area, and/or home range (summarized from table Q-7 in appendix Q). NSOs that are below the FWS recommended suitable habitat thresholds or are near those thresholds, either in the core area or home range, and would have suitable habitat removed could be impacted more by the Project than those above the recommended FWS suitable habitat thresholds (greater than 50 percent and/or greater than 40 percent available high NRF/NRF in their core area or home range, respectively). Table 3.3.4-14 tabulates the number of NSO home ranges/core areas below threshold, by physiographic province, that would have habitat removed and identifies the habitat use area (nest patch, core area, home range) for each owl group affected. Generally, removal of habitat from home ranges already below threshold represents less than 0.2 percent of available suitable habitat within the owls' home range (see table Q-7 in appendix Q). Since removal of habitat represents such a small percentage of available suitable NRF habitat (high NRF and NRF) within the core area and/or home range, removal of habitat within owl site core areas and home ranges should not adversely impact those NSO pairs or resident singles. However, habitat removed in closer proximity to the nest site or nest patch may have a greater impact to the NSO pair or resident single.

NSOs with suitable habitat availability within their core area and/or home range below the FWS recommended threshold of suitable habitat (less than 40 percent suitable habitat in home range/less than 50 percent suitable habitat in core area) could be considered adversely affected, especially if habitat is removed during the breeding season within 0.25 mile of an activity center. Habitat would be removed from 97 home ranges (including 40 core areas) within the four physiographic provinces crossed, of which 58 home NSO activity centers are below the recommended habitat thresholds in the core area and/or home range (table 3.3.4-3). Habitat removal within 0.25 mile of 13 NSO activity centers (9 known, 3 best location, and one PCGP assumed), of which nine are below recommended NRF threshold (core area and/or home range), would occur outside of the entire breeding period (between October 1 and February 28); disturbance associated with timber removal should not adversely affect spotted owls. If survey efforts prior to construction identify additional NSO reproductive activity within 0.25 mile, habitat removal would occur outside of the breeding season within 0.25 mile of those sites.

Eight nest patches would be crossed by the proposed action; suitable NRF habitat (high NRF, NRF, post-fire NRF (4008B)) would be removed from seven nest patches, of which five NSO home ranges have suitable habitat below the recommended NRF threshold in the core area and/or home range (see table 3.3.4-15). Timber would be removed outside the entire breeding season (after September 30 but before March 1) within each nest patch and 0.25 mile of that activity center; therefore, no direct impact to those NSOs is expected. Removal of habitat from the nest patches, however, could have an indirect, negative impact on those NSOs, especially in the four sites below recommended FWS NRF threshold for core area and/or home range. Three NSO sites represent pairs documented during 2008 survey efforts (best location sites); however, none of the sites had a nest tree identified. As a result, these nest patches represent a 300-meter radius around the "best location" as determined by the surveyors and local agency biologists based on detection date and time, individual owls (age and sex) present at particular detections, behavior of owls at a particular detection, and occasionally the habitat of a detection location. In discussions with various agency biologists (table S-1 in appendix S), it was thought that these sites were associated with other monitored pairs and that nesting at the "best location" sites was not occurring, but not enough information was available to be sure of this. Therefore, PCGP continues to include these best location NSO pair sites for analyzing worst case scenarios. If additional surveys conducted prior to construction and timber clearing indicate that these are not active, PCGP would revise the schedule accordingly. Table 3.3.4-15 provides details specific for each NSO nest patch crossed by the Pipeline. These details include the length of proposed Pipeline within each nest patch, how much suitable habitat would be removed, and the pre-action NRF habitat status of each NSO home range. Within the "additional description" column, information is provided about the effects to habitat in the nest patch and its location relative to existing disturbance and/or the creation of new edge in the nest patch.

Habitat Fragmentation

In addition to impact by surface disturbances, fragmentation of connected, contiguous habitat would occur. Fragmentation of NSO habitat is considered a cause for poor demographic performance, although the threat posed by fragmentation is still not fully understood (Courtney et al. 2004) and, as described below, NSO fecundity has also been positively correlated with forest edge, which is associated with fragmentation (Franklin et al. 2000; Olson et al. 2004; Hayward et al. 2011). FWS (2004b) indicated that habitat fragmentation was the "aggregate of effects of historical habitat loss, continuing habitat loss due to uncharacteristic wildfire, and continuing timber harvest, albeit at reduced levels," and that habitat fragmentation remained a threat in the northern part of the NSO's range but was reduced in the southern part. Courtney et al. (2004) indicated that typically a larger area is required for NSO home ranges in more fragmented habitats. Based on this assumption, the Provincial Home Range Radii provided in the 2012 Northern Spotted Owl Survey Protocol would be indicative of more fragmented habitats in the northern part of the NSO's range than in the southern portion (1.8-mile radius in the Washington Cascades, 2.2 miles on the Olympic Peninsula, 1.2 miles in the Oregon Cascades, 1.5 miles in the Oregon Coast Ranges, and 1.3 miles in Klamath Province).

TABLE 3.3.4-15

Summary of NSO Nest Patches Crossed by the Proposed Action

MSNO or Site ID	Site Name	Nest Patch Location (MP)	Landowner	Land Allocation	Available High NRF/NRF a/ (acres)	Length Crossed b/ (feet)	High NRF/NRF Affected c/		Pre-Action Habitat Condition d/	Additional Description
							Area (acres)	Percent of Available NRF		
Coast Range Physiographic Province										
2317B	Brewster Valley	35.90-39.41	Coos Bay BLM	LSR	69.63	2,068	4.77	6.9	<40% Home Range, >50% Core	Coos Bay BLM provided a newly documented alternate NSO activity center to PCGP in January 2014; this area had been surveyed in previous years by Coos Bay BLM and PCGP and spotted owl activity was identified in area, but no nest location or pair was documented (see Raymond et al. 2012; SBS 2008a); no detections in 2015 and 2016 (BLM 2017). Project would bisect late successional forest through the nest patch (generally High NRF) and western portion of the core area (generally NRF) of this site. This NSO nest patch is also located within MAMU Stand C3090 (see table 3.3.3-13).
Klamath Mountains Physiographic Province										
PCGP 064.2 (Best Location)	Kent Creek	62.70-65.66	Private	None	6.67	1,011	0	0	<40% Home Range, <50% Core Area	Project located in regenerating forest approximately 220 meters (720 feet) from best location site located within strip of mid-seral forest adjacent to regenerating forest; one road travels through the nest patch; within the home range, the right-of-way would create additional fragmentation and create edge within older regenerating interior forest as well as create new edge in forest already affected by existing edge.
PCGP 090.2 (Best Location)	Bland Mountain	88.86-91.61	Roseburg BLM	Matrix	25.20	2,035	2.66	10.6	<40% Home Range, <50% Core Area	Project located through middle of best location nest patch; best location site identifed adjacent to an existing access road that also bisects the nest patch; consultations within agencies (see table S-1 in appendix S) presume the nest site is not at this best location site; northern portion of the right-of-way traverses through old-growth, including interior forest and bisects the stand.
PCGP 095.3 (Best Location)	Milo South	93.82-97.04	Roseburg BLM	LSR	39.74	1,795	1.44	3.6	<40% Home Range, > 50% Core	Project bisects nest patch and traverses through late successional forest within the nest patch, some of which has been burned and left standing from the 2015 Stouts Creek fire; the remainder of project is in early regenerating forest or in recent clearcut affected by the 2015 Stouts Creek Fire.

TABLE 3.3.4-15

Summary of NSO Nest Patches Crossed by the Proposed Action

MSNO or Site ID	**Site Name**	**Nest Patch Location (MP)**	**Landowner**	**Land Allocation**	**Available High NRF/NRF a/ (acres)**	**Length Crossed b/ (feet)**	**High NRF/NRF Affected c/**		**Pre-Action Habitat Condition d/**	**Additional Description**
							Area (acres)	**Percent of Available NRF**		
4008B	Hatchet Creek South	99.23-101.98	Roseburg BLM	LSR CHU KLE1	40.49 (25.73)	432	0.58 (0.58)	1.4	> 40% Home Range, >50% Core Area	Project follows existing road on edge of nest patch (approximately 275 meters or 911 feet from activity center); removes regenerating forest on edge of road. Stouts Creek Fire burned most of this nest patch, core area, and home range; activity center provided by BLM occurs in post-fire NRF (previously NRF, standing dead trees) adjacent to fire-related clearcut.
West Cascades Physiographic Province										
1620 (PCGP 160.7)	Big Elk	160.13-162.77	Rogue River N.F.	LSR CHU KLE4	50.62	1,873	2.14	4.2	>40% Home Range, >50% Core Area	Project occurs approximately 133 meters (437 feet) from Forest-Service provided activity center generally along regenerating strip; one road traverses eastern portion of nest patch; the project would create new edge extending from regenerating strip to access road in old-growth forest.
0994	Cox Creek	161.81-164.49	Rogue River N.F.	LSR CHU KLE4	61.36	1,126	0.43	0.7	>40% Home Range, >50% Core Area	Project located approximately 200 meters (650 feet) from activity center; project traverses through regenerating forest patch adjacent to late successional forest; would bisect regenerating interior forest in the nest patch.
East Cascades Physiographic Province										
0023	Buck Lake	172.35-174.72	Winema N.F.	CHU ECS 1	19.71	129	0.18	0.9	<40% Home Range, <50% Core Area	Project located approximately 285 meters (930 feet) from activity center; project parallels or is adjacent to Clover Creek Road in old-growth forest adjacent to regenerating forest.

a/ Available high NRF and NRF in the nest patch; see table Q-7 in appendix Q.
b/ Length is provided for Pipeline across the nest patch.
c/ Acres of NRF (high NRF and NRF) affected within the nest patch, if NRF affected; see table Q-7 in appendix Q. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., "post-fire NRF").
d/ FWS et al. (2008) considers NSO home ranges and core areas to provide suitable NRF if the available NRF is greater than 50 percent (Core Area) or is greater than 40 percent (Home Range).

Effects of fragmentation on NSO demographic parameters are complex. Fragmentation includes increasing levels of edge between older forests and younger forest types and NSO fecundity has been positively related to forest edge (Franklin et al. 2000, Olson et al. 2004; Hayward et al. 2011). FWS (2011c) has suggested that spotted owls evolved with natural disturbance processes (e.g., fire) that caused mosaics of forest age classes, edges included. While the size of old-growth patches was strongly related to nest site selection by NSO, extent of clearcut forest and indices of forest fragmentation were not (Meyer et al. 1998). Prey abundance and higher nutritional status have been related to forest edges (Franklin et al. 2000; Franklin and Gutiérrez 2002; Hayward et al. 2011), particularly the abundance of woodrats (Ward et al. 1998), and possibly flying squirrels (Rosenberg and Anthony 1992). On one hand, reproductive output was found to be greater at sites with more edge between older forest (mature and old growth) and other adjacent vegetation, while reproductive output declined in areas with greater amounts of interior forest (Franklin et al. 2000). Alternatively, NSO survival increased with more interior forest and increased edge (Franklin et al. 2000). As reviewed by Franklin and Gutiérrez (2002), locations in which NSO have high reproduction and high survivorship (collectively, high fitness) represent a balance between the amounts of interior forest and edges with older forest.

Increased fragmentation can also lead to decreased survivorship of NSOs by facilitating predation by great horned owls, northern goshawks, and other avian predators (Franklin et al. 2000; FWS 2011c). Competition with barred owls may also be facilitated by forest fragmentation, although the levels of competition are not straight forward (Dugger et al. 2011). With increased fragmentation, NSO have been found to expand their home range size (Schilling et al. 2013) which could lead to increased predation (larger areas equating to more time spent away from nests) and possibly increased competition (Dugger et al. 2011).

The provincial analysis area has already been subjected to extensive fragmentation by past land uses including transportation corridors, timber harvest and associated activities (i.e., road construction), and urban development. The Project would cross approximately 192.1 miles of four physiographic provinces (MP 0.00 to MP 190.58), of which 109.5 miles occur within NSO home ranges (table Q9 in appendix Q). Within the four physiographic provinces crossed by the proposed action, the Pipeline would be located within or adjacent to existing utility or road corridors for approximately 77.8 miles (40.5 percent of proposed pipeline miles in the NSO range; see table Q-4 in appendix Q), thus minimizing fragmentation within approximately 78 home ranges and NSO habitat. Table Q-4 in appendix Q identifies the location of NSO home ranges (including nest patches and core areas) in relation to existing rights-of-ways and corridors. However, additional fragmentation would occur within high NRF and NRF habitat, as well as dispersal and capable habitat due to the proposed project. Depending on local conditions, fragmentation may not be an adverse impact to NSO home ranges if prey abundance ultimately increases, but on the other hand, fragmentation could contribute to increased predation of NSO nests which would be detrimental.

Habitat Edge. Other indirect effects from construction of the Pipeline are also expected within habitat adjacent to the construction right-of-way, including within interior forest within NSO high NRF, NRF, dispersal, and capable habitat. The conversion of large tracts of old-growth forest to small, isolated forest patches with large edge areas can create changes in microclimate, vegetation species, and predator-prey dynamics. In general, microclimates along edges differ from those in forest interiors. Two main physical factors affecting and creating an edge microclimate are sun and wind (Forman 1995; Chen et al. 1995; Harper et al. 2005). Compared to the forest interior, areas near edges receive more direct solar radiation during the day, lose more long-wave radiation at night, have lower humidity, and receive less short-wave radiation. Such a change in humidity could affect migration and dispersal of flying insects, including tree parasites such as the Douglas-fir beetle (Chen et al. 1995) and promote expansions of infestations which can affect interior forest stand structure and formations of gaps in formerly closed stands (Furniss 1979). Humidity, coupled with soil moisture and temperature, also affects decomposition of litter and coarse woody debris; rates of litter decomposition were higher near edges with a shallower organic layer (Chen et al. 1995). Decreased humidity may also affect distribution of fungi that are dependent on old-growth forest environments. Since the diets of northern flying squirrels mostly consist of fungi (Verts and Carraway 1998), changes in interior forest microclimates could affect local abundance of prey utilized by NSOs.

Another physical factor affecting edge is edge orientation (Chen et al. 1995). For example, the general orientation of the Pipeline is from northwest to southeast. Therefore, edge effects would be most pronounced on the southwest-facing edges and weakest along the northeast-facing edges (see discussion in Chen et al. 1995).

Harper et al. (2005) reported that the mean distance of edge influence could occur to approximately 328 feet (100 meters) and influence 1) tree mortality, damage, recruitment, growth rate, canopy foliage, understory foliage, and seedling mortality, 2) amounts of canopy trees, canopy cover, snags and logs, understory tree density, herbaceous cover, and shrub cover, and 3) stand composition metrics such as species, exotics, individual species, and species diversity. In other younger coniferous forests or mixed forests with deciduous species, edge effects compared to interior forests have been much less pronounced (Heithecker and Halpern 2007; Harper and MacDonald 2002).

Old-growth and late seral forests are important to NSOs as NRF habitat, but edges associated with those NRF habitats have been shown to increase NSO fitness in terms of fecundity and survivorship (see Franklin et al. 2000, Olson et al. 2004; Hayward et al. 2011). Annual survival of NSO was positively associated both with amounts of interior old-growth forest and with length of edge between those forests and other vegetation types. Conversely, reproduction was negatively associated with interior forest, but positively associated with edge between mature and old-growth conifer forest and other vegetation types (Franklin et al. 2000). Similarly, Olson et al. (2004) found that a mixture of mid- and late succesional with young forest and nonforested habitats appear best for NSO reproduction and survival. Roads create edges that affect interior forest biotic and microclimatological conditions, even narrow forest roads 40 feet wide (Baker and Dillon 2000). Edges created by roads with low levels of traffic disturbance have been shown to have a positive effect on NSO nutrition and fecundity (Hayward et al. 2011), perhaps due to abundance of prey (wood rats) along edges, including those associated with roads. Edges may affect interior old growth forests, but not necessarily adversely affect NSO fitness.

Interior Forest Habitat. Other indirect effects from construction of the Pipeline are also expected within habitat adjacent to the construction right-of-way, including within interior forest that the NSO relies on for nesting habitat. To determine other indirect effects to NSO habitat (high NRF, NRF, dispersal only, capable) from construction of the Pipeline outside of habitat removal within the right-of-way, PCGP assessed effects to NSO habitat within 100 meters (328 feet) of proposed habitat removal, including effects to interior forest. To determine which tracts of forested land (late regenerating, mid-seral, late successional, and old-growth) should be considered interior forest, existing edges, such as wide-surface roads, large rivers, early seral forest, and nonforested habitat were buffered by 100 meters (328 feet), and forested habitat included in the buffered area was identified as forested habitat currently affected by existing edge (FWS 2014c). Smaller roads with existing canopy cover were buffered by 50 feet per direction of FWS (2014c). Forested habitat (late regenerating to old-growth forest) that was not included in buffered "currently affected" area was classified as "interior forest" and incorporated into the interior forest model. This APDBA considers the indirect effects of the newly constructed right-of-way on NSO habitat within 100 meters (328 feet) of habitat removal, including interior forest.

Table 3.3.4-16 identifies the length of proposed Pipeline crossing through NSO habitat within and outside of interior forest habitat, and summarizes the acreage of NSO habitat directly removed and indirectly affected within 100 meters (328 feet) of the Pipeline project (habitat removal) by physiographic province, landowner, and NSO Groups (summarized from table Q-9 in appendix Q).

Approximately 13,294 acres of NSO habitat (1,307 acres of high NRF/NRF habitat, 4,147 acres of dispersal only habitat, and 5,690 acres of capable habitat) occur within 100 meters (328 feet) of habitat removal, of which 4,326 acres (or 32.5 percent of NSO habitat within 100 meters of habitat removal) of interior NSO habitat would be indirectly affected (1,586 acres of high NRF/NRF habitat, 1,388 acres of dispersal only habitat, and 1,352 acres of capable habitat; tabulated in table 3.3.4-16). The majority of NSO habitat indirectly affected occurs within NSO groups crossed by the Pipeline project: 8,393 acres (63.1 percent) of all NSO habitat within 100 meters (328 feet) of habitat removal, which includes 2,996 acres of interior NSO habitat and 5,397 acres of NSO habitat currently affected by existing edge. Table Q-9 in appendix Q identifies the acres of NSO habitat affected within 100 meters (328 feet) from habitat removal by physiographic province and general landowner, including effects within critical habitat and LSR. Effects to NSO habitat adjacent to the construction right-of-way would decrease as the forested area (a maximum of approximately 1,568 acres; see table 3.3.4-12) outside of the 30-foot maintenance corridor is replanted with trees and returned to early regenerating stands; however, this replanting would occur on certain federal lands and non-federal lands on a case-by-case basis and replanted trees may also be harvested from non-federal lands or federal lands slated for timber harvest (i.e., Matrix lands).

Based on analyses summarized in table 3.3.4-16, at least 38.5 miles of interior forest would experience fragmentation as a result of the proposed project, creating at least 77.0 miles (38.5 miles x 2) of additional edge in NSO habitat; this considers interior forest crossed by the proposed project within older regenerating forest to old-growth forest. Additional fragmentation of approximately 23.5 miles within forest currently affected by existing disturbance ("other" forest in table 3.3.4-16) could be affected since approximately 40.5 percent (77.8 miles) of the project within the range of NSO occurs within or is adjacent/parallels existing disturbance (see co-locate table Q-4 in appendix Q; 101.3 miles minus 77.8 miles = 23.5 miles), creating approximately 47.0 miles of additional edge in forest already affected by existing disturbance. In addition to NSO habitat crossed and affected within the NSO range, approximately 52.3 miles of non-capable habitat would be crossed with approximately 1,347 acres removed (see table Q-9 in appendix Q). Figure 3.3.4-6 provides an example of the area considered for acreage of other indirect effects to NSO habitat (100 meters from habitat removal), both within and outside of interior forest as presented in table 3.3.4-16.

TABLE 3.3.4-16

Other Indirect Effects from Construction of the Proposed Action to Northern Spotted Owl Habitat (High NRF, NRF, Dispersal Only, Capable), Including Interior Forest within and outside Northern Spotted Owl Groups by Landowner

			High NRF Habitat d/				NRF Habitat e/				Dispersal Only Habitat f/				Capable Habitat g/				Total Acres h/			
				Construction				Construction				Construction				Construction				Construction		
Landowner a/	General Location b/	Interior Forest c/	Miles Crossed	Removed i/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)
Coast Range Physiographic Province																						
Federal	NSO Groups	Interior	1.0	12.47	115.25	3.28	0.2	2.70	35.18	0.60	0.8	11.66	96.89	1.66	0.7	13.05	76.90	0.84	2.7	39.88	324.21	6.38
		Other	0.4	4.21	65.18	0.98	0.6	6.94	54.44	0.48	1.8	28.64	148.94	5.20	0.9	20.95	72.42	1.79	3.7	60.74	340.99	8.44
		Subtotal	1.4	16.68	180.43	4.26	0.8	9.64	89.62	1.08	2.6	40.31	245.83	6.85	1.6	34.00	149.32	2.63	6.4	100.62	665.20	14.82
	Outside NSO Groups	Interior	0.1	1.59	22.23	0.43	1.0	11.84	94.70	4.21	2.4	34.94	287.18	4.80	0.9	13.49	148.92	6.33	4.4	61.85	553.02	15.78
		Other	0.2	2.69	13.38	0.61	0.8	12.45	60.18	2.92	2.6	34.60	134.00	1.80	1.9	24.23	82.67	5.32	5.5	73.97	290.23	10.65
		Subtotal	0.3	4.29	35.61	1.04	1.8	24.29	154.88	7.14	5.0	69.53	421.17	6.60	2.8	37.72	231.59	11.65	9.9	135.83	843.26	26.43
	Federal Sub total	Interior	1.1	14.06	137.48	3.71	1.2	14.53	129.88	4.82	3.2	46.60	384.06	6.46	1.6	26.54	225.82	7.17	7.0	101.73	877.24	22.16
		Other	0.6	6.90	78.56	1.59	1.4	19.40	114.62	3.40	4.4	63.24	282.94	7.00	2.8	45.17	155.09	7.11	9.2	134.71	631.22	19.09
		Total	1.7	20.96	216.04	5.29	2.6	33.93	244.50	8.22	7.6	109.84	667.01	13.46	4.4	71.72	380.92	14.28	16.3	236.45	1,508.46	41.25
Non-Federal	NSO Groups	Interior	0.0	0.12	1.30		0.0	0.62	1.04		0.1	2.34	50.85	0.42	1.4	22.20	169.05	1.77	1.5	25.28	222.25	2.19
		Other	0.0	0.05	1.49	0.00	0.1	1.23	4.90	0.00	0.7	18.59	130.04	2.73	9.1	147.65	751.64	21.19	9.9	167.52	888.07	23.92
		Subtotal	0.0	0.17	2.79	0.00	0.1	1.85	5.94	0.00	0.8	20.93	180.89	3.15	10.5	169.85	920.69	22.96	11.4	192.80	1,110.31	26.11
	Outside NSO Groups	Interior		0.14	2.42	0.00	0.1	1.09	22.64	0.57	0.9	14.39	95.52	2.86	1.5	22.65	191.10	6.46	2.5	38.26	311.68	9.89
		Other	0.0	0.42	0.07	0.06	0.4	4.72	18.96	0.63	1.6	22.98	158.04	1.88	6.5	111.06	640.61	12.10	8.5	139.18	817.68	14.67
		Subtotal	0.0	0.56	2.49	0.07	0.4	5.81	41.60	1.20	2.5	37.36	253.56	4.74	8.1	133.71	831.71	18.56	11.0	177.45	1,129.36	24.56
	Non Federal Sub-total	Interior	0.0	0.26	3.72	0.00	0.1	1.71	23.68	0.57	1.0	16.73	146.37	3.28	2.9	44.85	360.15	8.23	4.1	63.54	533.93	12.08
		Other	0.0	0.47	1.56	0.06	0.5	5.95	23.86	0.63	2.2	41.56	288.08	4.61	15.7	258.71	1,392.25	33.28	18.4	306.70	1,705.75	38.59
		Total	0.1	0.73	5.28	0.07	0.5	7.66	47.54	1.20	3.3	58.29	434.45	7.89	18.6	303.56	1,752.40	41.52	22.5	370.24	2,239.68	50.67
Coast Range Total	NSO Groups	Interior	1.0	12.59	116.55	3.28	0.3	3.31	36.22	0.60	0.8	14.01	147.74	2.08	2.1	35.25	245.95	2.61	4.2	65.16	546.46	8.58
		Other	0.4	4.26	66.67	0.98	0.7	8.17	59.34	0.48	2.5	47.23	278.99	7.93	10.0	168.60	824.06	22.98	13.6	228.26	1,229.06	32.36
		Subtotal	1.4	16.85	183.22	4.26	0.9	11.49	95.56	1.08	3.3	61.24	426.73	10.01	12.1	203.85	1,070.01	25.59	17.8	293.42	1,775.52	40.94
	Outside NSO Groups	Interior	0.1	1.73	24.65	0.43	1.0	12.93	117.34	4.78	3.3	49.32	382.70	7.66	2.5	36.14	340.03	12.79	6.9	100.11	864.71	25.67
		Other	0.3	3.12	13.45	0.67	1.2	17.17	79.14	3.55	4.1	57.58	292.04	3.68	8.4	135.29	723.28	17.42	14.0	213.16	1,107.91	25.32
		Subtotal	0.4	4.85	38.10	1.10	2.2	30.10	196.48	8.33	7.5	106.90	674.73	11.34	10.9	171.43	1,063.31	30.21	20.9	313.27	1,972.62	50.99
	Coast Range Total	Interior	1.1	14.32	141.20	3.71	1.3	16.24	153.56	5.39	4.2	63.33	530.43	9.74	4.5	71.39	585.98	15.41	11.1	165.27	1,411.17	34.24
		Other	0.7	7.38	80.12	1.65	1.9	25.34	138.48	4.02	6.6	104.81	571.03	11.61	18.5	303.89	1,547.34	40.40	27.6	441.41	2,336.97	57.68
		Total	1.8	21.70	221.32	5.36	3.1	41.58	292.04	9.41	10.8	168.14	1,101.46	21.35	23.0	375.28	2,133.32	55.80	38.7	606.69	3,748.14	91.92
Klamath Mountains Physiographic Province																						
Federal	NSO Groups	Interior	3.8	49.81	397.25	26.18	3.1 (0.9)	44.28 (12.84)	293.60 (111.28)	45.18 (26.82)	1.9	29.78	220.64	15.91	1.2	17.16	122.40	5.56	9.9	141.03	1,033.89	92.83
		Other	2.5	33.97	275.15	16.93	3.3 (0.9)	56.12 (12.75)	241.71 (42.68)	23.85 (10.43)	2.0	38.85	268.78	7.82	4.4	65.87	283.43	17.76	12.2	194.81	1,069.06	66.35
		Subtotal	6.3	83.78	672.40	43.12	6.4 (1.8)	100.40 (25.59)	535.31 (153.95)	69.02 (37.25)	3.9	68.63	489.42	23.72	5.6	83.03	405.83	23.32	22.1	335.84	2,102.95	159.18
	Outside NSO Groups	Interior	0.2	3.08	19.39		0.2	3.42	20.73	0.11	0.7	8.62	45.81	1.64		0.00	0.01		1.2	15.13	85.93	1.75
		Other	0.1	1.33	10.94	0.10	0.2	3.84	18.17	1.02	0.3	3.18	19.80	0.01		0.00	2.56	0.00	0.6	8.35	51.47	1.13
		Subtotal	0.3	4.41	30.33	0.10	0.5	7.26	38.90	1.14	0.9	11.80	65.60	1.65		0.00	2.57	0.00	1.7	23.48	137.40	2.89
	Federal Sub total	Interior	4.0	52.90	416.64	26.18	3.3 (0.9)	47.70 (12.84)	314.33 (111.28)	45.29 (26.82)	2.6	38.40	266.45	17.55	1.2	17.16	122.41	5.56	11.1	156.16	1,119.82	94.58
		Other	2.6	35.30	286.09	17.03	3.6 (0.9)	59.97 (12.75)	259.87 (42.68)	24.87 (10.43)	2.2	42.03	288.57	7.83	4.4	65.87	285.99	17.76	12.8	203.16	1,120.53	67.49
		Total	6.6	88.20	702.73	43.22	6.9 (1.8)	107.66 (25.59)	574.20 (153.95(	70.16 (37.25)	4.8	80.43	555.02	25.37	5.6	83.03	408.39	23.32	23.9	359.32	2,240.35	162.07
Non-Federal	NSO Groups	Interior	0.0	0.43	18.96	1.25	0.2	3.67	30.32	1.33	2.4	33.73	284.08	44.86	1.4	19.15	130.04	16.02	4.0	56.99	463.41	63.45
		Other	0.2	6.17	56.36	7.78	1.1	20.00 (0.12)	130.52 (0.92)	16.15 (0.11)	5.4	77.03	459.51	42.54	8.6	140.95	857.42	110.14	15.4	244.15	1,503.81	176.62
		Subtotal	0.2	6.60	75.32	9.03	1.3	23.67 (0.12)	160.85 (0.92)	17.48 (0.11)	7.8	110.76	743.60	87.40	10.0	160.10	987.45	126.16	19.4	301.13	1,967.22	240.07
	Outside NSO Groups	Interior	0.0	0.18	2.06		0.0	0.73	6.77	0.18	1.6	20.88	141.89	8.12	0.0	0.04	16.25	0.30	1.7	21.83	166.97	8.60
		Other	0.0	0.76	7.54	0.42	0.2	6.57	19.33	0.86	4.8	69.51	502.89	9.53	1.4	17.38	175.75	12.13	6.4	94.22	705.51	22.94

TABLE 3.3.4-16

Other Indirect Effects from Construction of the Proposed Action to Northern Spotted Owl Habitat (High NRF, NRF, Dispersal Only, Capable), Including Interior Forest within and outside Northern Spotted Owl Groups by Landowner

Landowner a/	General Location b/	Interior Forest c/	High NRF Habitat d/ Miles Crossed	High NRF Habitat d/ Construction Removed i/ (acres)	High NRF Habitat d/ Construction Indirect j/ (acres)	High NRF Habitat d/ Construction UCSA k/ (acres)	NRF Habitat e/ Miles Crossed	NRF Habitat e/ Construction Removed i/ (acres)	NRF Habitat e/ Construction Indirect j/ (acres)	NRF Habitat e/ Construction UCSA k/ (acres)	Dispersal Only Habitat f/ Miles Crossed	Dispersal Only Habitat f/ Construction Removed i/ (acres)	Dispersal Only Habitat f/ Construction Indirect j/ (acres)	Dispersal Only Habitat f/ Construction UCSA k/ (acres)	Capable Habitat g/ Miles Crossed	Capable Habitat g/ Construction Removed i/ (acres)	Capable Habitat g/ Construction Indirect j/ (acres)	Capable Habitat g/ Construction UCSA k/ (acres)	Total Acres h/ Miles Crossed	Total Acres h/ Construction Removed i/ (acres)	Total Acres h/ Construction Indirect j/ (acres)	Total Acres h/ Construction UCSA k/ (acres)
		Subtotal	0.0	0.94	9.60	0.42	0.3	7.30	26.10	1.04	6.5	90.39	644.77	17.65	1.4	17.42	192.00	12.43	8.1	116.06	872.48	31.54
	Non Federal Sub-total	Interior	0.0	0.61	21.02	1.25	0.3	4.40	37.10	1.51	4.0	54.62	425.97	52.98	1.4	19.19	146.29	16.32	5.7	78.82	630.37	72.05
		Other	0.2	6.93	63.90	8.20	1.3	26.57 (0.12)	149.85 (0.92)	17.01 (0.11)	10.2	146.54	962.40	52.07	10.0	158.33	1,033.17	122.27	21.8	338.37	2,209.32	199.56
		Total	0.3	7.54	84.92	9.45	1.6	30.97 (0.12)	186.95 (0.92)	18.52 (0.11)	14.3	201.16	1,388.37	105.05	11.4	177.53	1,179.46	138.59	27.5	417.19	2,839.70	271.61
Klamath Mountains Total	NSO Groups	Interior	3.8	50.24	416.22	27.43	3.3 (0.9)	47.95 (12.84)	323.92 (111.28)	46.51 (26.82)	4.3	63.51	504.72	60.77	2.6	36.32	252.44	21.58	13.9	198.02	1,497.30	156.28
		Other	2.7	40.14	331.51	24.71	4.4 (0.9)	76.13 (12.88)	372.23 (43.60)	40.00 (10.53)	7.4	115.88	728.29	50.36	13.1	206.81	1,140.84	127.90	27.6	438.96	2,572.87	242.97
		Subtotal	6.5	90.38	747.72	52.14	7.7 (1.8)	124.07 (25.72)	696.15 (154.87)	86.51 (37.36)	11.7	179.39	1,233.02	111.12	15.7	243.13	1,393.28	149.48	41.6	636.98	4,070.17	399.25
	Outside NSO Groups	Interior	0.2	3.26	21.45	0.00	0.3	4.15	27.50	0.29	2.3	29.51	187.69	9.76	0.0	0.04	16.26	0.30	2.8	36.96	252.90	10.35
		Other	0.1	2.09	18.48	0.52	0.5	10.41	37.49	1.88	5.1	72.68	522.68	9.54	1.4	17.39	178.31	12.13	7.0	102.57	756.98	24.07
		Subtotal	0.3	5.35	39.93	0.52	0.8	14.56	65.00	2.17	7.4	102.19	710.38	19.30	1.4	17.43	194.57	12.43	9.8	139.53	1,009.87	34.42
	Klamath Mountains Total	Interior	4.0	53.50	437.66	27.43	3.6 (0.9)	52.10 (12.84)	351.42 (111.28)	46.80 (26.82)	6.6	93.02	692.42	70.53	2.6	36.36	268.69	21.88	16.8	234.98	1,750.20	166.64
		Other	2.8	42.23	349.99	25.24	4.9 (0.9)	86.53 (12.88)	409.73 (43.60)	41.88 (10.53)	12.5	188.56	1,250.97	59.90	14.4	224.20	1,319.16	140.03	34.6	541.53	3,329.85	267.04
		Total	6.8	95.74	787.66	52.67	8.5 (1.8)	138.63 (25.72)	761.15 (154.87)	88.68 (37.36)	19.1	281.58	1,943.39	130.42	17.0	260.56	1,587.85	161.91	51.4	776.51	5,080.05	433.68
West Cascades Physiographic Province																						
Federal	NSO Groups	Interior	1.2	14.93	125.29	7.59	2.4	35.03	229.69	14.11	0.9	12.24	76.36	3.67	2.1	26.82	221.26	12.54	6.6	89.01	652.60	37.91
		Other	1.4	15.74	126.25	5.39	3.1	39.20	265.36	12.89	1.7	23.79	148.26	4.58	4.2	76.01	327.89	11.46	10.5	154.74	867.76	34.32
		Subtotal	2.6	30.67	251.54	12.98	5.5	74.23	495.06	27.00	2.6	36.02	224.62	8.25	6.3	102.83	549.15	24.00	17.1	243.75	1,520.37	72.23
	Outside NSO Groups	Interior			1.61		0.3	4.45	25.94				0.96				0.43		0.3	4.45	28.94	0.00
		Other			0.62		2.1	31.31	208.57	5.51	0.3	4.55	38.52	1.19	0.1	1.00	10.63	0.68	2.5	36.86	258.33	7.38
		Subtotal			2.23		2.4	35.76	234.50	5.51	0.3	4.55	39.48	1.19	0.1	1.00	11.05	0.68	2.8	41.31	287.27	7.38
	Federal Sub total	Interior	1.2	14.93	126.90	7.59	2.7	39.47	255.63	14.11	0.9	12.24	77.32	3.67	2.1	26.82	221.68	12.54	6.9	93.46	681.54	37.91
		Other	1.4	15.74	126.87	5.39	5.2	70.51	473.93	18.40	2.1	28.33	186.78	5.77	4.3	77.01	338.52	12.14	13.0	191.60	1,126.10	41.71
		Total	2.6	30.67	253.77	12.98	7.9	109.99	729.56	32.51	3.0	40.57	264.10	9.44	6.5	103.83	560.20	24.68	19.9	285.06	1,807.63	79.61
Non-Federal	NSO Groups	Interior	0.1	0.90	2.88	0.45	0.2	3.30	23.22	1.80	0.2	5.05	38.26	0.08	0.6	11.39	66.21	0.56	1.2	20.64	130.57	2.89
		Other		0.01	3.15		0.2	3.38	33.46	0.79	2.0	30.12	183.58	3.21	2.4	37.38	184.78	7.95	4.7	70.88	404.97	11.96
		Subtotal	0.1	0.91	6.03	0.45	0.4	6.68	56.68	2.59	2.2	35.17	221.84	3.29	3.1	48.77	250.98	8.51	5.9	91.52	535.53	14.84
	Outside NSO Groups	Interior			1.62	0.02	0.1	0.99	6.29	0.51	0.0	0.14	5.74	0.03	0.2	3.21	21.66	0.54	0.3	4.34	35.32	1.10
		Other			0.88		0.9	12.19	52.30	1.90	3.4	49.79	335.10	2.01	0.7	7.68	145.52	1.07	5.0	69.66	533.79	4.98
		Subtotal			2.49	0.02	1.0	13.18	58.59	2.41	3.4	49.94	340.85	2.04	0.9	10.89	167.18	1.61	5.3	74.00	569.11	6.08
	Non Federal Sub-total	Interior	0.1	0.90	4.50	0.47	0.3	4.29	29.51	2.30	0.2	5.19	44.00	0.12	0.8	14.60	87.87	1.10	1.5	24.98	165.88	3.99
		Other	0.0	0.01	4.02	0.00	1.1	15.56	85.76	2.69	5.4	79.91	518.68	5.22	3.1	45.06	330.29	9.03	9.6	140.54	938.76	16.94
		Total	0.1	0.91	8.52	0.47	1.4	19.86	115.27	5.00	5.6	85.10	562.69	5.33	4.0	59.66	418.16	10.13	11.1	165.53	1,104.64	20.93
West Cascades Total	NSO Groups	Interior	1.3	15.83	128.17	8.04	2.6	38.33	252.92	15.91	1.1	17.29	114.62	3.75	2.7	38.21	287.46	13.10	7.8	109.65	783.17	40.79
		Other	1.4	15.75	129.40	5.39	3.3	42.58	298.82	13.68	3.7	53.90	331.84	7.79	6.7	113.39	512.67	19.42	15.1	225.62	1,272.73	46.28
		Subtotal	2.7	31.57	257.56	13.43	5.9	80.90	551.74	29.59	4.9	71.19	446.46	11.54	9.4	151.60	800.13	32.52	22.9	335.27	2,055.90	87.08
	Outside NSO Groups	Interior	0.0	0.00	3.23	0.02	0.4	5.44	32.23	0.51	0.0	0.14	6.71	0.03	0.2	3.21	22.09	0.54	0.6	8.79	64.25	1.10
		Other	0.0	0.00	1.49	0.00	3.0	43.50	260.87	7.41	3.7	54.34	373.62	3.20	0.8	8.68	156.14	1.75	7.5	106.52	792.12	12.36
		Subtotal	0.0	0.00	4.72	0.02	3.4	48.94	293.09	7.92	3.7	54.48	380.33	3.23	1.0	11.89	178.23	2.29	8.1	115.31	856.38	13.47
	West Cascades Total	Interior	1.3	15.83	131.40	8.06	3.0	43.77	285.14	16.41	1.1	17.43	121.33	3.79	2.9	41.42	309.55	13.64	8.4	118.44	847.42	41.90
		Other	1.4	15.75	130.89	5.39	6.3	86.08	559.69	21.09	7.5	108.25	705.47	10.99	7.5	122.07	668.81	21.17	22.6	332.14	2,064.86	58.64
		Total	2.7	31.57	262.29	13.46	9.3	129.84	844.83	37.51	8.6	125.68	826.79	14.77	10.4	163.49	978.36	34.81	31.0	450.58	2,912.28	100.54
East Cascades Physiographic Province																						
Federal	NSO Groups	Interior	0.1	1.53	14.20	0.79	0.6	6.99	47.46	2.59	0.1	1.38	13.95	0.58	0.6	7.30	70.00	2.77	1.5	17.20	145.61	6.74

TABLE 3.3.4-16

Other Indirect Effects from Construction of the Proposed Action to Northern Spotted Owl Habitat (High NRF, NRF, Dispersal Only, Capable), Including Interior Forest within and outside Northern Spotted Owl Groups by Landowner

			High NRF Habitat d/				NRF Habitat e/				Dispersal Only Habitat f/				Capable Habitat g/				Total Acres h/			
				Construction				Construction				Construction				Construction				Construction		
Landowner a/	General Location b/	Interior Forest c/	Miles Crossed	Removed i/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed j/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)
		Other	0.3	3.31	10.56		1.4	18.54	94.32	1.15	0.1	1.40	21.17	0.34	1.5	20.82	100.19	1.69	3.3	44.07	226.23	3.18
		Subtotal	0.4	4.84	24.75	0.79	2.0	25.53	141.78	3.75	0.2	2.78	35.12	0.92	2.1	28.12	170.19	4.47	4.8	61.27	371.85	9.92
	Outside NSO Groups	Interior	0.0	0.21	2.29	0.02	0.1	1.38	21.33	0.59		0.02	2.19				8.12		0.1	1.61	33.93	0.61
		Other	0.1	1.50	6.62	0.24	1.7	22.76	88.76	1.35	0.3	5.02	32.29	0.17	0.0	0.32	23.69	0.01	2.2	29.60	151.36	1.77
		Subtotal	0.1	1.71	8.92	0.26	1.8	24.14	110.08	1.93	0.3	5.04	34.48	0.17	0.0	0.32	31.80	0.01	2.3	31.21	185.29	2.38
	Federal Sub total	Interior	0.1	1.74	16.49	0.81	0.7	8.36	68.79	3.18	0.1	1.41	16.15	0.58	0.6	7.30	78.12	2.77	1.6	18.81	179.54	7.35
		Other	0.4	4.81	17.18	0.24	3.1	41.30	183.07	2.50	0.4	6.42	53.46	0.50	1.5	21.14	123.88	1.70	5.5	73.67	377.59	4.95
		Total	0.6	6.55	33.67	1.05	3.8	49.67	251.86	5.68	0.6	7.83	69.61	1.09	2.2	28.43	201.99	4.48	7.1	92.48	557.14	12.30
Non-Federal	NSO Groups	Interior					0.0	0.06	0.28	0.02			5.12		0.1	1.47	18.35	0.78	0.1	1.52	23.76	0.81
		Other					0.0	0.29	0.77		0.1	2.09	8.01		1.3	18.96	87.30	1.50	1.4	21.35	96.08	1.50
		Subtotal					0.0	0.35	1.06	0.02	0.1	2.09	13.13		1.4	20.43	105.65	2.28	1.6	22.87	119.84	2.30
	Outside NSO Groups	Interior							0.03		0.3	4.16	22.58		0.2	3.18	91.77		0.5	7.34	114.38	0.00
		Other					0.1	1.15	1.12	0.01	4.0	51.33	170.06		5.3	67.40	590.89	0.38	9.4	119.88	762.07	0.39
		Subtotal					0.1	1.15	1.15	0.01	4.3	55.49	192.63		5.5	70.58	682.66	0.38	10.0	127.23	876.44	0.39
	Non Federal Sub-total	Interior	0.0	0.00	0.00	0.00	0.0	0.06	0.32	0.02	0.3	4.16	27.70	0.00	0.4	4.65	110.12	0.78	0.7	8.86	138.14	0.81
		Other	0.0	0.00	0.00	0.00	0.1	1.44	1.89	0.01	4.2	53.43	178.07	0.00	6.6	86.36	678.19	1.88	10.8	141.23	858.15	1.88
		Total	0.0	0.00	0.00	0.00	0.1	1.49	2.21	0.03	4.5	57.59	205.77	0.00	6.9	91.01	788.31	2.66	11.5	150.10	996.28	2.69
East Cascades Total	NSO Groups	Interior	0.1	1.53	14.20	0.79	0.6	7.04	47.75	2.61	0.1	1.38	19.08	0.58	0.8	8.77	88.35	3.56	1.6	18.72	169.37	7.55
		Other	0.3	3.31	10.56	0.00	1.5	18.83	95.09	1.15	0.2	3.49	29.18	0.34	2.8	39.78	187.49	3.19	4.7	65.42	322.31	4.68
		Subtotal	0.4	4.84	24.75	0.79	2.0	25.88	142.84	3.77	0.4	4.88	48.26	0.92	3.5	48.55	275.84	6.75	6.3	84.14	491.69	12.23
	Outside NSO Groups	Interior	0.0	0.21	2.29	0.02	0.1	1.38	21.36	0.59	0.3	4.18	24.77	0.00	0.2	3.18	99.88	0.00	0.7	8.95	148.31	0.61
		Other	0.1	1.50	6.62	0.24	1.8	23.91	89.87	1.36	4.4	56.36	202.35	0.17	5.3	67.72	614.58	0.39	11.6	149.49	913.43	2.16
		Subtotal	0.1	1.71	8.92	0.26	1.9	25.29	111.23	1.94	4.7	60.54	227.12	0.17	5.6	70.90	714.46	0.39	12.3	158.44	1,061.73	2.76
	East Cascades Total	Interior	0.1	1.74	16.49	0.81	0.7	8.42	69.11	3.20	0.4	5.57	43.85	0.58	1.0	11.95	188.23	3.56	2.3	27.67	317.68	8.15
		Other	0.4	4.81	17.18	0.24	3.3	42.74	184.96	2.51	4.6	59.85	231.53	0.50	8.1	107.50	802.07	3.58	16.4	214.90	1,235.74	6.84
		Total	0.6	6.55	33.67	1.05	4.0	51.16	254.07	5.71	5.0	65.42	275.37	1.09	9.1	119.45	990.30	7.14	18.6	242.58	1,553.42	14.99
Entire Northern Spotted Owl Range																						
Federal	NSO Groups	Interior	6.1	78.73	651.99	37.84	6.3 (0.9)	88.99 (12.84)	605.93 (111.28)	62.48 (26.82)	3.7	55.07	407.84	21.82	4.6	64.33	490.56	21.71	20.7	287.12	2,156.32	143.86
		Other	4.6	57.23	477.14	23.30	8.5 (0.9)	120.81 (12.75)	655.83 (42.68)	38.36 (10.43)	5.6	92.68	587.15	17.92	11.1	183.64	783.93	32.71	29.8	454.36	2,504.05	112.30
		Subtotal	10.7	135.96	1,129.13	61.15	14.7 (1.8)	209.80 (25.59)	1,261.76 (153.95)	100.85 (37.25)	9.3	147.74	994.99	39.74	15.7	247.98	1,274.49	54.42	50.4	741.48	4,660.37	256.16
	Outside NSO Groups	Interior	0.4	4.88	45.53	0.45	1.6	21.08	162.69	4.91	3.1	43.58	336.14	6.44	0.9	13.49	157.47	6.33	5.9	83.04	701.82	18.13
		Other	0.4	5.53	31.56	0.95	4.9	70.37	375.67	10.81	3.5	47.34	224.61	3.17	2.0	25.55	119.55	6.01	10.8	148.79	751.39	20.94
		Subtotal	0.8	10.41	77.09	1.40	6.4	91.45	538.36	15.72	6.6	90.93	560.74	9.61	2.9	39.04	277.02	12.34	16.7	231.82	1,453.21	39.07
	Federal Sub total	Interior	6.4	83.62	697.51	38.29	7.9 (0.9)	110.07 (12.84)	768.62 (111.28)	67.40 (26.82)	6.8	98.65	743.98	28.26	5.5	77.82	648.03	28.04	26.6	370.16	2,858.14	161.99
		Other	5.1	62.76	508.70	24.26	13.3 (0.9)	191.18 (12.75)	1,031.50 (42.68)	49.17 (10.43)	9.1	140.02	811.76	21.09	13.1	209.19	903.48	38.72	40.6	603.15	3,255.44	133.24
		Total	11.5	146.38	1,206.22	62.55	21.2 (1.8)	301.25 (25.59)	1,800.13 (153.95)	116.57 (37.25)	15.9	238.67	1,555.74	49.35	18.6	287.02	1,551.50	66.76	67.2	973.30	6,113.58	295.23
Non-Federal	NSO Groups	Interior	0.1	1.45	23.14	1.70	0.5	7.64	54.87	3.15	2.7	41.13	378.32	45.36	3.5	54.21	383.64	19.14	6.9	104.43	839.98	69.34
		Other	0.2	6.23	60.99	7.78	1.4	24.90 (0.12)	169.65 (0.92)	16.95 (0.11)	8.2	127.83	781.15	48.49	21.5	344.94	1,881.13	140.78	31.4	503.89	2,892.93	214.00
		Subtotal	0.4	7.68	84.14	9.48	1.9	32.54 (0.12)	224.53 (0.92)	20.10 (0.11)	10.9	168.95	1,159.47	93.84	25.0	399.15	2,264.78	159.92	38.3	608.33	3,732.91	283.34
	Outside NSO Groups	Interior	0.0	0.32	6.09	0.03	0.2	2.81	35.74	1.25	2.9	39.57	265.73	11.01	2.0	29.08	320.78	7.30	5.0	71.78	628.35	19.59
		Other	0.0	1.19	8.49	0.48	1.6	24.62	91.70	3.39	13.8	193.62	1,166.08	13.42	13.9	203.53	1,552.77	25.68	29.3	422.95	2,819.05	42.97
		Subtotal	0.0	1.50	14.59	0.51	1.8	27.43	127.44	4.65	16.7	233.19	1,431.81	24.43	15.8	232.61	1,873.55	32.98	34.4	494.73	3,447.39	62.57
	Non Federal Sub-total	Interior	0.1	1.77	29.24	1.72	0.7	10.46	90.61	4.41	5.6	80.70	644.05	56.37	5.5	83.29	704.43	26.43	11.9	176.21	1,468.33	88.94

TABLE 3.3.4-16

Other Indirect Effects from Construction of the Proposed Action to Northern Spotted Owl Habitat (High NRF, NRF, Dispersal Only, Capable), Including Interior Forest within and outside Northern Spotted Owl Groups by Landowner

			High NRF Habitat d/				NRF Habitat e/				Dispersal Only Habitat f/				Capable Habitat g/				Total Acres h/			
				Construction				Construction				Construction				Construction				Construction		
Landowner a/	General Location b/	Interior Forest c/	Miles Crossed	Removed i/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed i/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed i/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed i/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)	Miles Crossed	Removed i/ (acres)	Indirect j/ (acres)	UCSA k/ (acres)
		Other	0.3	7.41	69.48	8.27	3.0	49.52 (0.12)	261.36 (0.92)	20.34 (0.11)	22.1	321.44	1,947.23	61.90	35.4	548.47	3,433.90	166.46	60.7	926.85	5,711.98	256.97
		Total	0.4	9.18	98.72	9.99	3.7	59.98 (0.12)	351.97 (0.92)	24.74 (0.11)	27.6	402.14	2,591.28	118.27	40.9	631.76	4,138.33	192.89	72.6	1,103.06	7,180.30	345.90
Total NSO Range	NSO Groups	Interior	6.2	80.19	675.13	39.54	6.8 (0.9)	96.63 (12.84)	660.81 (111.28)	65.64 (26.82)	6.4	96.19	786.16	67.18	8.1	118.55	874.20	40.85	27.5	391.55	2,996.30	213.20
		Other	4.9	63.46	538.13	31.08	9.9 (0.9)	145.71 (12.88)	825.48 (43.60)	55.31 (10.53)	13.8	220.50	1,368.30	66.41	32.6	528.59	2,665.06	173.49	61.1	958.25	5,396.98	326.29
		Subtotal	11.1	143.64	1,213.26	70.62	16.6 (1.8)	242.34 (25.72)	1,486.29 (154.87)	120.94 (37.36)	20.2	316.70	2,154.46	133.59	40.7	647.13	3,539.26	214.34	88.7	1,349.81	8,393.27	539.49
	Outside NSO Groups	Interior	0.4	5.20	51.62	0.47	1.8	23.89	198.43	6.17	5.9	83.15	601.87	17.46	2.9	42.57	478.25	13.63	11.0	154.81	1,330.17	37.73
		Other	0.5	6.71	40.05	1.44	6.5	94.99	467.38	14.20	17.3	240.96	1,390.69	16.58	15.9	229.08	1,672.32	31.69	40.1	571.74	3,570.44	63.91
		Subtotal	0.8	11.91	91.67	1.91	8.2	118.88	665.80	20.37	23.3	324.11	1,992.56	34.04	18.8	271.65	2,150.57	45.32	51.1	726.55	4,900.61	101.64
	NSO RangeTotal	**Interior**	**6.6**	**85.39**	**726.75**	**40.01**	**8.6 (0.9)**	**120.52 (12.84)**	**859.23 (111.28)**	**71.80 (26.82)**	**12.3**	**179.35**	**1,388.03**	**84.63**	**11.1**	**161.11**	**1,352.45**	**54.48**	**38.5**	**546.37**	**4,326.47**	**250.93**
		Other	**5.3**	**70.17**	**578.18**	**32.52**	**16.3 (0.9)**	**240.70 (12.88)**	**1,292.86 (43.60)**	**69.51 (10.53)**	**31.2**	**461.46**	**2,758.99**	**82.99**	**48.4**	**757.66**	**4,337.38**	**205.18**	**101.3**	**1,529.99**	**8,967.41**	**390.20**
		Total	**11.9**	**155.55**	**1,304.94**	**72.54**	**24.9 (1.8)**	**361.22 (25.72)**	**2,152.09 (154.87)**	**141.31 (37.36)**	**43.5**	**640.81**	**4,147.02**	**167.63**	**59.5**	**918.78**	**5,689.84**	**259.66**	**139.8**	**2,076.36**	**13,293.88**	**641.13**

a/ Landowner is summarized by Federal (BLM Districts and National Forests) and Non-Federal (Private, State, Corps of Engineers, and Bureau of Indian Affairs Land).
b/ General Location identifies areas within Northern Spotted Owl Groups (areas within NSO home ranges; see table Q-10 in appendix Q) and areas outside of NSO groups (outside of NSO home ranges).
c/ Interior Forest: forested habitat farther than 100 meters (328 feet) from existing disturbance (i.e., wide-surface roads, existing corridors) or adjacent land use/vegetation type (i.e., agriculture, non-forest, early regenerating forest), and/or farther than 50 feet from smaller roads with existing canopy cover (FWS 2014c). Other Forest Type includes forested habitat that is currently affected by existing disturbance or adjacent land use/vegetation types within 100 meters (328 feet) of disturbance
d/ High NRF (FWS 2014c): forested habitat that is characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species.
e/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., "post-fire NRF").
f/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.
g/ Capable Habitat (FWS 2014c): habitat that is forested or could become forested (i.e., recently harvested timberlands) that do not provide dispersal or NRF characteristics.
h/ Total habitat only considers forested NSO habitat within the range of the NSO; non-capable habitat affected in range of NSO is included in table Q-9 in appendix Q.
i/ Project components considered in calculation of habitat "Removed": construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, rock source/disposal sites, and hydrostatic test locations.
j/ Other Indirect Effects considers habitat within 100 meters (328 feet) of habitat removal as measured from the edge of habitat removal/edge of right-of-way/TEWA.
k/ Acres identified as UCSAs have been incorporated into the 100-meter other indirect effects. UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.

Summarized from table Q-9 in appendix Q.

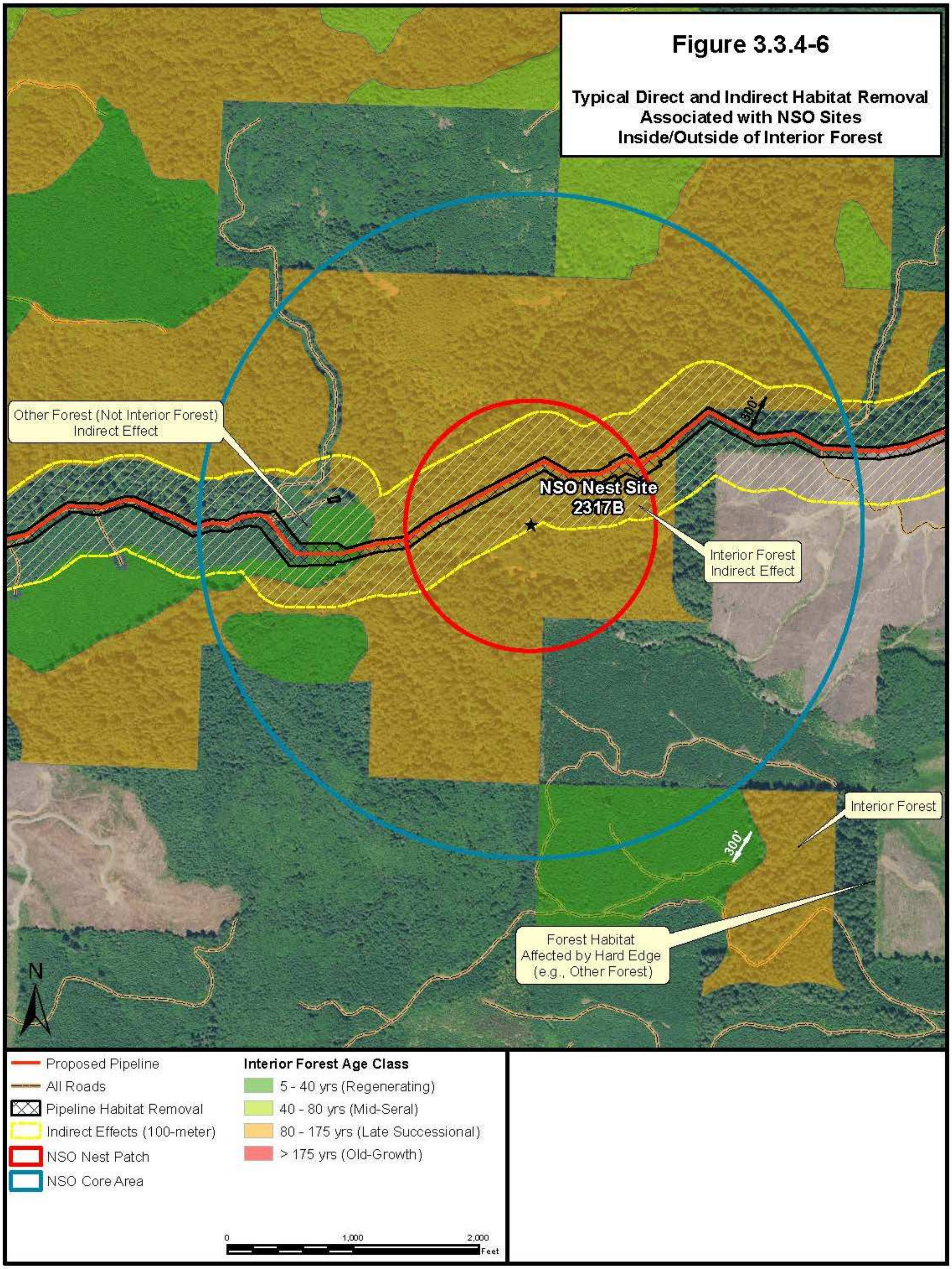


Figure 3.3.4-6
Typical Direct and Indirect Habitat Removal Associated with NSO Sites Inside/Outside of Interior Forest
Other Forest (Not Interior Forest) Indirect Effect
NSO Nest Site 2317B
Interior Forest Indirect Effect
300'
300'
Interior Forest
Forest Habitat Affected by Hard Edge (e.g., Other Forest)
N
Proposed Pipeline
All Roads
Pipeline Habitat Removal
Indirect Effects (100-meter)
NSO Nest Patch
NSO Core Area
Interior Forest Age Class
5 - 40 yrs (Regenerating)
40 - 80 yrs (Mid-Seral)
80 - 175 yrs (Late Successional)
> 175 yrs (Old-Growth)
0
1,000
2,000
Feet

Predation

Few empirical studies exist to confirm that habitat fragmentation contributes to increased levels of predation on NSOs (Courtney et al. 2004). Great horned owls are known and potential predators of NSO (Johnson 1992; Gutiérrez et al. 1995), particularly in the context of effects of forest fragmentation on predation response, since great horned owls appear closely associated with forest openings and clearcuts (Johnson 1992; Laidig and Dobkin 1995). However, after a review of available evidence including predation by great horned owls, Courtney et al. (2004, pages 8–30) conclude: "there appears to be no reasonable basis for regarding an effect of fragmentation on predation levels as a primary or significant effect on NSO populations. Absent new information, the indirect effects of fragmentation through predation remains an untested hypothesis." Also, the FWS (2004b) 5-Year Review stated that indirect evidence from demography studies suggests that predation, particularly by great horned owls, is not a major influence on NSO populations as was originally considered in the 1990 ESA listing.

Table 3.3.4-13 and table 3.3.4-14 indicate that 97 home ranges would be affected from habitat removal by the proposed action and may experience additional fragmentation with construction of the Pipeline, including 40 core areas and eight nest patches (see also table Q-7 in appendix Q). It is possible that the 58 NSO sites that are below recommended threshold of available NRF habitat in the core area and/or home range (table 3.3.4-14), and/or would have interior forest habitat removed (86 NSO sites; see table 3.3.4-17) could experience a greater increase of predation, as great horned owls have been identified throughout the provincial analysis area during surveys in 2007, 2008, and 2015. Table 3.3.4-17 summarizes the number of home ranges that would have interior forest habitat (late regenerating forest to old growth) removed (86 home ranges) by the proposed action and could experience additional fragmentation.

Competition

Since the listing of the NSO, FWS (2011 and 2017) has identified competition from intrusive, non-native barred owls as a foremost threat, second only to habitat loss, contributing to the demise of NSO in the Pacific Northwest. Early investigations of interactions between spotted owls and barred owls indicated the barred owls should be considered a threat to spotted owls (Kelley et al. 2003). Gutierrez et al. (2007) documented multiple competitive advantages of barred owls (a niche generalist) over spotted owls (a niche specialist). Specifically, barred owls have a wider range in cluch size than NSO and have smaller home ranges than NSO, indicative of their use of wider variety of habitats and more varied diet than NSO (Gutierrez et al. 2007). Barred owls may reduce the density of prey species utilized by NSO (resource competition) and have been documented being aggressive to NSO with consequences to NSO social interactions (eg., reduced NSO vocalizations in vicinity of barred owls), potentially interference competition (Gutierrez et al. 2007). Similar observations have been reported by Hamer et al. (2007) , Sovern et al. (2014), and Dugger et al. (2016) which similarly conclude that NSO are being displaced, perhaps forced to extinction, by barred owls (Yackulic et al. 2012; Kroll et al. 2016; Dugger et al. 2016).

TABLE 3.3.4-17

Number of NSO Home Ranges by Physiographic Province that
Could Experience Additional Fragmentation (i.e., interior forest removed by Project) a/

Suitable NRF Habitat Condition within Owl Home Ranges b/	Owl Status c/	Physiographic Province				
		Coast Range	Klamath Mountains	West Cascades	East Cascades	Total
Home Range >40%	Known	1	15	10	3	29
AND	Best Location	–	3	4	–	7
Core Area >50%	PCGP Assumed	–	–	–	–	0
(*Above Threshold)*	*Total*	*1*	*18*	*14*	*3*	36
Home Range >40%	Known	–	4	2	–	6
AND	Best Location	–	–	–	–	–
Core Area <50%	PCGP Assumed	–	1	–	–	1
(*Below Threshold)*	*Total*	*0*	*5*	*2*	*0*	7
Home Range <40%	Known	2	6	1	–	9
AND	Best Location	–	1	–	–	1
Core Area >50%	PCGP Assumed	–	–	–	–	–
(*Below Threshold)*	*Total*	*2*	*7*	*1*	*0*	10
Home Range <40%	Known	7	10	4	1	22
AND	Best Location	–	6	1	–	7
Core Area <50%	PCGP Assumed	3	1	–	–	4
(*Below Threshold)*	*Total*	*8*	*17*	*5*	*1*	33
Overall Total	**Known**	**10**	**35**	**17**	**4**	**66**
	Best Location	–	**10**	**5**	**0**	**15**
	PCGP Assumed	**3**	**2**	–	**0**	**5**
	Total	**13**	**47**	**22**	**4**	**86**

a/ Interior Forest: forested habitat farther than 100 meters (328 feet) from existing disturbance (i.e., wide-surface roads, existing corridors) or adjacent land use/vegetation type (i.e., agriculture, non-forest, early regenerating forest), and/or farther than 50 feet from smaller roads with existing canopy cover (FWS 2014c). Other Forest Type includes forested habitat that is currently affected by existing disturbance or adjacent land use/vegetation types within 100 meters (328 feet) of disturbance. Interior forest includes habitat from late regenerating to old-growth.

b/ FWS et al. (2008) consider core areas with 50 percent or greater suitable NRF habitat and home ranges with at least 40 percent suitable NRF habitat to be necessary to maintain NSO life history function. For detailed NRF/High NRF habitat available for each individual NSO and its habitat type (nest patch, core area, home range), refer to "pre-action" suitable habitat acres in table Q-7 in appendix Q.

c/ Owl Status: 1) Known sites represent NSO activity sites provided by BLM and Forest Service biologists within the provincial analysis area; 2) Best Location sites represent pairs or resident singles documented by PCGP during surveys in 2007 and 2008 with no nest site/activity center located, and; 3) PCGP assumed sites considered for analysis in this APDBA in areas that may provide nesting habitat for NSO.

Barred owls are known to use a wide variety of forest types, including early successional habitats, and some authors have suggested that timber harvest activities may favor the species. For instance, fragmentation of forest habitat may have created favorable conditions for survival and reproduction of barred owls. By contrast, NSOs appear to be more generally associated with old growth forest or forests that are structurally complex (Courtney et al. 2004). Therefore, timber harvest may have increased overlap of the two species' preferred and potential habitats which has led to increased competition.

Gutierrez et al. (2007) and Buchanan et al. (2007) considered management and research options that lead to understanding how to deal with the invasion of barred owls and competition with northern spotted owls. Both authors concluded that removal experiments (whether through translocations or lethal elimination) would provide the strongest approach for understanding barred owl effects on NSO populations. Results of removal experiments would lead to control of barred owls through some portion of NSO's range (Gutierrez et al. 2007; Buchanan et al. 2007). To this end, a pilot study was initiated in California in 2009 with an appropriate before-after/control-treatment study design with the treatment as lethal removal of barred owls (Dugger et al. 2016). Demographic paramenters including annual rate of population change (λ), fecundity, and survival of NSO in the the California study were compared to other locations across the species' range. The study found that the only instances of an increasing population rate of change for NSO in all locations occurred after lethal control of barred owls began in 2009 in the pilot study; barred owl removal combined with habitat conservation may slow or reverse declines of NSO populations on a local scale (Dugger et al. 2016). Other experimental study areas were initiated in Washington and Oregon in 2015 and scheduled to continue for five years (Wiens et al. 2017). Preliminary results indicate abiguous responses of spotted owls to removing barred owls during the first study year (Wiens et al. 2017).

Barred owls are present within the Pipeline project NSO provincial analysis area. Although survey design was not intended to locate or census barred owls or barred owl pairs, during surveys for NSOs conducted along the Pipeline route, barred owls were documented 79 times in 14 survey areas in 2007 (4 pairs), 115 times in 14 survey areas in 2008 (8 pairs), and 19 times in eight survey areas (3 pairs) in 2015 along the Blue Ridge portion of the Proposed Route – none within NSO home ranges. Of the barred owls documented, 46 were dispersed along the right-of-way within the Coast Range, 56 were documented within Klamath Mountains mostly along the eastern portion of the province, 21 were located in West Cascades, and 25 documented sites were located within the western portion of East Cascades province (see table 3.3.4-18). Davis (2007), provided an analysis using partial data (only 36 barred owl sites) provided in December 2007, that demonstrated barred owls located along the Pipeline occurred more often in marginal NSO suitable nesting, roosting, and foraging habitat than the NSOs documented during 2007 surveys, which were generally located within the more contiguous and suitable NRF habitat within the Pipeline project area. Reduction of suitable NSO habitat may have an effect on the NSO by providing a competitive advantage for barred owls, since some research and preliminary modeling by Davis (2007) has demonstrated that barred owls have a wider breadth of habitat use than the NSO and are more often located in marginal habitat than the NSO (Courtney et al. 2004).

TABLE 3.3.4-18

Summary of Barred Owls Detected During 2007, 2008, and 2015 Northern Spotted Owl Surveys

Barred Owls Documented in 2007/2008	Coast Range		Klamath Mountains		West Cascades		East Cascades		Total NSO Range	
	# NSO Home Ranges	# of Barred Owls	# NSO Home Ranges	# of Barred Owls	# NSO Home Ranges	# of Barred Owls	# NSO Home Ranges	# of Barred Owls	# NSO Home Ranges	# of Barred Owls
Total Documented outside of NSO Home Ranges	N/A	26	N/A	2	N/A	0	N/A	25	N/A	57
Total Documented within < 40 percent suitable NRF Habitat	7	26	8	17	1	5	1	7	17	55
Total Documented within > 40 percent suitable NRF Habitat	1	2	14	45	10	21	4	22	29	90
Total Documented within NSO Home Ranges	8	27	22	56	11	21	5	25	46	129

Table Q-7 in appendix Q provides a subscript "B" where barred owls were documented in the home range, core area, and/or nest patch.

Barred owls were documented in 46 of the 105 NSO home ranges during 2007/2008 PCGP survey efforts (see superscript "B" next to Site Name in table Q-7 in appendix Q), including five nest patches (two known NSO – UMP 0408 and UMP 0401), and three best location sites (PCGP 084.6, PCGP 097.6, and PCGP 165.8). A summary of barred owl locations for each physiographic province in respect to NSO home ranges and available suitable NRF habitat (high NRF and NRF) greater or less than 40 percent is provided in table 3.3.4-18. Habitat below the 40 percent available NRF habitat in the home range could be considered "marginal" habitat. Approximately 37 percent of the barred owls documented within NSO home ranges were documented in "marginal" habitat, and 63 percent of barred owls documented were located in NSO home ranges with more suitable NRF available (see >40 percent suitable NRF Habitat; table 3.3.4-18).

It is conceivable that construction of the Pipeline may serve as a corridor for barred owl expansion, but this is speculative. Review of available literature did not indicate that linear transportation corridors increase barred owl presence/expansion. If inclusion of these additional barred owl locations indicates that barred owls do occur more often in marginal NSO habitat than NSOs do, then focus should be on currently suitable NSO habitat (see Habitat Condition 1 in table Q-7 in appendix Q) being brought below FWS recommended thresholds by the proposed Project, and areas currently below thresholds that the proposed Project could further impact (see Habitat Conditions 2 through 4 in table Q-8 in appendix Q). With the exception of the Coast Range physiographic province, the majority of barred owls documented were located within NSO home ranges with adequate amounts of suitable habitat (greater than 40 percent suitable habitat available in home range and greater than 50 percent suitable habitat available in the core area).

Wildfire

Research demonstrates that NSO populations have declined following wildfires in previously occupied habitats. Clark (2007) documented declining occupancy in burned habitats with lower survival rates of spotted owls that had recently emigrated out of the burned habitat. Also, home ranges of spotted owls that persisted in the burned habitat were characterized by larger amounts of hard edges compared to home ranges outsited of burned areas (Clark 2007). However, Roberts et al. (2011) found that densities of California spotted owls inhabiting low to moderate serverity burned habitat were similar to densities in unburned habitat. California spotted owls foraged in high-severity burned forest more than in all other burn categories; high-severity burned forests had greater amounts of snags and higher shrub and herbaceous cover, which would likely be associated with increased abundance or accessibility of prey (Bond et al., 2009). High severity fires likely eliminate protective cover or perch sites for spotted owls compared to unburned or low to moderate severity fire that support intact forest canopy with protective cover or high prey availability (Eyes 2014). Additional observations from these studies indicate that activities associated with post-fire timber salvage also pose a significant risk to displacing spotted owls from otherwise occupied habitats.

In 2015, a large stand-replacing fire (Stouts Creek fire) occurred within the range of the northern spotted owl, burning approximately 26,452 acres on Roseburg BLM District, Umpqua National Forest, and some private landowners in the Days Creek-South Umpqua River and Elk Creek watersheds (Northwest Interagency Coordination Center 2015). On private lands, burned trees were harvested following the fire, whereas on federal lands, burned trees were left to stand. Approximately 10.7 miles (227 acres) of the Pipeline crosses the area burned by the Stouts Creek fire, generally from MP 95.5 through MP 108.8, including approximately 1.6 miles (57.36 acres) of burned forest that was harvested on private lands, and approximately 2.3 miles (73.95 acres) of burned forest that is still standing on federal lands: 1.57 miles (57.15 acres) in old-growth forest/late successional forest, 0.42 mile (13.16 acres) in mid-seral forest, and 0.24 mile (3.64 acres) in clearcut/regenerating forest (refer to table 3.3-9 or section 3.3.2.1 in PCGP's Resource Report 3). Additionally, Umpqua National Forest created a fire break within the fire boundary on 0.7 mile 7.0 acres) that would be crossed by the Pipeline project from approximately MP 106.8 to MP 108.8. In one location crossed by the Pipeline, the Stouts Creek fire burned an area that was dominated by contiguous, late successional/old-growth forest that provided highly suitable NRF habitat for the northern spotted owl. As noted earlier, areas where NRF habitat had been burned but was still standing has been identified as "post-fire NRF" in this APDBA: approximately 4,404 acres of "post-fire NRF" are present in the NSO provincial analysis area (approximately eight percent of all NRF in the analysis area; see table 3.3.4-5), of which 25.72 acres of "post-fire NRF" would be removed (seven percent of all NRF removed) by the Pipeline (table 3.3.4-13). Based on available sources, the Pipeline effects to "post-fire NRF" would primarily be to foraging habitat with some capability of providing suitable roosting structures.

Twenty NSO home ranges included for analysis within this APDBA had habitat affected by the Stouts Creek fire to varying degrees, and at least three activity centers analyzed in this APDBA either occur within habitat completely burned to the ground, within harvested habitat, or within post-fire NRF (see table Q7 in appendix Q and appendix Z2). Based on the information presented above, it is likely that NSOs using habitat affected by the Stouts Creek fire are still present, but utilize habitat in a different capacity. For example, "post-fire NRF" is likely used for foraging and possibly roosting, but may no longer provide the characteristics necessary for nesting. However, without additional surveys and per direction by the FWS, PCGP conservatively assumes NSO activity centers and supporting home ranges affected by Stouts Creek fire still support active NSO nests.

Construction of the Pipeline could increase the risk of fires; however, the exact risk of fires (either natural, or caused by human and/or pipeline activities) will be dependent on local conditions. Certain activities associated with construction and operation of the Pipeline, such as mowing, welding, and parking on dry, tall grass could increase the risk of starting wildland fires, especially if these activities occur within the fire season. PCGP has prepared a Fire Prevention and Suppression Plan (see Appendix K to the POD) in consultation with the BLM and Forest Service to reduce the risk of wildland and structural fires. This Plan is consistent with National Forest policies, BLM policies, current practices and plans. Conversely, the Pipeline right-of-way could also reduce or minimize the spread of fires by creating a fire break in forested areas similar to fire breaks constructed by Umpqua National Forest to control the 2015 Stouts Creek Fire along the Proposed Route between MPs 106.8 and 108.8.

Effects to Prey

Cleared areas would remove suitable habitat for arboreal prey species (flying squirrels, red tree voles), but could improve habitat for non-arboreal species (western red backed voles, deer mice) adjacent to cleared areas. NSOs seldom venture far into non-forested areas to hunt, although it is likely they would cross the Pipeline corridor at night to forage on both sides of the right-of-way. Edges can be areas of high prey availability, but also increased vulnerability (Zabel et al. 1995). Prey animals could be more exposed in the disturbed area and may move away from edges in the short term. Some minor changes in prey availability could occur as cover is disturbed and animals redistribute within the understory. Conversion of habitat on the right-of-way to non-forested conditions might attract other predators such as other owls, hawks, and mammals. This could increase competition for NSOs in the cleared right-of-way, but the exposure of prey could also benefit NSOs.

Some disturbance of habitat could improve forage conditions in remaining stands on both sides of the Pipeline corridor by bringing more light and resources into the stands and by stimulating forbs, shrubs, and other prey food. Once the initial impact of disturbance recovers (6 months to two years), the understory habitat conditions for prey food would increase over the next few years, until shrubs and residual trees create canopy and become more contiguous with adjacent forest stands.

Critical Habitat

The FWS (1992c) determined that the physical and biological habitat features (PCEs) that are essential for the recovery of the spotted owl are forested lands used or potentially used for nesting, roosting, foraging, and dispersal; more specificity to PCEs was provided in the revised critical habitat in 2012. Based on more current information on the life history, biology, and ecology of the species, the revised PCEs are summarized as (FWS 2012d): PCE-1 – forested habitat in a variety of seral stages that support the NSO across its geographical range; PCE-2 – forested habitat that provides for nesting and roosting, and could provide for foraging; PCE-3 – habitat the provides for foraging; and PCE4 – habitat that supports dispersal of spotted owls, which could provide NRF habitat, but could also be composed of other forest types between larger blocks of NRF habitat. Within this analysis, PCEs would be similar to NSO habitat mapped for the Pipeline: PCE-1 would be all forested habitat affected within the range of the NSO; PCE-2 would include high NRF as well as NRF; PCE-3 would include NRF and high NRF; and PCE-4 would include dispersal only habitat, as well as high NRF and NRF that provide dispersal habitat for the NSO.

Activities that disturb or remove the PCEs within designated CHUs might adversely modify NSO critical habitat. These activities may include effects to early-, mid-, or late-seral forests that support the NSO across its geographical range; nesting and roosting habitat; foraging habitat; and habitat to support the transience and colonization phases of dispersal (FWS 2012d).

In contrast, activities that would have no effect on critical habitat's PCEs almost certainly would not adversely modify the critical habitat. However, even though an action may not adversely modify critical habitat, it may still affect NSOs (e.g., through disturbance) and therefore be subject to consultation under the jeopardy standard of Section 7 of the ESA (FWS 1992c).

Approximately 37.4 miles of the proposed route cross seven designated critical habitat sub-units ORC-6, KLE-1, KLE-2, KLE-3, KLE-4, KLE-5, and ECS-1 (see table 3.3.4-19 and table Q11 in appendix Q), within which 35.0 miles cross NSO habitat. Table Q-11 in appendix Q provides the amount of high NRF, NRF, dispersal only, capable, and non-capable habitat within each CHU by landowner that would be removed and modified, which is summarized below in table 3.3.4-19. With the exception of CHU ECS-1, all CHU subunits occur completely within NSO home ranges, and partially within LSRs and Forest Service unmapped LSRs (see table Q-9 in appendix Q for overlap of CHUs with LSRs and unmapped LSRs).

Overall, the Project would remove 488.72 acres of NSO habitat from CHUs (86.43 acres of high NRF, 160.70 acres of NRF (includes 24.56 acres of "post-fire NRF"), 72.65 acres of dispersal only habitat, and 168.94 acres of capable habitat), of which 128.28 acres (25.07 acres in high NRF, 43.34 acres in NRF (includes 6.27 acres of "post-fire NRF"), 17.85 acres in dispersal only habitat, and 42.03 acres in capable) would be kept within an early seral state within the 30-foot operational corridor for the life of the Project (see table 3.3.4-19). Over the long term, 360.44 acres of NSO habitat within CHUs would return to their original state (outside of the 30-foot operational corridor) and begin functioning as dispersal only habitat (see table 3.3.4-19). Table Q-11 in appendix Q provides further detail of CHUs affected, including landowner by physiographic province within or outside of interior forest and identifies the acres of non-capable habitat affected within designated CHUs.

In addition to direct loss of critical habitat and effects to PCEs due to losses that were summarized in table 3.3.4-19, the Project's other indirect effects within 100 meters of habitat removal to NSO that were discussed above (fragmentation, edge, and interior forest) indirectly affect designated critical habitats and PCEs. Edge effects and effects to interior forest may induce changes to forest characteristics later in time and would indirectly affect PCEs. In particular, creation of isolated forest patches with large edge areas can create changes in microclimate, vegetation species, and predator-prey dynamics. Two main physical factors affecting and creating an edge microclimate are sun and wind (Forman 1995; Chen et al. 1995; Harper et al. 2005), which could directly affect characteristics of nesting trees and decrease canopy cover and stand conditions for future NSO habitat components described in the PCEs.

Interior forest has been defined as 100 meters (328 feet) from any existing edge of a contiguous forested stand (50 feet from canopy covered roads), including edges created by adjacent regenerating stands approximately 10 to 20 years old (see Harper et al. 2005). However effects of strong wind may extend beyond that distance (see Chen et al. 1995). Such effects are dependent on local conditions such as orientation of an edge; the magnitudes of change in humidity with distance from an edge are most extreme with south-facing edges, compared to east- and west-facing edges (see Figure 6 in Chen et al. 1995). Such effects may induce changes within PCEs. Long-term effects on edges and interiors of NSO habitat are less well defined and over time, edge effects would diminish as edges evolve from "hard" to "soft" (see for example, Peery and Henry 2010).

There is considerable overlap of forest habitat, including interior forest that is within NSO CHUs and within LSRs. Long-term effects from removal of forest within critical habitat and LSRs by the proposed project would be expected. Most indirect effects to forested habitat within 100 meters (328 feet) of habitat removal occur in NSO habitat that has been previously affected by existing edge, such as roads, waterbodies, early seral forest, and nonforested habitat (see "other interior forest" in table 3.3.4-16). Table Q-9 in appendix Q provides a more detailed tabulation of indirect effects to interior forest habitat within NSO critical habitat units and NWFP LSRs/unmapped LSRs by landowner and physiographic province.

Late-Successional Reserves

Additional habitat protection for the NSO was established when LSRs were adopted in the NWFP, and continued to be included in BLM 2016 RMPs. Within the provincial analysis area, NSO CHUs overlap with LSRs to varying degrees (see table Q-9 in appendix Q). The Pipeline crosses 27.6 miles of LSRs, including two allocated LSRs on Forest Service land: RO 223 (Umpqua National Forest) and RO 227 (Rogue River National Forest); see table 3.3.4-20.

TABLE 3.3.4-19

Summary of High NRF, NRF, Dispersal Only, and Capable Habitat by Physiographic Province Impacted within Northern Spotted Owl Critical Habitat Units during Construction and Operation of the Proposed Action

			High NRFb/				NRFc/				Dispersal Only d/				Capable e/				Total Acres f/			
			Construction			Operation	Construction			Operation	Construction			Operation	Construction			Operation	Construction			Operation
Critical Habitat Subunit	General Location a/	Miles of NSO Habitat Crossed	Removed g/	Other Indirect Effects h/	UCSA i/	30-foot Corridor j/	Removed g/	Other Indirect Effects h/	UCSA i/	30-foot Corridor j/	Removed g/	Other Indirect Effects h/	UCSA i/	30-foot Corridor j/	Removed g/	Other Indirect Effects h/	UCSA i/	30-foot Corridor j/	Removed g/	Other Indirect Effects h/	UCSA i/	30-foot Corridor j/
ORC 6	NSO Groups	1.7	2.66	24.52		0.72	5.84	37.93		1.77	9.68	54.60	1.26	2.76	3.84	24.14	0.06	0.74	22.03	141.19	1.33	5.99
	Outside NSO Groups																		0.00	0.00	0.00	0.00
	Total	1.7	2.66	24.52		0.72	5.84	37.93		1.77	9.68	54.60	1.26	2.76	3.84	24.14	0.06	0.74	22.03	141.19	1.33	5.99
KLE 1	NSO Groups	10.1	41.36	321.02	9.82	11.37	36.88 (12.63)	186.76 (70.01)	24.21 (22.15)	9.06 (3.40)	30.37	275.56	7.59	6.04	35.22	134.60	0.07	10.19	143.83	917.95	41.70	36.66
	Outside NSO Groups																		0.00	0.00	0.00	0.00
	Total	10.1	41.36	321.02	9.82	11.37	36.88 (12.63)	186.76 (70.01)	24.21 (22.15)	9.06 (3.40)	30.37	275.56	7.59	6.04	35.22	134.60	0.07	10.19	143.83	917.95	41.70	36.66
KLE 2	NSO Groups	2.2	6.24	61.16	0.67	1.82	16.83 (11.93)	94.47 (77.27)	15.11 (15.10)	4.07 (2.87)	7.02	22.05	1.52	1.36	1.50	19.95	2.23	0.79	31.59	197.63	19.52	8.04
	Outside NSO Groups																		0.00	0.00	0.00	0.00
	Total	2.2	6.24	61.16	0.67	1.82	16.83 (11.93)	94.47 (77.27)	15.11 (15.10)	4.07 (2.87)	7.02	22.05	1.52	1.36	1.50	19.95	2.23	0.79	31.59	197.63	19.52	8.04
KLE 3	NSO Groups	0.2	0.07	2.20			3.31	17.68		0.69									3.38	19.87	0.00	0.69
	Outside NSO Groups																		0.00	0.00	0.00	0.00
	Total	0.2	0.07	2.20			3.31	17.68		0.69									3.38	19.87	0.00	0.69
KLE 4	NSO Groups	13.1	30.76	248.55	13.20	9.51	48.07	329.87	22.79	13.84	17.17	108.37	7.33	5.46	80.11	436.74	24.08	18.42	176.11	1,123.53	67.41	47.23
	Outside NSO Groups																		0.00	0.00	0.00	0.00
	Total	13.1	30.76	248.55	13.20	9.51	48.07	329.87	22.79	13.84	17.17	108.37	7.33	5.46	80.11	436.74	24.08	18.42	176.11	1,123.53	67.41	47.23
KLE 5	NSO Groups	1.6	0.09	1.07	0.02	0.04	2.80	28.28	0.86	0.86	0.57	2.70		0.14	22.08	100.90	0.44	4.69	25.53	132.94	1.31	5.72
	Outside NSO Groups																		0.00	0.00	0.00	0.00
	Total	1.6	0.09	1.07	0.02	0.04	2.80	28.28	0.86	0.86	0.57	2.70		0.14	22.08	100.90	0.44	4.69	25.53	132.94	1.31	5.72
ECS 1	NSO Groups	4.3	3.55	16.39	0.13	1.11	24.07	128.54	3.27	6.79	2.78	35.12	0.92	0.84	25.86	156.43	3.95	7.08	56.26	336.49	8.27	15.82
	Outside NSO Groups	2.2	1.71	8.92	0.26	0.49	22.90	99.55	1.93	6.26	5.06	33.38	0.17	1.24	0.32	31.84	0.01	0.12	29.98	173.69	2.38	8.12
	Total	6.6	5.26	25.30	0.39	1.60	46.97	228.09	5.21	13.05	7.84	68.50	1.09	2.08	26.18	188.28	3.96	7.20	86.24	510.17	10.64	23.94
Total CHU	**NSO Groups**	**33.3**	**84.72**	**674.91**	**23.84**	**24.57**	**137.80 (24.56)**	**823.52 (147.28)**	**66.25 (37.250**	**37.08 (6.27)**	**67.59**	**498.41**	**18.62**	**16.61**	**168.62**	**872.77**	**30.83**	**41.91**	**458.73**	**2,869.61**	**139.53**	**120.16**
	Outside NSO Groups	**2.2**	**1.71**	**8.92**	**0.26**	**0.49**	**22.90**	**99.55**	**1.93**	**6.26**	**5.06**	**33.38**	**0.17**	**1.24**	**0.32**	**31.84**	**0.01**	**0.12**	**29.98**	**173.69**	**2.38**	**8.12**
	Total	**35.5**	**86.43**	**683.82**	**24.10**	**25.07**	**160.70 (24.56)**	**923.07 (147.28)**	**68.18 (37.25**	**43.34 (6.27)**	**72.65**	**531.79**	**18.79**	**17.85**	**168.94**	**904.61**	**30.84**	**42.03**	**488.72**	**3,043.29**	**141.91**	**128.28**

a/ General Location identifies areas within Northern Spotted Owl Groups (areas within NSO home ranges; see table Q-10 in appendix Q) and areas outside of NSO groups (outside of NSO home ranges).
b/ High NRF (FWS 2014c): forested habitat that is characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species.
c/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., "post-fire NRF").
d/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.
e/ Capable Habitat (FWS 2014c): habitat that is forested or could become forested (i.e., recently harvested timberlands) that do not provide dispersal or NRF characteristics.
f/ Total habitat only considers forested NSO habitat within NSO critical habitat units; non-capable habitat affected NSO critical habitats is included in table Q-11 in appendix Q.
g/ Project components considered in calculation of habitat "Removed": construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, and hydrostatic test locations.
h/ UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.
i/ Other Indirect Effects considers habitat within 100 meters (328 feet) of habitat removal as measured from the edge of habitat removal/edge of right-of-way/TEWA.
j/ 30-foot Maintenance Corridor would be kept in a shrub/sapling state for the life of the project; all other habitat outside of the 30-foot maintenance corridor would be revegetated, except for those habitats on non-federal or matrix/harvest-based lands where there is less certainty that replanting would occur or be maintained on the landscape.

Note: More detailed information on BLM Districts and National Forests impacted in critical habitat units is located in table Q-11 in appendix Q. Overlap with LSRs can be reviewed in table Q-9 in appendix Q.

TABLE 3.3.4-20

Summary of High NRF, NRF, Dispersal, and Capable NSO Habitat Impacted within NWFP Late-Successional Reserves (LSRs) and Unmapped LSRs, Including Area within and outside of NSO Groups

			High NRF Habitat b/				NRF Habitat c/				Dispersal Only Habitat d/				Capable Habitat e/				Total Acres f/			
			Construction			Operation	Construction			Operation	Construction			Operation	Construction			Operation	Construction			Operation
Landuse Allocation	General Location a/	Miles NSO Habitat Crossed	Removed g/ (acres)	Other Indirect h/ (acres)	UCSA i/ (acres)	30-foot Corridor j/	Removed g/ (acres)	Other Indirect h/ (acres)	UCSA i/ (acres)	30-foot Corridor j/	Removed g/ (acres)	Other Indirect h/ (acres)	UCSA i/ (acres)	30-foot Corridor j/	Removed g/ (acres)	Other Indirect h/ (acres)	UCSA i/ (acres)	30-foot Corridor j/	Removed g/ (acres)	Other Indirect h/ (acres)	UCSA i/ (acres)	30-foot Corridor j/
BLM-Managed Lands Late Successional Reserves																						
LSRs	NSO Groups	3.8	15.75	174.62	4.48	4.95	8.21	78.77	1.54	2.55	9.26	63.55	3.74	2.36	22.83	70.53	1.95	4.20	56.05	387.47	11.71	14.06
	Outside NSO Groups	6.3	3.79	32.11	0.88	1.09	18.03	106.15	6.30	4.77	42.23	236.36	5.99	10.79	24.15	115.57	6.60	6.30	88.21	490.19	19.76	22.95
	Subtotal	10.1	19.54	206.74	5.35	6.04	26.25	184.92	7.83	7.32	51.49	299.90	9.74	13.14	46.98	186.10	8.55	10.50	144.26	877.66	31.47	37.00
Forest Service Managed Lands Late Successional Reserves																						
LSR RO 223	NSO Groups	4.5	18.51	168.05		4.93	18.87 (8.89)	124.54 (57.31)	17.23 (17.23)	4.80 (2.53)	2.77	91.04		0.69	20.88	71.98		6.01	0.00	0.00	0.00	0.00
	Outside NSO Groups																		61.03	455.61	17.23	16.43
	Subtotal	4.5	18.51	168.05		4.93	18.87 (8.89)	124.54 (57.31)	17.23 (17.23)	4.80 (2.53)	2.77	91.04		0.69	20.88	71.98		6.01	0.00	0.00	0.00	0.00
LSR RO 227	NSO Groups	12.9	30.58	245.22	13.08	9.48	47.60	326.15	22.43	13.68	17.13	111.42	7.33	5.46	78.49	432.01	23.71	18.05	61.03	455.61	17.23	16.43
	Outside NSO Groups																		173.80	1,114.79	66.55	46.68
	Subtotal	12.9	30.58	245.22	13.08	9.48	47.60	326.15	22.43	13.68	17.13	111.42	7.33	5.46	78.49	432.01	23.71	18.05	0.00	0.00	0.00	0.00
Unmapped LSR	NSO Groups											6.63							173.80	1,114.79	66.55	46.68
	Outside NSO Groups																		0.00	6.63	0.00	0.00
	Subtotal											6.63							0.00	0.00	0.00	0.00
Total Late Successional Reserves																						
Total LSRs and Unmapped LSRs	**NSO Groups**	**21.3**	**64.84**	**587.89**	**17.55**	**19.37**	**74.69 (8.89)**	**529.46 (57.31)**	**41.19 (17.23)**	**21.03 (2.53)**	**29.16**	**272.64**	**11.08**	**8.51**	**122.20**	**574.51**	**25.66**	**28.26**	**290.88**	**1,964.50**	**95.49**	**77.17**
	Outside NSO Groups	**6.3**	**3.79**	**32.11**	**0.88**	**1.09**	**18.03**	**106.15**	**6.30**	**4.77**	**42.23**	**236.36**	**5.99**	**10.79**	**24.15**	**115.57**	**6.60**	**6.30**	**88.21**	**490.19**	**19.76**	**22.95**
	NSO RangeTotal	**27.6**	**68.63**	**620.00**	**18.43**	**20.46**	**92.72 (8.89)**	**635.61 (57.31)**	**47.49 (17.23)**	**25.80 (2.53)**	**71.39**	**509.00**	**17.07**	**19.29**	**146.36**	**690.08**	**32.26**	**34.56**	**379.09**	**2,454.69**	**115.25**	**100.11**

a/ General Location identifies areas within Northern Spotted Owl Groups (areas within NSO home ranges; see Table Q10 in Appendix Q) and areas outside of NSO groups (outside of NSO home ranges).
b/ High NRF (FWS 2014c): forested habitat that is characterized by large trees (> 32 inches dbh), high canopy cover (>60 percent), and multistoried structure with sufficient down wood and snags to support prey species.
c/ NRF (FWS 2012d, 2014c; North et al. 1999): conifer-dominated forested habitat greater than 80 years that does not meet the definition of High NRF but has multi-storied structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood. Acreage in parenthesis identifies the area of NRF (or High NRF) prior to the 2015 Stouts Creek fire that are currently dead standing trees (i.e., "post-fire NRF").
d/ Dispersal ONLY (FWS 2012d, 2014c): an average tree diameter of 11 inches dbh or greater; conifer overstory trees; canopy closure greater than 40 percent in moist forests and greater than 30 percent in dry forests; open space beneath the canopy to allow for NSO to fly; High NRF and NRF provide dispersal habitat, as well.
e/ Capable Habitat (FWS 2014c): habitat that is forested or could become forested (i.e., recently harvested timberlands) that do not provide dispersal or NRF characteristics.
f/ Total habitat only considers forested NSO habitat within the range of the NSO; see table Q-12 in appendix Q for effects to non-capable habitat in NWFP LSRs and unmapped LSRs.
g/ Project components considered in calculation of habitat "Removed": construction right-of-way, temporary extra work areas, aboveground facilities, permanent and temporary access roads (PAR, TAR), pipe storage yards, and hydrostatic test locations.
h/ Other Indirect Effects considers habitat within 100 meters (328 feet) of habitat removal as measured from the edge of habitat removal/edge of right-of-way/TEWA.
i/ Acres identified as UCSAs have been incorporated into the 100-meter other indirect effects. UCSAs would not be cleared of trees during construction and would not affect nesting structures or characteristics. These areas would be used to store forest slash, stumps and dead and downed log materials that would be removed and scattered across the right-of-way after construction during restoration and are considered as temporary insignificant understory habitat effects.
j/ 30-foot Maintenance Corridor would be kept in a shrub/sapling state for the life of the project; all other habitat outside of the 30-foot maintenance corridor would be revegetated, except for those habitats on non-federal or matrix lands where there is less certainty that replanting would occur or be maintained on the landscape.

Note: More detailed information on BLM Districts and National Forests impacted in critical habitat units is located in table Q-12 in appendix Q. Overlap with CHUs can be reviewed in table Q-9 in appendix Q.

Table 3.3.4-20 summarizes the impact to NSO high NRF, NRF, dispersal, and capable habitat within each LSR and Forest Service unmapped LSRs impacted (i.e. habitat affected (within 100 meters of habitat removal including UCSAs) or habitat removed) by the proposed Project. Overall, the Pipeline would remove 442.44 acres from LSRs (table Q-12 in appendix Q), of which 379.09 acres is NSO habitat or capable of becoming NSO habitat (68.63 acres of high NRF, 92.72 acres of NRF (includes 8.89 acres of "post-fire" NRF), 71.39 acres of dispersal only habitat, and 146.36 acres of capable habitat). After construction, approximately 100.23 acres (20.46 acres of high NRF, 25.80 acres of NRF (includes 2.53 acres of "post-fire NRF"), 19.29 acres of dispersal only habitat, and 34.56 acres of capable habitat) would be kept within an early seral state within the 30-foot-wide operational right-of-way for the life of the Project (see table 3.3.4-20). Over the long term, 278.98 acres of forested habitat within LSRs would return to their original state (outside of the 30-foot operational right-of-way) and begin functioning as dispersal only habitat (see table 3.3.4-20). Table Q-12 in appendix Q provides NSO habitat affected within NWFP LSRs and unmapped LSRs, by landowner and physiographic province within and outside of interior forest.

LSRs and Forest Service unmapped LSRs cover approximately 61,278 acres within the provincial analysis area and provide approximately 36,826 acres of high NRF and NRF habitat (includes 2,317 acres of "post-fire NRF;" see table 3.3.4-7). The proportional amount of available NRF habitat that would be removed (161.35 acres, including 8.89 acres of "post-fire NRF") within LSRs in the provincial analysis area is 0.4 percent, while 0.2 percent of available NRF would be affected in the short term within UCSAs (65.92 acres, including 17.23 acres of "post-fire NRF").

Cumulative Effects

Habitat removal and construction disturbance from the Pipeline are expected to be complete one year before the in-service date due to the longer construction period for the LNG terminal, access channel, and slip (figure 2.1.1-1). Consequently, the foreseeable future required for cumulative effects analysis would actually occur before implementation of the proposed action, not after its implementation, which is more often the case.

Cumulative effects to NSO would be generated by timber harvesting and other sources of nesting, roosting, and/or foraging (NRF) habitat losses on non-federal lands in the foreseeable future. High NRF is considered habitat that is characterized by large trees (greater than 32 inches dbh), high canopy cover (greater than 60 percent), and multistoried structure with sufficient down wood and snags to support prey species, and NRF consists of conifer-dominated stands older than 80 years that is multi-storied in structure with large overstory trees (20-30 inches dbh), moderate to high canopy closure greater than 60 percent, and sufficient snags and down wood, and does not meet the definition of High NRF (see section 3.3.4.2). As defined, High NRF and NRF NSO habitats correspond with forested and mixed coniferous forests older than 80 years.

Areas of NSO nesting/roosting habitats have been monitored as a component of the NWFP. In Oregon, NSO nesting/roosting habitat was evaluated in 1993 and in 2012 (Davis et al., 2016) within each of the physiographic provinces crossed by the Pipeline. Differences in areas of NSO habitat were described in the four physiographic provinces on federal land and all lands (federal and nonfederal) from which changes in NSO habitat on nonfederal lands were computed. Most of the losses of NSO habitat on federal lands were attributed to large fire events including the 2002 Biscuit Fire in the Klamath Mountains, the 2003 B&B Fire in the Western Cascades, and the 2003 B&B Fire and Davis Fire in the Eastern Cascades (Davis et al. 2016). However, losses associated with wildfire were negligible on non-federal lands where most of the decline in NSO habitat was due to timber harvest, primarily concentrated in the Oregon Coast Range and Western Cascades provinces (compare Table 6 with Table 7 in Davis et al. 2016)

In 2017, there were 7,214 acres of High NRF habitat and 11,124 acres of NRF habitat on non-federal lands within the provincial analysis area (see table 3.3.4-4 in section 3.3.4.2) in all four physiographic provinces, combined. During the 19-year period from 1993 to 2012 there was an overall net loss of NSO nesting/roosting habitat on non-federal lands within the Coast Range province (-1.84 percent), Western Cascades province (-1.51 percent), and Eastern Cascades province (-0.51 percent), but a slight increase in NSO habitat on non-federal lands in the Klamath Mountains province (+0.07 percent) (Davis et al. 2016). Percent loss of NSO habitat on non-federal lands during the 19-year period was used as the basis for the annual loss of High NRF and NRF habitats included in table 3.3.4-21. The rates of change on non-federal lands were assumed to be constant over time within the provincial analysis area. Areas of High NRF and NRF habitats present in 2020, presumed to be the first year of Pipeline implementation, would be expected to change at the annual rates of loss specific to each physiographic province with an overall slight net loss in 2020 (from 18,338 acres in 2017 to 18,234 acres in 2020). Using the annual rates of NSO nesting/roosting habitat loss, there would be an estimated 7,195 acres of High NRF and 11,039 acres of NRF habitats within the analysis area on non-federal land in 2020 (see table 3.3.4-21).

The Project would remove 9.18 acres of High NRF habitat and 59.98 acres of NRF habitat on non-federal (state and private) lands (see table 3.3.4-12 in section 3.3.4.3) in all four Physiographic Provinces, combined. The amount of High NRF habitat removed would be 0.14 percent of the High NRF habitat remaining on non-federal lands (7,195 acres) within all four provinces of the analysis area by 2020. Likewise, the amount of NRF habitat removed by the Pipeline would be 0.54 percent of the NRF habitat remaining on non-federal lands (11,039 acres) within all four provinces of the physiographic analysis area by 2020. When compared to the estimated amount of NSO habitat on non-federal land within the analysis area, the Project would affect a total of 60.77 acres, which would be 0.33 percent of the total High NRF and NRF habitat available within the foreseeable future in 2020.

TABLE 3.3.4-21

Estimates for Losses of Northern Spotted Owl Nesting, Roosting, and Foraging Habitat on Non-Federal Land within the Provincial Analysis Area by 2020, with Pipeline Project-Related Effects on Non-Federal Land in Relation to the Expected Cumulative Effects

	NRF Area on Non-federal Land in Analysis Area in 2017 a/			**Change in NRF on Non-federal Land in Province, from 1993 to 2012 b/**		**NRF Area on Non-federal Land in Analysis Area Expected in 2020**			**NRF Removed by the Project on Nonfederal Land in Analysis Area in 2020 c/**			**Percent of NRF in Analysis Area Expected in 2020 Likely to be Affected by the Project**		
Physiographic Province	**High NRF (acres)**	**NRF (acres)**	**Total NRF (acres)**	**Total Area Change (acres)**	**Percent Change per Year**	**High NRF (acres)**	**NRF (acres)**	**Total NRF (acres)**	**High NRF (acres)**	**NRF (acres)**	**Total NRF (acres)**	**High NRF**	**NRF**	**Total NRF**
Coast Range	524	1,284	1,808	-102,300	-1.84	495	1213	1,708	0.73	7.55	8.28	0.15	0.62	0.48
Klamath Mountains	6,508	8,645	15,153	+3,000	+0.07	6,521	8,662	15,183	7.54	30.97	38.51	0.12	0.36	0.25
Cascades West	694	2,134	2,828	-136,400	-1.51	663	2,037	2,700	0.91	19.86	20.77	0.14	0.97	0.77
Cascades East	12	345	357	-10,500	-0.51	12	340	352	0.00	1.49	1.49	0.00	0.44	0.42
Totals	**7,214**	**11,124**	**18,338**	**-143,900**	**-0.92**	**7,195**	**11,039**	**18,234**	**8.45**	**52.32**	**60.77**	**0.12**	**0.47**	**0.33**

a/ Data from table 3.3.4-4 in section 3.3.5.2.
b/ Percent loss in Physiographic Provinces on Non-Federal Land computed by subtracting values in Table 6 from values in Table 7 in Davis et al., 2016 .
c/ Data from table 3.3.4-12 in section 3.3.4.3.

3.3.4.4 Conservation Measures

PCGP has implemented or proposed conservation measures including avoidance, minimization, and rehabilitation/restoration as described below.

Avoidance, Minimization, and Rehabilitation / Restoration

Conservation measures have been proposed by PCGP to minimize construction and operational impacts to NSO habitat within the provincial analysis area. Those measures have been compiled in table 2C in appendix N. Specific conservation measures that minimize project impacts on NSOs include those that:

- avoid timber clearing during the breeding and nesting season;
- avoid construction activities within 0.25 mile of NSO activity sites during the critical breeding season (March 1 – July 15);
- route the Pipeline through previously disturbed lands near LSRs so that impacts to these areas are minimized;
- minimize removal of forest by incorporating UCSAs into the Pipeline project design;
- utilize two-year construction schedule to minimize the overall TEWAs;
- flag large diameter trees on edges of construction right-of-way or temporary work areas where feasible to save from clearing, as outlined in the Plan of Development's Leave Tree Protection Plan;
- ensure that all trash, food waste, and other items attractive to crows, jays, and other corvids would be contained and removed from the project area on a daily basis to minimize potential predation of spotted owl nestlings;
- utilize logging methods to minimize damage to adjacent trees when clearing the right of way to reduce potential infestation from forest pathogens and insects; and
- minimize potential for establishment of invasive vegetation and establish control of noxious weeds.

Plans included in the appendices to PCGP's POD identify methods that would minimize effects to NSO habitat and/or nesting NSOs. The *Leave Tree Protection Plan* describes the preconstruction surveys that would be completed to clearly mark the boundaries of the Pipeline project's certificated working limits, and procedures to identify individual trees within and along the edges of the certificated work limits that can be conserved or left standing, as well as BMPs that would be employed to minimize damage to trees within UCSAs and protect trees not removed from the construction right-of-way (see appendix P to the POD, available upon request). An *Integrated Pest Management Plan* (see appendix N to the POD, available upon request) describes BMPs to address the control of noxious weeds, invasive plants, forest pathogens, and soil pests, as well as measures to minimize the potential spread of invasive species and potential adverse effects of control treatments. The *Blasting Plan* and *Air Noise and Fugitive Dust Plan* (see Appendices C and B to the POD, respectively – available upon request) provide mitigation measures and monitoring plans to minimize noise effects to nesting spotted owls during construction of the Pipeline.

During the Pipeline project route selection and construction footprint design processes (e.g., placement and sizing of temporary extra work areas), PCGP determined a alignment that would ensure the long-term safety and integrity of the proposed Pipeline through geotechnical evaluations while attempting to minimize adverse impacts to NSO nest patches, core areas, critical habitat, LSRs, and otherwise potential suitable habitat. However, not all designated critical habitat, LSRs, suitable habitat, and known NSO nest patches and core areas could be avoided. Major and minor route alternatives have been considered and incorporated into the Proposed Route that minimize effects to NSO and habitat (see PCGP's Resource Report 10).

PCGP prepared an *Avoidance and Minimization Plan for MAMU and NSO* (see appendix V1) that identifies the additional measures that have been incorporated into the project design to reduce impacts to both MAMUs and NSOs. This avoidance plan was developed through consultations with the FWS and the cooperating agencies (Interagency Habitat Quality Subgroup-Micro Siting Working Group, June 4, 2008). Application of measures outlined in the plan would minimize the impacts to suitable NSO habitat by 1) converting TEWAs to UCSAs to reduce the amount of suitable habitat removed by the Pipeline project, 2) moving TEWAs to avoid impacts to suitable habitat within core areas, and 3) moving the alignment to avoid NSO nest patches. A "Standard Rules Set" was developed during the meeting to further minimize effects to NSO nest patches, and this Standard Rules Set would be implemented prior to or concurrent with tree felling. The Standard Rules Set measures include:

- identify potential nest trees to be allowed to remain standing within TEWAs or edge of right-of-way;
- identify TEWAs to be reduced in size or eliminated to reduce removal of suitable habitat;
- identify any additional minor route adjustments that would not alter constructability but would further reduce removal of suitable habitat;
- identify any previously unknown nest trees discovered and assure that they are properly protected by applying seasonal restrictions associated with similar locations along the project alignment; and
- provide support to EIs by qualified biologists to identify habitat or potential nest trees.

Prior to timber clearing, PCGP would have experienced biologists cruise NSO core areas and nest patches where high NRF and NRF habitat would be modified by construction of the Pipeline and mark trees that have potential NSO nesting structures (i.e., snags, large cavities). PCGP would avoid removal of those marked trees, if feasible. Additionally, to minimize disturbance within forested areas, PCGP has designated nearly 676.44 acres (see table 3.3.4-12) of UCSAs within the range of NSOs that would not be cleared of trees but would be used to store forest slash, stumps, and dead and downed log materials during construction that would be scattered across the right-of-way after construction and during restoration. The UCSAs would be useful for the construction of the Pipeline project while not requiring removal of trees or understory vegetation and allowing the maintenance of high NRF, NRF, dispersal, and capable habitat function. Where feasible, PCGP would leave large trees on the edges of the construction right-of-way and TEWAs throughout the project area to benefit the NSO and other late-successional-dependent wildlife species.

To minimize effects to NSOs potentially nesting within 0.25 mile of the Pipeline, PCGP would remove timber outside of the NSO breeding season (after September 30 and before February 28) within at least 0.25 mile of activity centers (known, best location, and PCGP assumed sites) to ensure that trees with nesting NSO and owlets are not felled. To minimize disturbance and/or disruption to potentially nesting NSO within 0.25 mile of Pipeline construction, PCGP would construct the Pipeline where activity centers (known, best location, PCGP assumed) occur within

0.25 mile of the Pipeline project after the critical breeding period (after July 15), and only after timber has been felled outside of the breeding season. If PCGP decides to construct within 0.25 mile of NSO activity centers during the NSO critical breeding period (March 1 through July 15), PCGP would conduct reproductive follow-up surveys at NSO activity centers that are within 0.25 mile of the construction right-of-way the year of construction to determine if documented nest sites and/or pairs within 0.25 mile of construction activities are active. The follow-up surveys would either consist of two visits before May 1 at least one week apart or one survey after May 1 as described by the revised NSO survey protocol (FWS 2012i). If spotted owls are determined to not be nesting during reproductive follow-up surveys, construction of the Pipeline project could occur during the breeding season with no expected impact to nesting NSO; however, reproductive follow-up surveys should be repeated each year if construction activities during the critical breeding season are proposed within 0.25 mile of NSO activity centers (FWS 2012i).

To ensure that minimization measures would be applied to all potentially nesting NSO within 0.25 mile of the Pipeline project, one year prior to construction activities, PCGP would conduct spot check surveys within 0.25 mile of the construction right-of-way in known, best location, and assumed NSO home ranges, where permitted, as well as previously surveyed NRF habitat outside of analyzed NSO home ranges, to supplement the full survey efforts conducted in 2007 and 2008, as recommended by FWS. These surveys would determine if sites are still occupied or have moved, attempt to locate nest trees per protocol, determine if best location or assumed owl sites are occupied, adjust the construction schedule to apply seasonal constraints, if necessary, and apply minor route adjustments to further minimize impact, if feasible. The spot check surveys would include at least three night visits spaced a minimum of 7 days apart to confirm occupancy status (FWS 2012i).

During construction, PCGP would ensure that construction contracts include stipulations ensuring that all trash, food waste, debris, and other items attractive to crows, jays, and other corvids would be picked up and removed from the project area on a daily basis during the breeding season to minimize potential predation of northern spotted owlets. PCGP's EIs would be responsible for confirming that the construction contractor is following these stipulations.

Measures have also been proposed to rectify, repair, and rehabilitate and otherwise reduce impacts to forested habitats once construction of the Pipeline is complete. Those measures have been compiled in table 3C in appendix N. Specific conservation measures that would benefit NSOs include those that:

- replant conifer species outside of the 30-foot-wide maintenance corridor after construction, where feasible, which would contribute to the reestablishment of native vegetation and soften the edge effect created from construction of the Pipeline;
- contribute to forest habitat structural diversity (e.g., snags and downed timber); and
- minimize potential for increased human use of the reclaimed construction right-of-way and intrusion into undisturbed habitats.

Following construction, a maximum of approximately 1,568 acres of affected forested lands (the construction right-of-way and temporary extra work areas outside of the 30-foot-wide operational right-of-way; NSO habitat in table 3.3.4-12) would be replanted and allowed to return to pre-construction condition where possible with tree species in the approximate proportion to those species removed. This replanting would occur on certain federal lands and non-federal lands on a case-by-case basis. Replanted trees may also be harvested from non-federal lands or federal lands slated for timber harvest (i.e., Matrix lands). Tree establishment would be allowed to occur up to within 15 feet on either side of the centerline. Over the long term (80 years or more), revegetated areas outside of the 30-foot maintenance corridor may achieve tree structural characteristics comparable to those removed, had they not been affected, which could serve as NSO suitable habitat. Although nesting function may not be reestablished over the long term, the habitat may provide structures suitable for foraging, roosting, and dispersal as it regrows.

3.3.4.5 Determination of Effects

Species

The Project **may affect** NSOs because:

- suitable habitat is available within the provincial analysis area, and
- NSO pairs and resident singles have been located within the provincial analysis area during survey efforts.

The Project is **likely to adversely affect** NSOs because:

- noise from blasting during construction within 0.25 mile of NSO sites during the late breeding season would occur and could increase the risk of predation to fledglings that are generally not as able to escape as adults during the latter part of the breeding season.
- construction of the Pipeline would remove approximately 516.77 acres of high NRF and NRF habitat (including 25.72 acres of "post fire NRF" within the 2015 Stouts Creek fire area) within within the provincial analysis area. This would result in effects to NSO nest patches, core areas, and home ranges of known, best location, and PCGP assumed owls, some of which are currently below thresholds needed to sustain NSOs. Once suitable NRF habitat is reduced or modified in NSO home ranges, there is an increased likelihood that NSOs remaining in the Pipeline project area would be subject to:
  - displacement from nesting areas;
  - concentration into smaller, fragmented areas of suitable nesting habitat that may already be occupied;
  - increased interspecific (with barred owls) and intraspecific competition for suitable nest sites;
  - decreased survival due to increased predation and/or limited resource (forage) availability; and
  - diminished reproductive success for nesting pairs.
- construction of the Pipeline would remove and modify high NRF, NRF, dispersal only, and capable habitat for NSOs throughout the project area, including removal of habitat within the home range of 97 NSOs, 58 of which are currently below sustainable threshold levels of suitable habitat for continued persistence in their home range and/or core area.
- construction of the Pipeline would bring one NSO core area (best location activity center affected by 2015 Stouts Creek fire) below the 50 percent NRF threshold, and two NSO home ranges (known activity centers, one of which was affected by the 2015 Stouts Creek fire) below the 40 percent NRF threshold.

Critical Habitat

A **may affect** determination is warranted for NSO critical habitat because:

- the Pipeline would be within designated NSO critical habitat; and
- construction of the Pipeline would result in habitat impacts within designated critical habitat areas.

A **likely to adversely affect** determination is warranted for NSO critical habitat because:

- the Pipeline would remove or potentially downgrade PCEs in critical habitat sub-units ORC-6, KLE-1, KLE-2, KLE-3, KLE-4, KLE-5, and ECS-1 as defined in the Final Rule designating critical habitat for the NSO (FWS 2012e).

3.0 SECTION 3

3.1

3.2

3.3

3.4 HERPETOFAUNA

3.4.1 Green Turtle

3.4.1.1 Species Account and Critical Habitat

Status

Green turtles were listed as threatened under the ESA on July 28, 1978 (FWS 1978), except for an endangered population nesting on the Pacific Coast of Mexico. On March 23, 2015 the FWS and NMFS identified 11 Distinct Population Segments (DPS) including the East Pacific DPS, which ends approximately 100 miles south of the Project area (FWS and NMFS 2015)

Threats

In addition to the general threats to marine turtles mentioned below, the primary cause of green turtle population decline has been the harvest of both eggs and adults on nesting beaches and juveniles and adults on feeding grounds (NMFS 2017c).

NMFS has identified eight general threats to marine turtles, including green turtles. These threats include:

- Entanglement in and/or injury by fishing gear
- Ingestion or entanglement in marine debris
- Environmental contamination
- Disease, especially fibropapillomatosis in green turtles, but also reported in loggerhead and olive ridley turtles
- Loss or degradation of nesting habitat
- Beach armoring
- Artificial lighting
- Non-native vegetation

In addition, global climate change could have a potentially extensive impact on all aspects of marine turtles' life cycles and may affect the abundance and distribution of prey items (NMFS 2017d).

Species Recovery

A Recovery Plan for the U.S. Pacific green turtles was issued on May 22, 1998 (NMFS and FWS 1998a). The recovery goal is to delist the species, and the plan listed the following necessary actions:

- Minimize boat collision mortalities, particularly within San Diego County, California.
- Minimize incidental mortalities of turtles by commercial fishing operations.
- Support the efforts of Mexico and the countries of Central America to census and protect nesting East Pacific green turtles, their eggs, and nesting beaches.
- Determine population size and status in U.S. waters through regular surveys.
- Identify stock home range(s) using DNA analysis.
- Identify and protect primary foraging areas in U.S. jurisdiction.

The stepdown outline in the recovery plan included the following recommendations:

- Protect and manage turtles on nesting beaches.
- Protect and manage nesting habitat.
- Protect and manage East Pacific green turtle populations in the marine habitat.
- Protect and manage marine habitat, including foraging habitats.
- Develop standards for the care and maintenance of sea turtles, including diet, water quality, tank size, and treatment of injury and disease.
- Establish a catalog of all captive sea turtles to enhance use for research and education.
- Designate rehabilitation facilities.
- Support existing international agreements and conventions to ensure that turtles in all life-stages are protected in foreign waters.
- Encourage ratification of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) for all non-member Pacific countries, compliance with CITES requirements, and removal of sea turtle trade reservations held by member nations.
- Develop new international agreements to ensure that turtles in all life-stages are protected in foreign waters.
- Develop or continue to support informational displays in U.S. airports and ports of entry that have direct flights to Mexico and Latin America.

Life History, Habitat Requirements, and Distribution

The green turtle is globally distributed in tropical and subtropical waters generally between 30° north and 30°south of the equator. Many facets of the green turtle's life history and ecology remain unknown, including details of its residence in and use of the U.S. Pacific Coast. The NMFS identified 11 DPSs including the East Pacific DPS which is found from the California/Oregon border southward along the Pacific coast of North, Central, and South America to Central Chile including Mexico’s Revillagigedos Archipelago, and Ecuador’s Galapagos Archipelago. East Pacific green turtles regularly strand along the Oregon shoreline (FWS and NMFS 2015). Green Turtle nesting is widely dispersed in the Eastern Pacific Ocean. The two largest nesting aggregations for the East Pacific DPS are on the coast of Michoacan, Mexico and in the Galapagos Islands, with significant nesting on a variety of other beaches along the tropical eastern Pacific Coast.

Except during breeding migrations, green turtles tend to be found in shallow waters such as those inside reefs, bays, and inlets. The turtles are attracted to lagoons and shoals with an abundance of marine grass and algae. Seagrasses are the principal dietary component of juvenile and adult green turtles throughout the Caribbean region and degradation of seagrass beds has slowed recovery of green turtles due to reduced carrying capacity of seagrass meadows (NMFS 1998b). Green turtles apparently have strong nesting site fidelity and migrate long distances between feeding grounds and nesting beaches.

Green sea turtles grow to an average size of about 3 feet and weigh between 300 and 350 pounds. Hatchling green turtles eat a variety of plants and animals, but adults are vegetarian, feeding on sea grass and algae. The nesting season varies with the locality and clutch size varies from 75 to 200 eggs (FWS 2007d). Incubation of the eggs varies between 45 and 75 days. Age at sexual maturity is between 20 and 50 years (FWS 2007d).

Population Status

The mean annual number of nesting green turtle females has declined by 48 to 67 percent over the last three generations, which was estimated from index nesting sites (Marine Turtle Specialist Group 2004). East Pacific green turtles are widely distributed in coast waters south of the United States, in Mexico and Central America where the main aggregations are along the west coast of Baja California, in the Sea of Cortez, along the coast of Oaxaca, and breeding grounds of Michoacan, Mexico (NMFS and FWS 1998a). There is no known nesting by green turtles on the U.S. Pacific Coast (NMFS and FWS 1998a).

Critical Habitat

Critical habitat was established for this species on Culebra Island, Puerto Rico on September 2, 1998 (NMFS 1998b). No critical habitat for green sea turtles occurs on the U.S. Pacific Coast.

3.4.1.2 Environmental Baseline

Analysis Area

The analysis area applicable to green turtles is the area directly off Coos Bay out to the continental shelf break, which is represented as a depth of 200 meters. For this stretch of the Oregon coast the shelf break is approximately 12 nmi offshore from the Coos Bay estuary, the same as described above for blue whales (see figure 2.1.1-2). Within the marine analysis area, potential effects to green turtles would be associated with LNG carriers inbound and outbound from the LNG Terminal.

To date, the origins of LNG carriers arriving at the LNG Terminal and the destinations of LNG cargo that would be shipped from the LNG Terminal have not been identified. However, for the reasons discussed with respect to blue whales (see section 3.2.1.3), LNG carriers are assumed to traverse the marine analysis area perpendicularly—east and west—as they approach and depart from Coos Bay. The assumption of perpendicular transits is based on existing shipping traffic between Asia and the continental U.S. Pacific Coast travelling the “Great Circle route” (Pacific States/British Columbia Oil Spill Task Force 2002), as well information provided by the Coast Guard (Berg and Lawrenson 2015).

Species Presence

Green sea turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south (NMFS 2007b). Green sea turtles primarily use three types of habitat: oceanic beaches (for nesting), convergence zones in the open ocean, and benthic feeding grounds in coastal areas (NMFS 2007b). Reports of strandings suggest that the green turtle is a frequent visitor off the California coast. The northernmost stranding was reported in 1993 in Homer, Alaska, although it was speculated that this turtle may have died farther to the south and drifted north (NMFS 1998b). Based on this data, green turtles are likely infrequent, transient visitors to the Oregon coast, but may occasionally be found in the marine analysis area within the LNG ship transit zone.

Habitat

Sightings offshore of the Pacific Coast have occurred but there are no known sea turtle nesting sites on the U.S. Pacific Coast (NMFS and FWS 1998a). The East Pacific green turtle was the most commonly observed hard-shelled sea turtle on the U.S. Pacific Coast (NMFS and FWS 1998a) but most of the sightings (62 percent) were reported from northern Baja California and Southern California. The northernmost known resident population of East Pacific green turtles occurs in San Diego Bay, in the warm effluent of a power plant (NMFS and FWS 1998a).

3.4.1.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, underwater ship noise, and potential adverse effects from fuel spills at sea. Spills could indirectly affect green turtles by impacting forage species. These effects are addressed below.

Ship Strikes by LNG Carriers

The proposed action would result in increased shipping traffic and may increase potential vessel strikes to green turtles within the marine analysis area. Boat collisions are listed as a major problem for green turtle recovery off the continental U.S. Pacific Coast (NMFS 1998b). Sea turtles can be injured or killed when struck by a boat, especially by an engaged propeller. Eighty percent of sea turtle deaths reported recently in San Diego Bay and Mission Bay, California were associated with evidence of boat collision. Experiments conducted with a small 20-foot aluminum boat used to approach green sea turtles at various speeds found that turtles could avoid collision more effectively with vessels travelling at slow speeds (4 kilometers/hour) compared to vessels travelling at moderate and fast speeds (11 and 19 kilometers/hour, respectively; Hazel et al. 2007). However, methods for reducing boat collisions are not included in recovery objectives, and based on their warm water requirements, green sea turtles are likely to only be occasional visitors to waters as far north as Oregon.

The proposed action is expected to increase traffic by 240 additional ship transits through the marine analysis area each year of operation (inbound and outbound transits by 120 LNG carriers). Given the low population and occurrence of the green turtles in Oregon coastal waters and current estimate of vessel traffic, the addition of 240 LNG carrier transits through the marine analysis area is not expected to result in measurable additional ship strike-related mortality or injury to green turtles.

Underwater Noise

Green sea turtle hearing is most sensitive between 200 and 700 Hz (Bartol and Ketten 2006 cited in NSF 2011), which is within the same range of low frequencies generated by ships and sounds generated by large baleen whales (Würsig and Richardson 2009). However, most research has been related to sea turtles's responses to seismic noises while their resonses to ship noise have not been studied or documented.

Ambient noise in the northeast Pacific Ocean has increased over the past several decades. Comparisons of ambient noise from the 1990s with noise measurements taken during the 1960s indicate ambient noise has increased by about 10 dB (Andrew et al. 2002) although analyses of more recent vessel-traffic related noise is that such levels along the US west coast are holding steady or increasing slightly off Southern California but decreasing in the area off Oregon and Washington, Andrew et al. 2011).

Existing commercial vessels within the marine analysis area produce underwater noise levels that are comparable or exceed noise from the LNG tanker described by Hatch et al. (2008). Noise generated by various types of commercial ships (container ships, crude oil tankers, product tankers, bulk carriers, and others) were recently evaluated by McKenna et al. (2012). Underwater noise levels varied by ship type and also by vessel length, gross tonnage, vessel speed, and to some extent, vessel age (older vessels tended to be louder than newer vessels). Potential effects by LNG tanker-related noise on green sea turtles are remotely possible in the marine analysis area but any such noise would be commensurate with existing noise levels and would not be expected to cause injury or any measurable effect to any green sea turtles.

Fuel Spills

Fuel or lubricants spilled from LNG carriers at sea, or released during normal operations such as bilge tank flushing, could adversely affect green turtles directly if ingested or if turtles become coated in oil. Effects of oil on turtles include direct mortality due to oiling in hatchlings, juveniles, and adults, and negative impacts to the skin, blood, digestive and immune systems, and salt glands (Milton et al. 2010). Effects of potential spills from LNG carriers are not comparable to spills from oil tankers because LNG carriers only carry quantities of oil used for propulsion fuel and not the quantities transported by oil tankers.

The Federal Water Pollution Control Act, as amended by the CWA (33 U.S.C. 1251–1387), prohibits the discharge of oil upon the navigable waters of the U.S., which include, and, where it can be determined that the natural resources of the United States are impacted, out to the EEZ (200 miles). LNG carriers calling on the LNG Terminal would be required by the Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills, and comply with the U.S. and International regulations discussed under the blue whales section that prohibit the release of oil at sea. Green turtle forage areas exist outside of the marine analysis area in bays and inlets along the coast of Baja California, Mexico, and southern California (NMFS and FWS 1998a). Additionally, there are no known sea turtle nesting sites on the continental U.S. Pacific Coast. As green turtles are likely infrequent, transient visitors to the marine analysis area and the Oregon coast, adverse effects of fuel and lubricants spilled from 120 LNG carriers transiting the marine analysis area annually are expected to be insignificant and discountable, especially given the required spill prevention measures.

Cumulative Effects

The vessels transiting to and from the LNG Terminal would contribute to the ambient noise levels in the marine analysis area. However, the contribution of additional noise will occur within a context of diminishing traffic-related noise (Andrews et al, 2011), so the cumulative impact should be limited. Annual commercial ship traffic into and out of the Oregon International Port of Coos Bay has declined in recent years from a high of 310 deep-draft vessel calls at the Port in 1988 to 52 in 2016. The Port is also visited, by conservative estimates, by 50 tug/barge units per year, with 14 tug/barge units requesting pilotage during 2016 as per data from the Coos Bay Pilots Association (Whipple 2017). Even with the addition of 120 LNG carriers per year visiting the LNG Terminal, commercial ship traffic into Coos Bay would likely not reach historic levels.

As a result of this projected increase in vessel traffic, threats from ship strikes, underwater noise, and the effects of fuel spills are likely to increase. However, as green turtles are infrequent, transient visitors to the marine analysis area and the Oregon coast, cumulative effects from 120 LNG carriers transiting the marine analysis area combined with reasonably foreseeable non-federal projects are expected to be insignificant and discountable.

3.4.1.4 Conservation Measures

Measures to reduce ship speeds once inside the Coos Bay navigation channel to between 4 to 6 knots and within the marine analysis area when pods or large assemblages of cetaceans are observed near an underway ship would provide some protection to green turtles. However, it is highly unlikely that green turtles or other sea turtles would be seen from an LNG carrier. Nevertheless, the same *Ship-Strike Reduction Plan*, including marine mammal avoidance guidelines that were described in section 3.2.1.4 (Blue Whale), applies to green turtles further reducing any potential impacts in the unlikely event that a green turtle is found in the analysis area.

3.4.1.5 Determination of Effects

Species

The Project **may affect** green turtles because:

- green turtles may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area.

However, the Project is **not likely to adversely affect** green turtles because:

- the increase in annual ship traffic due to the proposed action is expected to cause an immeasurable increase for potential ship strikes to green turtles;
- JCEP would provide a Ship Strike Avoidance Measures Package to shippers calling on the LNG Terminal that consists of multiple measures to avoid striking marine mammals, which should also benefit sea turtles;
- LNG carriers approaching Coos Bay would be traveling slowly and be escorted by tractor tugs from 5 nmi offshore to the LNG Terminal;
- noise produced by LNG carriers would contribute to overall noise within the marine analysis area en route to Coos Bay and increased ship noise could affect green sea turtle behavior. However, JCEP expects that the noise levels of the LNG carriers would be comparable to the noise levels of existing ship traffic and would be infrequent enough so as not to cause injury or result in behavioral changes.

3.4.2 Leatherback Turtle

3.4.2.1 Species Account and Critical Habitat

Status

Leatherback turtles were listed as endangered under the Endangered Species Conservation Act on December 2, 1970 (FWS 1970) and have been listed under the ESA since its implementation in 1973. NMFS (2017e) recognizes two subpopulations of Pacific leatherback turtles, Eastern and Western. Eastern Pacific leatherbacks nest along the Pacific coast of the Americas in Mexico and Costa Rica while Western Pacific leatherbacks nest in the Indo-Pacific and migrate back to feeding areas off the Pacific coast of North America including the coast of Oregon (NMFS 2017e).

Threats

The NMFS and FWS (1998b) cited 22 general threats to leatherbacks; egg collection and bycatch in fishing gear are the primary reasons for the declines in Pacific leatherback turtle populations.

Direct threats to leatherback turtles include harvesting. The primary threat to leatherback turtles on the continental U.S. Pacific Coast continues to be incidental take in commercial fisheries operations (NMFS and FWS 1998b). Other threats include ingestion of debris, primarily plastics and plastic bags that are thought to be mistaken for jellyfish and eaten, leading to esophagus and stomach blockage and eventually death (Mrosovsky et al. 2009; Plotkin 1995). These deaths, and the evidence for this type of death by this specific type of ingestion, appear to be on the rise (Schuyler, et al. 2013). Threats at nesting grounds outside the United States still remain from collection of eggs and development along coastal areas. In addition, artificial light (during egg hatch viewing) causes confusion of newly hatched turtles that head in the direction of the light rather than out to sea (Plotkin 1995; FWS 2012e; NMFS and FWS 1998b).

Species Recovery

NMFS issued a recovery plan for the U.S. Pacific Coast population on May 22, 1998. The recovery goal (NMFS and FWS 1998b) is to delist the species, and the plan listed the following necessary actions:

- Eliminate incidental take of leatherbacks in United States and international commercial fisheries.
- Support the efforts of Mexico and the countries of Central America to census and protect nesting leatherbacks, their eggs, and nesting beaches.
- Determine movement patterns, habitat needs, and primary foraging areas for the species throughout its range.
- Determine population size and status in U.S. waters through regular aerial or on-water surveys.
- Identify stock home ranges using DNA analysis.

The stepdown outline in the recovery plan included the following recommendations:

- Protect and manage turtles on nesting beaches.
- Protect and manage nesting habitat.
- Protect and manage leatherback turtle populations in the marine habitat.
- Protect and manage marine habitat, including foraging habitats.
- Support existing international agreements and conventions to ensure that turtles in all life-stages are protected in foreign waters.
- Encourage ratification of CITES for all non-member Pacific countries, compliance with CITES requirements, and removal of sea turtle trade reservations held by member nations.

- Develop new international agreements to ensure that turtles in all life-stages are protected in foreign waters.
- Develop or continue to support informational displays in airports that provide connecting legs for travelers to the areas where leatherbacks occur.

Life History, Habitat Requirements, and Distribution

The leatherback is the largest, most migratory, and widest ranging of all extant sea turtles (NMFS 2017e). Leatherback sea turtle nesting grounds are located around the world, with the largest remaining nesting assemblages found on the coasts of northern South America and West Africa. Adult leatherback sea turtles are capable of tolerating a wide range of water temperatures, and have been sighted as far north as the Gulf of Alaska (NMFS and FWS 2007a). Their diet consists of soft-bodied prey, such as jellyfish and tunicates. Nesting occurs on sandy tropical beaches, with each female laying several clutches at intervals of 8 to 12 days. Mating occurs in the waters adjacent to nesting beaches within migration corridors. After nesting, female leatherbacks migrate from tropical waters to more temperate latitudes, which support high densities of jellyfish prey in the summer (NMFS and FWS 1998b). Incubation of eggs takes between 55 and 75 days, and hatching occurs at night. Sexual maturity is reached between 6 and 10 years (FWS 2012e). No known nesting locations occur on the U.S. Pacific Coast.

NMFS (2012d) defined nine geographic areas along the continental U.S. Pacific Coast from Washington to Northern California that are occupied by leatherback turtles. Areas 2 and 3 include nearshore waters from Point Arena in northern California to Cape Flattery in Washington, extending offshore to the 2,000-meter isobath. Area 2 (Cape Blanco to Cape Flattery) includes most of the Oregon coast and is a principal foraging area for leatherbacks. They feed on a variety of moon jellies and brown sea nettles that are present in high densities associated with the Columbia River Plume and Heceta Bank, Oregon (NMFS 2012d). Areas 4 and 5 extend offshore west of Areas 2 and 3 to the EEZ. Jellyfish densities in those areas are unknown and likely serve as secondary foraging areas and areas of passage to the primary foraging region in Area 2. The marine analysis area is located within Area 2.

Population Status

In recent decades, Western Pacific leatherbacks have declined more than 80 percent (NMFS 2017e). Turtles foraging along the California coast are part of the Western Pacific subpopulation (Harris et al. 2011), and the same is assumed for leatherbacks foraging along the Oregon and Washington coasts. Between 1984 and 2011, there was an overall significant decline of 78 percent in the number of leatherback turtle nests monitored in Papua Barat, Indonesia (Tapilatu et al. 2013). Approximately 75 percent of the leatherbacks nesting in the western Pacific nest at Papua Barat. In the Pacific, the International Union for Conservation of Nature estimated that leatherback turtle populations have declined by 80 percent over three generations (Wallace et al. 2013).

Critical Habitat

Critical habitat was established for the Atlantic population in the U.S. Virgin Islands on March 23, 1979 (NMFS 1979). NMFS designated critical habitat for the Pacific population in 2012 (77 Fed. Reg. 4170), designating approximately 16,910 square miles as critical habitat for leatherback turtles along the California coast from Point Arena to Point Arguello and 25,004 square miles along the Washington and Oregon coasts from Cape Blanco, Oregon to Cape Flattery, Washington (NMFS 2012d).

NMFS (NMFS 2012d) originally identified two primary constituent elements (PCEs) to determine areas proposed as critical habitat for the Pacific population of leatherbacks; 1) occurrence of prey species, primarily jellyfish, of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction and development, and 2) migratory pathway conditions to allow for safe and timely passage and access to/from/within high use foraging areas. However, NMFS subsequently eliminated the second PCE, an identified migratory pathway. In the final designation, there is only one PCE, occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (especially brown sea nettles, *Chrysaora fuscescens*) of sufficient condition, distribution, diversity, abundance and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

3.4.2.2 Environmental Baseline

Analysis Area

The analysis area applicable to leatherback turtles is the area directly off Coos Bay out to the continental shelf break, which is represented as a depth of 200 meters, the same as the marine analysis area described above for green turtles and blue whales (see figure 2.1.1-2).

Species Presence

The leatherback sea turtle is the most common sea turtle in U.S. waters north of Mexico (NMFS and FWS 1998b). Leatherbacks occur as far north as Alaska, and numerous sightings have been documented off the Oregon coast. Green et al. (1992) observed 16 Pacific leatherback turtles off the Oregon and Washington coasts, all of them north of a point due west of Pacific City in Tillamook County, Oregon. Sixty-two percent of the sightings occurred over the continental slope, with the remainder occurring over the continental shelf. Incidental catch of leatherback turtles has also occurred in gill-nets off the coasts of Washington, Oregon, and California. Of 104 records of sea turtle strandings on the continental U.S. Pacific Coast between 1982 and 1991, 50 were leatherbacks (NMFS and FWS 1998b). No attempt has yet been made to assess the status of foraging populations. Despite occasional reports of leatherbacks sighted at sea, and a growing database documenting their incidental catch in coastal and pelagic fisheries, there are very few areas where the species is routinely encountered. An exceptions is Monterey Bay, California (NMFS and FWS 1998b). These data suggest that leatherback sea turtles would be present in the marine analysis area in higher densities relative to other sea turtle species, but still in low densities overall.

Habitat

Adult leatherback turtles are highly migratory and available information indicates that eastern Pacific migratory corridors exist along the U.S. Pacific Coast (NMFS and FWS 1998b). The continental U.S. Pacific Coast may represent some of the most important foraging habitat in the world for the leatherback turtle (NMFS and FWS 1998b). Therefore, the marine analysis area is assumed to provide important habitat for leatherback turtles. Coastal upwelling of the California Current occurs along the Oregon Coast north of Cape Blanco. Peak numbers of leatherback turtles (July to September) occur in neritic zones when there are intermittent decreases in upwelling that allow surface water temperatures to increase to their warmest annual levels. Leatherback turtles aggregate in the warm, highly productive coastal areas to forage on their preferred prey, scyphomedusae, the cnidarian jellies (NMFS 2012d).

Critical Habitat

NMFS' final rule designated critical habitat within 25,004 square miles along the Washington and Oregon coasts from Cape Blanco, Oregon to Cape Flattery, Washington (NMFS 2012d). NMFS defined an area (Area 2) from Cape Blanco to Cape Flattery, including most of the Oregon coast, as a principal foraging area for leatherbacks. They feed on a variety of moon jellies and brown sea nettles that are present in high densities associated with the Columbia River Plume and Heceta Bank, Oregon. Based upon the best available scientific information, the features of Area 2 produce sufficient prey to provide forage for leatherback turtles that is essential to the conservation of the species, thus this area contains the prey PCE. Critical habitat extends to a water depth of 80 meters from the ocean surface and is delineated along the shoreline at the line of extreme low water offshore to the 2,000-meter depth contour. Critical habitat includes nearshore waters through which LNG carriers would transit to Coos Bay and the LNG Terminal.

3.4.2.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, underwater ship noise, and potential adverse effects from fuel spills at sea. Spills could indirectly affect leatherback turtles by impacting forage species. These effects are addressed below.

Ship Strikes by LNG Carriers

Sea turtles can be injured or killed when struck by a boat, especially if struck by an engaged propeller (NMFS and FWS 1998b). The proposed action would result in increased shipping traffic and may increase potential vessel strikes to leatherback sea turtles within the marine analysis area. However, the largest threat to leatherback turtles outside of their nesting grounds is entanglement in gill-nets and other incidental take. While Harris et al. (2011) reports 2 of 19 leatherback turtles examined had multiple parallel lacerations in the carapaces that had healed and were consistent with wounds from boat propellers, boat collisions are not listed as a current threat to the recovery of leatherback populations (NMFS 2017e). Risk of collision increases with increased vessel speed (Hazel et al. 2007), as discussed for green sea turtles, above. The risk was described for small craft but is unknown for large tankers.

The proposed action is expected to increase traffic by 240 additional ship transits through the marine analysis area each year of operation (inbound and outbound transits by 120 LNG carriers). Due to the known occurrence of the leatherback turtles in Oregon coastal waters, the addition of 240 LNG carrier transits through the marine analysis area may result in additional ship strike-related mortality or injury to leatherback turtles. The paucity of documented ship-strike incidences to sea turtles in general or frequencies of collision precludes any quantification of effects to leatherback turtles of additional vessel traffic due to LNG carriers. However, although the proposed action could result in additional potential for ship strike-related mortality or injury, these incidents are still expected to be rare occurrences, and thus the effects on leatherback turtles are discountable.

Underwater Noise

Loggerhead sea turtle hearing is most sensitive to lower frequencies below 1000 Hz (Bartol et al. 1999; Martin et al. 2012, Dow Piniak et al. 2012), within the same range of low frequencies generated by ships and sounds generated by large baleen whales (Würsig and Richardson 2009). As with green sea turtles, the same hearing sensitivity is assumed to be the case for leatherback turtles, and the effects are expected to be similar. See section 3.4.1, Green Turtle, above for a full discussion of these effects. With the existing levels of background shipping noise and the expected increase in shipping traffic, effects by LNG carrier-related noise on leatherback sea turtles are possible in the marine analysis area but the noise would be commensurate with existing noise levels and would not be expected to cause injury or any measurable effect.

Fuel Spills

Fuel or lubricants spilled from LNG carriers at sea, or released during normal operations such as bilge tank flushing, could impact both leatherback turtles and their jellyfish prey. Known effects of oil on turtles include direct mortality due to oiling in hatchlings, juveniles, and adults, and negative impacts to the skin, blood, digestive and immune systems, and salt glands (Milton et al. 2010). As described in section 3.4.1.3 for green turtles, direct effects of potential spills from LNG carriers are not comparable to spills from oil tankers because LNG carriers only carry quantities of oil used for propulsion fuel and not the quantities transported by oil tankers. However, low-level exposure to oil may still affect sea turtles, although effects related to specific toxicity levels have not been determined (Milton et al. 2010).

NMFS (2012d) identified LNG projects and oil spills as activities that may affect leatherback turtle prey within Area 2, which coincides with the nearshore habitat that would be transited by Project LNG carriers. Fuel and oil spilled by LNG carriers has the potential to affect leatherback turtles by altering prey abundance and prey contamination levels. However, as discussed above under green turtles, LNG carriers calling on the LNG Terminal would be required to comply with U.S. and International regulations regarding spill prevention. As a result, LNG carriers are not likely to contribute oil, fuel, or lubricants to the marine analysis area to the extent that would adversely affect leatherbacks or their prey species.

Cumulative Effects

Annual commercial ship traffic into and out of the Oregon International Port of Coos Bay has declined in recent years from a high of 310 deep-draft vessel calls in 1988 to 52 in 2016. The Port is also visited, by conservative estimates, by 50 tug/barge units per year, with 14 tug/barge units requesting pilotage during 2016 as per data from the Coos Bay Pilots Association (Whipple 2017).. However, even with the addition of 120 LNG carriers per year visiting the LNG Terminal, commercial ship traffic into Coos Bay would likely not reach historic levels.

As a result of this projected increase in vessel traffic, threats from ship strikes, underwater noise, and the effects of fuel spills are likely to increase. However, as discussed in section 3.2.1 for blue whales, it appears that the background rate of oil spills off the Oregon coast by fishing vessels, recreation vessels, and other vessel types is generally low, a frequency that would be expected to continue into the foreseeable future. According to annual reports published by the

Pacific States/British Columbia Oil Spill Task Force between 2002 and 2007, ODEQ reported an average of 37 spills annually from fishing, recreational, and other vessels.

With their spill prevention measures, LNG carriers are not likely to contribute oil, fuel, or lubricants to the marine analysis area to the extent that would adversely affect leatherback prey species. Additionally, although an increased likelihood of ship strikes are possible, the effects of these increases on leatherback turtles are expected to be unmeasurable. As a result, the cumulative effects of 120 LNG carriers transiting the marine analysis area combined with reasonably foreseeable non-Federal projects are expected to be insignificant.

Critical Habitat

Critical habitat has been designated within 25,004 square miles along the Washington and Oregon coasts from Cape Blanco, Oregon to Cape Flattery, Washington (NMFS 2012d). NMFS (2012d) defined an area (Area 2) from Cape Blanco to Cape Flattery, including most of the Oregon coast, as a principal foraging area for leatherbacks. Critical habitat coincides with nearshore waters through which LNG carriers would transit to Coos Bay and the LNG Terminal. The single PCE for this leatherback turtle critical habitat is the occurrence of prey species, primarily jellyfish, of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development (NMFS 2012d).

The proposed action could affect this PCE within critical habitat in the marine analysis area if a fuel or lubricant spill occurred from a LNG carrier. As discussed above under fuel spills, NMFS (2012d) identified LNG projects and oil spills as activities that may affect the PCE by altering prey abundance and prey contamination levels. However, with their spill prevention measures, LNG carriers are not likely to contribute oil, fuel, or lubricants to the marine analysis area to the extent that would adversely affect leatherback prey species. Fuels and lubricants are kept in relatively small quantities on ships and would not result in the types of effects associated with a spill from an oil tanker.

NMFS (2012d) identified potential effects of LNG Terminal construction and operation on the leatherback critical habitat PCE, including leaks and spills, disturbance of benthic habitat, and noise. Leaks, spills, and release of contaminants could affect water quality, but effects on the PCE are not known. However, these effects, if any, would be avoided and/or minimized as described in *Preliminary Spill Prevention, Containment, and Countermeasure Plan* (appendix F.2-Construction and appendix G.2-Operation in JCEP's Resource Report 2).

NMFS (2009d) stated that "Dredging and filling associated with construction and maintenance (to allow tanker passage) could have impacts on benthic habitat and possibly the early life stages of leatherback prey resources." However, the leatherback's prey species are open-ocean, broadcast spawners with pelagic larvae. There is no information in the literature that suggests the larvae would preferentially enter Coos Bay estuary, and if they did, there is likely nothing that would cause them to preferentially settle at the LNG Terminal. Also, Shanks et al (2010 and 2011) did not report collection of significant numbers of larval scyphozoans that would support the polypoid stage of the jellyfish commonly consumed offshore by leatherback turtles. Given the aerial extent available for larval settlement and polyp development along the Oregon and Washington coast, the loss of substrate from the dredging for the LNG Terminal footprint would have no impact on leatherback foodstocks.

For the same reason that dredging would not measurably impact the larval stages of leatherback turtle's foods, noise levels associated with construction would also not measurably impact these life stages, and would therefore have no impact on leatherback food sources.

3.4.2.4 Conservation Measures

Measures to reduce ship speeds once inside the Coos Bay navigation channel to between 4 to 6 knots and within the marine analysis area when pods or large assemblages of cetaceans are observed near an underway ship would provide some protection to leatherback turtles. However, it is highly unlikely that leatherbacks or other sea turtles would be seen from a LNG carrier. Nevertheless, the same Ship-Strike Reduction Plan, including marine mammal avoidance guidelines that was described in section 3.2.1.4 (blue whale) apply to leatherback turtles.

3.4.2.5 Determination of Effects

Species

The Project **may affect** leatherback turtles because:

- leatherback turtles may occur within the marine analysis area during operation of the proposed action;
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area; and
- the continental U.S. Pacific Coast provides important foraging habitat for this species.

However, the Project is **not likely to adversely affect** leatherback turtles because:

- there is limited evidence that leatherback turtles have been struck by ships, and a measurable increase in collision potential as a result of the proposed action is expected to be highly unlikely;
- JCEP would provide a ship strike avoidance measures package to shippers calling on the LNG Terminal that consists of multiple measures to avoid striking marine mammals, which should also benefit sea turtles;
- LNG carriers approaching Coos Bay would be traveling slowly and escorted by tractor tugs from 5 nmi offshore to the LNG Terminal, limiting impacts to foraging leatherback turtles; and
- noise produced by LNG carriers would contribute to overall noise within the marine analysis area en route to Coos Bay and increased ship noise could affect leatherback turtle behavior. However, the noise levels of the LNG carriers would be comparable to the noise levels of existing ship traffic and would be infrequent enough so as not to cause injury or result in behavioral changes.

Critical Habitat

The Project **may affect** critical habitat for the leatherback turtle because:

- the marine analysis area that would be transited by LNG carriers includes coastal marine waters between Coos Bay, Oregon and Cape Flattery, Washington, that are designated critical habitat; and

However, the Project is **not likely to adversely affect** critical habitat for the leatherback turtle because:

- disturbance of benthic habitats within Coos Bay due to dredging would be of sufficiently short duration and small scale relative to the area available for settlement of larvae of the scyphozoan prey species within Area 2 that effects on PCE 1 would be unmeasurable and would therefore be are insignificant.

3.4.3 Olive Ridley Turtle

3.4.3.1 Species Account and Critical Habitat

Status

Olive ridley turtles were listed as threatened, except for the breeding colony populations on the Pacific coast of Mexico, which were listed as endangered, under the ESA on July 28, 1978 (FWS 1978).

Threats

Direct threats to the species include the harvesting of sea turtles and their eggs and incidental capture in fishing gear (NMFS 2017f). Olive ridley turtle eggs were collected at first by indigenous people and then for economic gain to sell in markets once the eggs were found to have commercial value (NMFS and FWS 1998c). Another market was created that used olive ridley turtle leather that aided in the demise and ultimately the listing of the olive ridley turtle as threatened/endangered (NMFS and FWS 1998c).

Natural disasters, debris entanglement and ingestion, and incidental take from domestic fisheries are listed as minor threats to olive ridley turtles (NMFS and FWS 1998c). Primary threats to olive ridley turtles off the continental U.S. Pacific Coast include incidental take from commercial fishing and boat collisions usually involving smaller boats (NMFS and FWS 1998c). The more frequent occurrence of El Niño and general warming trends in the Pacific may be the reason that the zooplankton in the California Current are declining, resulting in the reduction of higher level vertebrates and other foods for the turtles to forage on (Plotkin 1995).

Species Recovery

A recovery plan was issued in 1998. The recovery goal (NMFS and FWS 1998c) is to delist the species, and the plan listed the following necessary actions:

- Minimize incidental mortalities of turtles by commercial fishing operations;
- Support the efforts of Mexico and the countries of Central America to census and protect nesting olive ridleys, their eggs, and nesting beaches; and
- Identify stock home ranges using DNA analysis.

The stepdown outline in the recovery plan included the following recommendations:

- Protect and manage turtles on nesting beaches;
- Protect and manage nesting habitat;
- Protect and manage olive ridley populations in the marine habitat;
- Protect and manage marine habitat, including foraging habitats;

- Develop standards for the care and maintenance of sea turtles, including diet, water quality, tank size, and treatment of injury and disease;
  - Establish a catalog of all captive sea turtles to enhance use for research and education.
  - Designate rehabilitation facilities;
  - Support existing international agreements and conventions to ensure that turtles in all life-stages are protected in foreign waters;
  - Encourage ratification of CITES for all non-member Pacific countries, compliance with CITES requirements, and removal of sea turtle trade reservations held by member nations;
  - Develop new international agreements to ensure that turtles in all life-stages are protected in foreign waters; and
- Develop or continue to support informational displays in airports that provide connecting legs for travelers to the areas, which support olive ridleys.

Life History, Habitat Requirements, and Distribution

The olive ridley is primarily a pelagic sea turtle, but does occasionally inhabit coastal areas such as bays and estuaries. Olive ridleys undertake an annual migration from open-ocean foraging grounds to coastal breeding and nesting grounds. Olive ridley turtles are well known for their arribada behavior where hundreds to tens of thousands of ridley turtles emerge synchronously from the ocean over a few days to nest in close proximity (NMFS 2017f).

Olive ridleys have been observed as far as 2,400 miles from shore. Adult turtles are small compared to other sea turtles, with an average weight of approximately 100 pounds. The olive ridley feeds on a variety of food items, including algae, lobster, crabs, tunicates, mollusks, shrimp, and fish. Females nest each year after reaching sexual maturity at about age 15. They nest one to three times per season, producing clutches of approximately 100 eggs each time. Incubation of the eggs generally takes between 50 and 60 days.

Population Status

The olive ridley is considered the most abundant sea turtle in the world, with an estimated 800,000 females nesting annually. However, there has been an estimated 50 percent reduction in population since the 1960s (Marine Turtle Specialist Group 2004 in NMFS 2017f). The eastern Pacific population that nests in El Salvador, Guatemala, Costa Rica, and Panama has declined since the 1970s. However, since Mexico banned harvest of nesting females and eggs, the nesting population at La Escobilla, Oaxaca, Mexico increased from 50,000 nests in 1988 to more than 1 million nests in 2000 (NMFS 2017f). At-sea estimates of density and abundance of olive ridley turtles were conducted along the Mexico and Central American coasts from 1992 to 2006. The yearly weighted average was 1.39 million in the eastern Pacific and consistent with increased nesting prior to 2007 (NMFS and FWS 2007b).

Critical Habitat

Critical habitat has not been designated for this species.

3.4.3.2 Environmental Baseline

Analysis Area

The analysis area applicable to olive ridley turtles is the area directly off of Coos Bay out to the continental shelf break, which is represented as a depth of 200 meters, the same marine analysis area as described above for green sea turtles and blue whales (see figure 2.1.1-2).

Species Presence

At-sea occurrences in waters under U.S. jurisdiction are limited to the West Coast of the continental United States and Hawaii, where the species is rare, but possibly increasing. This species does not nest in the United States, but during feeding migrations, olive ridley turtles nesting in the East Pacific may disperse into waters off the Pacific west coast as far north as Oregon (FWS 2013f). Olive ridleys have occasionally been killed by gill-nets and boat impacts as well as cold-stunning (or cold-stranding due to hypothermia by rapid decline of water temperatures) in Oregon and Washington (NMFS and FWS 1998c). Based on sightings off the Oregon coast, olive ridley turtles may occasionally occur in the marine analysis area.

Habitat

Little is known about the abundance and distribution of olive ridley turtles in the northeastern Pacific. Important foraging grounds have not been identified although forage areas most likely exist along the coast of Baja California and Southern California (NMFS and FWS 1998c). Less is known about the potential importance of Oregon waters and the marine analysis area to olive ridley turtles.

Critical Habitat

Critical habitat has not been designated for this species.

3.4.3.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, underwater ship noise, and potential adverse effects from fuel spills at sea. These effects are addressed below.

<u>Ship Strikes by LNG Carriers</u>

The proposed action would result in increased shipping traffic and may increase potential vessel strikes to olive ridley turtles within the marine analysis area. Boat collisions are listed as a moderate problem for olive ridley turtle recovery off the continental U.S. Pacific Coast (NMFS and FWS 1998c). Sea turtles can be injured or killed when struck by a boat, especially by an engaged propeller. Risk of collision with sea turtles increases with increased vessel speed (Hazel et al. 2007), as discussed for green sea turtles, above. However, methods for reducing boat collisions are not included in recovery objectives, and based on their warm water requirements, olive ridley sea turtles are likely only occasional, transient visitors to waters as far north as Oregon.

The proposed action is expected to increase traffic by 240 additional ship transits through the marine analysis area each year of operation (inbound and outbound transits by 120 LNG carriers). Given the low population and occurrence of the olive ridley turtles in Oregon coastal waters and current estimate of vessel traffic, the addition of 240 LNG carrier transits through the marine analysis area is not expected to result in measurable additional ship strike-related mortality or injury to olive ridley turtles. However, lack of ship-strike incidences to sea turtles in general or frequencies of collision precludes any estimate of effects to olive ridley turtles of additional vessel traffic due to LNG carriers.

Underwater Noise

As with green sea turtles, the same hearing sensitivity is assumed to be the case for olive ridley turtles, and the effects are expected to be similar. See section 3.4.1, Green Turtle, above for a full discussion of these effects. With the existing levels of background shipping noise and the expected increase in shipping traffic, effects by LNG carrier related noise on olive ridley turtles are possible in the marine analysis area but the noise would be commensurate with existing noise levels and would not be expected to cause injury.

Fuel Spills

Oil, fuel, or lubricant spills from an LNG carrier at sea could impact both olive ridley turtles and forage species such as benthic invertebrates and fish as described above for green turtles. However, these products are kept in relatively small quantities onboard LNG carriers. Additionally, LNG carriers carry spill kits to prevent or minimize the release of oil, fuel, and lubricants as described under blue whales in section 3.2.1.3. As a result, effects of oil, fuel, and lubricants on loggerhead turtles are expected to be insignificant and discountable.

Cumulative Effects

In addition to the fishing fleet housed in Charleston Marina, current commercial traffic into Coos Bay includes about 50 deep-draft cargo ships and 50 barges. However, even with the addition of 120 LNG carriers per year visiting the LNG Terminal, commercial ship traffic into Coos Bay would probably not reach historic levels.

Also, as discussed above for blue whales, it appears that the background rate of spills off the Oregon coast by fishing vessels, recreation vessels, and other vessel types is generally low, a frequency that would be expected to continue into the foreseeable future. With their double hulls, onboard spill kits, and spill prevention measures, LNG carriers are not likely to contribute to oil spills in the marine analysis area or waterway to the extent that may affect aquatic species.

As a result of this projected increase in vessel traffic, threats from ship strikes, underwater noise, and the effects of fuel spills are likely to increase. However, given that olive ridley turtles occur infrequently in the marine analysis area, cumulative effects are not expected even if an increasing trend in vessel traffic is observed, because any effects are expected to be unmeasurable and thus insignificant.

Critical Habitat

No critical habitat would be affected by the proposed action as none has been designated.

3.4.3.4 Conservation Measures

Measures to reduce ship speeds once inside the Coos Bay navigation channel to between 4 to 6 knots and within the marine analysis area when pods or large assemblages of cetaceans are observed near an underway ship would provide some protection to olive ridley turtles. However, it is highly unlikely that olive ridleys or other sea turtles would be seen from a LNG carrier. Nevertheless, the same Ship-Strike Reduction Plan, including marine mammal avoidance guidelines, that was described in section 3.2.1.4 (blue whale) applies to olive ridley turtles.

3.4.3.5 Determination of Effects

Species

The Project **may affect** olive ridley turtles because:

- olive ridley turtles may occur within the marine analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) within the marine analysis area.

However, the Project is **not likely to adversely affect** olive ridley turtles because:

- the increase in annual ship traffic due to the proposed action is expected to cause an immeasurable increase for potential ship strikes to olive ridley turtles;
- JCEP would provide a ship strike avoidance measures package to shippers calling on the LNG Terminal that consists of multiple measures to avoid striking marine mammals, which should also benefit sea turtles;
- LNG carriers approaching Coos Bay would be traveling slowly and escorted by tractor tugs from 5 nmi offshore to the LNG Terminal; and
- noise produced by LNG carriers would contribute to overall noise within the marine analysis area en route to Coos Bay and increased ship noise could affect olive ridley turtle behavior. However, JCEP expects the noise levels of the LNG carriers would be comparable to the noise levels of existing ship traffic and would be infrequent enough so as not to cause injury or result in behavioral changes.

Critical Habitat

No critical habitat has been designated or proposed for the olive ridley turtle.

3.4.4 Loggerhead Turtle

3.4.4.1 Species Account and Critical Habitat

Status

Loggerhead turtles were listed as threatened under the ESA in 1978 (FWS 1978). In 2011, NMFS (2011e) published a final rule in which the agencies determine loggerhead sea turtles are composed of nine DPSs distributed worldwide; four DPSs are listed as threatened and five are listed as endangered. The North Pacific Ocean DPS is listed as endangered (NMFS 2017g).

Threats

The two biggest threats to the loggerhead turtle are incidental capture in fishing gear and directed harvesting. There is no information about direct take of the loggerhead turtle, although is it assumed to be nonexistent in the continental U.S. Pacific Coast because of the species' rarity. Reasons for listing the loggerhead turtle include direct harvest in the Bahamas, Cuba, and Mexico as well as incidental capture of turtles in commercial fishing gear (NMFS 2017g).

The primary threats to loggerhead turtles on the continental U.S. Pacific Coast include natural disasters and incidental take from commercial fishing operations (NMFS and FWS 1998d). Minor threats to loggerhead turtles on the continental U.S. Pacific Coast include natural disasters, environmental contaminants, debris entanglement and ingestion, and power plant entrapment (NMFS and FWS 1998d). Threats with an unknown degree of significance on the continental U.S. Pacific Coast include predation, boat collision, and oil exploration and development (NMFS and FWS 1998d). Dredging is listed as another important potential threat to loggerhead turtles, as they spend much of their time in continental shelf waters closer to shoreline looking for food (Plotkin 1995).

Species Recovery

A recovery plan was issued on May 22, 1998 (NMFS and FWS 1998d). The recovery goal is to delist the species, and the plan listed the following necessary actions:

- Reduce incidental capture of loggerheads by coastal and high seas commercial fishing operations;
- Establish bilateral agreements with Japan and Mexico to support their efforts to census and monitor loggerhead populations and to minimize impacts of coastal development and fisheries on loggerhead stocks;
- Identify stock home ranges using DNA analysis;
- Determine population size and status (in U.S. jurisdiction) through regular aerial or on-water surveys; and
- Identify and protect primary foraging areas for the species.

The stepdown outline in the recovery plan included the following recommendations:

- Protect and manage turtles on nesting beaches;
- Protect and manage nesting habitat;
- Protect and manage loggerhead populations in the marine habitat;
- Protect and manage marine habitat, including foraging habitats;
- Develop standards for the care and maintenance of sea turtles, including diet, water quality, tank size, and treatment of injury and disease;
- Establish a catalog of all captive sea turtles to enhance use for research and education;
- Designate rehabilitation facilities;
- Support existing international agreements and conventions to ensure that turtles in all life-stages are protected in foreign waters;
- Encourage ratification of CITES for all non-member Pacific countries, compliance with CITES requirements, and removal of sea turtle trade reservations held by member nations;

- Develop new international agreements to ensure that turtles in all life-stages are protected in foreign waters; and
- Develop or continue to support informational displays in airports and other ports of call that provide connecting legs for travelers to the area.

Life History, Habitat Requirements, and Distribution

Loggerhead turtles occur throughout temperate and tropical regions of the Atlantic, Pacific, and Indian Oceans. They are the most abundant sea turtle found in U.S. coastal waters, although they are much more prevalent on the Atlantic than Pacific Coasts, with major nesting areas being present in Florida. In the North Pacific, loggerhead nesting has only been documented in Japan but may also occur on beaches of the South China Sea (NMFS 2011e). Turtles hatching on Japanese beaches enter the Kuroshio and North Pacific Currents and develop during migration; some reach the eastern Pacific and Baja California. Foraging areas have been documented off the coast of Baja California, Mexico (NMFS 2011e). Adult loggerheads typically prey on benthic invertebrates in hard bottom habitats, although fish and plants are occasionally taken (NMFS and FWS 1998d). Evidence indicates that loggerhead turtles hatching in Japan remain in the North Pacific Basin for their entire life cycle, never crossing the equator into the South Pacific Basin (NMFS 2011e).

Loggerheads reach sexual maturity at around 35 years of age. In the southeastern United States, mating occurs in late March to early June and females lay eggs between late April and early September. Females generally lay three to five nests per season. The eggs incubate approximately 2 months before hatching between late June and mid-November. Hatchlings move from their nest to the surf, swim and are swept through the surf zone, and continue swimming away from land for about one to several days. Post-hatchlings within this habitat are float-and-wait foragers feeding on a wide variety of floating food items. From these relatively nearshore habitats, juvenile turtles are swept into the open ocean by currents. Between the ages of 7 and 12 years, oceanic juveniles migrate to nearshore coastal areas where they remain until reaching adulthood.

Population Status

In the United States, loggerhead turtles lay an estimated 68,000 to 90,000 eggs per year on the east and Gulf coasts. There is no known nesting of loggerhead turtles on the U.S. Pacific Coast. Occasional cold-strandings occur in Washington and Oregon and incidental take by fisheries probably occurs (NMFS and FWS 1998d). In the eastern Pacific, loggerheads have been reported as far north as Alaska. In the U.S., occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California. The west coast of Mexico, including the Baja Peninsula, provides critically important developmental habitats for juvenile loggerheads. Records of females in the North Pacific Oceans DPS nesting on Japanese beaches indicate numbers increased from the late 1990s through 2005 but declined in 2006 and 2007 (Conant et al. 2009).

Critical Habitat

Critical habitat has not been designated for this species.

3.4.4.2 Environmental Baseline

Analysis Area

The analysis area applicable to loggerhead turtles is the area directly off Coos Bay out to the continental shelf break, which is represented as a depth of 200 meters, the same marine analysis area as described above for green turtles and blue whales (see figure 2.1.1-2).

Species Presence

Loggerhead turtles are rarely sighted along the Pacific Coast near the Project area. Individuals found in western US Pacific Coast waters likely originate on Japanese nesting grounds (NMFS and FWS 1998d). In the United States, occasional sightings are reported from the coasts of Washington and Oregon, but most records are of juveniles off the coast of California. The most recent record of a loggerhead in Oregon waters was on February 13, 2017 of a nearly comatose individual that died shortly after being rescued by the Oregon Coast Aquarium (KCBY 2017). Therefore, based on sightings and documented strandings, loggerhead turtles are likely infrequent visitors to the marine analysis area. The California/Oregon (CA/OR) drift gillnet fishery (for swordfish and thresher shark) was observed to incidentally capture 17 loggerheads (12 released alive, one injured, and four killed) from 1990 to 2000. Based on a worst-case scenario, NMFS estimated that a maximum of 33 loggerheads in a given year are possibly incidentally taken by the CA/OR drift gillnet fleet (Conant et al. 2009).

Habitat

The fact that juveniles are captured incidentally in longlines and driftnets in the pelagic Pacific indicates that the species' range includes coastal and pelagic waters (NMFS and FWS 1998d). The potential importance of Oregon waters and the marine analysis area to loggerhead turtles is unknown. Loggerheads are likely to move into the U.S. Pacific coast from Baja California as they follow preferred prey species, the pelagic red crab (Conant et al. 2009).

Critical Habitat

Critical habitat has not been established for this species.

3.4.4.3 Effects of the Proposed Action

Direct and Indirect Effects

Direct effects of the proposed action include injury and/or mortality due to ship strikes, underwater ship noise, and potential adverse effects from fuel spills. Dredging for the Navigation Reliability Improvements, LNG slip and access channel could also affect loggerhead turtles if they are present in Coos Bay. These effects are addressed below.

<u>Ship Strikes by LNG Carriers</u>

The proposed action would result in increased shipping traffic and may increase potential vessel strikes to loggerhead sea turtles within the analysis area. However, the largest threat to loggerhead turtles outside of their nesting grounds is entanglement in gill-nets and other incidental take. Boat collisions are listed as a threat with unknown significance to the recovery of loggerhead populations (NMFS and FWS 1998d). However, risk of collision with sea turtles increases within increased vessel speed (Hazel et al. 2007), as discussed for green sea turtles, above.

The proposed action is expected to increase traffic by 240 additional ship transits through the marine analysis area each year of operation (inbound and outbound transits by 120 LNG carriers). Given the low population and occurrence of the loggerhead turtles in Oregon coastal waters and current estimate of vessel traffic, the addition of 240 LNG carrier transits through the marine analysis area is not expected to result in measurable additional ship strike-related mortality or injury to loggerhead turtles. However, lack of ship-strike incidences to sea turtles in general or frequencies of collision precludes any estimate of effects to loggerhead turtles of additional vessel traffic due to LNG carriers.

Underwater Noise

Loggerhead sea turtles can detect sound and their hearing is most sensitive to lower frequencies below 1000 Hz (Bartol et al. 1999; Martin et al. 2012), within the same range of low frequencies generated by ships and sounds generated by large baleen whales (Würsig and Richardson 2009). Effects of underwater noise to loggerhead sea turtles are expected to be similar to those described above under the green turtle (section 3.4.1). With the existing levels of background shipping noise, effects by project LNG tanker-related noise on loggerhead sea turtles are possible in the marine analysis area but the noise would be commensurate with existing noise levels and would not be expected to cause injury.

Fuel Spills

Environmental contaminants are listed as a minor threats to loggerhead turtles on the continental U.S. Pacific Coast (NMFS and FWS 1998d). Oil, fuel, or lubricant spills from an LNG carrier at sea could impact both loggerhead turtles and forage species such as benthic invertebrates and fish as described above for green turtles. However, these products are kept in relatively small quantities onboard LNG carriers. Additionally, LNG carriers carry spill kits to prevent or minimize the release of oil, fuel, and lubricants as described under blue whales in section 3.2.1.3. As a result, effects of oil, fuel, and lubricants on loggerhead turtles are expected to be insignificant and discountable.

Dredging

Dredging is listed as an important potential threat to loggerhead turtles, as they spend much of their time in continental shelf waters closer to shoreline looking for food (Plotkin 1995) and adult loggerheads typically prey on benthic invertebrates (NMFS and FWS 1998d). However, because loggerhead turtles are not likely to occur either offshore or within Coos Bay, there is essentially no potential that dredging activity would affect loggerhead individuals or have an effect on the population of loggerheads.

Cumulative Effects

In addition to the fishing fleet housed in Charleston Marina, current commercial traffic into Coos Bay includes about 50 deep-draft cargo ships and 50 barges. While this may remain constant for the near term, in the future non-fishing commercial traffic into Coos Bay may increase if the Port is able to make its planned improvements to attract new customers. However, even with the addition of 120 LNG carriers per year visiting the LNG Terminal, commercial ship traffic into Coos Bay would probably not reach historic levels.

As a result of this projected increase in vessel traffic, , threats from ship strikes, underwater noise, and the effects of fuel spills are likely to increase. However, as loggerhead turtles are likely infrequent, transient visitors to the analysis area and the Oregon coast, cumulative effects from 120 LNG carriers transiting the analysis area combined with reasonably foreseeable non-federal projects are expected to be insignificant and discountable.

Critical Habitat

No critical habitat would be affected by the proposed action; none has been designated.

3.4.4.4 Conservation Measures

Measures to reduce ship speeds once inside the Coos Bay navigation channel to between 4 to 6 knots and within the marine analysis area when pods or large assemblages of cetaceans are observed near an underway ship would provide some protection to loggerhead turtles. However, it is highly unlikely that loggerheads or other sea turtles would be seen from a LNG carrier. Nevertheless, the same Ship-Strike Reduction Plan, including marine mammal avoidance guidelines, that was described in section 3.2.1.4 (blue whale) apply to loggerhead turtles.

3.4.4.5 Determination of Effects

Species

The Project **may affect** loggerhead turtles because:

- loggerhead turtles may occur within the analysis area during operation of the proposed action; and
- the proposed action would increase shipping traffic (LNG carriers) within the analysis area.

However, the Project is **not likely to adversely affect** loggerhead turtles because:

- whether or not loggerhead turtles have been struck by ships is unknown but is expected to be highly unlikely;
- the increase in annual ship traffic due to the proposed action is expected to cause an immeasurable increase for potential ship strikes to loggerhead turtles;
- JCEP would provide a ship strike avoidance measures package to shippers calling on the LNG Terminal that consists of multiple measures to avoid striking marine mammals, which should also benefit sea turtles;
- LNG carriers approaching Coos Bay would be traveling slowly and escorted by tractor tugs from 5 nmi offshore to the LNG Terminal; and
- noise produced by LNG carriers would contribute to overall noise within the analysis area en route to Coos Bay and increased ship noise could affect loggerhead turtle behavior. However, the noise levels of the LNG carriers would be comparable to the noise levels of existing ship traffic and would be infrequent enough so as not to cause injury or result in behavioral changes.

Critical Habitat

No critical habitat has been designated or proposed for the loggerhead turtle.

3.4.5 Oregon Spotted Frog

3.4.5.1 Species Account and Critical Habitat

Status

The Oregon spotted frog was listed as threatened under the ESA in August 2014 (FWS 2014e). The species had been proposed for listing in August 2013 (FWS 2013h), and petitioned for listing in May 2004 with a positive (warranted but precluded) 90-day finding issued in 2005, and had been a candidate species since then with Listing Priority of 2 (imminent with high magnitude of threat, see FWS 2011e).

Threats

Oregon spotted frogs may be extirpated from as much as 90 percent of their historically documented range including all historical locations in California (FWS 2014e). Thirty to 85 percent of the species' wetland habitats have been lost across its range. Sources of loss include draining wetlands, water diversions, conversion of wetlands to agriculture and livestock grazing, developments adjacent to occupied habitats that alter seasonal hydrology (through creation of impervious surfaces), and occurrence of droughts which have become more frequent in parts of the species' range. Also, riverine functions that promote early successional wetland habitats have been altered including connectivity with floodplains. Beaver activities had contributed to historical mosaic of aquatic habitats and fires burning in summer influenced shallow water breeding habitats the following spring (FWS 2013h).

Introductions of exotic species, including reed canarygrass that degrades native wetland vegetation, and nonnative predators including bullfrogs and warm water fish species have been and continue to threaten the species. Chytrid fungus infections have been documented in Oregon spotted frog populations in all of the sites sampled, including five sites located in the Klamath Basin (Pearl et al. 2009). Declines in various amphibian populations have been associated with fungal infections and may have contributed to the demise of Oregon spotted frog populations although some populations appear to be resistant (Padgett-Flohr and Hayes 2011). There may be additional pathogens that affect Oregon spotted frogs (FWS 2013h).

Species Recovery

The species has been listed as threatened; however, no recovery plan has been published. A Conservation Agreement to conserve Oregon spotted frogs in the Klamath Basin has been developed by the FWS, Forest Service, and BLM (FWS et al. 2010) with the objectives to:

> "1) manage occupied habitat in a manner that sustains and/or restores its ability to support Oregon spotted frog populations; 2) stabilize or increase populations within the Klamath Basin; 3) reduce threats; and 4) increase distribution among available suitable habitats by restoring or creating habitat."

Implementing the conservation agreement has focused on a bullfrog eradication program on Crane Creek since bullfrogs appeared in 2010, and controlling and reducing bullfrogs and analyzing the gut contents of bullfrogs at all life stages on BLM lands at Wood River. While the number of bullfrogs removed and seen at that site has decreased, bullfrog removal has also focused on areas outside the Oregon spotted frog site that are considered to be the strongest source areas for movement into the Oregon spotted frog site (FWS 2013h). Despite these efforts, bullfrogs continue to persist in these Oregon spotted frog habitats in the Klamath Basin (FWS 2013h).

Life History, Habitat Requirements, and Distribution

The current range of Oregon spotted frogs extends from the Fraser River subbasin in southern British Columbia (Haycock 2000) and adjacent areas in Whatcom County, Washington, south through the Puget Trough lowlands, through the Willamette Valley, to southeast Oregon including Jackson and Klamath counties, and adjacent areas in the Pit River subbasin of northern California (FWS 2011e).

Spotted frogs inhabit perennial water bodies such as springs, ponds, lakes or slow moving streams and are usually associated with nonwoody, herbaceous wetland vegetation communities composed of sedges, rushes and grasses (Leonard et al. 1993). Several aspects of the Oregon spotted frog's life history have been proposed as contributing to the species' vulnerability to habitat alterations (FWS 2011e): 1) communal egg laying at sites used year after year restricts the number of reproductive sites; 2) the species' warm water requirement results in habitat overlap with introduced warm water fish; 3) the active season warm water requirement may limit suitable habitat in the cool climates of the Pacific Northwest; 4) the species may be vulnerable to the potential loss or alteration of springs used for overwintering; and 5) changes that increase deep, permanent water components are likely to favor establishment of non-native bullfrogs and fish, both of which may be detrimental to Oregon spotted frogs.

In lower elevations of Washington and Oregon, breeding occurs during February and March; at higher elevations breeding occurs in late May or early June (Leonard et al. 1993). Oregon spotted frogs typically oviposit communally; males may gather in large groups at a location and females lay eggs adjacent to or attached to other egg masses which are only partially submerged. These aggregations can contain eggs from 100 or more females in larger populations (FWS 2011e). Spotted frogs use traditional oviposition sites, year after year. Such sites may have limited availability because of unique characteristics and adults may have limited flexibility to switch sites if they become unsuitable. That possibility makes the Oregon spotted frog particularly vulnerable to habitat changes at oviposition sites (FWS 2011e).

Population Status

Population estimates in most subbasins inhabited by Oregon spotted frogs are insufficient to derive any trends (FWS 2013h). The best available information indicates declining populations in the lower Fraser River in British Columbia and Middle Klickitat subbasin in Washington, but an undetermined trend in Oregon (FWS 2013h).

In 2012, there were an estimated 7,368 breeding adults at five extant population sites in Washington and 12,847 breeding adult Oregon spotted frogs at 8 extant population sites in Oregon (FWS 2014e). In Oregon the species’ extant distribution includes 22 sites in the Central Oregon Cascades (with the largest population of 500 to 2,500 breeding females at two sites) and nine sites in the Klamath Basin (FWS 2011e). In 2005, personnel with the Forest Service surveyed 28 different sites in Lake, Klamath, and Jackson counties but no new Oregon spotted frogs were found. Data from the Klamath Basin suggests that one population has declined since 2000, two populations appear stable, and five sites do not have enough data to determine trend, including the Buck Lake site. However, FWS (2014e) note that surveys conducted at Buck Lake suggest a population decline and have documented most recently small numbers of egg masses

(38 masses in 2010), or the equivalent of 76 breeding individuals (male and female) (cited in FWS 2014e). The minimum population estimate for this Klamath sub-basin was estimated to be 112 breeding individuals in 2014 suggesting drastic population declines since 1998 (FWS 2014e). The Buck Lake site is isolated from all other Oregon spotted frog populations with little or no chance for genetic interchange or re-colonization; there is no hydrologic connectivity to other occupied habitats in the Klamath Basin (FWS 2011e).

Critical Habitat

Critical habitat for the Oregon spotted frog was finalized in May 2016 (FWS 2016c). In June 2014, FWS proposed to expand four of the proposed critical habitat units based on new information, including occupancy of those areas by Oregon spotted frogs (FWS 2014e). The expanded critical habitat units are included in the final rule. The units include critical habitat in Washington (Units 1 through 6) and in Oregon (Units 7 through 14). The Buck Lake site is within designated critical habitat Unit 14: Upper Klamath, Oregon. The Upper Klamath Unit 14 consists of 262 acres of lakes and creeks in Klamath and Jackson Counties, Oregon. In Klamath County, Oregon, Buck Lake critical habitat includes seasonally wetted areas adjacent to the western edge of Buck Lake encompassing Spencer Creek downstream due west of Forest Service Road 46, three unnamed springs, and Tunnel Creek (FWS 2016c), shown in figure 3.4.5-1.

FWS (2016c) determined that the PCEs specific to the Oregon spotted frog are:

1. PCE-1 (applicable to the following seasonal life stage periods – Nonbreeding (N), Breeding (B), Rearing (R), and Overwintering Habitat (O)) is ephemeral or permanent bodies of freshwater, including, but not limited to natural or manmade ponds, springs, lakes, slow-moving streams, or pools or oxbows within or adjacent to streams, canals, and ditches, that have one or more of the following characteristics:
    - Inundated for a minimum of 4 months per year (B, R) (timing varies by elevation but may begin as early as February and last as long as September);
    - Inundated from October through March (O);
    - If ephemeral, areas are hydrologically connected by surface water flow to a permanent water body (e.g., pools, springs, ponds, lakes, streams, canals, or ditches) (B, R);
    - Shallow water areas (less than or equal to 30 centimeters (cm) (12 inches), or water of this depth over vegetation in deeper water (B, R);
    - Total surface area with less than 50 percent vegetative cover (N);
    - Gradual topographic gradient (less than 3 percent slope) from shallow water toward deeper, permanent water (B, R);
    - Herbaceous wetland vegetation (i.e., emergent, submergent, and floating leaved aquatic plants), or vegetation that can structurally mimic emergent wetland vegetation through manipulation (B, R);
    - Shallow water areas with high solar exposure or low (short) canopy cover (B, R);
    - An absence or low density of nonnative predators (B, R, N).
2. PCE 2 is aquatic movement corridors. Ephemeral or permanent bodies of fresh water that have one or more of the following characteristics:
    - Less than or equal to 5 kilometers (3.1 miles) linear distance from breeding areas;

- Impediment free (including, but not limited to, hard barriers such as dams, biological barriers such as abundant predators, or lack of refugia from predators).

3. PCE 3 is refugia habitat. Nonbreeding, breeding, rearing, or overwintering habitat or aquatic movement corridors with habitat characteristics (e.g., dense vegetation and/or an abundance of woody debris) that provide refugia from predators (e.g., nonnative fish or bullfrogs).

3.4.5.2 Environmental Baseline

Analysis Area

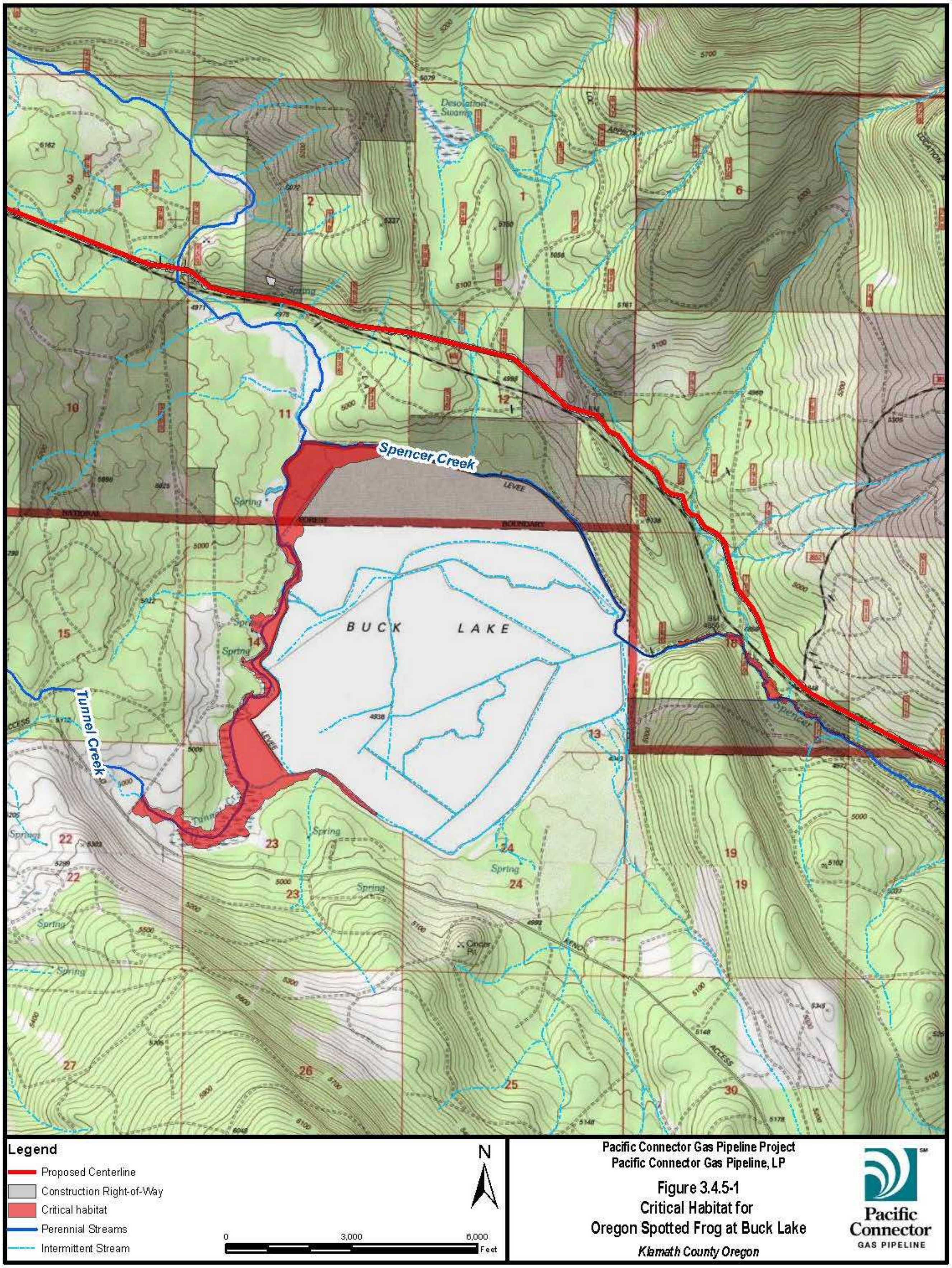
The analysis area for Oregon spotted frogs includes two components 1) Spencer Creek from the point where it is proposed to be crossed by the Pipeline, downstream to the maximum extent of Pipeline project effects (1,450 feet) and 2) the riparian zone associated with Spencer Creek.

Similar to listed fish species, the first component of the analysis area for Oregon spotted frogs is the Spencer Creek riverine analysis area associated with Spencer Creek and Buck Lake. This component of the analysis area includes the water column and substrate of Spencer Creek to the extent downstream of the proposed crossing where water quality could be adversely affected by turbidity generated during construction, and from sediment generated by runoff from the construction right-of-way. The associated riparian zone of Spencer Creek is included in the analysis area over the short-term during construction, and in the long-term by operation.

Construction across Spencer Creek is expected to mobilize silt, assumed to be the predominant substrate particle at the crossing location. As discussed below in the description of potential effects, the downstream distance that silt particles would be expected to settle out of the water column during construction using the proposed dam-and-pump crossing method, is estimated to be 1,450 feet (based on assumptions and estimation procedures below). Consequently, the Spencer Creek riverine analysis area would extend 1,450 feet downstream from the point of construction.

Species Presence

As of 2016, Oregon spotted frogs continued to inhabit Buck Lake. Oregon spotted frogs were first documented in 1994 at Buck Lake in the Winema National Forest and adjacent private lands in a canal on the northwestern edge of Buck Lake and on BLM lands within Tunnel Creek (Forest Service and BLM 1995), inhabiting the channelized portion of the perennial stream that enters the Buck Lake basin from the southwest. Forest Service and BLM (1995) indicated that these were the only sites in the Spencer Creek watershed likely to be inhabited by Oregon spotted frogs. However, FWS (2016c) indicated that Spencer Creek from Buck Lake downstream approximately 1.6 miles to the intersection of FS Road 46 and Clover Creek Road is also occupied by the Oregon spotted frog (FWS 2016c), including 15 acres of BLM and NFS lands and 2 acres of private land. At its closest location to the Project, this occupied habitat is 280 feet from the right-of-way, although Clover Creek Road separates the right-of-way from Spencer Creek (figure 3.4.5-1).



Pacific Connector Gas Pipeline Project
Pacific Connector Gas Pipeline, LP

Figure 3.4.5-1
Critical Habitat for
Oregon Spotted Frog at Buck Lake

Klamath County Oregon

A mark-recapture study to assess the Oregon spotted frog population in Buck Lake was conducted between 1995 and 1997 by Marc Hayes. The study results provided a population estimate of about 519 adults (with a range of 0 to 1,499, derived from 95 percent confidence intervals; Lerum (2012). Demographic information from this study showed limited evidence of recruitment likely attributable to the presence of resident brook trout (FWS 2011e). Observations of adult Oregon spotted frogs made between 1994 and 2001 ranged from 25 to 176, no adult frogs were observed in 2005 or 2009 (FWS 2011e; see figure 3.4.5-2). Since Hayes' study, various Forest Service, BLM, FWS, and USGS personnel have sporadically resurveyed this population documenting continued presence through 2011 (Lerum 2012). Since 2006, egg mass surveys have been conducted in addition to searches for adult frogs. Results are included in figure 3.4.5-2 and range from 6 egg masses in 2011 to 38 egg masses counted in 2010. However, the locations and search efforts varied from year to year, making inferences about trends based on egg masses counted inappropriate (Lerum 2012).

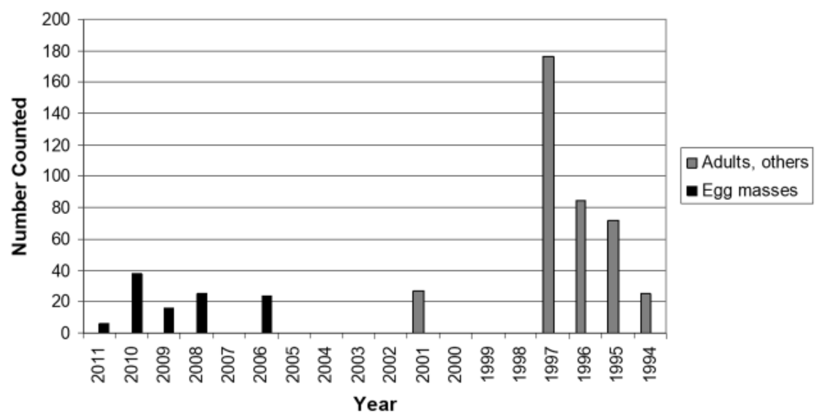


Figure 3.4.5-2 Observations of Oregon Spotted Frog Adults (Including Juveniles and Metamorphs) and Egg Masses at Buck Lake (Sources: FWS 2011e; Lerum 2012)

Oregon spotted frogs at Buck Lake have been consistently monitored from 2012 to 2016, along with other populations in the Oregon Cascades (Adams et al. 2017). Observations of frogs at two sites in Buck Lake and one in Tunnel Creek (both in critical habitat Unit 14) indicate some variability in counts for each of several life stages but adults and larva or juveniles were found each year. Numbers of adults were highest in 2016 (table 3.4.5-1.

TABLE 3.4.5-1 Numbers of Oregon Spotted Frogs Counted within the Buck Lake Critical Habitat Unit (CHU 14) from 2012 to 2016					
Surveyed Site	**Legal Location**	**Survey Periods**	**Adults**	**Subadults Juveniles**	**Larva**
1A Buck Lake	T38S,R5E,S14	Jun-Jul 2012	2		
		Jun-Aug 2013			
		Jun-Jul 2014	3		1
		Jun-Jul 2015	1		
		Jun-Aug 2016	3	2	1
2A Buck Lake	T38S,R5E,S14	Jun-Jul 2012	13	9	2
		Jun-Aug 2013	6	14	
		Jun-Jul 2014	4	1	2
		Jun 2015	7		1
		Jun-Aug 2016	14	2	
15A Tunnel Creek	T38S,R5E,S23	Jun-Jul 2015	1		
		Jun-Aug 2016	1		3

Source: Adams et al. 2017

Habitat

Historically, Buck Lake was likely a large, shallow marsh fed by springs and streams. Two perennial streams, Spencer Creek and Tunnel Creek, flow into Buck Lake but the basin is currently a meadow with drainage ditches, and at least two impounded areas fed by springs (Lerum 2012). ORBIC (2017c) has mapped Oregon spotted frog habitat at Buck Lake to include Spencer Creek from its inflow at the lake to approximately 6,100 feet upstream to where Spencer Creek passes through a culvert beneath Clover Creek Road. That segment of Spencer Creek is almost equally subdivided into Buck Marsh, closest to the highway, and Buck Meadow, closest to Buck Lake (Lerum 2012). Spencer Creek flows through Buck Marsh and Buck Meadow on Forest Service lands. Buck Marsh is fed by several springs with evidence of beaver activity and Buck Meadow is a pasture that often floods in the spring but does not stay flooded long enough to provide Oregon spotted frog breeding habitat. Further, soils in Buck Marsh are dense, possibly compacted by past heavy livestock use, and provide little water infiltration. Riparian vegetation is sparse, and is unlikely to support beaver occupancy that could help to create suitable habitat (Lerum 2012). Neither Buck Marsh nor Buck Meadow currently provide habitat for Oregon spotted frogs (Lerum 2012).

Some winters Spencer Creek freezes and flows cease. It is unknown if the site could provide overwintering habitat. It is not known exactly where Oregon spotted frogs in the Buck Lake complex overwinter. Underwater video cameras installed in 2010 and 2011 did not detect Oregon spotted frogs at suspected overwintering sites until March when frogs began to move to breeding sites (Lerum 2012).

Lerum (2012) reported on a Level II stream survey of Spencer Creek flowing through Buck Marsh and Buck Meadow conducted by the Forest Service on June 28, 2010 (Forest Service 2011 cited in Lerum 2012). Spencer Creek characteristics in this area (Reach 5) were summarized as: "a Rosgen E6 stream channel type due to its gradient and silt dominated substrate. A large portion (3500') of reach 5 was determined to be a marsh. The average wetted width (Rosgen E channel only) is 6.4 feet. The reach averages 19 pools per mile with residual pool depth of 1.2 feet. Stream banks are 98 percent stable and 2 percent unstable with sections of unstable bank along both sides of the stream. The reach had six pieces of LWD per mile (zero large/medium and six small pieces per size class). The stream side vegetation was dominated by grass forbs with an overstory of grass forbs. There are some isolated pockets of lodgepole pine. The stream runs through a very large valley dominated by marshland. A channel begins to take shape at the end of the valley up to the road crossing. There are active beaver dams in the marsh. Unidentified fish were observed throughout the reach." Typical Rosgen E6 channels (Wildland Hydrology 1994):

- are slightly entrenched (entrenchment ratio >2.2);
- have very low width to depth ratios (ratio <12);
- have high sinuosity (>1.5);
- have water surface slope gradients <2 percent; and
- channel substrate particles are predominantly silt and clay.

In 2002, lower Spencer Creek was listed by the Oregon Department of Environmental Quality (303(d) List, ODEQ 2002) as impaired due to sediment based on the formation of appreciable bottom or sludge deposits. However, there are no estimates of ambient turbidity in Spencer Creek (Forest Service and BLM 1995) although intense cattle grazing around Buck Lake has contributed to elevated sediment in the creek, probably downstream from Buck Lake. Within the watershed, the principal causes of stream sedimentation are bank erosion and delivery of sediment from roads and stream crossings (BLM 2008).

There are no long-term discharge data for Spencer Creek. Flows were measured downstream from Buck Lake from 1992 to 1998 during which annual peak flows were from 150 to 200 cubic feet per second (cfs) and summer base flows were 20 cfs, with a minimum of 5 cfs following a dry winter (BLM 2008). Peak flows in the middle portion of the Spencer Creek watershed were caused by snowmelt and rain-on-snow events.

Critical Habitat

Proposed critical habitat Unit 14 includes seasonally wetted areas adjacent to the western edge of Buck Lake encompassing Spencer Creek, three unnamed springs, and Tunnel Creek, as well as Spencer Creek downstream of Buck Lake as shown in figure 3.4.5-1. Buck Marsh and Buck Meadow are not included in the proposed critical habitat. The proposed critical habitat is approximately 6,400 feet downstream from where the Pipeline would cross Spencer Creek. The proposed critical habitat downstream of Buck Lake is approximately 280 feet overland from the right-of-way at its closest location to the Project, although Clover Creek Road separates the right-of-way from Spencer Creek at this location and there is no hydrologic connection.

There are approximately 203 acres within proposed Unit 14 at Buck Lake: approximately 53 acres are federally managed BLM and Winema National Forest land, and approximately 149 acres are privately owned (FWS 2014e). Another area, Keene Creek in Jackson County, is also included in Unit 14 but is approximately 14.5 miles from the proposed critical habitat at Buck Lake. According to FWS (2013i, page 53551), "all of the essential physical or biological features are found within the unit, but are impacted by woody vegetation succession, nonnative predators, lack of beaver, and hydrological changes. The essential features within this unit may require special management considerations or protection to ensure maintenance or improvement of the existing nonbreeding, breeding, rearing, and overwintering habitat; aquatic movement corridors, or refugia habitat, and to address any changes that could affect these features."

3.4.5.3 Effects of the Proposed Action

Direct and Indirect Effects

Construction of the Pipeline could directly and/or indirectly affect Oregon spotted frog through one or more of the following pathways:

- interference with key life history functions;
- acoustic shock from blasting pipe trench through bedrock streambeds or use of a track hoe or impact hammer if frogs are proximate to the construction site;
- turbidity generated during construction across waterbodies;
- introduction and/or re-distribution of nonnative aquatic species and pathogens;
- accidental release of fuels and entry of other petroleum products into surface waters; or
- application of herbicides to control noxious weeds near waterbodies.

Timing

State guidelines (ODFW 2008) would allow instream construction across Spencer Creek (a tributary to the Klamath River below Keno) and tributaries to Spencer Creek from July 1 through September 30. Construction during that period would avoid any downstream effects to egg masses or spotted frogs during metamorphosis in Buck Lake. Hydrostatic discharge is projected to occur in the late summer to early fall immediately following construction.

Acoustic Shock

The base material where the Pipeline is proposed to cross Spencer Creek is described as igneous rock and locally tuffaceous rock with local valley fill. There is a high potential that blasting would be needed to construct the trench across Spencer Creek if volcanic rocks cannot be excavated to the appropriate depth (GeoEngineers 2013a). Effects of underwater blasting on frogs is generally unknown although effects on frogs' lungs are expected to be similar to effects on fish with swim bladders, and would cause mortality (Keevin and Hempen 1997). Effects of underwater blasts on coho salmon are discussed below in section 3.5.3.3. The analysis in that section identified straight line distances through rock and other materials for a single shot explosive charge, of given weight, to dissipate to an overpressure standard of 2.7 pounds per square inch (psi), the threshold for non-lethal pressure for anadromous fish, and assumed to be applicable to frogs. PCGP may opt to blast across stream locations where consolidated rock makes traditional trenching methods unfeasible.

Typical trench blasting scenarios use multiple 1- to 2-pound charges separated by an 8-millisecond delay to excavate the trench. With use of 1- to 2-pound charges in rock, the set back distance (at which 2.7 psi would occur) from the blast trench to the aquatic habitat is between 34 and 49 feet (see Table 3, in ADFG 1991). Blasting would be conducted within dry streambanks isolated from the water column, most likely using dam-and-pump construction to bypass water around the dry workspace. Since no Oregon spotted frogs are expected in the vicinity of the Spencer Creek construction right-of-way, blasting is not expected to affect this species.

Suspended Sediment

Suspended sediments (turbidity) directly affect survival and growth of salmonids and other fish species, interferes with gill function, and adversely affects substrate for fish egg development (reviewed and compiled by Newcombe and Jensen 1996 and Bash et al. 2001). Effects of turbidity on frogs have not been extensively reported. Densities of three amphibian species were significantly lower in streams impacted by sediment due to road construction than in non-impacted streams (Welsh and Ollivier 1998) and relative abundances in larvae of two frog species were less in wetlands impacted by turbidity caused by livestock than non-impacted wetlands (Schmutzer et al. 2008). As summarized by Henley et al. (2000), sedimentation can reduce food availability, water and environmental quality, and habitats used by aquatic organisms resulting in decreased plant, zooplankton, and insect abundance and biomass that would affect aquatic food chains and consequently would affect frogs during different life stages.

Although background levels of suspended sediment in Spencer Creek are unknown (Forest Service and BLM 1995), construction of the Pipeline would probably mobilize particles into the water column, primarily silt which is the predominant substrate material in Spencer Creek (see above and Lerum 2012). The distance downstream that silt particles would be transported can be estimated with the following equation:

$$L = (D\ V_A) / V_S$$

where L is the transported distance downstream (in feet); D is the average depth of stream flow (in feet), V_S is the particle size-specific settling velocity (in inches or feet per second), and V_A is the average streamflow velocity (in feet per second). The settling velocity (V_S) for medium silt is 0.009 inch per second or 0.00075 feet per second (see the Wentworth Grain Size Chart, USGS 2003). The average depth of streamflow within Spencer Creek at the time of construction is unknown but, using the average wetted width of 6.4 feet (see above and Lerum 2012) and a low width to depth ratio of 10 (for Rosgen E6 channels the width to depth ratios are <12), the average depth is estimated to be 0.64 feet (8 inches).

Assuming a rectangular channel cross section, the cross-sectional area is A = 4.1 square feet (ft^2). The estimated cross-sectional area (A) can be used in Manning's Formula (Limerinos 1970; Arcement and Schneider 1989) to estimate Q, the stream discharge rate (cfs) and ultimately to estimate V_A , the average streamflow velocity. Manning's Formula is:

$$Q = A\ (k/n)\ (R^{2/3})\ (S^{1/2})$$

with estimated A = 4.1 ft^2, R is the hydraulic radius (in feet, where R = A/P, and P is the wetted perimeter in feet), S is the slope of channel (vertical feet per horizontal feet), the constant *k* equals 1.486 if English units are used but *k* equals 1 with metric units, and n is Manning's roughness coefficient (Manning's n).

For Spencer Creek, the wetted perimeter P = (2 x 0.64 feet) + 6.4 feet = 7.68 feet so that the hydraulic radius R = 0.53 feet, the slope of channel S = 0.015 (or 1.5 percent, for Rosgen E6 channels the water surface slope gradient is <2 percent). Manning's n was estimated at n = 0.070, based on a natural stream channel with sluggish reaches, weedy, and with deep pools (Chow 1959).

With these parameters estimated, the solution for Manning's Equation is Q = 6.98 cfs. With the estimate for Q, and A = 4.1 ft^2, the estimated stream velocity is $V_A = Q / A = 1.7$ feet per second.

Solving the distance-rate-time equation (above) using the following values: D = 0.64 feet, V_S = 0.00075 feet per second, and V_A = 1.7 feet per second, the estimated distance downstream (L) that silt particles would settle out of the water column would be L = 1,453 feet from the location where the Pipeline crosses Spencer Creek. That distance would fall within Buck Marsh. Currently, there are no Oregon spotted frogs inhabiting Buck Marsh although the presence of beaver activity and spring flooding could provide suitable breeding habitat (Lerum 2012). Based on current information however, sediment mobilized during construction is not expected to reach habitats occupied by frogs in Buck Lake.

Construction of the Pipeline project is not expected to increase suspended sediment in Spencer Creek downstream of Buck Lake. Although the right-of-way occurs as close as 280 feet from Spencer Creek, the right-of-way and Spencer Creek are separated by Clover Creek Road (paved road) and are not hydrologically connected. BMPs and erosion control measures should prevent sediment from the construction right-of-way from entering Spencer Creek. PCGP indicated in their ECRP (appendix F) that they would install sediment barriers "at the base of slopes adjacent to road, wetland and waterbody crossings where sediment could flow from the construction right-of-way onto the road surface or into the wetland or waterbody" and temporary erosion control structures would be inspected by the EI at least on a daily basis in areas of active construction and equipment operation. Although a major precipitation event significant enough to wash out Project erosion control devices could cause sheet flow over Clover Creek Road to carry sediment into Spencer Creek, such an event is highly unlikely and not expected to occur.

The Pipeline route would cross two tributaries to Spencer Creek at MPs 171.57 and 173.74, approximately 740 and 5,900 feet upstream of the confluence with Spencer Creek, respectively. The stream at MP 171.57 was mapped as two feet wide fanning out into a wetland/stream complex and the stream at MP 173.74 was mapped as a four-foot-wide ephemeral snowmelt-fed stream. Both would be crossed using the dry-open cut method. They are expected to be dry at the time of construction (July 1 through September 30 per ODFW 2008), and thus are not expected to contribute sediment to Spencer Creek as a result of construction.

The proposed hydrostatic discharge site at MP 169.52 is approximately 1.6 miles from Spencer Creek. An accidental release during discharge could cause the discharge water to carry sediment downstream into Spencer Creek. However, the water would be discharged at a rate to prevent scour, erosion, and sediment migration to sensitive resources such as wetlands and waterbodies, as described in the *Hydrostatic Test Plan* (appendix U). When discharged, the test water would be released into a dewatering device such as a straw bale structure or sediment bag to minimize possible peak flow effects by dissipating the energy of the test water flow, filtering the test water to avoid sedimentation, and by allowing release of the test water as sheet flow back into the ground. Additionally, the hydrostatic test water would be discharged to a vegetated upland area (greater than 150 feet from any wetland or waterbody). Effects to Oregon spotted frogs from hydrostatic discharge are not anticipated considering these procedures and BMPs, the distance between the discharge site and occupied habitat, and the extremely low likelihood of a test water spill.

Introduction of Non-Native Species and Disease

Non-indigenous aquatic species (NAS) are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). FWS (2013j) identified warm water non-native fish (bullhead, fathead minnows), and cold water non-native brook trout that had been introduced to Buck Lake, although bullfrogs were absent. Non-native fish may limit numbers of juvenile frogs by predating larvae and/or juveniles. Bullfrogs also may act as direct predators on larval and juvenile frogs but bullfrogs are not known to occur on federal land in the Buck Lake complex (Lerum 2012). Although unlikely, introduction of bullfrogs and/or other warm water predaceous fish species could occur through hydrostatic test water discharge.

Oregon spotted frogs in Buck Lake are infected with the fungal pathogen *Batrachochytrium dendrobatidis* (Bd), which causes chytridiomycosis (Pearl et al. 2009; FWS 2013j). However, Oregon spotted frogs experimentally infected with the chytrid pathogen were able to clear the infections with no mortality suggesting some resistance to Bd (Padgett-Flohr and Hayes 2011). The fungus may infect other nonamphibian hosts (e.g., crayfish), persisting in freshwater ecosystems that are uninhabited by frogs, but infected hosts may transmit the disease to uninfected frogs (McMahon et al. 2013)

The water mold *Saprolegnia* has been suggested as one possible cause of amphibian declines in the Pacific Northwest which destroys developing Oregon spotted frog egg masses (FWS 2013h). Water-molds of the genus *Saprolegnia* have been identified in Oregon spotted frog populations in the Klamath Basin (Lerum 2012). Mortality may be caused by parasitic infections by the trematode *Ribeiroia ondatrae* that are transmitted through aquatic snails (genus *Planorbella*), an intermediate host. The infections cause limb malformations in amphibians. Human manipulation of upland areas adjacent to amphibian breeding areas and direct manipulation of the breeding areas can affect the prevalence of *Planorbella* snails and the infection rate of *Ribeiroia ondatrae* (FWS 2013h). Increased prevalence of trematodes and risks of parasitism to frogs may occur if water runoff from areas of heavy livestock use causes eutrophication, algal blooms, and increased snail abundance in frog habitats (Johnson et al. 2007). The trematode has not been documented in the Buck Lake frog population (FWS 2013i).

The risk of introducing *Saprolegnia*, *Ribeiroia ondatrae*, and/or other pathogens into Buck Lake during construction appears to be low. Pathogens might be brought to the Spencer Creek construction site if attached to machinery or if introduced by hydrostatic water discharged at a test header. The closest hydrostatic discharge location to Spencer Creek (adjacent to MP 171.07) is 1.6 miles away at MP 169.52; at that site, 2,126,306 gallons (6.53 acre feet) of test water are proposed to be discharged on the construction right-of-way. The discharge site is 2.4 miles away with intervening higher topography relative to Buck Lake; also, the Clover Creek Road intervenes and would block any flow toward the lake. Hydrostatic discharge water is not expected to reach Spencer Creek downstream of Buck Lake as described above under Suspended Sediment.

PCGP has developed BMPs to avoid the potential spread of the aquatic invasive species and pathogens of concern (see *Hydrostatic Testing Plan*, appendix U). If determined to be feasible for hydrostatic testing requirements, all water used in hydrostatic testing would be returned to its withdrawal source location after use; however, cascading water from one test section to another to minimize water withdrawal requirements may make it impractical to release water within the same watershed where the water was withdrawn. If it is not possible to return the water to the same water basin from where it was withdrawn, various water treatment methods would be used to disinfect water that would be transferred across water basin boundaries including screening/filtering, chlorine treatment, and discharge to upland sites. After hydrostatic test water withdrawal, all equipment used in the withdrawal process would be cleaned and sanitized to prevent the potential spread of aquatic invasives and pathogens from the use of this equipment in other waterbody sources (see appendix U).

Fuel and Chemical Spills

Oregon spotted frog habitat in the Buck Lake complex could be adversely affected if petroleum products were accidentally discharged into aquatic environments. Such materials are toxic to algae, invertebrates, fish and amphibians. Of the products likely to be present during construction, data compiled from a wide range of sources indicate that diesel fuels and lubricating oils are considerably more toxic to aquatic organisms than other, more volatile products (gasoline) or heavier crude oil (Markarian et al. 1994). Lytle and Peckarsky (2001) showed that release of diesel fuel in freshwater habitats significantly reduced aquatic invertebrate densities and species richness at least 3 miles downstream from the release but invertebrate densities recovered within a year. Impacts to aquatic habitats that primarily affect aquatic substrates – hence spawning, incubating and rearing habitats – can remain for much longer periods (Markarian et al. 1994).

Construction equipment used to construct the Pipeline across waterbodies can potentially release hydraulic fluid that include a variety of compounds, most commonly being mineral oil-based, organophosphate esters, and polyalphaolefins (HHS 1997). Release from machinery can occur through faulty seals, hoses, sumps and reservoirs, or general system failure. Components of mineral oil and polyalpaolefins do appear to bioaccumulate in animals whereas larger molecular constituents in organophosphate esters can concentrate in fish, primarily partitioning in fat tissue (HHS 1997). In general, toxicity of organophosphate esters is greater than either mineral oil or polyalphaolefin-based hydraulic fluids for inhalation, oral, and dermal for humans but toxicities have not been clearly described for aquatic invertebrates, fish, or amphibians and would be dependent on specific chemical components (HHS 1997).

Inadvertent spills of fluids used during construction, such as fuels and lubricants, could contaminate wetland soils and vegetation. To minimize the potential for spills and any impacts from such spills, PCGP's Spill Prevention, Containment, and Countermeasure Plan (SPCCP; see appendix L) would be implemented. In general, hazardous materials, chemicals, fuels, lubricating oils, and concrete-coating activities would be not be stored, nor would refueling operations be conducted within 150 feet of a wetland or waterbody in accordance with the FERC's *Procedures* (see appendix C) and the SPCCP (see appendix L).

Herbicide Application

Following construction, PCGP would implement a *Noxious Weed Control Plan* in part through the application of herbicides. Herbicides have the potential to cause toxic effects to different salmonid life stages and to other aquatic species, causing direct impacts, if used improperly. When herbicides are properly used according to label restrictions and BMPs to control noxious weeds, there is little to no chance of causing injury or mortality to aquatic organisms; thus the impact would likely be avoided.

PCGP has developed an *Integrated Pest Management Plan* (IPM) in consultation with the ODA, BLM and Forest Service (see appendix N to the POD, available upon request) to address the control of noxious weeds and invasive plants across the project. The BMPs would minimize the potential spread of invasive species and minimize the potential adverse effects of control treatments.

According to the Pacific Northwest Weed Management Handbook (see Peachey et al. 2007), herbicides used in forests to control brush and weed-trees could include one of the following: 2,4-D, glyphosate, imazapyr, picloram, and triclopyr, which are applied during spring or fall dormancy although triclopyr or 2,4-D was not approved use by the Winema National Forest. Clopyralid may be used during summer to control thistles, other composites, and legumes while not damaging conifers. Only herbicides that are approved for use within treated lands (private, state, or federal) would be used. In general, most impact to waterbodies occurs from direct overspray or drift of herbicides (aerial applications) as well as leaching through soils into groundwater or as they are carried by surface/subsurface runoff (Tu et al. 2001). The ester form of herbicides is more toxic to fish and other aquatic species than salt or acid forms because esters are readily adsorbed through skin and gills. Esters are also water insoluble so that they are not diluted in waterbodies (Tu et al. 2001).

Herbicides potentially used during the project breakdown over various periods of time, marked by the average half-life (the time it takes for the herbicide concentration to decline by 50 percent due to microbial metabolism –dependent on the microbial population, environmental pH, soil moisture and temperature - mineralization, and/or photolysis:

- 2,4-D—averages 10-day half-life in soils, less than 10 days in water. Salt formulations with low toxicity are registered for use against aquatic weeds. Acute exposure of 2,4-D to leopard frog tadpoles reduces their activity and feeding but does not appear to be a particularly strong threat to larvae (Ryan et al. 2006).
- Glyphosate—ranges from several weeks to years, but averages two months. In water, glyphosate is rapidly dissipated through adsorption to suspended and bottom sediments, and has a half-life of 12 days to 10 weeks. Toxicity of glyphosate-based pesticides to amphibians varies with developmental stage because there is some evidence that some formulations may interfere with metamorphosis (Howe et al. 2004).
- Imazapyr—ranges from one to five months in soil. In aqueous solutions with photodegradation the half-life may be two days. It has low toxicity to fish and algae, and submerged vegetation is not affected. Adverse effects to terrestrial and aquatic animals appear to be unlikely (Durkin and Follansbee 2004).
- Picloram – ranges from one month to three years in soil, and two to three days in water. It is characterized as slightly to moderately toxic to aquatic species, and was shown to be slightly toxic to tadpoles (Tu et al. 2001; Johnson 1976).
- Triclopyr – averages 30 days in soils, and one to four days in water. Toxicity to aquatic organisms is variable depending on life stage, pH, available sunlight, but appears to be overall low when applied correctly (Tu et al. 2001; Antunes-Kenyon and Kennedy 2004; Durkin and Follansbee 2003).

The potential for adverse effects to Oregon spotted frogs and other aquatic species by these herbicides appear to be extremely remote, especially since application would be at least 100 feet from wetlands and waterbodies unless allowed by the land manager. PCGP would not use aerial herbicide applications and would not use herbicides for general brush/tree control within the 30-

foot maintained easement. Given low toxicities and short half-lives in soil and water, expected effects of herbicides to amphibians would be discountable and insignificant.

Where weed control is necessary along the construction right-of-way, PCGP's first priority would be to employ hand and mechanical methods (pulling, mowing, biological, disking, etc.) applicable to the species to prevent the spread of potential weed infestations, where feasible. To determine if an herbicide is to be used over other control methods, PCGP would base the decision on weed characteristics and integrated weed management principles (Forest Service 2005). If herbicides are used to control noxious weed infestations, they would be used when they are the most appropriate treatment method. Spot treatments and the use of selective herbicides would be utilized to minimize impact to native or non-target species.

PCGP would employ a state or federally-licensed herbicide applicator to ensure that the appropriate herbicides are utilized for the targeted weed species during its proper phenological period and at the specified rate. The applicator would ensure that the herbicides and any adjuvants[1] are used according to the labeling restrictions and warnings, following all applicable laws and conforming to the appropriate land managing agency decision documents. The applicator would also ensure that the herbicides that are used are registered for their intended use. Permits or approvals for the use of herbicides and adjuvants on federal lands would be obtained prior to use/treatment, as detailed in the IPM (see appendix N to the POD, available upon request).

Cumulative Effects

The majority of the Oregon spotted frog analysis area is within the Winema National Forest or on lands managed by the BLM. Actions on these federal lands would require section 7 consultation and thus are not considered here.

No specific private reasonably foreseeable actions were identified within the Spencer Creek fifth-field watershed, including the Oregon spotted frog analysis area. However, ongoing grazing and timber harvests on private lands within and around Buck Lake and Spencer Creek are likely to continue. Potential impacts of grazing at this site include both the direct impacts of grazing sedimentation and trampling, as well as the indirect effect of egg mass desiccation resulting from water management techniques that drain water early in frog breeding season to stimulate grass production (FWS 2014e). However, as construction and operation of the Project are not expected to result in increased sedimentation or trampling, or changes in hydrology, to Oregon spotted frog habitat, no cumulative effects are expected. Additionally, mitigation for construction includes riparian plantings and fencing to exclude livestock in Spencer Creek upstream of Buck Lake, which would reduce sediment within the occupied habitat downstream and could potentially encourage beaver occupancy, which would help create suitable Oregon spotted frog habitat.

Critical Habitat

A portion of proposed critical habitat Unit 14 in Spencer Creek downstream of Buck Lake is within the Oregon spotted frog analysis area. Unit 14 contains all three PCEs identified by FWS

[1] Adjuvant(s) are substances added to the pesticide formulation to enhance the toxicity of the active ingredient or to make the active ingredient easier to handle.

(2013i), including suitable ephemeral or permanent bodies of freshwater (PCE1), aquatic movement corridors (PCE2), and refugia habitat (PCE3). Construction of the Project could affect PCEs within Unit 14 by impacting site hydrology or introducing nonnative predators, although these effects are not expected as described below.

The right-of-way occurs as close as 280 feet from proposed critical habitat in Spencer Creek downstream of Buck Lake; however, the right-of-way and Spencer Creek are separated by Clover Creek Road and are not hydrologically connected. As a result, construction of the Project at this location is not expected to affect hydrology within the proposed critical habitat.

As described above, the proposed hydrostatic discharge site at MP 169.52 is 1.6 miles upstream from Spencer Creek and is about 4.7 miles from the designated critical habitat in Spencer Creek and 2.38 miles (straight-line distance) from designated critical habitat in Buck Lake. An accidental release of water during hydrostatic discharge could cause the discharge water to travel downstream into Spencer Creek, temporarily altering hydrology within the proposed critical habitat, and potentially introducing nonnative aquatic predators. However, the test water would be released into a dewatering device such as a straw bale structure or sediment bag which would allow the water to return as sheet flow back into the ground, and minimize the potential for test water to reach Spencer Creek as described in the *Hydrostatic Test Plan* (appendix U). Additionally, various water treatment methods would be used to disinfect water that would be transferred across water basin boundaries including screening/filtering, chlorine treatment, and discharge to upland sites to prevent the potential spread of aquatic invasives (see appendix U).

3.4.5.4 Conservation Measures

Conservation measures have been proposed by PCGP to minimize construction and operation impacts to waterbodies and riparian zones. Those measures have been compiled in table 2C in appendix N and would apply to Oregon spotted frogs.

3.4.5.5 Determination of Effects

Species

The Project **may affect** Oregon spotted frogs because:

- the Pipeline would cross Spencer Creek, which is hydrologically connected to Buck Lake and is occupied by the Oregon spotted frog; and
- the Pipeline is within 280 feet of Spencer Creek and crosses tributaries to Spencer Creek downstream of Buck Lake, which is occupied by the Oregon spotted frog.

However, the Project **is not likely to adversely affect** Oregon spotted frogs for the following reasons:

- Buck Lake is approximately 6,400 feet downstream from where the Pipeline would cross Spencer Creek. Suspended sediment generated by construction is expected to remain in the water column for up to 1,450 feet downstream from the construction site. Suspended sediment in Spencer Creek would pass through Buck Marsh but Oregon spotted frogs do not currently inhabit Buck Marsh.
- If the Oregon spotted frog does occur in Buck Marsh at the time of construction, conservation measures would limit potential effects due to acoustic shock,

introduction of non-native species and/or disease, fuel and chemical spills, and herbicides. Future presence of Oregon spotted frogs in the Spencer Creek upstream of Buck Lake at the time of construction is extremely unlikely, and is considered to be discountable.

- Although the right-of-way occurs as close as 280 feet from Spencer Creek downstream of Buck Lake, the right-of-way and Spencer Creek are separated by Clover Creek Road and are not hydrologically connected; BMPs and erosion control measures should prevent sediment from the construction right-of-way from entering Spencer Creek.
- Effects on Oregon spotted frogs from hydrostatic discharge are insignificant and discountable because the nearest hydrostatic discharge site is approximately 2.38 miles (straight-line distance) from designated critical habitat in Buck Lake. BMPs would prevent adverse effects from sedimentation or introduction of non-native species and disease, and a spill of hydrostatic test water is highly unlikely.

Critical Habitat

The Project **may affect** proposed critical habitat for the Oregon spotted frog because:

- the Pipeline is within 280 feet of proposed critical habitat within Spencer Creek downstream of Buck Lake; and

However, the Project would **not adversely modify** designated critical habitat for the Oregon spotted frog because:

- the designated critical habitat within 280 feet of the right-of-way is not hydrologically connected to the right-of-way; and
- test water from the proposed hydrostatic discharge site at MP 169.52 is not expected to reach the proposed critical habitat in Spencer Creek or Buck Lake, so effects to PCEs from changes in hydrology or introduction of nonnative species from the Project are discountable.

The Pipeline **may affect, but is not likely to adversely affect** critical habitat Unit 14 for the Oregon spotted frog.

3.5 FISH

3.5.1 North American Green Sturgeon (Southern Distinct Population Segment)

3.5.1.1 Species Account and Critical Habitat

Status

On January 29, 2003 (NMFS 2003), NMFS determined that the North American Green Sturgeon comprises two Distinct Population Segments (DPSs) that qualify as species under the ESA: 1) a northern DPS consisting of populations in coastal watersheds northward of and including the Eel River in California; and 2) a southern DPS consisting of coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River. At that time however, neither DPS was listed because of the uncertainty about the population structure and status.

In April 2006, NMFS listed the Southern DPS as threatened under ESA within California, including spawning population of green sturgeon south of the Eel River, principally the Sacramento River green sturgeon spawning population (NMFS 2006c). The Pacific Northern DPS, which includes coastal spawning populations from the Eel River north to the Klamath and Rogue Rivers, remains unlisted but is a Species of Concern (NMFS 2007c, 2014d). NMFS performed a five-year status review in 2015, wihich determined that no change in status was needed for the Southern DPS (NMFS 2015c).

Threats

The southern DPS was proposed for listing as threatened in 2005 (NMFS 2005b) because 1) the majority of spawning adults were concentrated in one spawning river (Sacramento River), 2) threats since the first status review (see NMFS 2002) have not been adequately addressed, 3) new evidence of loss of spawning habitat in the upper Sacramento and Feather Rivers, and 4) data showing a negative trend in juvenile green sturgeon abundance. One factor that was not considered a primary factor causing the decline of the Southern DPS, but likely poses a threat to the Southern DPS, was past and present commercial and recreational fishing, primarily ocean and estuarine bycatch of green sturgeon in the Oregon and Washington white sturgeon and salmonid fisheries; however, recent fishing regulations have reduced the risk for Southern DPS in Oregon and Washington (NMFS 2006c). Actions that may negatively affect the Southern green sturgeon DPS include water diversion for human use, point and non-point source discharge of persistent contaminants, contaminated waste disposal, water quality standards, and fishery management practices (NMFS 2006c).

The principal threat to the southern DPS green sturgeon remains as limited spawning habitat in the Sacramento River, California. Multiple dams on the river prevent adult migration to former spawning sites. Also, flow rates in the river and Delta have been affected by water diversions for agricultural, municipal and industrial uses, and insufficient flow rates in the Sacramento River system are likely a significant threat to green sturgeon (NMFS 2006c). In particular, entrainment of juveniles in water diversion structures has been identified though may not be as much as a problem as thought earlier (NMFS 2005b). Other adverse effects within the Sacramento River system include elevated water temperatures and contamination from toxic materials (e.g., bioaccumulation of PCBs and selenium).

Species Recovery

No recovery plan has been drafted.

Life History, Habitat Requirements, and Distribution

Green sturgeons spawn in deep pools in large, turbulent river mainstems, generally from March through July with peak spawning from mid-April to mid-June (Moyle 2002). Adults migrate to/from spawning grounds during the spring and fall, consecutively, and juvenile migration occurs from April through November (Rien et al. 2001). Northern DPS green sturgeons enter the Rogue River during March through June to spawn. Spawning appears to be related to water temperature (8.8º to 16.4ºC or 48º to 62ºF) but low flows probably dictate how far upstream sturgeon are able to migrate to potential spawning habitat (Erickson and Webb 2007).

Little is known about sturgeon feeding, but some studies have found that adults and juveniles feed on benthic invertebrates including shrimp, mollusks, amphipods, and even small fish

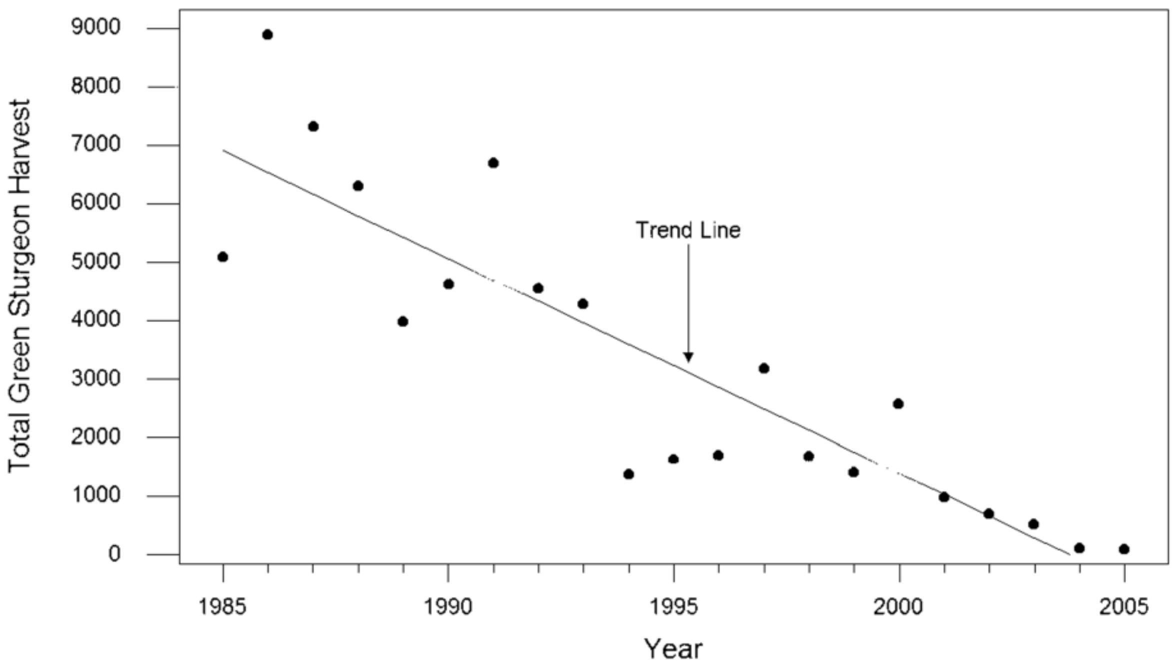
(Moyle 2002). They are thought to spend most of their lives in nearshore oceanic waters, bays, and estuaries (NMFS 2014d).

Green sturgeon move into estuaries of non-natal rivers to feed (Beamis and Kynard 1997). They occupy large estuaries during the summer and early fall in the Pacific Northwest. Green sturgeons enter Washington estuaries during summer when water temperatures are more than 4ºF warmer than adjacent coastal waters (Moser and Lindley 2007). Green sturgeon abundance peaks during October in the Columbia River estuary, based on commercial catches. In Washington (Willapa Bay and Grays Harbor), green sturgeons appear to be present from June until October (Moser and Lindley 2007). Sturgeons in the Southern DPS that originate in the Sacramento River have been found widely in Washington estuaries and the Columbia River. In the lower Columbia River (river mile 0 to 35), between 77 and 88 percent of the green sturgeons collected originated from the Southern DPS (Israel and May 2007).

Data from tagged green sturgeons occurring offshore from the Klamath River in California suggests they are from the northern and southern DPS. Tagged green sturgeons that utilize the lower Klamath River have been observed in Grays Harbor, Washington (McCovey 2007), approximately 400 nmi north of the Klamath River. There are no records of tagged green sturgeon occurring within Coos Bay which is approximately 125 nmi from the Klamath River estuary.

Population Status

It has been reported that there are no good data on current population of the green sturgeon (NMFS 2014d). ODFW evaluated the presence of green sturgeon in coastal tributaries through 2005 and provided summaries of harvests of green sturgeon in California, Oregon, and Washington commercial and sport fisheries (Farr and Kern 2005). Although many factors contribute to annual catch of sturgeons in the three states whether in coastal, estuarine, or riverine habitats, the overall declining trend since 1985 (see figure 3.5.1-1) is probably indicative of the species' declining population.



Source: Farr and Kern 2005

Figure 3.5.1-1 Total Harvest of Green Sturgeon in California, Oregon, and Washington Commercial and Sport Fisheries from 1985 to 2005. The linear relationship is significant (r^2 = 0.786, P<0.001).

There are confirmed records of green sturgeon in the Umpqua River, captured above the zone of tidal influences. In 2000, two juvenile green sturgeons were regurgitated from a smallmouth bass caught in the Umpqua River (river kilometer 134 [RM 83.3]), and in 1979, a green sturgeon nearly 2 meters (6.6 feet) long was caught at river kilometer 164 (RM 101.9; NMFS 2005b). In addition, a possible juvenile green sturgeon was captured at Big Butte Creek, near Lost Creek Dam on the Rogue River (NMFS 2005b). From 2000 to 2004, 249 green sturgeons were captured in the Rogue River, while 33 fish were captured and 2 sturgeons that had been tagged were recaptured in the Umpqua River (Farr and Kern 2005). However, there is no indication to which DPS any of those reported green sturgeons belonged.

Critical Habitat

During reviews prior to designating critical habitat, NMFS (2008b) determined that subadult and adult Southern DPS green sturgeon inhabited certain estuaries along the coast of northern California, Oregon, and Washington during summer and inhabited coastal marine waters from central California to British Columbia over the winter. NMFS (2008b) noted large numbers of adult and subadult green sturgeons used Coos Bay as summer habitat, in particular Southern DPS green sturgeons tagged in San Pablo Bay, a northern extension of San Francisco Bay. Based on that information, NMFS (2009b) designated critical habitat for the Southern DPS of North American green sturgeon to include all tidally influenced areas of Coos Bay up to the elevation of mean higher high water, including the head of tide endpoint in the Coos River and Stock Slough both of which are crossed by the Pipeline. The Pipeline would cross Stock Slough approximately 220 feet upstream from the head of tide endpoint for critical habitat in Stock Slough.

PCEs have been identified for critical habitats including: 1) freshwater riverine systems, 2) estuarine habitats, and 3) nearshore coastal marine area. The fresh water riverine component includes the Upper and Lower Sacramento River, Lower Feather River, Lower Yuba River, and several bypasses in the Sacramento-San Joaquin Delta, all of which are in California.

Coos River and Stock Slough are identified as freshwater river habitat components of designated critical habitat although no spawning has been documented in either. Likewise, green sturgeon early life stages are within freshwater and affected by water flow and temperature, but post-larval juvenile sturgeons are not expected in the Coos River or Stock Slough because there are no spawning sites. Nevertheless, the Pipeline has some potential to affect some PCEs essential for the conservation of the Southern DPS in freshwater riverine systems which include:

1. Food resources. Abundant prey items for larval, juvenile, subadult, and adult life stages.
2. Substrate type or size. Substrates suitable for egg deposition and development, larval development, and subadults and adults.
3. Water flow. A flow regime (magnitude, frequency, duration, seasonality, and rate-of-change of fresh water discharge over time) necessary for normal behavior, growth, and survival of all life stages.
4. Water quality. Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.
5. Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within riverine habitats and between riverine and estuarine habitats.
6. Water depth. Deep (≥5 m) holding pools for both upstream and downstream holding of adult or subadult fish, with adequate water quality and flow to maintain the physiological needs of the holding adult or subadult fish.
7. Sediment quality. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

All of the riverine PCEs, except for PCE 2, are expected within the riverine analysis area (described below).

The Pipeline project has the potential to affect estuarine PCEs within Coos Bay and coastal tributaries when occupied by subadult and adult green sturgeon (NMFS 2009c). NMFS (2008b) determined that the Coos Bay estuary provided food resources, water flow, water quality, and migratory corridors to support migration and possibly feeding by subadult and adult green sturgeon. Estuarine PCEs include:

1. Food resources. Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.
2. Water flow. Within bays and estuaries adjacent to the Sacramento River (i.e., the Sacramento-San Joaquin Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds.
3. Water quality. Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages.

4. Migratory corridor. A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats.
5. Depth. A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages.
6. Sediment quality. Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages.

NMFS (2009c) identified coastal marine water depths within 110 meters (360 feet) as occupied areas necessary to critical habitat, including coastal waters segments from San Francisco Bay to Humboldt Bay, California and from Humboldt Bay to Coos Bay. Migratory corridors, water quality and food resources are PCEs associated with coastal marine habitat components of critical habitat (NMFS 2009c).

The specific PCEs in coastal marine areas include:

1. a migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine and between estuarine and marine habitats without human-induced impediments, either physical, chemical, or biological, that would affect the migratory behavior of the fish such that its survival or the overall viability of the species is compromised;
2. coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contaminants (e.g., pesticides, PAH heavy metals that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon); and
3. abundant prey items for subadults and adults, which may include benthic invertebrates and fish.

3.5.1.2 Environmental Baseline

Analysis Area

Three analysis areas within the overall action area are applicable to green sturgeons in the Southern DPS: the marine analysis area, the estuarine analysis area, and the riverine analysis area. The marine analysis area is a fan-shaped area spreading outward from the Coos Bay entrance to the outer continental shelf, which extends approximately 12 nmi offshore. Within the marine analysis area, LNG vessel traffic may have effects on green sturgeons within coastal marine waters up to 110 meters (about 360 feet) deep. This accounts for approximately half of the marine analysis area, or out to 7.5 nmi from the Coos Bay entrance. The LNG carriers are assumed to transect the marine analysis area mostly perpendicularly (east and west as they approach and depart from Coos Bay (see the discussion in section 3.2.1.3 for blue whales).

The Coos Bay estuarine analysis area includes: 1) the existing Federal Navigation Channel which forms part of the waterway for LNG carrier traffic to and from the LNG Terminal, 2) the proposed access channel to the terminal slip, 3) the Navigation Reliability Improvements, 4) the area of North Slough adjacent to the Trans Pacific Parkway/U.S. Highway 101 (US-101) Intersection Widening, 5) the Eelgrass Mitigation site, 6) the Kentuck Project site, and 7) sites temporarily occupied during construction activities (see figure 2.1.1-2 under section 2.1.1, Jordan Cove Energy Project Component Description and figure 3.3.3-3 under section 3.3.3, Marbled Murrelet).

The riverine analysis area includes accessible freshwater tributaries to Coos Bay that would be crossed or potentially affected by construction of the Pipeline below the head-of-tide influence with potential use by green sturgeon.

Species Presence

It is likely that the North American green sturgeon (both the unlisted Northern DPS and threatened Southern DPS) occur within Coos Bay and its adjacent waterbodies, such as the Coos River. Green sturgeon have been taken in almost all of the Oregon coastal estuaries from the Chetco River to Nehalem Bay (EPIC et al. 2001) and genetic studies indicate that both Northern DPS and Southern DPS occur in the Columbia River (Israel et al. 2004).

There are historical records of green sturgeons caught in the Coos Bay commercial fishery (ranging from 67 to nearly 2,000 pounds of fish annually) between 1923 and 1949. Furthermore, ODFW has records of green sturgeon caught off Cooson Point, Hays Slough, at the confluence of the Millicoma and Coos Rivers, in Davis Slough, and South Coos River (Farr and Kern 2005). If their presence in Coos Bay is similar to occurrences on other large estuaries in Oregon and Washington, including the Columbia River, Willapa Bay and Grays Harbor, then a relatively high proportion of green sturgeons may be from the Southern DPS, perhaps as high as 77 to 88 percent, similar to occurrence in the lower Columbia River (Israel and May 2007).

Green sturgeon movements within the 100-meter (328-foot) isobath during migration along the West Coast were monitored using pinger-tags and hydrophone arrays. Although data are limited, tagged sturgeons moved from Seal Rock, Lincoln County, on the Oregon coast north of Coos Bay, south to Monterey Bay, California at the rate of 2 kilometers (1.2 miles) per day and from Seal Rock north to Brooks Peninsula, B.C. at the rate of 4.2 kilometers (2.6 miles) per day (Lindley et al. 2008). Migrating green sturgeons were documented along the Oregon coast (Seal Rock) mostly between October and June (Lindley et al. 2008).

Habitat

Coos Bay is known to support a small population of green sturgeon; however, natural reproduction in the estuary is considered low (Wagoner et al. 1990). The Coos River system is not considered to provide suitable spawning habitat for green sturgeon (Whisler et al. 1999). However, historical records of the American shad gill-net fishery in the Isthmus Slough indicate that green sturgeon were incidentally captured nearly every year from 1980 to 1992 (Farr and Rien 2002). ODFW reported that many of these fish were probably younger than three years old based on their size and suggested that the Coos Bay system may provide spawning or at least rearing habitat for juveniles (Cummings and Schwartz 1971; ODFW 2006b). Green sturgeons may utilize both shallow and deep water habitats within the estuarine analysis area though there is no information relating individuals' occurrence to DPS membership.

Coastal bays and estuaries provide habitats that support juvenile rearing and growth through the time when they enter coastal marine habitats (NMFS 2009c). Since no spawning occurs in freshwater tributaries to Coos Bay, the estuary most likely provides feeding and migratory habitat for adult and possibly subadult green sturgeons. Based on food habit studies in several Washington estuaries, adult and subadult green sturgeon fed on a variety of invertebrates such as crangonid shrimp, burrowing thalassinidean shrimp, burrowing ghost shrimp (*Neotrypaea californiensis*) and possibly other related species, amphipods, clams, and juvenile Dungeness crab (*Metacarcinus magister*) as well as vertebrates including anchovies, sand lance (*Ammodytes hexapterus*), lingcod (*Ophiodon elongatus*), and other fish (NMFS 2009c).

Presence of potential forage species within the vicinity of the Federal Navigation Channel (Miller et al. 1990) is discussed below for Oregon Coast coho salmon (see section 3.5.4). Total benthic invertebrate densities in Coos Bay were found to be lower than densities observed in the Umpqua River Estuary and the Columbia River Estuary (Bottom et al. 1985; Miller et al. 1989; Durkin and Emmett 1980). Benthic studies conducted by NMFS within and in the vicinity of Coos Bay found that the amphipod, *Corophium salmonis*, occurred in much lower densities than in other Oregon estuaries (Miller et al. 1990; Bottom et al. 1985; Miller et al. 1989; Durkin and Emmett 1980). Previous studies in Coos Bay have found that *Corophium* spp. were abundant in intertidal areas and constituted an important diet element for juvenile Chinook salmon and striped bass (BLM 1971).

Green sturgeons utilize West Coast estuaries during summer months when estuarine water temperatures exceed ocean coastal temperatures, perhaps optimizing their growth potentials by foraging in relatively warm, saline estuarine water (Moser and Lindley 2007). The Oregon Department of Environmental Quality (ODEQ) periodically monitored water temperatures in Coos Bay at Marker #23 (near Henderson Marsh) from 1957 to 2005 (ODEQ 2006), located just downstream from the Project site. Although the data are not continuous, they provide a general range of water temperatures in close proximity to the Project site. Temperatures collected during the period of record ranged from 5°C to 13°C (41°F to 55°F) in the winter to 9°C to 20°C (48°F to 68°F) in the summer (ODEQ 2006).

Dissolved oxygen (DO) in lower Coos Bay is generally higher in the winter and lower in the summer. During winter, DO ranged from 8.9 to 10.4 mg/l and averaged 9.4 mg/l. During summer, DO ranged from 6.0 to 9.6 mg/l and averaged 7.4 mg/l (ODEQ 2006). Arneson (1976) also sampled DO in the bay and reported that DO concentrations were slightly higher in December and March than in June and September. Lower DO levels in the summer are associated with lower freshwater inputs but would be a “properly functioning” habitat indicator, overall.

Critical Habitat

NMFS (2009c) designated critical habitat for the Southern DPS of North American green sturgeon to include all tidally influenced areas of Coos Bay up to the elevation of mean higher high water, including the head of tide endpoints in the Coos River and Stock Slough, both of which are crossed by the Pipeline.

The Coos Bay estuary provides several PCEs including food resources, migratory corridors (passage) between estuarine and marine habitats, sediment quality and water quality (NMFS 2009c), all necessary to support various green sturgeon life stages. Similarly, coastal marine waters between Coos Bay and San Francisco Bay provide food, passage, and water quality as PCEs.

NMFS (2008b) determined that the Coos Bay estuary provided food resources, water flow, water quality, and migratory corridors to support migration and possibly feeding by subadult and adult green sturgeon. Shallow water habitats near the Project site have been mapped as habitat for *Corophium* spp. by Coos County Planning Department (1979). Ghost shrimp more commonly inhabit tide flats closer to the ocean and in Coos Bay; ghost shrimp may be further inland because of predation by the Pacific staghorn sculpin (Hornig et al. 1989; Posey 1986). Those species as well as bivalve mollusks (softshell, butter, littleneck, cockle, gaper piddocks and mussels) may provide food for migratory green sturgeon within the estuarine and near-shore marine analysis areas.

Lower Coos Bay provides unobstructed migratory access for juvenile and adult salmonids, discussed above, and similarly assumed to be unobstructed for green sturgeons. Within the estuarine analysis area and lower riverine analysis area entering Coos Bay, access for migrating fish species is uninhibited, and is therefore considered "properly functioning."

3.5.1.3 Effects of the Proposed Action

Analyses of effects for green sturgeon are addressed separately for the marine analysis area, estuarine analysis area, and riverine analysis area.

Direct and Indirect Effects – Marine Analysis Area

Potential project-related effects to the Southern DPS of green sturgeon within the marine analysis area include the following : 1) acoustic effects to sturgeon from LNG carriers transiting the marine analysis area, and 2) oil, gas, and fuel spills from LNG carriers at sea.

Acoustic Effects

Underwater noise produced by LNG carriers transiting the marine analysis area may affect green sturgeon. Underwater noise levels are expected to vary by ship type and also by vessel length, gross tonnage, vessel speed, and to some extent, vessel age—older vessels tend to be louder than newer vessels (see discussion in section 3.2.1.3 for blue whales). Based on the general trend for higher underwater noise generated by larger vessels (McKenna et al. 2012), it is possible for some of the LNG carriers that would utilize the LNG Terminal to generate more noise than the LNG carriers built in 2003 with 138,028 m^3 capacity reported by Hatch et al. (2008) that produced sound levels (with 1 standard error) of 182 ± 2 dB re: 1 µPa @ 1 meter.

State agencies in Washington, Oregon, and California along with federal agencies have developed interim noise exposure threshold criteria for pile-driving effects on fish (WSDOT 2011a; Fisheries Hydroacoustic Working Group 2008; Popper et al. 2006). These threshold criteria are considered levels below which injury effects would not occur to fish from in water noise. These thresholds should be thus suitable for all forms of in-water noise. Interim noise exposure threshold criteria for pile driving effects on fish include: 1) a cumulative sound exposure level (SEL_{cum}) of 187 dB re 1 μPa^2 s for fishes weighing more than two grams, 2) a SEL_{cum} of 183 dB re 1 μPa^2 s for fishes less than two grams, and 3) a single-strike peak level (SPL_{peak}) of 206 dB re 1 µPa for all sizes of fishes (WSDOT 2011a). The LNG carrier in the Hatch et al. (2008) study produced sound levels (with one standard error) of 182 ± 2 dB re: 1 µPa @ 1 meter that attenuated to 160 dB at 35 ± 11 meters and to 120 dB at 16,185 ± 5,359 meters (Hatch et al. 2008).

All project vessel noise values generated in the marine analysis area would be less than those noted above as causing direct harm to fish, with the possible exception for very small fish within 1 meter (3 feet) of an LNG carrier hull for an extended period. Green sturgeon are generally epibenthic and would rarely be in the near surface waters. Additionally, since vessels are in transit, fish can easily move away from vessels, which would keep their exposure very brief and further reduce the chance for harmful exposure to sound and the potential for adverse noise effects.

Noise from LNG vessels would likely increase the background noise within the marine analysis area, While the background levels are not specifically known in the marine analysis area, analyses of more recent vessel-traffic related noise show that levels along the U.S. west coast area holding steady or increasing slightly off Southern California but decreasing in the area off Oregon and Washingon (Andrew et al. 2011). As noted above, green sturgeon in the marine analysis area might detect noise from LNG vessels but are not expected to be adversely affected.

Fuel or Oil Spills at Sea

The LNG carriers use either a steam or dual fuel diesel electric propulsion system that is primarily fueled by natural boil-off gas. Fuel (e.g., diesel) used for back-up generation for LNG carrier propulsion and oil or hydraulic fluids used for mechanical equipment could possibly leak or be spilled while the carriers are in transit. The low volumes of petroleum oils and fuel on LNG carriers greatly reduces the risk of impacts in the marine environment or on green sturgeon from petroleum spills. The Federal Water Pollution Control Act, as amended by the CWA (33 U.S.C. 1251–1387), prohibits the discharge of oil upon the navigable waters of the U.S., which include. Also, LNG carriers calling on the LNG Terminal would be required by the Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills, as described in section 3.2.1.4 for blue whales. As reported by Pacific States/British Columbia annual reports (2002), the number of oil spills reported from fishing, recreational and other harbor marine vessels in Oregon ranged from about 9 to 65 per year, which is fairly infrequent considering that thousands of marine vessels, both recreational and commercial, utilize Oregon coastal marine waters. Therefore, neither fuel nor oil leaks from LNG carriers transiting in the waterway to and from the LNG Terminal are likely to have adverse effects on aquatic resources including green sturgeon.

Direct and Indirect Effects – Estuarine Analysis Area

A summary of marine and estuarine habitat areas temporarily and permanently affected by construction and operation of the LNG Terminal is presented in tables 2.3-1 and 2.3-2 in JCEP's Resource Report 2. Potential project-related effects to the Southern DPS of green sturgeon within the estuarine analysis area are summarized below:

a. Timing of construction activities to life history functions;
b. Turbidity from capital related to the Terminal slip entrance, access channel, and Navigation Reliability Improvements, and the Eelgrass Mitigation Site;
c. Contamination from dredging;
d. Suspended sediment potentially released during HDD construction across Coos Bay Estuary and Coos River;
e. Turbidity from LNG carrier propeller wash and ship wakes;
f. Erosion and runoff;
g. Stormwater discharge at the LNG Terminal;
h. Stranding of juvenile sturgeons by LNG carrier ship wake;
i. Introduction of exotic, invasive species from ballast water exchange;
j. Entrainment during dredging activities;

k. Entrainment and impingement of juvenile sturgeons and prey species at engine cooling water intake portals of LNG carriers while at berth;
l. Effects from changes in temperature;
m. Lighting systems associated with construction and operation;
n. Noise from capital and other in-water construction;
o. Effects to habitat; and
p. Shading the water surface by construction of overwater structures.

Timing to Life History Functions

In-water construction of the JCEP Project within the Coos Bay estuary is planned from October 1 through February 15 following ODFW's recommendation. Because spawning is undocumented in freshwater tributaries to Coos Bay, the estuary most likely supports adult and possibly subadult green sturgeons by providing feeding and migratory habitat. In other watersheds where tributaries support spawning, adults migrate to/from spawning grounds during the spring and fall, consecutively, and juvenile migration occurs from April through November (Rien et al. 2001). Green sturgeon move into estuaries of non-natal rivers to feed (Beamis and Kynard 1997) and occupy large estuaries during the summer and early fall in the Pacific Northwest. Green sturgeon abundance peaks during October in the Columbia River estuary, but the same may not be true of green sturgeon abundance in Coos Bay. Nevertheless, the Southern DPS of green sturgeon could be present within the estuary coincidental with in-water construction for the Project.

Turbidity Effects from Dredging in Coos Bay

Resuspension of sediments and temporary increases in turbidity above Coos Bay background levels would occur while installing and removing the temporary earthen berm at the LNG Terminal slip and while dredging the access channel and Navigation Reliability Improvement sites. Construction of the LNG Terminal slip would require the excavation and dredging of Coos Bay shoreline near Jordan Cove, including removal of about 5.7 mcy of sediment as part of the development of a slip and access channel. The 5.7 mcy of materials would be used to raise the elevation of the LNG Terminal and the South Dunes site to elevations above the tsunami inundation zone.

At least 3.6 mcy at the slip would be removed behind a berm in an upland area separated from the bay, with little potential for sediments to affect the marine environment. The remaining 2.1 mcy would be removed by dredging of the berm (0.7 mcy) and the new access channel (1.4 mcy) in the bay. The access channel would be dredged to a depth of minus 45 feet (NAVD88).

Turbidity was modeled for the capital (i.e., new construction) dredging operations based on the anticipated geotechnical and environmental conditions for this project using the COE's DREDGE model and two dimensional numerical model Mike21 (Moffat & Nichol 2006, 2017a). Modeling results and additional information provided the basis for characterizing effects from turbidity generated by the various JCEP dredging activities.

Dredging of the access channel would result in elevated suspended sediment and turbidity levels in a localized area for a short time period. The time frame over which turbidity plumes would dissipate, from the point of dredging, is anticipated to be on the order or minutes to less than an hour in areas of higher tidal currents due to dilution and spreading. When dredging the Access Channel directly adjacent of the FNC, the turbidity plume is expected to become more elongated as the dredging becomes more proximate to the main channel flow. Modelling demonstrated the maximum extent of the turbidity plume, defined by the simulated 10 nephalometric turbidity units (NTUs) above background contour, to be approximately 780 and 750 feet when using cutter suction and clamshell dredges, respectively. (Moffatt & Nichol 2017a). Construction of the Access Channel and removal of the berm at the Slip would require a total volume of 1.9 million cubic yards (mcy) of material from saltwater dredging using a combination of cutter suction and clamshell dredge methods. This would require about four to six months to complete over three in-water work windows (October 1 to February 15). Turbidity is expected to dissipate to background levels within a few hours after dredge operations cease.(Moffatt & Nichol 2017a).

On average, the COE removes approximately 550,000 cy from the bar, 200,000 cy from CM 2 to 12, and 150,000 cy from CM 12 to 15 each year. The COE claims that its maintenance dredging of the Federal Navigation Channel does not significantly increase turbidity below CM 12 (Roye 1979).

For the Navigation Reliability Improvement sites, a total of approximately 584,300 cy of dredge material would be removed from four locations (referred to as Dredge Areas 1 through 4) adjacent to the existing Federal Navigation Channel between RM 2 and 7. These areas would be dredged to a controlled depth to match the adjacent Federal Navigation Channel, which is currently -37 feet MLLW. Dredging is expected to require about 5 months to complete, with an additional 45-day mobilization period, based on an assumed production rate of 7,700 cy per day and could be spread over four in-water work windows. Extending this in-water work over four construction seasons also would improve the logistical feasibility of material placement at APCO Site 2.

Dredging methods would be similar to what is described above for the slip and access channel and could include mechanical methods from a barge or hydraulic cutter section dredging. Material from the four dredge areas would be moved to the APCO Sites. The potential turbidity plume extents, defined by the simulated 10 NTU above background contour, from the Navigation Reliability Improvements varies by location and dredge equipment but could extend from 2,820 feet to 4,600 feet from the activity for a short period depending on the ebb and flow of the tidal current and extent of additional sediment generated (Moffatt & Nichol 2017c).

Aquatic organisms in Coos Bay are adapted to periods of high to moderate TSS (measured as turbidity) during winter months. Dredge operations are expected to result in exposure to similar levels of TSS, with higher concentrations expected in the immediate area of dredging. Ambient background levels of TSS in water are created by flows, waves and ship traffic. Within Coos Bay, ambient turbidity levels have been assessed based on several studies. As described by Moffatt & Nichol (2006), the average concentration of TSS measured near the proposed LNG terminal site was 14 mg/l with a range of 0-25 mg/l. This report also references a longer record of Coos Bay background data reported by NOAA for the period of April 2002 to December 2004 at the Charleston Bridge station located closer to the bay entrance than the LNG terminal site. Based on results from this study, the average summer and winter TSS levels at the Charleston Bridge station were 10.1 and 27.3 mg/l, respectively, which are equivalent to 5.8 and 12.2 NTUs.

More recently, hourly turbidity readings taken at the North Spit-BLM boat ramp gauge were compiled between August 2013 and January 2015. Preliminary data processing was first conducted to remove high turbidity measurements obtained over extended periods of time, as these typically occurred when dredging activities were ongoing. In addition, based on an empirical relationship developed for nine streams in the Pacific Northwest, turbidity values expressed in NTUs were converted to TSS in mg/L. Based on these data, the average natural turbidity level was calculated to be 40 mg/L at the North Spit-BLM boat ramp gauge (Moffatt &Nichol 2016).

At the Eelgrass Mitigation Site, a total of 40,000 cy of dredge material will be removed most likely with a small hydraulic dredge. Modeled turbidity values were determined to range from 270 to 290 NTUs. The potential turbidity plume extent, defined by the simulated 10 NTU above background contour, from the excavator dredge area would be generally limited to between 340 and 360 feet in all directions (Moffatt &Nichol 2017c). Since the site is a more confined and shallow area with somewhat limited circulation, the turbidity plume would be maintained within the local area of excavation. The duration of suspended sediment settling, therefore, is expected to be very short with turbidity dissipating to background levels within an hour after dredge operations cease, depending on the tidal cycle.

As indicated in Section 3.1.6 of the DMMP and Section 4 of the 10-17-17 Eelgrass Dredging/Excavation Means and Methods Feasibility Technical Memo, the design approach for dredging and turbidity management at the eelgrass mitigation site would involve:

- a hydraulic dredge pump system mounted on a long-reach excavator;
- a 3,900 foot long, 14-inch diameter, steel or anchored HDPE material transport pipeline;
- two booster pumps mounted on small anchored/spudded barges (or on small temporary platforms secured by 3-4 support piles);
- a loader operating on a 60-foot by 200-foot deck barge stationed near the FNC in about 20 feet of water;
- several 10 to 24-inch diameter moorage pile for stationing the deck barge;
- and scows and/or barges equipped with containment berms to accommodate hydraulic loading and settling of dredge material

The containment system on the scows and/or barges will minimize the release of turbid decant water back into the bay. If determined feasible, silt curtains at the dredge site also could be deployed to limit the dispersion of turbid waters to the local embayment as the bathymetry is modified to make it more suitable for eelgrass transplants the following year. As described in Section 4.2.2.1 of the APDBA, other operational controls would be employed to assure compliance with water quality criteria as stipulated in the Section 401 Certification issued by Oregon DEQ. As a result, effects to listed fish would be minimal.

If green sturgeon are exposed to moderate to high levels of suspended sediment for prolonged periods, adverse effects could occur to rearing fish. As noted, dredging is expected to create spikes of high to moderate turbidity in a localized area. Effects to green sturgeon are expected to be insignificant and discountable due to the limited area affected, the low likelihood of individual fish being present in the estuary, and limitations on construction periods. Based on these results, it is not anticipated that turbidity and suspended sediment generation at the dredging site would be a substantial issue.

Contamination Effects from Dredging

NMFS (2009c) has noted that subadults and adults feeding in bays and estuaries may be exposed to contaminants that may affect growth and reproduction. Such effects due to bioaccumulation of pesticides and other contaminants have been documented in white sturgeons that also inhabit West Coast estuaries (NMFS 2009c).

Sediments within the proposed dredge prism for the access channel were sampled to determine whether they meet Dredged Material Evaluation Framework (DMEF) guidelines, as identified for the Lower Columbia River Management Area, for in-water disposal (SHN 2006). An analysis of grain size distribution and total volatile solids composition was initially performed to determine if the sediments require further testing for chemical analysis. All of the samples were primarily composed of medium to fine grained sand and had a very low percentage of total volatile solids. Since none of the samples exceeded 20 percent fines or 5 percent total volatile solids, no further chemical testing was required and the sediments were deemed suitable for in-water disposal, according to DMEF guidelines. These findings indicate that resuspension of sediments associated with the dredging for the access channel should not result in significant increases in the bioavailability of contaminants to fish and fish food organisms within the analysis areas. Therefore, there is little to no risk of contamination as a result of dredging the access channel.

This conclusion is further supported by previous sediment evaluations conducted by the USACE in 2004 for Coos Bay channel maintenance and improvement dredging at various stations along the FNC (COE 2005). Throughout the entire sampling area, only low levels of sediment contaminants were identified, with all levels well below their respective DMEF screening levels. One of the sampling stations (0915CB-BC-10) was located approximately 0.4 mile downstream of the LNG Terminal. The 2004 sediment sampling effort found only low levels of chemical contaminants, with all levels below their respective DMEF screening levels. None of the samples contained dichlorodiphenyltrichloroethane (DDT) or its derivative by-products (dichlorodiphenly-dichloroethylene [DDE], dicholordiphenyldichloroethane [DDD]) at levels that could cause adverse effects to fish resources.

In 2011 and 2016, JCEP conducted geotechnical investigations at the NRI sites to support the JCEP's DMMP. Analysis of the physical characteristics of sediments at the NRI sites determined that sediment composition consisted of sand, silty sand, sandstone, and siltstone. This is similar to sediments collected from the adjacent FNC and from within the footprint of the proposed LNG Terminal access channel. These sediments were generally described as coarse-grained with high sand content, which the Portland Sediment Evaluation Team (PSET) previously determined suitable for unconfined aquatic disposal. Due to their proximity to previous sampling locations in the FNC and access channel, sediments to be dredged from the NRI sites will have a similar chemical character as will be confirmed based on future coordination with the PSET. Therefore, sediments at the NRI sites will also have a low likelihood of potential contaminants and will be suitable for unconfined aquatic disposal.

Turbidity Effects from Temporary In-water Construction

In-water construction activities are likely to temporarily increase TSS concentrations and turbidity. Such increases would result from in-water construction related to the:

- Temporary Material Barge Berth (TMBB),
- Material Offloading Facility (MOF),
- Trans Pacific Parkway/US-101 Intersection Widening,
- APCO Site access bridge construction,
- replacement of anchoring systems for existing meteorological ocean data collection buoys as well as addition of anchoring systems for two new buoys,
- establishment of hydraulic connections to the Kentuck Project for estuarine habitat mitigation, and
- creation of the Eelgrass Mitigation site.

Turbidity increases would be localized and limited to the time required to complete each of the respective JCEP Project components. Construction activities would occur within the ODFW in-water work window (October 1 to February 15). Effects to green sturgeon are expected to be insignificant and discountable due to the limited area affected, the low likelihood of individual fish being present in the estuary and limitations on construction periods. Based on these results, it is not anticipated that turbidity and suspended sediment generation at the construction site would be a substantial issue.

Suspended Sediment – HDD across Coos Bay Estuary and Coos River

Coos Bay would be crossed by two HDDs, one from MP 0.28 to MP 1.00 (West HDD), the other from MP 1.46 to MP 3.02 (East HDD). The Coos River (a tributary to the estuary) would also be crossed using HDD at MP 11.13. At that location, the Coos River is under tidal influence and is addressed here in the estuarine analysis area rather than in the riverine analysis area.

The horizontal crossing length of the West HDD would span 5,192 feet, extending from the North Spit to the southeast, crossing the Federal Navigation Channel and terminating at North Point in North Bend, Oregon. The HDD profile would pass approximately 158 feet below the railroad trestle bridge and approximately 138 feet below the deepest part of the Federal Navigation Channel. The depth and the locations of the railroad trestle foundations are unknown at this time (GeoEngineers 2017a). The feasibility analysis for the West HDD anticipates a relatively low risk of hydraulic fracture and drilling fluid surface releases occurring along most of the HDD alignment during construction. However, there would be a high risk of hydraulic fracture and drilling fluid surface release within about 150 feet of either end of the HDD due to the anticipated loose sand and decreased depth of cover. Installation of an oversized casing may be needed at both ends of the HDD path to assist in efficiently transferring axial loads to the drill bit, and to mitigate against hydraulic fracture and drilling fluid surface releases within the loose sand anticipated in the upper 30 feet (GeoEngineers 2017a).

The horizontal crossing length of the East HDD would span 8,972 feet extending from North Point in North Bend, Oregon eastward across Coos Bay and ending at the mouth of Kentuck Slough. Surface conditions at North Point at the west end of the HDD consist of a relatively flat ground surface covered with fill stockpiles. The east end of the HDD would be located within a flat grass vegetated area in Kentuck Slough Valley. The proposed depth of the Pipeline would be 210 feet below ground surface.

The alignment of the HDD would cross the Federal Navigation Channel and shallow tidal mud flats east of the Federal Navigation Channel. GeoEngineers (2017a) anticipates that the HDD would be completed using pilot hole intersect methods, due to the substantial length. Because this crossing would be completed using pilot hole intersect methods, both ends are identified as entry points. For this design, the carrier pipe would be strung and fabricated along the Kentuck Slough valley floor on the east end of the crossing. The proposed carrier pipe stringing area would be located northeast of the east entry point along the Kentuck Slough valley floor. Kentuck Slough and Kentuck Way limit the available pipe string length to 5,293 feet so a tie-in weld would be required during pullback operations. The orientation of the HDD alignment would require two horizontal curves in the pull section, making fabricating and handling the pipe more difficult.

Drilling fluid containment would be via relatively small fluid containment pits excavated adjacent to the entry points of the drill. These pits typically measure approximately 6 to 10 feet square and 4 to 6 feet deep. During drilling operations, drilling fluid returns and cuttings from downhole flow into the pits where the fluid is then pumped to a recycling system where most of the cuttings are removed and the drilling fluid can be recirculated downhole (GeoEngineers 2017a).

Because of the length of the HDD, there would be an increased risk of drilling fluid surface release during reaming operations. This risk can be reduced by reaming the hole from both ends of the crossing. This methodology helps reduce downhole annular drilling fluid pressures by shortening the flow path of the drilling fluid through the hole. Although this increased risk does not necessarily affect the technical feasibility of the proposed HDD, reaming from both sides of the crossing could potentially have cost impacts that may require consideration. In general, GeoEngineers (2017a) expects the risk of drill hole instability along the HDD drill paths to be relatively low.

According to GeoEngineers' design (2017b) for construction using HDD across the Coos River (see appendix E), the design length of the Coos River HDD crossing would be approximately 1,602 feet. The proposed entry point would be located approximately 500 feet from the north bank of the Coos River and the exit point would be approximately 630 feet from the south bank. The entry and exit points would allow for adequate depth beneath the Coos River. The preliminary design would provide a minimum of 50.3 feet of cover below the Coos River. GeoEngineers' evaluation determined that the construction of the Coos River HDD crossing is likely feasible. GeoEngineers opined that there is a relatively high risk of hydraulic fracture and drilling fluid surface releases along the first 500 feet and last 300 feet of the HDD, respectively. However, the risk of drilling fluid surface release to the Coos River would be relatively low. As is typical with all HDDs, the risk of drilling fluid surface release becomes high within approximately 150 feet of the exit. Drilling fluid surface releases may occur within these high risk zones even if the contractor maintains drilling fluid returns during construction and also maintains drilling fluid properties that are conducive to cuttings removal and formation of a "wall cake" to help stabilize the borehole and limit fluid interaction between the borehole and surrounding soils (GeoEngineers 2017b).

Inadvertent Release of Drilling Muds (Inadvertent Return)

The HDD installation method is considered an effective technique for avoiding in-stream impacts by eliminating the need for in-stream excavation (Reid and Anderson 1998; Reid et al. 2004). Even with this technique, there is a potential for impact as a result of the HDD process. Drilling requires use of a drilling mud for lubrication of the bit and removal of cuttings. A biodegradable bentonite clay mixture makes up drilling mud; bentonite is considered to be "practically non-toxic" (Reid and Anderson 1998). Because the drilling mud is under pressure during drilling, if the bit encounters substrate fractures or channels, it is possible for bentonite to escape from the hole (termed an "inadvertent return"). Bentonite can escape to the surface through fractures in the drilled substrate.

Bentonite by itself is generally considered a non-toxic drilling mud (Breteler et al. 1985; Hartman and Martin 1984; Sprague and Logan 1979), although according to Reid and Anderson (1998), the toxicity of bentonite (sodium montmorillonite) in fresh water ranges from 5,000 to 19,000 ppm (mg/liter) based on 96-hour tests for LC50 (the concentration at which 50 percent of the test population dies after 95 hours of exposure) on rainbow trout. The toxicity classifications based on LC50 values ranged from "slightly toxic" (5,000 ppm) to "practically non-toxic" (19,000 ppm) (Reid and Anderson, 1998). In other tests, toxicities to lake whitefish and rainbow trout demonstrated threshold concentrations of 16,613 and 49,838 ppm (mg/l), respectively (Reid and Anderson, 1998). LC50 concentrations >10,000 ppm would be considered "practically non-toxic". In marine water, a 96-hour LC50 bioassay for toxicity of bentonite on a mysid shrimp (*Mysidopsis bahia*) was >1,000,000 ppm (Reid and Anderson 1998).

Bentonite, as with any fine particulate material, can interfere with oxygen exchange by the gills of aquatic organisms (EPA 1986). The degree of interference generally increases with water temperature (Horkel and Pearson 1976). Impacts would be localized and would normally be limited to individual fish in the immediate vicinity of the inadvertent return. The majority of highly mobile aquatic organisms, such as fish, would be able to avoid or move away from turbidity spots and plumes (Reid and Anderson 1999). Other less mobile or immobile organisms, such as clams, mussels and other macroinvertebrates, would incur direct mortality (Wilbur and Clark 2001). Bentonite can smother macroinvertebrates and adversely affect filter-feeders (Falk and Lawrence 1973 in Hair et al. 2002 and Land 1974 in Cameron et al. 2002). Bentonite can also exacerbate or enhance the effects of toxic compounds to fish and aquatic invertebrates if those compounds are present in aquatic habitats (Hartman and Martin 1984). Similar to other fine-grained particulates, bentonite in flowing water is more likely to remain in suspension longer than in standing water. Consequently, effects to green sturgeon by a release of bentonite into a waterbody would ultimately depend on volume of the release, volume of water present, and current. Green sturgeon inhabiting larger waterbodies with swift currents would be less affected by a given volume of bentonite than those inhabiting small waterbodies with no current. Green sturgeon spawning would not occur within the estuarine or riverine analysis areas and larval sturgeons are not expected in either area.

Reid and Anderson (1998), the Canadian Pipeline Water Crossing Committee (1999), and Reid et al. (2008) reported that 13 of 30 HDD stream crossings had drilling mud releases (citing Harder Associates 1996). The statistic is based on drilling mud releases during the early days of HDD technology (first conducted in 1971). The summary by Reid and Anderson (1998) provides a substantive description of effects to streams and habitat in the cases with inadvertent returns.

Drilling mud releases during HDD construction can result from:

1. Circulation losses through highly permeable gravels;
2. Mud migration along rock joints or fractures which intersect with the river bottom;
3. Loss of pilot hole directional control resulting in the intersection with the river bottom or approach slope;
4. Drilling mud pressures exceeding ground stress, widening existing or creating new fractures (hydraulic fracturing), allowing for mud migration; or
5. Substantially different elevations of entry and exit drill locations. Resulting pressure head differences can cause substantial upland leakages of drilling muds once the drill bit nears the ground surface or when it breaks the surface.

Drilling mud releases may surface through river and streambeds, wetland bottoms, or at upland locations. The volume of mud released to the surface would depend on:

1. Porosity of the substrate transporting the mud;
2. Extent and size of the porous material;
3. Pressure exerted on the mud by the hydraulic system;
4. Viscosity of the mud at the time of exposure; and
5. Whether mud circulation can be maintained.

Magnitude of effects by mud releases to fish, streams and habitat would depend on the following (page numbers referenced from Reid and Anderson, 1998):

1. Toxicity of the drilling mud components and additives (pages 57-59; also Table 1);
2. Increased sediment loads (page 59);
3. Effects to hydrological conditions that would cause poor conditions for wetland plant establishment and growth (pages 59-60);
4. Release into streams and rivers that could cause increases in the downstream drift of stream macroinvertebrates (page 60); and/or
5. Level of exposure to fish (e.g., concentration), duration of exposure, lifestage of fish present, timing of release, and ability of the watercourse to remove or incorporate the released muds without degrading existing habitats (page 61).

The report by Reid and Anderson (1998) summarizes the general effects, known or hypothesized, associated with drilling mud releases but does not provide specific effects associated with each of the 13 instances cited.

Likewise, Canadian Pipeline Water Crossing Committee (1999) reported that drill mud seepage occurred in 36 of 146 cases of HDD cases reviewed with most significant leakage occurring at the drill entry or exit points due to different pressure heads with large differences in elevation between the two points. Leakage also occurred during reaming or pull-back. However, the report did not describe the effects to fish, streams and habitat in the cases with leakages or inadvertent returns. Potential inadvertent returns are more common near the HDD drill entry and exit locations; however, impacts to waterbodies are minimized by locating the drill entry and exit points away from the waterbody. The probability of an inadvertent return may increase when the drill bit is working nearest the surface (see GeoEngineers 2017a and 2017b) but is dependent on numerous factors including substrate characteristics, head pressure of the drilling mud, topography, elevation, and subsurface hydrology.

Benthic organisms, on which green sturgeon would feed, could also be affected by burial. However, bentonite is more likely to stay in suspension than settle when compared to common bottom sediment; therefore, in flowing water areas, effects to benthic organisms from burial from inadvertent return are likely to be low.

Hydraulic fracture typically occurs when the drill path passes through relatively weak cohesive soils with low shear strength or very loose granular soils. Loose and silty sands and soft to medium stiff silts and clays typically have a higher hydraulic fracture potential. Medium dense to dense sands and gravels and very stiff to hard silts and clays have a low to moderate hydraulic fracture potential. Unfractured rock, because of its high shear strength, typically has a low potential for hydraulic fracture. HDD installations with greater depth or in formations with higher shear strength may reduce the potential for hydraulic fracturing (see appendix E).

In the event an inadvertent return occurs into a waterbody, drilling fluid would enter the waterway causing short-term, temporary water quality impacts downstream of the project area including sedimentation and turbidity. The behavioral avoidance response of green sturgeon is presumed to be triggered within the immediate vicinity of the release, and the fish are expected to return and utilize the affected area shortly after the inadvertent release has been halted. PCGP's *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations* (see appendix D) describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The HDD Contingency Plan also includes procedures for cleanup of drilling mud releases. If significant concentrations are found during monitoring as a result of a release, the following possible corrective measures would be taken:

1. Deployment of containment structures, if feasible, and removal of drilling mud from substrate and streambanks if possible.
2. Increase the drilling fluid viscosity in an attempt at sealing the point at which fluid is leaving the drilled hole. The drilling operation may be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the higher viscosity drilling fluid.
3. If increasing the drilling fluid viscosity is ineffective, lost circulation materials (LCM) may be introduced into the hole by incorporating them in the drilling fluid and pumping the material down-hole. The drilling operation may again be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the LCMs.
4. Depending on the location of the fractured zone, a steel casing may be installed that is of sufficient size to receive the largest expected down-hole tools for the crossing. This casing installation provides a temporary conduit for drilling fluids to flow while opening the remaining section of the hole to a diameter acceptable for receiving the proposed pipe sections. To alleviate future concerns with the steel casing after the HDD installation is completed, the casing is generally extracted from the hole prior to or just after completing

the HDD installation. However, there have been instances when attempts at extracting the steel casing were unsuccessful.

5. In the event drilling fluid flow is not regained through the annulus of the drilled hole and a steel casing installation is not utilized, the HDD contractor may elect to install a grout mixture into the drilled hole in an attempt to seal the fractured zone. The down-hole drilling assembly is generally extracted and existing hole is re-drilled to the point at which it had previously been drilled prior to having encountered the loss of drilling fluid.

In some instances, it may be determined that the existing hole encountered a zone of unsatisfactory soil material and the hole may have to be abandoned. If the hole is abandoned, it would be filled with cuttings and drilling fluid.

Overall at the site of any inadvertent return, the amount of drilling mud released into a waterbody would be low. The HDD location on the Coos Estuary and Coos River has a large volume of water and swift flows, where the drilling mud would be diluted. If an inadvertent release of drilling mud from an HDD occurred on the Coos River, it would have minor short-term adverse effects to aquatic resources including green sturgeon. Likewise, inadvertent release of drilling mud from one or both HDDs beneath Coos Bay would be expected to have minor short-term consequences to water quality and substrate composition and characteristics in the estuary.

Dispersion of drilling fluids from a release site (inadvertent return) is a function of the energy, salinity, and sediment transportation characeristics of the watercourse and the amount of fluid released. In low-flow areas such as tidal mudflats, releases will exhibit limited horizontal transport. If drilling fluid is released into Coos Bay, the drilling fluid will not likely mobilize as it would in a rapidly moving river (Reid and Anderson 1998). Coos Bay is relatively shallow throughout much of the HDD alignment. The mudline becomes exposed during low tides across much of the alignment except within the dredged shipping channel. In the event of a drilling fluid release into Coos Bay, the drilling fluid would likely settle onto the bay floor, where it could be contained and removed Pacific Connector Gas Pipeline 2017). Since marine bioassays suggest bentonite to be non-toxic (Reid and Anderson 1998), a coating of bentonite on mudflats would most likely create a temporary physical barrier to benthos burrows and interfere with species' feeding mechanisms, similar to existing depositional phenomena in the estuary. If drilling fluid is released into Coos Bay it would be addressed in accordance with the provisions of the containment plan (Pacific Connector Gas Pipeline 2017). It is unlikely that any drilling fluid released would remain on the bay floor and not be captured and cleaned up.

Turbidity Effects – LNG Vessels in the Waterway

Propeller wash from LNG vessels and tug boat propellers associated with the Project, as well as ship wakes (waves) breaking on shore, could cause increased erosion along the shoreline, re-suspend the eroded material within the water column, and displace bottom organisms due to bottom scour. This may affect the diversity and health of the benthic community regarding food availability and feeding conditions for foraging and migrating fish species. At high concentrations, suspended sediments can affect oxygen exchange over the gills, resulting in weakened individuals or mortality. Waves from vessels breaking on the shoreline can also cause fish stranding. The possible magnitude and effects of the proposed Project including approximately 120 inbound and 120 outbound LNG carrier trips per year on shoreline erosion were approximated by JCEP through model studies, the results of which are discussed below.

Overall effects on bank and bottom erosion and elevated suspended sediment effects are expected to be unsubstantial.

Model Parameters

To estimate the effects of waves and propeller wash from LNG vessels in Coos Bay, JCEP developed two separate model approaches. One was developed by Moffatt & Nichol (2008b) and another by CHE (2011). Both used similar baseline information but different approaches to determine likely effects on shoreline erosion. These models assumed that upon entering Coos Bay, LNG vessels would travel at approximately 8 to 10 knots (9.2 to 11.5 mph) within the first mile of the Coos Bay entrance. For the remainder of the route to the LNG Terminal, LNG vessel speed would be approximately 6 knots (6.9 mph) or less. Vessels would be assisted by tugboats during transit and docking. Both models assumed that the maximum speed of the LNG vessels would be 6 knots (6.9 mph) and made comparisons to natural waves' effects in the bay. The Moffatt & Nichol model (2008b) assumed about 200 vessel transits per year (combined inbound and outbound; about 180 combined vessel transits are proposed) of a 934-foot-long vessel traveling at about 6 knots (6.9 mph), which is the upper range of speed that may occur during transport within the Federal Navigation Channel for LNG vessels.

The CHE (2011) model, however, used the wake generated by the tugboat providing transport in the bay as it would be traveling at the same speed as the LNG carrier and would actually generate larger waves. CHE (2011) also compared the energy, size and effects of waves produced by proposed LNG carriers to those generated by existing large vessel traffic in the Coos Bay route as well as natural wind waves. Both models considered the effect of waves at varied locations from near the mouth of Coos Bay to near the docking facility of the LNG carrier (7 to 9 locations along the proposed LNG route for the two models). In consultation with state agencies (ODEQ and ODFW), CHE selected model points that were considered "sensitive" areas. Their model assumed 113 round trips (i.e., 226 vessel channel transits) of LNG carriers annually traveling at about 6 knots (6.9 mph) along most of the route but 4 knots (4.6 mph) near the airport.

A more recent vessel wake analysis was recently completed (Moffatt & Nichol 2017d). This study compared two modeling scenarios – "without project" and "with project." The "with project" scenario included the latest anticipated dredged depths for the Federal Navigation Channel, access channel, and marine slip. This study also incorporated the latest anticipated vessel characteristics for the new facility, which included 240 vessel transits, bulk carriers and tugs. For the "with project" scenario, all LNG carriers were assumed to travel no faster than 5 knots, with tugs traveling up to 10 knots outbound. Results of the 2017 wake analysis are summarized below.

Wave Model Results

The Moffatt & Nichol (2008b) model found that the maximum wave height generated would be about 1.1 feet. Although waves of this size occur throughout much of the bay, they only occur about 2 percent or less of the time annually based on the locations modeled. Among the seven locations chosen by Moffatt & Nichol, the model predicted that the waves generated would equal from 0.0 to 3.1 percent of the annual wave energy at these locations above the current wave energy level.

The CHE (2011) model compared the two measures of potential changes of shoreline waves from LNG vessel activity. The first was a comparison of single event (one vessel passage) shoreline wave energy (as measure by wave velocity) to that of existing large Coos Bay vessels that already occurs. The other comparison was overall cumulative yearly effect of LNG passage to that of existing vessels and that generated by natural wind waves. Their model results showed that the single passage events of LNG carriers would have slightly less shoreline wave impact (as measured by average wave velocity at the shore) per event than that of large existing vessel passage. Existing large vessel velocity was assumed to be 10 knots (11.5 mph), which is greater than the lower velocity of 6 knots (6.9 mph) typical of LNG vessels and likely affected this result. This model estimated example direct shore wave height to be less than about 0.6 foot for the assumed mean higher high water tidal conditions for LNG carrier passage.

The CHE model simulated varied natural wind and tidal conditions (1,080 total combination conditions) to estimate wave effects on the shore sediment transport. One example of data results for high wind conditions indicated a maximum wave height near 0.9 foot high at some shore locations (assuming a 22 knot [25.3 mph] west wind). The model results indicated that nearly all of the annual shoreline wave-generated sediment transport would be generated by natural wind waves (greater than about 90 percent at all locations modeled). Overall, the model estimated that additional waves generated by the new LNG carrier traffic could increase shoreline sediment transport at the modeled point by 5 to 8 percent over existing conditions (wind-generated waves plus existing large vessel–generated waves).

Overall, while both of the CHE models indicated some additional shore sediment movement could occur from the waves generated by the passage of LNG carriers through Coos Bay, the effects would be small because increased waves would occur infrequently, contribute a very small portion of total annual wave energy and sediment transport, and be within the normal magnitude of waves that naturally occur within the bay. Therefore, the total effect is likely to be within the range of natural annual variability of wave conditions.

Additionally, the analysis indicates that the outer mile of the entrance, where LNG carriers would be traveling at 8 to 10 knots (9.2 to 11.5 mph), may have higher vessel-generated waves because of the greater speed. However, this area is already less protected from naturally occurring ocean-generated waves (this region directly faces the ocean entrance) and likely has higher background naturally generated waves than the regions farther in the bay. Overall, increased sedimentation and disruption of aquatic nearshore habitat from additional tugboat and LNG carriers generated waves would be unlikely because of the factors noted above.

The results of the more recent vessel wake analysis indicates the drawdown generated by LNG carriers' departure and arrival under the proposed Project would be lower than existing conditions (0.4 - 0.5 feet for bulk carriers compared to 0.1-0.2 feet for LNG carriers at the shoreline). The predicted wave heights at the shoreline are higher with the tugs (0.6 – 0.8 feet) than with the bulk carriers under the proposed project. However, even the magnitude of tug wakes would be at the low end of the locally generated wind-wave heights ranging from about 0.5 to 3 feet (CHE 2011, Moffatt &Nichol 2017e). The wave effect on the shoreline from increased vessel transits can be managed by reducing vessel speed (Moffatt & Nichol 2017e).

Propeller Wash Model Results

Effects of propwash on bank and bed erosion were estimated by the CHE (2011) and Moffatt & Nichol (2008b) reports noted above. The two models estimated the likely bottom velocity and effects to sediment along the entire route. These models considered boat and bottom sediment characteristics in the area of interest and tidal levels when transport and docking would occur.

The Moffatt & Nichol (2008b) report indicated that along most of the route (approximately from CM 1 to the new access channel for the LNG Terminal) bottom disturbance would be slight within the Federal Navigation Channel. The bottom velocity caused by the propeller would be similar to the maximum velocity of peak tides (about 4 feet per second [ft/sec]). However, near the docking location, they estimated bottom velocity would be roughly double, or about 7 to 8 ft/sec. The report noted that along most of this route the main channel bottom is considered coarse (sand and sandstone). This type of substrate is hard to suspend and rapidly settles. Generally, along most of the route no marked bottom disturbance or sediment suspension would occur, as the increased velocity would be similar to maximum tidal currents. Within about the last half- to quarter-mile before reaching the slip (based on the point selected for modeling) is where bottom velocity is increased. Some increased bottom scour and locally elevated turbidity may occur in this area, but the effects would be limited in dimension. Disturbance would be limited, partly due to the coarse (mostly sand) bottom substrate that is relatively resistant to resuspension and rapidly settles.

The CHE (2011) report found slightly different results using a different model. It reported that maximum bottom velocity in a narrow band along the route would be 13 ft/sec, higher than the previous report. This report also noted that maximum velocity diminished rapidly from directly below the propeller to 0.6 ft/sec along the edge of the Federal Navigation Channel (150 feet from mid-channel), which is below levels that would suspend fine sediment. Based on model results, bottom velocity greater than about 4 ft/sec would occur only in an approximate 80-foot-wide band. Therefore, velocity generated by the propeller in excess of tidal flow velocity would be limited to a narrow band in the mid-channel, limiting the area where sediment may be suspended from propeller actions of the LNG carriers. Additionally, as noted by Moffatt & Nichol (2008b), this region is generally of coarser sediment that is less prone to suspension.

The CHE (2011) report also modeled likely bottom disturbance from existing large vessel transit (assumed 106 trips annually) in the bay and found that bottom velocity from these would be slightly greater than that of the LNG carriers (projected 113 trips annually). Therefore, during LNG transit, where these high bottom velocities occur, some sediment would be moved during arrival and departure. This would occur below the intertidal area. Turbidity would likely be slight due to the coarse characteristics of the Federal Navigation Channel sediment that is resistant to current induced suspension and have unsubstantial direct effect from elevated suspended sediment to green sturgeon.

The CHE (2011) report also modeled velocities and likely effects on sediment scour at the access channel and marine slip from the tugboat pushing of LNG carrier into the dock. Assuming very high power use by the tug to dock the LNG carrier, the model estimated maximum velocity on the far bank (about 275 feet from the propeller) would be mostly less than 2.0 ft/sec, which would be unlikely to erode the bank. Furthermore, this area would be armored so no erosion would occur. Near the bottom, maximum velocity in the docking channel would be about 2.16

ft/sec. Sediment analysis suggests that over 95 percent of the bottom material (mostly silt/clay size) in the access channel would be susceptible to suspension at this velocity. The report also estimated that bottom scour would be limited to about 2 inches over a limited bottom area (approximately 100 by 50 feet) in the access channel. Some bottom disturbance would likely occur during docking. In most cases, this disturbance is likely to be much less than estimated because of the conservative assumptions used for this model. Again elevated suspended sediment levels during LNG carrier docking are expected to be brief and have only short-term local effects to any green sturgeon in the docking area.

An updated 2017 prop wash memo (Moffatt and Nichol 2017e) included modeling the use of ship engines and tug assist for berthing and unberthing in the marine slip area. Results indicated high propeller wash velocities along the east side of the slip during unberthing. The largest bottom velocities (13.6 feet/sec) were estimated to occur on the eastern side of the Access Channel and the Slip near the MOF. During berthing, the largest bottom velocities (5.4 feet/sec) are expected to be near the western slope within the Slip and the Access Channel.

Scour depths were estimated to be nearly 0.5 feet due to propeller wash near the eastern side of the Access Channel and the Slip if there is no slope protection installed. However, slope protection is planned for each side of the slip, and for the east and west sides of the access channel. These results do not change the earlier conclusion that suspended sediment levels during carrier docking are expected to only have short-term localized effects to individual green sturgeon that may occur in the docking area.

Erosion and Runoff from the JCEP Upland Facilities

Impacts on marine resources could occur from the clearing of vegetation at the terminal, erosion and sediment runoff, and potential hazardous substance spills during construction. While no streams are present in the upland portion of the terminal, the removal of current vegetation could modify the character and amount of water runoff into the bay.

Nearshore vegetation clearing could indirectly affect aquatic resources in the bay. However, the amount of nearshore vegetation that would be removed for this Project is small. The existing disturbed shoreline near the South Dunes site would be used as a temporary laydown area.

During construction, uncontrolled increases in sediment runoff to Coos Bay could impact local aquatic resources. JCEP would prevent uncontrolled releases of sediment runoff during construction by implementing erosion control and revegetation measures from its Plan and Procedures. Additionally, accidental spills of hazardous materials (e.g., equipment fuel, oils, and paints) during construction could have effects on aquatic resources in the bay. JCEP prepared a draft site-specific SPCCP to minimize the potential for accidental releases of hazardous materials. BMPs for erosion and pollution control are outlined in appendix N – Conservation Measures.

Stormwater Discharge

Stormwater discharge has the potential to contain chemicals toxic to green sturgeon. However, the NPDES permit that the applicants would obtain requires discharges to not modify state water quality standards of the receiving water. The stormwater permit application states, "The permit registrant must not cause a violation of instream water quality standards." Since the water quality standards are designed to protect aquatic resources, including green sturgeon, the applicants are to ensure the standards are not exceeded, and therefore not cause adverse harm to the aquatic resources. Thus, issuance of the permit by the state should ensure that aquatic resources are protected. However, it is known that stormwater runoff often does result in chemical concentration values at the point of discharge in excess of EPA water quality criteria (WDOE 2009). The general characteristics of the stormwater system and levels of some discharge items are presented below.

The proposed stormwater management system is designed to direct any flow that does not come into contact with any equipment containing potential contaminants (grease or lubrication oil) to designated areas for treatment. . Treatment of runoff from areas that have low potential for oil or grease contamination will generally consist of on-site infiltration to treat for suspended solids. Cartridge filter vaults may also be used in some locations. Stormwater collected in areas that are potentially contaminated with oil or grease will be pumped or will flow to the oily water system. Primarily, these localized drains are located around equipment to contain grease and/or lubrication oil. The oily water from the collection sump overflows to the oily waste separator package which is equipped with plate type separation devices to remove any oil and grease washed down from the facility equipment. Recovered oil and grease is held in the sump and periodically pumped directly to storage drums for disposal. The oily water system will flow to the oily water separator package(s) before being treated and discharged to the IWWP. The facility will be designed to provide drainage of surface water to designated areas for disposal in accordance with 49 CFR § 193.2159. Stormwater collection and treatment facilities will be designed to meet regulatory requirements from the NMFS and ODEQ.

The proposed oil and grease treatment system is designed to limit discharges of oil and grease. This system design would ultimately need approval from the State to obtain the NPDES permit. The treatment system function is an additional level of protection for inadvertent spills that come into contact with stormwater. The facility is not designed to intentionally mix oil and grease with stormwater, and there are no continuous discharges of oil and grease from the LNG Terminal. Discharges from the LNG Terminal that could contain oil and grease would be directed to the oily water treatment system.

LNG Terminal Site

The LNG facility and marine LNG loading area will include various drainage elements to manage segregated networks for contaminated and uncontaminated water from designated areas. Liquid effluent from the LNG facility and marine LNG loading area consists mainly of water from rainfall, protection of equipment with fire water, processing areas, storage areas, domestic areas, and utilities units. Water from all oil-filled equipment in LNG spill impounding basins will be pumped by submersible pumps to the oily water treatment system. Stormwater from areas other than LNG spill impounding basins will be collected in a system of stormwater swales, a buried storm water system, infiltration basins, and other treatment facilities. Stormwater facility overflow outfalls will ultimately connect to Coos Bay.

The stormwater management plan has been prepared to address stormwater system design, which would require approval from ODEQ (see Storm Water Management Plan appended to JCEP's Resource Report 2). Impervious surfaces associated with the LNG Terminal site include concrete at operational laydown areas, vehicle offloading areas, secondary containment areas, and working areas for operational maintenance. General surfacing in other areas where operational maintenance access would potentially be required would be dense-graded aggregate. In the areas of the Administration building and the Southwest Oregon Regional Safety Center (SORSC) building, finished surfacing would be asphalt for the parking lots and concrete for the helipad. The gas metering station would be surfaced with dense-graded aggregate. Runoff would be separated into either the stormwater system or the oily waste system. Stormwater with a high potential to encounter oil and grease pollution would be contained via curbs or other means and routed to an oil/water separator prior to disposal through the Industrial Wastewater Pipeline (IWWP) according to the applicable the NPDES permit requirements. For areas of the site where stormwater has a low potential to encounter oil and grease pollution, the first flush of stormwater would be treated onsite by either infiltration facilities, flow-through type cartridge filter devices, or vegetated side slopes. Infiltration facilities would provide treatment for the majority of the stormwater falling on the site. The facilities would be designed to capture and infiltrate all stormwater for 100% of the 2-year, 24-hour storm. Overflows from the infiltration facilities would be routed to pipe outfalls in the slip and Coos Bay. For locations that are not feasible to infiltrate, stormwater would be routed to cartridge filter devices, where the treated effluent would be discharged to Coos Bay. Stormwater from access roads to the site would flow through vegetated side slopes or ditches for treatment prior to being discharged to natural grade.

Industrial wastewater would be conveyed to the Port’s existing ocean outfall, pursuant to the NPDES permit issued by the Oregon Department of Environmental Quality (ODEQ). Stormwater collection and treatment facilities would be designed in consultation with NMFS and the ODEQ.

During construction, spills or leaks of hazardous liquids such as fuel or oil associated with construction equipment have the potential to reach surface waters including Coos Bay. Potential effects from a fuel spill would likely be short-term but could be detrimental to aquatic species within localized spill areas within the estuarine analysis area. Petroleum-based contaminants such as fuel, oil, and some hydraulic fluids contain polycyclic aromatic hydrocarbons (PAHs) which can be acutely toxic to the aquatic environment for fishes, and can also cause lethal and chronic sublethal effects to aquatic organisms (Breteler et al. 1985). Potential impacts from these spills would be avoided or greatly reduced by regulating storage and refueling activities, and by requiring immediate cleanup should a spill or leak occur. In order to avoid the contamination of surface water, the preliminary SPCCP, prepared for the construction phase; describes the measures that would minimize the potential for accidental releases of hazardous materials and to establish protocols concerning minimization, containment, remediation and reporting of any releases that occur. The SPCCP would be included as part of the NPDES permit.

The operation of the LNG Terminal would not require or produce large quantities of hazardous materials. Solvents and paints would be used during normal maintenance activities and would be kept in specialized containers with secondary containment to prevent spills. Within the LNG Terminal would be a system of curbs, drains, and basins that contain and collect accidental spills or leaks, thus preventing releases into Coos Bay that may impact water quality and reduce feeding opportunities for aquatic species within the estuarine analysis area. For the operational phase of the LNG Terminal, the preliminary SPCCP, to be included as part of the NPDES permit, would minimize the potential for accidental releases of hazardous materials and to establish proper protocol concerning minimization, containment, remediation, and reporting of any releases that occur. This SPCCP would meet the requirements of 40 CFR Part 112.

If a spill were to occur, the hazardous material from the concrete basins would be collected and trucked offsite to appropriate disposal areas. In the unlikely event that an accidental spill of LNG were to occur, no effects on marine life are anticipated. LNG is not toxic and, if spilled on water, would vaporize when exposed to the warmer atmosphere, and this vapor, being lighter than air, would rise. LNG is not soluble, does not mix with water and would not result in effects to marine life.

During the operation of the LNG Terminal, LNG carriers calling on the LNG Terminal could have accidental releases of fuels or other contaminants found on all ships. Since there is no planned bunkering (loading of fuel oils) for the LNG carriers, these spills would be limited to small inadvertent spills of petroleum-based fuels and lubricants from equipment onboard that would be managed according to the carrier's oil spill response plan. These products are kept in relatively small quantities on ships and therefore would not result in the types of volumes associated with a spill from an oil tanker. Depending on the timing, weather conditions, and the efficiency of the response and cleanup, localized adverse impacts may still occur depending on the proximity to aquatic habitat.

Trans Pacific Parkway/US-101 Intersection Widening

Stormwater generated as a result of new impervious area at the Trans Pacific Parkway/US-101 Intersection Widening would be collected and conveyed to treatment facilities to provide treatment for 100% of the 2-year storm event. Drainage curbs would be installed near the edge of pavement along the northwest side of the roadway. These drainage curbs would collect and convey flow from the road crown to water quality treatment facilities. The water quality facilities would provide treatment for the design flow volume and bypass higher flows before discharging the runoff into Coos Bay.

Kentuck Project Site

Roadway improvements associated with the Kentuck Project, which include elevating and re-paving East Bay Drive and Golf Course Lane, would result in the addition of new impervious area. The stormwater facilities at the Kentuck Project site would be designed to provide treatment for 100% of the 2-year storm event wherever feasible.

East Bay Drive would sheet flow stormwater runoff to roadside drainage curbs. Once along the curb, water would flow toward cartridge filters which would treat water before discharging the runoff onto rip-rap road base adjacent to the receiving waters in Kentuck Inlet.

Along most of Golf Course Lane, surface water ditches and flow-through bio-infiltration conveyance systems are proposed. In these areas, collected flow that does not fully infiltrate into the underlying well-draining soils would be conveyed to an outfall into the Kentuck Slough. At the north end of Golf Course Road, runoff would be collected in drainage curbs and conveyed to cartridge filters before discharging to Kentuck Slough.

Temporary Construction Facilities

Construction laydown areas would be surfaced to a large extent with larger, open-graded aggregate that would allow infiltration; therefore, stormwater from these areas would be self-contained and would infiltrate without the need for outfalls. Impervious surface would not be added at the Pony Village and Myrtlewood Offsite Park & Rides for the JCEP Project Area.

Stormwater treatment for temporary facilities is described further in JCEP's Resource Report 2 (Storm Water Management Plan appendix), and the ESCP in an appendix to JCEP's Resource Report 7.

APCO Sites

APCO Site 1 (East) would be surfaced with dense-graded gravel and existing drainage patterns would be preserved to the maximum extent practical. Stormwater would be treated primarily by vegetated swales and filter strips. Fill placed on APCO Site 2 (West) would be surfaced with native vegetation. Additional storm water controls would be added if necessary. The bridge connecting APCO Site 1 and 2 is in preliminary design. The stormwater run-off from the bridge would be treated prior to discharge to Coos Bay.

PCGP Contractor Yards

PCGP has proposed contractor yards that border Coos Bay at the shore and another that borders Isthmus Slough at the shoreline, all designated critical habitat for coho. Although the yards are previously disturbed industrial sites, stored materials and surface runoff could enter green sturgeon critical habitat. Any potential risks due to surface runoff will be mitigated through implementation of an approved stormwater management plan.

Stranding from Ship Wake

Fish stranding can occur when fish become caught in a vessel's wake and are deposited on shore by the wave generated by the vessel's passing. Stranding typically results in mortality unless another wave carries the fish back into the water. Pearson et al. (2006), in a study of fish stranding, noted that a series of interlinked factors act together to produce stranding during vessel traffic. These factors may include water surface elevations, with low tides more likely to result in strandings than high tide; beach slope, with strandings more likely on low gradients than high; wake characteristics influenced by vessel size, hull form, depth underwater (draft), and speed with faster speed producing large wakes; and biological factors, such as numbers of small fish present near the shoreline and whether or not fish are strong swimmers. All of these factors can vary simultaneously, making it difficult to predict the location and to what degree strandings may occur. A few areas may have the potential to strand fish in Coos Bay. One is the mud flats on the west side of the Federal Navigation Channel along the Coos Bay and Empire Range that have beach morphology that has been shown to have potential for stranding, especially at low tide. Size of juvenile green sturgeons that have been reported caught in the Coos Bay estuary in the 1950s through the 1990s have varied from 40 cm to over 100 cm (15.7 to >39.4 inches) fork length or total length (Farr and Kern 2005). Since the Coos Bay system is not a known spawning area, small juveniles would be absent; the sizes of green sturgeon expected in the estuary are thus considerably larger than sizes of juvenile Chinook salmon (less than 9 cm) stranded by ship wakes in the Columbia River (Pearson et al. 2006) and may not be susceptible to stranding by ship wake.

Ship wakes produced by deep-draft vessels traveling at speeds greater than the estimates for LNG carrier speeds along most of the route have been observed to cause occasional stranding of juvenile salmon with no observed strandings occurring from vessels traveling under 9 knots (10.4 mph) (Pearson et al. 2006). The hull geometry of the LNG carriers is such that bow wakes are minimized, especially at the slower speeds of 4 to 6 knots that would occur during most of the transit route through Coos Bay. The one exception is near the Coos Bay entrance (first mile), when vessels may be traveling 8 to 10 knots in this portion of the waterway. While waves generated in this region may be larger than those generated farther in the bay, this is an area likely already receiving larger ocean-generated waves, so the vessel-generated waves would be little different than current conditions in this region. Therefore, the LNG carriers would be traveling along most of the route at speeds less than that observed (Pearson et al. 2006) to cause stranding. In models and research conducted by JCEP, wave heights produced by LNG carriers traffic would not exceed that of normal conditions in Coos Bay and overall waves would contribute to a small portion of the total waves that occur in the bay. In addition, the LNG carriers would be arriving and leaving at high tide, which is a period when gently sloping beaches are mostly covered and less likely dewatered from waves. Considering that LNG marine traffic (about 120 round trips per year) would enter and leave at high slack tide, have mostly low vessel speeds, and wave height would be in normal range, and that green sturgeon would be of larger size than those found to be stranded, it appears unlikely that the Project would substantially contribute to stranding of green sturgeon within Coos Bay.

Exotic, Invasive Species

Invasive species have the potential to modify the food base and induce other ecological modifications in the estuarine area of Coos Bay. NAS are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Within the Coos Bay estuary, over 67 NAS have been identified (ANSTF 2006).

NMFS (2005b) identified effects by exotic species as a risk to green sturgeons in the Southern DPS. For example, exotic species are concerns because of replacement of food items; the exotic clam *Potamocorbula amurensis*, was introduced to the Sacramento-San Joaquin River and Delta systems (California) in ship ballast water from Asia in 1988 and has become the most common food of white sturgeon. The clam was also found in the only green sturgeon so far examined and is known to bioaccumulate selenium (Linville et al. 2002), a toxic metal potentially causing teratogenesis or abnormal embryonic developmental (Lemly 1996). Further, rapid expansion of the exotic clam caused changes in the primary productivity and benthic community dynamics of portions of San Francisco Bay (Werner and Hollibaugh 1993; Nichols et al. 1990).

Loaded with water from the surrounding ports and coastal waters throughout the world, ships can carry a diverse assemblage of marine organisms in ballast water that may be foreign and exotic to the ship's port of destination. If water were transported from port to port, which is not what is proposed, this transfer of water could result in aquatic biological invasions. Invasive species threaten to outcompete and exclude native species and the overall health of an ecosystem, causing algal blooms and hypoxic conditions and affecting all trophic levels resulting in a decline in biodiversity. EPA developed specific requirements for ballast water treatment under the Vessel General Permit requirement under the CWA NPDES program to reduce the chance of releasing invasive organisms in U.S. waters in 2013 (78[7] Federal Register 121938 [April 12, 2013]). This regulation requires that beginning December 19, 2013, all newly built large vessels would be required to treat ballast water to kill potential invasive organisms, with older vessels of the size that would be used for the Project having some delay in implementation of this requirement (first scheduled dry dock date after January 1, 2016). The current ballast water exchange (BWE) process is mandatory under the National Ballast Water Management Program. Prior to implementing treatment of ballast water, all large vessels that would discharge ballast water within 200 miles of the U.S. coast would be required to exchange ballast water outside of this 200-mile area. This was originally established by Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 and further amended by National Invasive Species Act of 1996 and National Aquatic Invasive Species Act of 2003, amended in 2005 and again in 2007 (NEMW 2007).

The required treatment of water would ultimately be an improvement over the requirement to just exchange ballast water to “flush” potential invasive organisms outside of the 200-mile territorial waters of the U.S., which was reported to reduce organisms by 88 to 99 percent (NRC 2011). The new requirement for treatment level is to reduce most organism types to less than 10 living organisms per cubic meter of ballast water. While this requirement may not eliminate all risk of invasive species entering waters, it is a substantial measure that would reduce the risk of project actions introducing invasive organisms into waters of the project area. Several other regulations apply to ballast water management and discharge that would be followed by all LNG carriers; these regulations would also aid in both ensuring reduction of discharge of potentially invasive species and, through vessel inspections, that procedures are followed as noted above.

All ships utilizing the Port of Coos Bay are subject to the 2012 USCG Final Rule on Ballast Water Discharges. Pursuant to this Final Rule, in order to discharge ballast water into the slip area while concurrently loading LNG cargo, all LNG carriers are required to carry out an exchange of ballast water in waters beyond the EEZ, from an area more than 200 nautical miles from any shore, and in waters more than 2,000 meters deep, or utilize one of several USCG-approved Ballast Water Management (BWM) methods. It is expected that LNG carriers calling at the LNG Terminal would be required to exchange ballast water at sea, more than 200 miles offshore; therefore, the discharge of ballast water would comply with the 2012 Ballast Water Discharge Standards and the potential impact for ballast water to introduce invasive species of interest in Coos Bay would be negligible.

ODEQ recently revised the Oregon ballast water regulations to make the Oregon regulations more stringent for vessels arriving from “low salinity ports” by requiring ballast exchange in addition to the current Federal ballast water treatment requirements. This applies to vessels that represents a ”high-risk” for the transport and release of aquatic invasive species arriving from “low salinity ports” (like those in Oregon). A “low salinity port” is defined as a port where ballast water salinity is less than or equal to 18 parts per thousand (or when the vessel operator is unable to verify ballast salinity). A “High Risk Voyage” is defined as voyages originating in the “low salinity ports” that represents a “high-risk” for the transport and release of aquatic invasive species arriving from such “low salinity ports.” The new rules retain ballast water exchange requirements, in addition to meeting federal ballast water treatment requirements, for what is termed as “high-risk voyages.,”. This is a measure to protect Oregon’s low-salinity ports during a period when the reliability of new “first generation” ballast water technologies are proven to be effective for low salinity ballast.

LNG carriers would discharge ballast concurrently with the LNG cargo loading at the LNG Terminal. JCEP expects its terminal to be visited by 120 LNG carriers per year. Each LNG carrier would discharge approximately 9.2 million gallons of ballast water during the loading cycle to compensate for 50 percent of the mass of LNG cargo loaded.[2] The LNG loading rate is designed to be 10,000 m^3/hr (with a peak capacity of 12,000 m^3/hr), or 4,600 metric tons per hour (5,520 metric tons per hour peak); consequently, the ballast water discharge rate would be approximately 20,250 gpm. Typical LNG carriers have three ballast water pumps, each capable of 3,000 m^3/hr (13,210 gpm) rated capacity. JCEP estimates it would take approximately 24 hours at the terminal to load a vessel with LNG cargo.

The ballast water discharged at the terminal would be that from 200 miles out in the open sea. Therefore, it is expected, based on the existing and future procedures to eliminate discharge of invasive species, that LNG carriers would not likely cause exotic nuisance species to be introduced into Coos Bay. The release of ballast water from LNG carriers at the LNG Terminal would not have adverse effects on green sturgeon.

Another potential source of invasive species, other than LNG carrier ballast water, is transfer between waterbodies by construction equipment used in water, or other water transfer actions. USGS (2017) identified two NAS that may occur within the Coos Bay estuary: New Zealand mud snails (*Potamopyrgus antipodarum)* and brackish water snail *(Assiminea parasitologica)*. PCGP would not obtain hydrostatic test water from either Coos Bay or the Coos River, to prevent the spread of NAS from the estuary to inland watersheds. PCGP currently has procedures in the *Hydrostatic Testing Plan* (see appendix U), which includes measures such as inspection and cleaning of all dredge and similar equipment prior to use intended to reduce or eliminate the chance of spreading invasive species.

<u>Entrainment from Dredging</u>

After a review of dredging studies done through 1998, Reine et al. (1998) concluded that “much of the available evidence suggests that entrainment is not a significant problem for many species of fish and shellfish in many bodies of water that require periodic dredging.” Since the Coos River is not a known spawning area for this DPS of green sturgeon, smaller individuals that would be more susceptible to entrainment because of slower swimming ability, would not be present. In addition, green sturgeon have been found to often leave estuaries in the winter months, when dredging would occur. Considering these factors, their likelihood of being susceptible to entrainment during dredging, and their likely low abundance, it is not anticipated that construction dredging would impact green sturgeon.

<u>Entrainment and Impingement through Vessel Cooling Water Intake at the Terminal Dock</u>

During operation of the LNG Terminal, vessels at the export terminal slip may entrain marine organisms through cooling water intake needed for vessel power plant operations. The quantity of cooling water used depends primarily on size and type of vessel, time at the terminal, power source used while at the dock, and the amount of recirculation. LNG carriers would need to

[2] One cubic meter of LNG is 0.46 metric tons, which for the maximum size of LNG carrier authorized to call on the LNG Terminal (148,000 m^3) would be 68,080 metric tons of LNG per ship. Assuming 1 metric ton of seawater is 1.027 m^3, the amount of seawater ballast discharged (50 percent of the weight of the LNG loaded) would be approximately 34,959 m^3 (approximately 9.2 million gallons).

recirculate water while loading LNG at the berth. The amount of cooling water to be recirculated is a function of the ships' propulsion systems.

A steam propulsion LNG vessel's typical cooling water flow rate while at the berth is expected to be approximately 11,000 cubic meters per hour (m^3/hr) (2.9 million gallons per hour or 48,430 gallons per minute [gpm]). For a 148,000 cubic meter (m^3) vessel, this flow rate would result in a total of approximately 69.7 million gallons of water being recirculated during the 24-hour loading cycle of LNG cargo. If a dual fuel diesel electric propulsion system (160,000 – 170,000 m^3 ship) were used, the typical cooling water flow rates are expected to be approximately 3,200 m^3/hr (845,376 gallons per hour or approximately 14,000 gpm). This would result in a total of approximately 22 million gallons of cooling water being recirculated to the slip over a 26-hour loading cycle of LNG cargo.

Initial estimates are that 40% of the LNG vessels loading at the terminal would be steam propulsion and 60% would be dual fuel diesel electric propulsion. Over time, the trend is anticipated to shift to a greater number of dual fuel diesel electric propulsion LNG vessels, thereby reducing the total cooling water intake per vessel call in the future. Once the LNG fleet has been identified, cooling water flow rates and the amount of water required can be further addressed. Generally, the total water intake would occur over a 24-hour period during each loading period, about 110 to 120 times per year.

Water to cool engines would be taken in through the sea chests located on the bottom of the vessel hull. An LNG carrier usually has sea chests on each side of the hull. The lower unit is just above the keel of the ship, approximately 15 to 20 feet above the channel bottom. The typical sea chest is approximately 3.5 to 4.2 square meters covered by a screen with 4.5 mm bars, spaced every 24 mm. Currently, no additional screening system other than that already employed on the LNG carriers is proposed for water intakes. Additional finer mesh screens are located internally on the vessels to prevent larger items from entering the system. These screens would not meet NMFS (1997c) screening criteria for juvenile salmonids.

As presented in detail below under Oregon Coast coho salmon (section 3.5.3.3), zooplankton entrainment loss would occur from water intake. Some organisms small enough to pass through the screens covering the vessel's sea chests would be drawn in with the cooling water and would be lost from the population in the slip area. The loss of planktonic species through entrainment is likely to be insignificant relative to current population in the bay as loss rate would be well below estimated natural mortality in the bay (Shanks et al. 2011, and analysis below).

Additionally, since green sturgeon primarily feed on benthic organisms, losses of plankton in the water column would have very limited influence on their available prey source in Coos Bay. Thus, mortality of some plankton from water intake through the vessel sea chests, while docked, would have no detectable adverse effect to green sturgeon.

The estimated velocity at the opening of the cooling water intake for a steam propulsion system ranges from 2.2 to 4.4 feet per second (ft/sec) (0.66 to 1.3 meters/second), depending on the intake rate of cooling water used. The estimated velocity at the opening of the cooling water intake for a dual propulsion system is approximately 1.3 ft/sec (0.39 meters/second), depending on the intake rate of cooling water used. NMFS recommends an approach velocity of 0.33 ft/sec for screening systems for salmonids of less than 60 mm, and 0.8 ft/sec for larger juvenile salmonids (NMFS 1997c). These guidelines also include other requirements such as sweeping velocity and type and size of openings that are not present on these screens. The result is likely to be that fish at least up to fry and possibly larger juvenile size fish near the intakes may be entrained or impinged during cooling water intake. The intake velocities for cooling water are low enough that it is not anticipated that any larger organisms (fish, marine mammals, or invertebrates) would be impinged on the intake screen. This includes likely exclusion of juvenile green sturgeon due to their larger size from being entrained or impinged. Green sturgeon also primarily remain near the sea bottom, which would be away from the vessel water intake. Therefore, it is unlikely that entrainment or impingement during engine water intakes by a vessel at the terminal would occur or have adverse effects on green sturgeon.

Temperature Effects in the Marine Slip from Vessels at LNG Terminal

The LNG carriers would increase water temperature within the slip slightly while at the terminal through the discharge of water after its use for engine cooling. The engines would be running to provide power for standard hotelling activities as well as running the ballast water pumps. The activities that would require LNG carrier power and the assumptions used to develop the cooling water flow requirements are described in Moffat & Nichol (2017g). .

Analysis and numerical modeling were performed to identify potential impacts of LNG carrier cooling water discharge on water quality in the slip and adjacent area of Coos Bay. The modeling was initially performed with two different numerical models: the 3-D UM3 model and the DKHW model. The models simulate hydrodynamic mixing processes of submerged discharges and predict temperature fields and dispersion of non-conserved substances in ambient water bodies. Cooling water numerical modeling requires input of steady-state flow velocity in the modeling domain. The results of tidal flowing modeling using the SELFE model showed that ambient current velocities inside the LNG Terminal area vary, depending on tidal stage. Peak current speeds in the berth only exceed approximately 0.32 ft/sec less than two percent of the time. Therefore, for cooling water modeling, two steady state ambient flow velocities were assumed and used further in the analysis: high velocity = 0.32 ft/sec and typical velocity = 0.16 ft/sec.

Results of the modeling showed that for typical ambient flow conditions at a distance of 50 feet from the discharge point (LNG carrier sea chest), temperatures from dual fuel diesel electric LNG carriers would not exceed 0.3°C (0.54°F) above the ambient temperature. This difference would decrease with further distance. Based on estimated slip volume, this total heat could result in an average water increase for the total slip volume during one day when the carrier is loading from 0.03 to 0.06°F. No temperature effects would extend beyond the slip due to the much larger water volume of Coos Bay.

However, the slight increase in water temperature in the slip due to the release of engine cooling water while the vessel is at dock would be ameliorated by cooling of the slip water during cargo load, due to the fact that LNG is at a temperature of -260°F. There would be a heat exchange between the cold hull of the vessel and the surrounding slip water, as discussed below.

The results of the 2011 modeling described above were supplemented in 2017 with additional thermal plume modeling to investigate the extent of the regulatory mixing zone (RMZ) where cooling water discharge would be greater than 0.3 degrees Celsius above ambient (Moffatt & Nichol 2017g). The RMZ used in the temperature plume modeling is defined as the three-dimensional extent where water quality standards may be exceeded as long as acutely toxic conditions are prevented and fish habitat and other uses are protected. This modeling analyzed LNG carriers with capacity of 148,000 m^3 and 170,000 m^3. It also modeled cooling water discharges of 10 degrees to nearly 21 degrees Celsius into various ambient temperatures ranging from 8 degrees to 18 degrees Celcius and under constant and stratified salinity conditions.

In summary, this latest modeling showed that the largest RMZ was associated with steam-driven carriers and extended up to 79.2 feet and 22.1 feet in longitudinal and transverse directions respectively, with a vertical rise of 12.1 feet under peak summer temperature conditions. Dual fuel diesel-electric driven carriers had a substantially smaller RMZ that extended up to 36.5 feet and less than 7 feet in longitudinal and transverse directions, respectively, with a vertical rise of up to 1.3 feet. In the future, LNG vessels will trend more to dual fuel diesel electric propulsion systems thereby reducing the total cooling water intake per vessel call (Moffatt & Nichol 2017g). It is unlikely that the water temperature of the slip would be greatly increased from the release of engine cooling water, therefore, no significant adverse impacts on aquatic species in the bay are anticipated.

Fish and invertebrates are adapted to function over the normal range of conditions encountered in their environment. Moderate to large temperature increases have the potential to reduce fish and invertebrate growth and reproductive success, and, if high enough, cause direct mortality. Fish of the north Pacific, including those found in Coos Bay, are adapted to cool water conditions and could be adversely affected by sharp large increases in water temperature. Temperatures over about 24 to 26°C (75 to 79°F) would be considered lethal in the short-term (a few days) for salmonids (WDOE 2002). These temperatures would likely be similarly lethal to green sturgeon, which have demonstrated significantly reduced growth for larvae at 24°C (Cech et al. 2000). The temperature of the water in Coos Bay undergoes both seasonal and diurnal fluctuations. In December and March, the ocean and fresh water entering the estuary had similar temperatures, around 50°F. In summer, low stream flows results in a rise of temperatures in the bay, to above 60°F in September at CM 8 (Roye 1979).

It is expected that water temperature in the terminal slip influenced by engine water releases from an LNG carrier at dock is not likely to cause any direct adverse impacts on green sturgeon. First, engine cooling water released into the slip would only slightly increase water temperature for a limited distance away from the vessel. Second, the slight increase in water temperatures from engine cooling water releases would be offset by cooling from contact with the hull of a vessel loading LNG. Third, the volume of water in the slip, and exchanges during tidal cycles would further minimize temperature variations.

Effects of Operational Lighting

Localized changes in light regime have been shown to affect fish species behavior in a variety of ways (Valdimarsson et al. 1997; Tabor et al. 2004; Nightingale and Simenstad 2001). Disorientation may cause delays in migration, while avoidance responses may cause diversion of migratory routes into deeper, less protected waters. In some cases, increased light may attract both predators and potential prey species (Simenstad et al. 1999; Valdimarsson et al. 1997; Tabor et al. 2004). Green sturgeon are bottom oriented and would likely be less affected by shore lights than near surface and pelagic species like salmonids.

Nighttime construction is likely to occur in the estuarine analysis area for in-water work activities such as dredging or placing revetment, as well as on-water activities such as receiving deliveries at the TMBB or MOF. Construction lighting would be designed, installed, and operated at a level that allows construction work to be completed safely and effectively while minimizing glare to surrounding areas. Construction lighting would be directed only to the surface waters of Coos Bay when necessary, in order to minimize impacts to aquatic organisms. Lighting for in-water work would be limited to the area around each vessel and the area of the in-water work. For example, during dredging, the area under the crane boom for clamshell dredging or derrick arm for cutter suction dredging would be lit. Lighting is anticipated to be a mix of fluorescent and sodium fixtures around the vessels (dredge, barges, tugs, and support vessels) with larger sodium or halogen lights shining on the work area (i.e., the water) under the crane boom or derrick of the suction dredge. Lighting for on-water work, such as barge or ship unloading, would be limited to the vessels and adjacent landing areas. Final marine construction lighting requirements would be subject to review and approval by the USCG as part of the Construction Security Plan.

The lighting levels would be based on American Petroleum Institute standards. Lighting around equipment and facilities where routine maintenance activities could occur on a 24-hour basis would range from 1 to 20 foot-candles, and there would be 20 foot-candle lighting levels within the compressor enclosures. General process area lighting would be kept to a minimum, on the order of 2 foot-candles. As a point of reference, 20 foot-candles is close to the indoor lighting in a typical home, 2 foot-candles is typical of that found in a store parking lot, and 0.4 foot-candle is typical of residential street lighting. The lighting design would use high-pressure sodium light fixtures during construction and for the final plant.

Lighting at the LNG Terminal and onshore facilities would likely include a mixture of low-power fluorescent lighting and higher intensity security lighting that would primarily be located on shore, in and adjacent to the slip. No high intensity lighting would be present near the water except possibly during vessel docking. When an LNG carrier is not in the berth, the lighting would be reduced to that required for security. It would be focused upon the structures and not be in proximity to the water so as to serve as an attractant or deterrent to fish species. When an LNG carrier is at the berth, it would physically block the lighting on the berth from the slip waters and, due to its proximity to the slip wall, would block the fish from getting too close to the lighting on the berth. Lighting used at the LNG Terminal would be similar to that already in place at other Coos Bay facilities.

Lighting on the tug dock would be low intensity lighting for safety, providing sufficient light for personnel movements on the trestle out to the tug berth and for movement on the berth itself. There is no intention to provide lighting near the water line or high intensity lighting that would be associated with activities other than the simple berthing of the tugs at this location. The reduced lighting levels near the water would reduce or eliminate any behavioral effects to fish in the Project vicinity. JCEP plans to develop the details of its final lighting plan in consultations with the FWS, NMFS, and ODFW to minimize potential impacts on aquatic resources. Increased lighting from facility operations is not expected to substantially affect the Southern DPS of green sturgeon.

Acoustic Effects from Construction and Operation

Underwater noise may affect green sturgeon. State agencies in Washington, Oregon, and California along with federal agencies have developed interim noise exposure threshold criteria for pile driving effects on fish (WSDOT 2011a; Fisheries Hydroacoustic Working Group 2008; Popper et al. 2006). Interim noise exposure threshold criteria for pile driving effects on fish include: 1) a SEL_{cum} of 187 dB re 1 μPa^2 s for fishes more than two grams, 2) a SEL_{cum} of 183 dB re 1 μPa^2 s for fishes less than two grams, and 3) an SPL_{peak} of 206 dB re 1 μPa for all sizes of fishes (WSDOT 2011a). SEL_{cum} is the cumulative sound pressure squared, integrated over time, and normalized to one second. SEL_{cum} is calculated as SEL (single strike at 10 meters from the pile) + 10 Log (number of strikes).

Noise would be generated during excavation and dredging of the slip and access channel. Noise would also be generated when an impact hammer is used to install the piles to support the LNG berth and tugboat dock, the temporary mooring piles at the TMBB, temporary dredge transport pipelines at the ARCO Site, Kentuck Project and Eelgrass Mitigation site, temporary mooring piles for booster and off load barges used for Navigation Reliability Improvement dredging, APCO and Trans Pacific Parkway/US 101 Intersection Widening temporary work bridge piles, and the MOF fender piles. However, the sheet pile walls and LNG Terminal berth and tugboat dock piling installation would occur while the marine berth is still isolated from the bay by the berm.

Construction noise levels for the LNG Terminal are expected to be similar to typical commercial structure construction programs, which average from 47 to 57 dBA at 2,000 feet (H&K 1994). Noise levels 50 feet air distance from typical construction equipment (not including pile driving, or sheet wall installation) to be used at the site would typically range from about 70 to 90 dB (see table 3.3.2-1 under Western Snowy Plover). Typical noise generated from operations would be less. Considering that noise levels would be attenuated from this equipment into water, based on the interim NMFS criteria, levels of noise that could cause direct adverse effects to fish would be unlikely from typical equipment and future operations.

Some dredging activities may generate underwater noise levels that may be harmful to very small fish in close proximity to the activity. Fischer (2004) noted dredging source decibel levels of 172 and 185 at one meter (three feet) from the dredge. The upper range of these values exceeds the interim noise criteria for small fish (those less than two grams). Thus, small fish very near (within about a meter of) the dredging, may be harmed if they remained in the area for a period of time. Initial slip dredging would have some sediment removal from shallow water.. Small green sturgeon of the size to be affected by these noise levels would not be present in the bay because this system does not include a spawning population that would supply small sturgeon to this area. Since no very small green sturgeon would be present in the bay and the fact that harmful levels of noise would occur only at the site of dredging, it is expected that green sturgeon would not be in a zone considered directly hazardous from noise levels.

Potential underwater acoustic effects of in-water and land-based pile driving are addressed separately in the sections below.

Land-based Pile

Underwater noise may be generated by driving piles on land (dry piles) since some noise propagates through ground and sediments (especially through harder substrates such as rock and clay) and may transfer to the water column somewhere else (known as sound flanking).

Sound in the water column would be at a lower level than at the source (WSDOT 2011a) since most sound energy does not travel through water but through the sediment. The propagation of underwater construction noise from the "dry" impact pile driving associated with the MOF was modeled in several reports prepared by JASCO Applied Sciences (O'Neill and MacGillivray 2017; Wladichuk et al. 2017; Wladichuk et al. 2018). Wladichuk et al. (2018) modeled potential impacts of land-based pipe pile impact driving on fish using both current guidelines (FHWG 2008) and new proposed guidelines (Popper et al. 2014).

Previous noise studies investigated radii to marine mammal and fish threshold criteria from a pipe pile with the same diameter (36 inch (0.9 m)) but a shorter length (60 ft (18.3 m)), as well as different number of strikes in a 24-hr period and at 4 set-back locations behind the MOF (O'Neill and MacGillivray 2017, Wladichuk et al. 2017, Wladichuk and MacGillivray 2018). After receiving additional construction details, the most recent study examined the threshold radii from driving a 104.8 ft (31.9 m) pile at the MOF and at 98.4 ft (30 m) set-back distance behind the MOF using a reduced impact hammer energy of 65%. This study found that injury to fish from peak sound pressure levels (206 dB in current guidelines) would occur up to 37m from the face of the MOF. Also, this study predicted that injury to both small (less than 2 grams) and large (greater than or equal to 2 grams) fish from cumulative sound exposure levels (183 and 187 dB respectively under current guidelines) would occur up to 1,723 meters from the shoreline. This distance was the same for both 10,000 and 20,000 total impact strikes because in both cases this was the distance when the noise attenuated to the sound level considered effectively quiet (150 dB). Under proposed guidelines (Popper et al. 2014), modeled distances to injury were considerably less, although the distance to temporary threshold shift (TTS) was the same – 1,723 meters. Figure 3.5.1-2 shows the modeled extent of this potential zone of injury in the project area from land-based pipe pile driving at the MOF face for 206 dB peak and 187dB SEL. Based on the results of Wladichuk et al. 2018, installation of land-based piles at the MOF face would increase potential exposure of listed green sturgeon to underwater noise in an area encompassing the navigation channel from the MOF across the bay to the airport and southwest to the vicinity of Southport Lumber yard. These noise thresholds could be reached during pile driving of the 8 mooring bollards at the MOF that would take approximately 14 days to install. Individual fish occurring in this area during pile driving could experience physiological effects sufficient to cause injury.

Land-based pile driving at the MOF shown to generate injury-level in-water noise would be limited to the approved in-water work window, which is October 1 through February 15. This window would minimize potential interaction with green sturgeon, which are most likely to be in the bay during summer. Also, small green sturgeon that would be most susceptible to barotrauma from increased sound pressures would not occur in the bay due to the lack of a spawning population in the area.

In-water Pile

In addition to the large number of piles that would be driven on land, a smaller number of piles would be driven in the water column in various locations throughout the estuarine analysis area, mostly for temporary mooring of vessels and structures during construction. These piles are summarized in table 3.5.1-1.

TABLE 3.5.1-1

In-water Pile and Structures Summary

Project Component	Description	Pile Type	Installation Method	# of PIles	Pile Size (inches)
Temporary Material Barge Berth (TMBB)	Temporary – breasting/mooring	Steel Pipe	Vibratory/proof with impact	6	<24
Material Off-loading Facility (MOF)	Permanent – fender pile	Steel H-pile	Vibratory/proof with impact	12	18
Temporary Dredge Transfer Line	Temporary – mooring piles or spuds	Steel pipe	Vibratory only	TBD	<24
APCO Temporary Dredge Transfer Line Support Cradle	Temporary	Steel pipe	Vibratory only	5	24
APCO Temporary Work Bridge	Temporary – 3 piles per bent	Steel pipe	Vibratory/proof with impact	12	24
Dredge Off-loading Area at Kentuck	Temporary – piles or spuds	Steel pipe	Vibratory/proof with impact	16	24
Dredge Off-Loading Area at Eelgrass Mitigation Site	Temporary – piles or spuds	Steel pipe	Vibratory/proof with impact	16	24
Dredge Off-Loading at APCO	Temproary – piles or spuds	Steel pipe	Vibratory/proof with impact	16	24
Trans Pacific Parkway/US 101 Intersection Temporary Work Bridge	Temporary	Steel pile	Vibratory/proof with impact	36	24
Trans Pacific Parkway/US 101 Intersection	Temporary – sheet pile	Sheet pile	Vibratory only	TBD	TBD
Trans Pacific Parkway/US 101 Intersection	Permanent	Untreated timber pile	Vibratory/proof with impact	1,150	14
Total Steel Piles				Approx. 119	
Total Wood Piles				1,150	

Installation of both land-based and underwater piles would increase potential exposure of listed green sturgeon to underwater noise. If individual fish are close enough to a pile while it is being driven, injury or behavioral changes could occur. Most of the in-water piles would be driven with vibratory hammer only, which would essentially eliminate the potential for injury. However, if an impact hammer is required for proofing of the piles, for instance in the case of some of the longer term temporary piles (e.g., dredge booster barges), then fish would be exposed to disturbance and potential injury for some distance surrounding each pile driving location.

NMFS pile driving effects calculator was used to determine the threshold distances where injury and disturbance are likely to be encountered by fish of different sizes for vibratory and impact pile driving (see tables 3.5.1-2 and 3.5.1-3). Peak, SEL and RMS noise values were obtained from documented noise levels for vibratory and impact pile driving of 24-inch piles (the largest piles proposed for the project as described in Table 3.5.1-2). These noise levels have been summarized in WSDOT (2018) but have other sources such as Laughlin (2005) and CalTrans (2015). All values were measured at 10m. The rationale for using 3000 strikes was that all in-water piles will first be driven with vibratory pile driver, and an impact driver will only be used for proofing.

Based on these calculators, the following effect distances have been determined:

- For vibratory pile driving, fish would not experience injury from peak sound pressures. Physical injury from cumulative sound exposure levels would occur within 233 feet (71 meters) for larger fish (greater than or equal to two grams) and within 328 feet (100 meters) for smaller fish (less than two grams).

- For impact pile driving, fish would experience physical injury within 40 feet (12 meters) from peak sound pressures. Physical injury from cumulative sound exposure levels would occur within 1,712 feet (522 meters) for larger fish (greater than or equal to two grams) and within 2,415 feet (736 meters) for smaller fish (less than two grams). Disturbance could occur anywhere within 28,133 feet (8,577 meters) of impact pile driving. Disturbance is where individual fish could experience behavioral effects such as decreased foraging efficiency, changes in daily movements, movement of prey species, etc. due to impact pile driving.

It was assumed that temporary pilings could be driven anywhere along the navigation channel to support the NRI pump stations. The location and number of these pump stations is currently unknown, so it was conservatively assumed that they could be located anywhere along the navigation channel. Therefore, potential noise impacts from pile driving are shown along the entire channel. The extent of these distances would be limited in some cases by the physical interruption of land masses and sharp turns in the landscape. Figures 3.5.1-2 and 3.5.1-3 show the physical extent of underwater noise disturbance and injury thresholds measured above.

In-water pile driving would be limited to the approved in-water work window for the project, which is October 1 through February 15. This window would minimize potential interaction with green sturgeon, which are most likely to be in the bay during summer. Also, small green sturgeon that would be most susceptible to barotrauma from increased sound pressures would not occur in the bay due to the lack of a spawning population in the area.

Operation

The addition of approximately 120 LNG carriers to the existing average commercial traffic of 50 ships per year is predicted to increase the in-water sound level by 4.5 dB in the Federal Navigation Channel. The intensity of the sound pressure levels from vessel traffic can vary considerably. However, sound pressure levels are generally in the range of 112 to 160 dB, intensities that may influence organism behaviors or perceptions but are not great enough to cause physiological damage (Richardson 1995; Hastings and Popper 2005; Fisheries Hydroacoustic Working Group 2008).

It is expected that LNG carrier noise in Coos Bay would be less than in the marine analysis area as vessel speed and engine output would be greatly reduced, which affects the magnitude of sound levels. In the Hatch et al. (2008) study, an LNG carrier during travel produced sound levels (with 1 standard error) of 182 ± 2 dB re: 1 µPa at 1 meter that attenuated to 160 dB at 35 ± 11 meters and to 120 dB at 16,185 ± 5,359 meters (Hatch et al. 2008). Other than possibly within 1 meter of the vessel hull, these are all values less than the current interim noise levels for fish noted above.

Generally, response to noise impacts would be behavioral and perceptual, and not physiological in nature, as fish would tend to avoid the area during periods of high noise output. It is expected that operational noise would not have adverse effects on aquatic resources including green sturgeon.

TABLE 3.5.1-2. Distance Thresholds for Disturbance and Injury to Fish from In- water Vibratory Pile Driving

Fill in green cells: estimated sound levels and distances at which they were measured, estimated number of pile strikes per day, and transmision loss constant.				
	Acoustic Metric			
	Peak	SEL	RMS	Effective Quiet
Measured single strike level (dB)	182	165	165	150
Distance (m)	10	10	10	
Estimated number of strikes	3000			
Cumulative SEL at measured distance				
200				
	Distance (m) to threshold			
	Onset of Physical Injury			Behavior
	Peak	Cumulative SEL dB**		RMS
	dB	Fish ≥ 2 g	Fish < 2 g	dB
Transmission loss constant (15 if unknown)	206	187	183	150
15	0	71	100	100
** This calculation assumes that single strike SELs < 150 dB do not accumulate to cause injury (Effective Quiet)				

TABLE 3.5.1-3. Distance Thresholds for Disturbance and Injury to Fish from In-water Impact Pile Driving

Fill in green cells: estimated sound levels and distances at which they were measured, estimated number of pile strikes per day, and transmision loss constant.				
	Acoustic Metric			
	Peak	SEL	RMS	Effective Quiet
Measured single strike level (dB)	207	178	194	150
Distance (m)	10	10	10	
Estimated number of strikes	3000			
Cumulative SEL at measured distance				
213				
	Distance (m) to threshold			
	Onset of Physical Injury			Behavior
	Peak	Cumulative SEL dB**		RMS
	dB	Fish ≥ 2 g	Fish < 2 g	dB
Transmission loss constant (15 if unknown)	206	187	183	150
15	12	522	736	8577

** This calculation assumes that single strike SELs < 150 dB do not accumulate to cause injury (Effective Quiet)

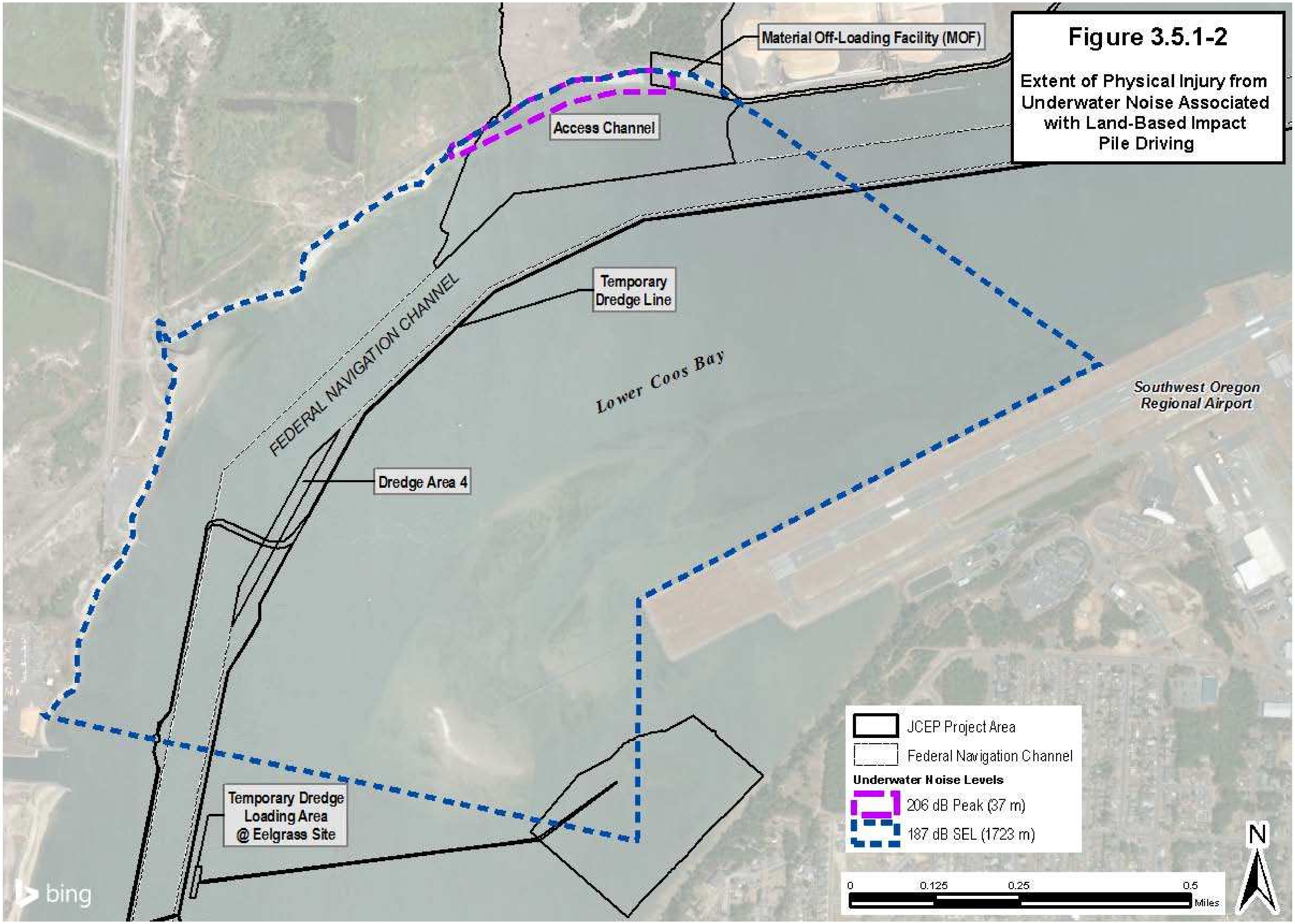


Figure 3.5.1-2
Extent of Physical Injury from Underwater Noise Associated with Land-Based Impact Pile Driving
Material Off-Loading Facility (MOF)
Access Channel
Temporary Dredge Line
FEDERAL NAVIGATION CHANNEL
Lower Coos Bay
Southwest Oregon Regional Airport
Dredge Area 4
Temporary Dredge Loading Area @ Eelgrass Site
JCEP Project Area
Federal Navigation Channel
Underwater Noise Levels
206 dB Peak (37 m)
187 dB SEL (1723 m)
0
0.125
0.25
0.5
Miles
N
bing

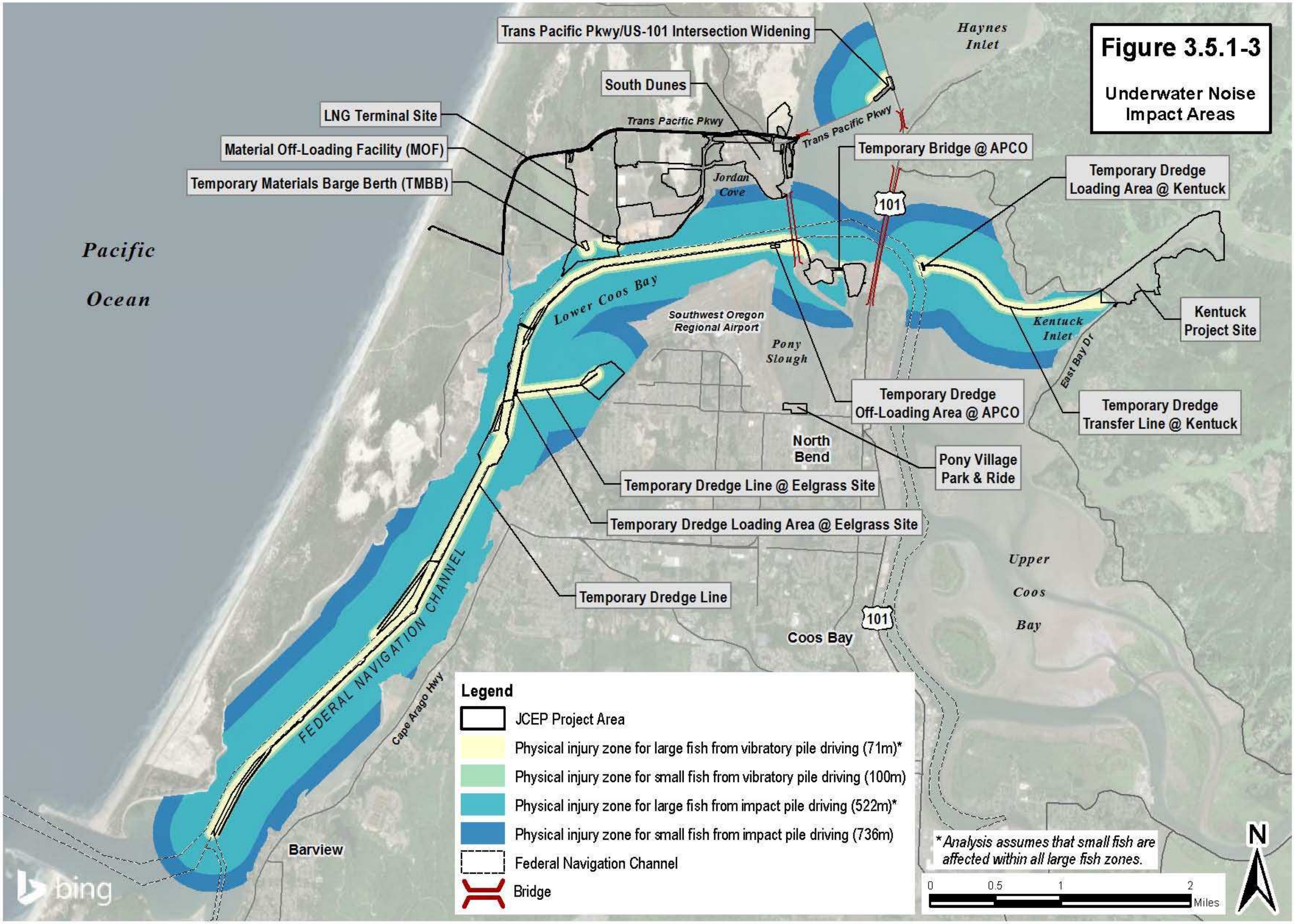


Figure 3.5.1-3
Underwater Noise Impact Areas
Trans Pacific Pkwy/US-101 Intersection Widening
South Dunes
LNG Terminal Site
Material Off-Loading Facility (MOF)
Temporary Materials Barge Berth (TMBB)
Temporary Bridge @ APCO
Temporary Dredge Loading Area @ Kentuck
Kentuck Project Site
Temporary Dredge Off-Loading Area @ APCO
Temporary Dredge Transfer Line @ Kentuck
Pony Village Park & Ride
Temporary Dredge Line @ Eelgrass Site
Temporary Dredge Loading Area @ Eelgrass Site
Temporary Dredge Line
Haynes Inlet
Trans Pacific Pkwy
Jordan Cove
101
Pacific Ocean
Lower Coos Bay
Southwest Oregon Regional Airport
Pony Slough
Kentuck Inlet
East Bay Dr
North Bend
Upper Coos Bay
Coos Bay
FEDERAL NAVIGATION CHANNEL
Cape Arago Hwy
Barview
Legend
JCEP Project Area
Physical injury zone for large fish from vibratory pile driving (71m)*
Physical injury zone for small fish from vibratory pile driving (100m)
Physical injury zone for large fish from impact pile driving (522m)*
Physical injury zone for small fish from impact pile driving (736m)
Federal Navigation Channel
Bridge
*Analysis assumes that small fish are affected within all large fish zones.
0 0.5 1 2 Miles
N

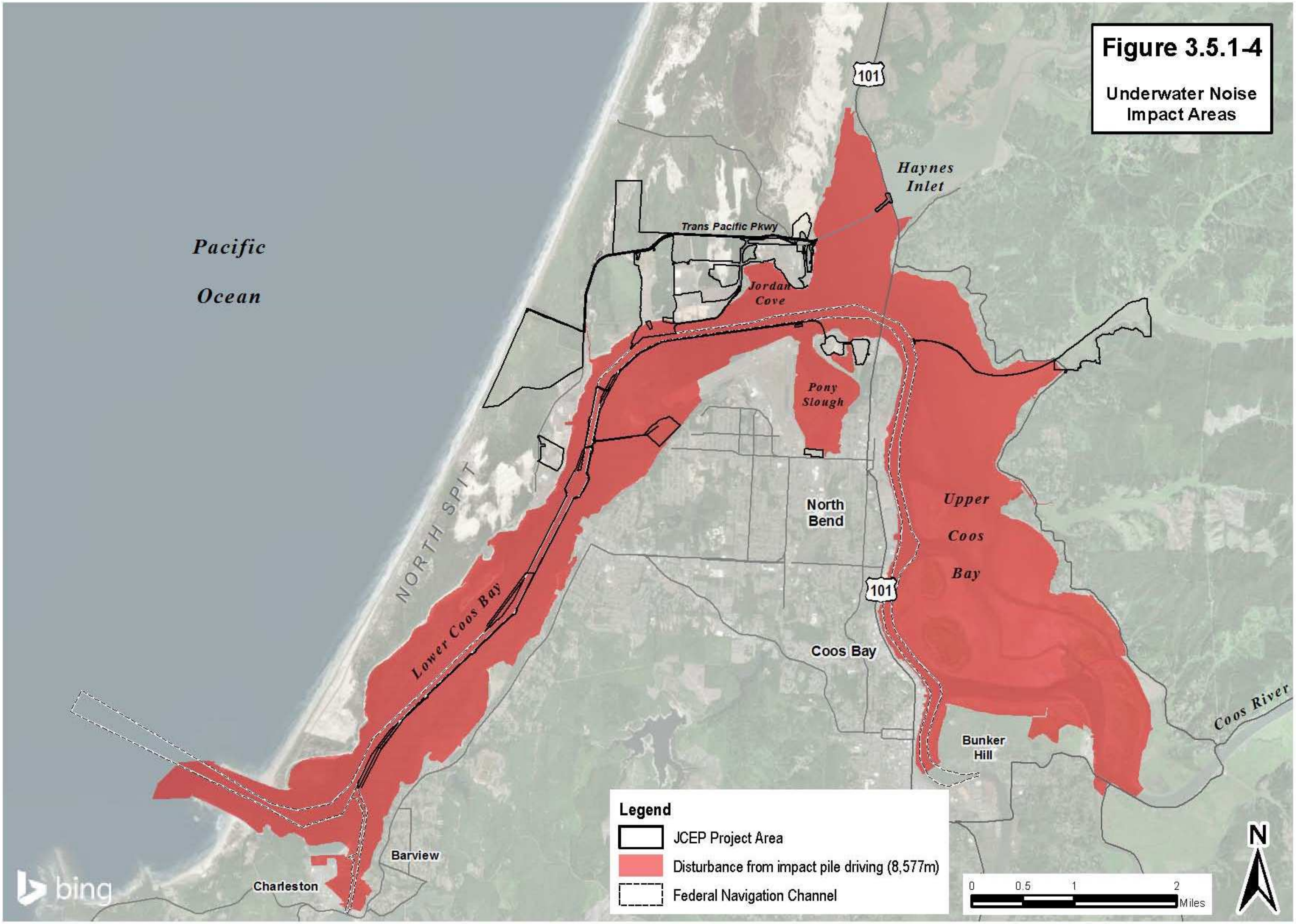


Figure 3.5.1-4
Underwater Noise Impact Areas
Pacific Ocean
NORTH SPIT
Trans Pacific Pkwy
Haynes Inlet
Jordan Cove
Pony Slough
North Bend
Upper Coos Bay
Lower Coos Bay
101
Coos Bay
Coos River
Bunker Hill
Barview
Charleston
Legend
JCEP Project Area
Disturbance from impact pile driving (8,577m)
Federal Navigation Channel
0 0.5 1 2 Miles
N

Habitat Effects – Slip, Access Channel, Pile Dike Rock Apron and Navigation Reliability Improvement Sites

Construction of the LNG Terminal facilities would impact about 82 acres of existing estuarine habitat, of which 39.8 acres would be from construction of the slip and access channel and associated MOF (table 3.5.1-4). About 14.76 acres of intertidal to shallow subtidal habitat, including 1.9 acres of eelgrass habitat, and 0.06 acre of salt marsh would be modified to primarily deep subtidal habitat as a result of the dredging for the slip and access channel,. The dredging operation would change physical conditions of the bottom, locally altering the bathymetry and potentially altering the morphology and water currents. About 36.7 acres of upland habitat would be converted to open water, primarily deep subtidal habitat.

The construction of the proposed marine slip, pile dike rock apron, and access channel would impact local aquatic resources by removal or conversion of some habitats. The pile dike rock apron will convert approximately 2.3 acres of former estuarine habitat (eelgrass, intertidal, subtidal, etc.) into angular rock. This change in habitat will create a variety of effects to listed fish species, including providing new substrate for seaweeds that can provide cover, providing potential habitat for predators (particularly in subtidal areas), and interrupt normal shoreline drift processes by acting like a groin. Use of riprap in the proposed marine slip would have no significant impacts to listed fish. There would also be short-term turbidity from dredging in the bay, and additional erosion of the shoreline during construction activities could result in sedimentation. To control soil erosion and potential sedimentation, JCEP would follow the measures outlined in its ESCP.

There is also the potential for an accidental oil or fuel leak from dredging equipment to affect aquatic resources in the bay. To avoid or reduce impacts from oil or fuel leaks, JCEP developed Preliminary Draft SPCCPs for both construction and operation.

TABLE 3.5.1-4

Estuarine Habitat Impacted from Construction of JCEP LNG Facilities

	Acres Permanently Impacted ***Acres Temporarily Impacted (in italics)***											
Habitat Type	**Wetland APC-A2**	**Access Channel**	**TMBB**	**Materials Offloading Facility**	**Hydraulic Dredge Pipeline**	**NRI Dredge Areas 1 through 4**	**Pile Dike Rock Apron**	**NRI Temporary Dredge Line**	**APCO Temporary Dredge Transfer Line**	**Eelgrass Temporary Dredge Line**	**Kentuck Temporary Dredge Line**	**Trans Pacific Parkway/Hwy 101**

Shallow Subtidal		3.637 *0.10*	*0.001*	0.074	*0.05*		0.38 *0.18*	*0.030*				
Salt Marsh		0.055	*0.003*									
Intertidal	*0.003*	9.16 *0.074*	*1.256*	1.635 *0.027*	*0.080*		1.27 *0.57*	*0.05*		*0.410*	*0.009*	0.512
Eelgrass		1.9 *0.110*	*0.023*				0.178 *0.11*	*0.03*		*0.114*	*0.023*	
Deep Subtidal		*17.564*				*26.979*	0.488 *0.632*	*12.95*	*0.911*	*0.530*	*1.543*	
Total	***0.003***	**14.755** ***21.023***	***1.283***	**1.709** ***0.027***	***0.13***	***26.979***	**2.316** ***1.484***	***13.06***	***0.911***	***1.068***	***2.184***	**0.512**
	Notes: Acreage in *italicized* font represents temporary impacts. Acreage in regular font represents permanent impacts.											

Prey species that are important for local fish species, likely including those for green sturgeon, rely on many of the same habitat conditions. Eelgrass habitat supplies a diverse habitat for fish (Murphy et al. 2000). Eelgrass is an important ecological component in Coos Bay affecting many species. For example, submerged aquatic grasses are important habitat for small prey species of adult lingcod (in Appendix B-2 of PFMC 2008). Submerged grass meadows provide cover and food for a large number of organisms including burrowing, bottom-dwelling invertebrates; diatoms and algae; herring that deposit eggs clusters on leaves; tiny crustaceans and fish that hide and feed among the blades; and, larger fish, crabs and wading birds that forage in the meadows at various tides. Eelgrass provides shelter for a variety of fish and may lower predation, allowing more opportunity for foraging. The protective structure attribute of eelgrass is primarily for smaller organisms and juvenile life history stages of fishes. Previous studies (Akins and Jefferson 1973) have reported that Coos Bay has 1,400 acres of lower intertidal and shallow subtidal flats covered by eelgrass meadows. Therefore, changes in eelgrass abundance may have food chain effects to green sturgeon.

Permanent eelgrass impacts at the access channel would affect less than 1% of the estimated total area where eelgrass was detected in lower Coos Bay. This impact would result in an unnoticeable and extremely localized, short-term loss in forage food available for green sturgeon. Located south of the impact site, the mitigation site would be created within an existing eelgrass bed to replace the narrow band of eelgrass habitat lost at the impact site. The mitigation site would take several years to develop, but it would result in a long-term benefit to eelgrass, listed fish, critical habitat, and EFH.

Benthic and epibenthic invertebrates that presently inhabit shallow intertidal and subtidal regions within the boundaries of the proposed access channel dredging area would be removed with the dredged material. Ghost shrimp and sand shrimp (adults, juveniles and larvae), amphipods, clams, Dungeness crab, and various fish species are important prey for green sturgeon.

Therefore, the loss of invertebrates and vertebrates at the access channel would result in a reduction in fish food available to green sturgeon in those areas affected by the Project.

Dredging at the four NRI sites will take place in deep subtidal habitat used by benthic organisms, macroinvertebrates, and demersal fishes (e.g., worms, clams, crustaceans, mollusks, flatfish, and Pacific sand lance) some of which serve as prey to green sturgeon. Entrainment from dredging could injure or kill these and other bottom-dwelling species that have limited mobility and move, rest, find shelter, and feed within the dredge prisms for these areas.

The NRI sites are located entirely within deep subtidal habitats along the FNC. Such habitat is less productive than shallow subtidal and intertidal habitats. Furthermore, the FNC is subject to periodic dredging and propeller scour which can disturb the associated benthic community. Benthic communities associated with mud substrates like those within Coos Bay, however, have been shown to recolonize to pre-dredging conditions within four weeks following dredging (Newell et al. 1998). Impacts to bottom-dwelling marine life where dredging is planned at the NRI sites, LNG terminal slip, and access channel, therefore, are expected to occur over a short-term duration. While it is anticipated that affected areas would recolonize by similar species within a month or two following dredging, the relative composition among species likely would be altered over the near term.

Direct mortality or injury from dredging is not expected for most pelagic fishes due to their swimming ability and behavioral tendency to avoid disturbance. Dredging could affect other bottom-dwelling fishes, however, such as Pacific sand lance (Ammodytes personatus) which frequently inhabit sands and fine-grain sediments for rest and predator avoidance. Sand lance are an important prey species for many marine mammals, birds (including marbled murrelet), and fishes (including Pacific salmon and green sturgeon). While sand lance could be subject to mortality or injury from proposed dredging, the timing and extent of their presence in the lower bay at the NRI sites has not been confirmed.

As noted above, the CHE (2011) modeling indicated during LNG transit, bottom disturbance from high bottom velocities would occur. This could result in some benthic organisms (potential green sturgeon prey) being disrupted and some sediment being moved during arrival and departure. Mobile organisms (e.g. crabs, shrimp) would be able to return to the region, while some benthic organisms may be permanently displaced. Turbidity would likely be slight due to the coarse characteristics of the Federal Navigation Channel sediment that is resistant to current induced suspension. Overall, some loss of benthic organisms may occur from LNG carrier propeller wash during each transport trip near the slip approach, but the magnitude would be small and likely less than currently occurs under each existing large vessel trip.

Benthic communities in Coos Bay inhabiting mud substrates recovered to pre-dredging conditions in four weeks (McCauley et al. 1977). However, recovery in estuarine channel muds has been reported in a review paper of dredging to be typically six to eight months (Newell et al. 1998). In the lower Columbia River, McCabe et al. (1997, 1998) noted benthic organism recovery in three months. Because of the large quantity being dredged, including areas not in the channel with more varied substrate, it may take longer than four weeks to completely recover.

Shading Effects

Shading from over-water structures reduces the amount of light available to phytoplankton and aquatic macrophytes. However, the area where shading from LNG Terminal facilities would occur is intended for industrial uses and not the creation of new habitat. The general habitat within the excavated slip would not be conducive for many marine resources because of depth and steep armored banks, so relatively few resources would likely utilize this newly created area. The slip would be created from an area that is currently upland, and therefore no shading of currently unshaded water habitat, and no net loss in productivity due to shading, would occur. Project components that potentially could shade the new open water created by the construction of the slip include those listed below.

- The tug dock would be built over an open water portion of the newly developed slip and would be about470 feet long by 18 feet wide. In addition, there would be 360 feet of 8-foot-wide floats for mooring and accessing the security vessels.
- The tug dock would be connected from shore by a pile-founded trestle.

Most fish, have developed countershading as an adaptation to avoid predation (Moyle and Cech 2000) from above (dark dorsal surface blends with bottom substrate) and from below (light ventral surface blends with light from the surface). Fish within a shaded area would be more easily detected by a predator, especially from below because light colored ventral surfaces would stand out against a shaded water surface. Predation potential, based on some observed fish behavior, is a concern (Nightingale and Simenstad 2001). However, actual increased occurrence in predator numbers from even substantial overwater structures has rarely been documented. Additionally, a review of many marina and pier studies has not documented actual increased predation at these facilities (Nightingale and Simenstad 2001). For example, marine marina studies have found no documentation of increased concentrations of juvenile salmonid predators and some predators such as birds may be of lower abundance than under natural shoreline conditions (Cardwell et al. 1980, and Heiser and Finn 1970, as cited in NMFS 2005c). The extent to which any of these predators affect juvenile green sturgeon in shaded areas created by the proposed action is unknown; however, the probability of this occurring is low since it shades less than one percent of the slip surface area and the dock is located at the north side of the slip

Direct and Indirect Effects – Riverine Analysis Area

Two waterbodies, Coos River and Stock Slough, are within the green sturgeon riverine analysis area. Potential effects of the Pipeline crossing of the Coos River were addressed above in the estuarine analysis area section since the crossing location is within a tidally influenced river reach, and the Coos River would be crossed by HDD along with two crossings of Coos Bay.

The Pipeline would cross Stock Slough at MP 15.11 approximately 220 feet upstream from the head of tide endpoint and designated critical habitat for Southern DPS green sturgeon. At that location, Stock Slough is classified as a minor stream, <10 feet wide with intermittent flow. PCGP would use dry open-cut construction, either with a flume or using dam-and-pump. While these methods would have limited impacts on streams and aquatic species, they could result in some erosion and turbidity, as discussed below. At the point of crossing, green sturgeons would not require salvaging during dry open-cut construction because adults or subadults would not be expected upstream from the head of tide in intermittent streams.

Flume. The flume method typically is used to cross small to intermediate flowing waterbodies that are either fish-bearing or non-fish-bearing streams. The flume technique involves diversion of stream flow into a carefully positioned steel pipe of suitable diameter to convey the maximum flow of the stream across the work area, and ensures that stream flow rate is not interrupted.

Dam-and-Pump. With the dam-and-pump method, stream flow is diverted around the work area by pumping water through hoses over or around the construction work area. The goal of this technique is to create a relatively “dry” work area to avoid or minimize the transportation of heavy sediment loads and turbidity downstream of the crossing. This crossing method may be used on all waterbodies where stream flow can be diverted by pumping around the work area.

Turbidity and sedimentation impacts associated with dry open cut methods are generally minor and temporary, lasting typically for only a few hours, and are associated with 1) installation and removal of the upstream and downstream dams used to isolate the construction area; 2) water leaking through the upstream dam and collecting sediments as it flows across the work area and continues through the downstream dam; 3) movement of in-stream rocks and boulders to allow proper alignment and installation of the flume and dams; and 4) when streamflow is returned to the construction work area after the crossing is complete and the dams and flume are removed.

Estimates of suspended sediment concentrations are presented in detail in section 3.5.3 (SONCC coho) and section 3.5.4 (Oregon Coast coho) and are not repeated here. Stock Slough is wthin the Coos Bay Frontal-Pacific Ocean fifth field watershed. Characteristics of channel conditions for streams within the watershed were derived from the ODFW (n.d.) Aquatic Inventory Project; average conditions of bankfull widths, bankfull channel depths, channel gradients and percent sand, silt and organics in streambed substrates in the watershed are assumed to apply to Stock Slough for analysis purposes.

Using the available data, including stream flow estimates during instream crossing periods designated by ODFW (2008) which extends from July 1 to September 15 for Stock Slough (which could be dry at the time of construction), modeled dry open-cut construction could generate suspended sediment concentrations from 11.1 mg/L at 637 meters downstream to 0.26 mg/L at 1,323 meters downstream if a flumed crossing is used and concentrations of 11.1 mg/L at 51 meters to 0.26 mg/L at 1,247 meters downstream if dam-and-pump construction is used to cross Stock Slough. In general, the duration for exposure to those concentrations would be approximately 2 hours for crossing a stream less than 10 feet wide. Use of severity of ill effects (SEV) models developed by Newcombe and Jensen (1996) for adult estuarine nonsalmonids (Model 5 in Newcombe and Jensen), the maximum concentration of 11.1 mg/L lasting for 2 hours would produce a SEV score of 6, equating to moderate physiological stress but effects to green sturgeon in Stock Slough would be sublethal according to the model for adult estuarine nonsalmonids.

In their review of TSS effects and SEV scores in relation to estuarine fish and shellfish, Wilber and Clarke (2001) determined that the Newcombe and Jensen (1996) Model 5 for estuarine nonsalmonids yielded erroneous results, predicting lethal effects at very low concentrations of suspended sediment. Wilber and Clarke (2001) revised Model 5 so that SEV scores would be reduced by one. With this revision, the SEV score of 6, derived from a concentration of 11.1 mg/L lasting for 2 hours , above, would be corrected to SEV =5, equating to minor physiological stress (increase in rate of coughing, increased respiration rate). No records of sturgeons’

(Acipenseridae) response to dose and exposure to suspended sediments were used in the development of Newcombe and Jensen (1996) Model 5 or in the corrected model described by Wilber and Clarke (2001) so the adjusted SEV model may not be applicable. Nevertheless, sediment generated by dry open-cut construction across Stock Slough would not cause lethal effects to green sturgeons if present in designated critical habitat downstream.

Habitat Effects –Pipeline

The same approach utilizing suspended sediment concentration and exposure to evaluate levels of risk to fish (Newcombe and Jensen 1996) was applied to quantifying effects of sediment on fish habitat, termed harmful alteration, disturbance or destruction (HADD) of habitat by Anderson et al. (1996). HADD risk includes concentration and exposure to sediment along with sensitivity of the habitat affected. As described above, SEV of 7 would equate to moderate habitat degradation. Based on the modeling similar to that conducted for SONCC coho and Oregon Coast coho, there would be no risk of suspended sediment generated during Pipeline construction reaching concentrations that would cause moderate habitat degradation in Stock Slough and designated green sturgeon critical habitat 220 feet downstream from the Pipeline construction site.

Cumulative Effects

Additional projects within the action area (estuarine analysis area and the marine analysis area) are anticipated as human population growth continues in the region. Associated road and commercial development, as well as maintenance and upgrading of existing infrastructure within the estuary, are likely to occur in the foreseeable future. For example, the Port owns and operates the Charleston Marina, the Charleston Marina RV Park, and Charleston Shipyard. As a component of the Port's economic development, the focus of the Charleston Marina Master Plan is to develop commercial fishing and seafood processing, recreational fishing and boating, tourism, and growth in the retail and commercial sectors. Other, similar economic developments in the region could occur and, if they did, could contribute to the region's human population growth which could be detrimental to Southern DPS green sturgeon within and around the Coos Bay estuary.

A standard of "reasonably certain to occur" is clarified as "those actions that are likely to occur, bearing in mind the economic, administrative, or legal hurdles which remain to be cleared." NMFS provides that "speculative actions that are factored into the cumulative effects analysis add needless complexity into the consultation process" (51 Federal Register 19933). No specific state or private actions have been identified within the action area that meets this standard. Furthermore, activities described above are somewhat speculative in nature and cannot be quantified here. Therefore, a logical conclusion is that there would be no cumulative effects to green sturgeon associated with the proposed action.

Within the action area, gradual habitat and water quality improvements may also occur over time as federal, state and private conservation and habitat enhancement efforts are implemented. There are a number of potential federally permitted projects (e.g., repair of the entrance jetties and widening and deepening of the lower portion of the Federal Navigation Channel) that could result in cumulative effects. However, since these projects would require federal permits, their impacts would be evaluated through the federal permitting process when and if they occur.

The vessels transiting to and from the LNG Terminal would contribute to the ambient noise levels in the marine analysis area. However, the contribution of additional noise would occur within a context of diminishing traffic-related noise (Andrew et al, 2011), so the cumulative impact should be limited. In addition to the fishing fleet housed in Charleston Marina, current commercial traffic into Coos Bay includes about 60 deep-draft cargo ships and 50 barges. While this may remain constant for the near term, in the future non-fishing commercial traffic into Coos Bay may increase if the Port is able to make its planned improvements to attract new customers. However, even with the addition of 120 LNG carriers per year visiting the LNG Terminal, commercial ship traffic into Coos Bay would probably not reach historic levels. In the mid-1990s, as many as 200 non-fishing commercial ships per year called on the Port.

Even with the uncertainty generated by available data, there is a reasonably foreseeable increasing trend, albeit imprecise, for vessel traffic volume in the future although unforeseen global events such as future economic crises could influence the predictions. Although there would be a greater risk of noise to green sturgeon as a result increase ship traffic, because Project effects are expected to be minor, cumulative effects in the marine analysis area are expected to be insignificant.

Releases of diesel fuel and/or gasoline by commercial and recreational vessels are possible. According to annual reports published by the Pacific States/British Columbia Oil Spill Task Force (2002), ODEQ reported 34 spills from fishing vessels or other harbor craft in 2002, 38 spills in 2003, and 7 spills from fishing vessels plus spills from 27 other vessel types in 2004. Those relatively consistent incidences apparently increased in 2005 with 18 spills from fishing vessels 20 from recreational vessels, and 27 spills by other vessel types. By contrast in 2006, there were 3 spills from fishing vessels, 6 spills from recreational vessels, and only 6 spills from other vessel types. Though not known, it appears that the background rate of spills off the Oregon coast (incidence of spills in proportion to total vessel operation) by fishing vessels, recreation vessels, and other vessel types is generally low. Based on existing information, future rates of off-shore releases are also expected to be low and potential for green sturgeon to be affected by contamination by oil and other pollutants is not expected to increase above existing levels.

Considering the potential effects to green sturgeon in the marine and estuarine habitat described above, cumulative effects are likely to be minimal. This is based on the fact that non-federal actions like shipping traffic within Coos Bay, petroleum product spills at sea, and estuarine development and dredging, are unlikely to substantially increase in the foreseeable future.

Critical Habitat

Coos Bay has been included in estuarine critical habitat for the species. The Coos Bay estuary provides several PCEs including food resources, migratory corridors (passage) between estuarine and marine habitats, and sediment quality and water quality (NMFS 2009c), all of which are necessary to support various green sturgeon life stages. Similarly, coastal marine waters 110 meters (60 fathoms) deep or less, between Coos Bay and San Francisco Bay provide food, passage, and water quality as PCEs. Within Coos Bay, NMFS (2009c) noted that in-water construction or alterations, point and non-point source pollution, and LNG projects could affect the estuary portion of designated critical habitat. Project-related effects to Southern DPS green sturgeon within the Coos Bay estuary are likely to be similar to those discussed above including the following: 1) turbidity effects to forage/prey species and habitat by dredging, 2) shading effects on marine plants, 3) introduction of exotic species, 4) ship wake, and 5) pile driving.

Overall, adverse short-term effects would occur to the critical habitat of Southern DPS of green sturgeon from modification of nearshore and bottom habitat from slip construction, modification of bottom habitat from Navigation Reliability Improvements dredging which would disrupt food supply.

Similar to the modeling conducted for SONCC coho (section 3.5.3) and Oregon Coast coho (section 3.5.4), there would be no risk of suspended sediment generated during Pipeline construction reaching concentrations that would cause moderate habitat degradation in Stock Slough and designated green sturgeon critical habitat 220 feet downstream from the Pipeline construction site.

3.5.1.4 Conservation Measures

The proposed Project would implement a comprehensive suite of BMPs to avoid and minimize potential impacts to estuarine habitat that could be used on an intermittent basis by adult foraging green sturgeon. These BMPs are detailed in many different project documents, including the DMMP, the SWMP, the Corps of Engineers 404 permit application, etc., and summarized in appendix N to this document. Several specific conservation measures are called out below for additional discussion.

Effects within the estuarine analysis area would be offset by wetland restoration mitigation at a the Kentuck Project (see appendix O/Compensatory Wetland Mitigation Plan). The permanent loss of the 2.08 acres of eelgrass by construction and operation of the LNG Terminal would be mitigated at an off-site proposed eelgrass mitigation location south of the west end of the Southwest Oregon Regional Airport; at this site approximately 9.3 acres of new eelgrass habitat would be created.

The interim loss of unvegetated mud flat (intertidal and shallow subtidal habitats) would be restored at a 3:1 ratio. Restoration would occur at the Kentuck Slough golf course, east of North Bend, where a portion of the golf course would be converted to intertidal and mudflat habitat to offset the estuarine impacts. Conversion would require removing existing levees and removing tide gates, actions that would reestablish tidal connections between former intertidal habitat within the golf course and Kentuck Slough. JCEP also proposes wetland mitigation to offset the effects on freshwater wetlands associated with the development of the LNG Terminal site, South Dunes site, and utility corridor and access road between the LNG Terminal and South Dunes (see appendix O/Compensatory Wetland Mitigation Plan). Overall, approximately 90 acres of estuarine habitat would be recreated and/or enhanced at the Kentuck site.

Potential acoustic impacts to aquatic organisms identified in the analysis above are based on worst case use of impact pile driving without any sound attenuations measures. There are a number of measures (listed below) which could reduce the peak and cumulative sound pressures, which in turn could significantly reduce the range of sound waves that could injure or disturb listed fish species. Installation of piles during various phases of the Project would use the following measures to minimize risk of physical injury to fish:

- use vibratory pile driver whenever possible to minimize impulsive noise;

- use sound attenuation measures whenever driving in-water piles with an impact hammer;
- limit pile driving in the bay to the in water work window; and
- limit total impact hammer strikes on in-water piles per day to less than 3,000 or another amount determined in consultation with NMFS.

3.5.1.5 Determination of Effects

Species

The Project **may affect** green sturgeon (Southern DPS) because:

- adult and/or subadult green sturgeons may occur within the estuarine analysis area during construction and operation of the proposed action;
- adult and/or subadult green sturgeons may occur within the marine analysis area during operation of the proposed action; and
- green sturgeon may occur in Stock Slough which is included in the riverine analysis area during construction of the proposed action.

Some Project components are **likely to adversely affect** southern green sturgeon, including:

- short-term increase in noise generated from MOF land-based pile driving and in-water pile driving at various temporary construction sites throughout the bay may cause disturbance and physical injury to green sturgeon if individuals are in proximity to the noise during construction
- TSS could adversely affect green sturgeon. Exposure to TSS concentrations of 0.26 mg/l at 1,247 m downstream during dry open-cut construction (fluming or dam-and-pump) in Stock Slough for 2 hours could potentially equal SEV 5. Such an effect could cause minor physiological stress to green sturgeons if present in Stock Slough at the time of construction.
- on a localized basis, the proposed action may affect migratory and feeding behavior, potential food resources, and water quality (TSS) during the short-term construction period within the estuarine analysis area.
- localized bottom disturbance from project construction, which may reduce the abundance and diversity of benthic food sources in discrete areas of Coos Bay and cause direct impact to individual listed fish.

Critical Habitat

The Project **may affect** critical habitat for the green sturgeon (Southern DPS) because:

- the riverine analysis area includes Stock Slough which is included in designated critical habitat;
- the estuarine analysis area includes the Coos Bay estuary which is included in designated critical habitat; and
- the marine analysis area includes coastal marine waters up to 110 meters (60 fathoms) deep, which have been included as coastal marine critical habitat.

While several Project actions are not likely to cause adverse effects to critical habitat, some effects from Project components **are likely to adversely affect** critical habitat for southern green sturgeon because:

- bottom disturbance from construction would locally affect the abundance and diversity of food sources and habitat usability within discrete areas of Coos Bay;
- suspended sediment produced during dry open-cut crossing Stock Slough, 220 feet upstream from designated critical habitat in Stock Slough, could affect water quality (PCE 4) in freshwater riverine critical habitat.

3.5.2 Pacific Eulachon (Southern Distinct Population Segment)

3.5.2.1 Species Account and Critical Habitat

Status

NMFS was petitioned on July 16, 1999, to list and designate critical habitat under the ESA for Columbia River populations of Pacific eulachon (Columbia River smelt) in 1999. NMFS (1999a) found that although eulachon catches within the Columbia River basin had recently declined, substantial scientific information was lacking to support the petition (NMFS 1999a). In 2007, the Cowlitz Indian Tribe petitioned NMFS to list the eulachon population south of the U.S./Washington-Canada Border as threatened or endangered under the ESA (Cowlitz Indian Tribe 2007). NMFS found that the 2007 petition did provide sufficient information to warrant delineation of a DPS for the eulachon south of the U.S./Washington-Canada border and that this population had substantially declined in abundance (NMFS 2009e).

NMFS listed the eulachon (Columbia River smelt), Southern DPS, as threatened in 2010 (NMFS 2010c). The Southern DPS includes eulachon spawning in rivers from California into British Columbia (NMFS 2008c).

Threats

Five primary threats to the eulachon include 1) climate change impacts on ocean conditions, 2) climate change impacts on freshwater habitat, 3) eulachon by-catch in offshore shrimp fisheries, 4) dams and water diversions in the Klamath and Columbia Rivers, and 5) predation in the Fraser and British Columbia coastal rivers (NMFS 2008c).

The most serious threat recognized throughout the four subareas is climate change impacts on ocean conditions. This is closely followed by climate change impacts on freshwater habitat and eulachon by-catch in offshore shrimp fisheries. Additional threats cited include dams and water diversions in the Klamath and Columbia Rivers and predation in the Fraser and British Columbia coastal rivers (NMFS 2008c).

Species Recovery

NMFS published a recovery plan for the Southern DPS of eulachon in September of 2017 (NMFS 2017h). The recovery strategy includes research and monitoring actions that include but are not limited to the following: 1) estimating long-term spawner abundance, 2) survival of larval eulachon, 3) evaluating importance of the tidal freshwater, estuary, plume, and nearshore ocean environments to the viability and recovery of eulachon in the Klamath, Columbia, and Fraser Rivers, 4) determining the significance of plume and ocean conditions that affect eulachon survival, 5) developing a marine abundance survey for eulachon and correlation with riverine abundance estimates, 6) determining the significance of climate-related impacts on ocean conditions that affect eulachon survival, and 7) determining the significance of water quality degradation by potential contaminants on eulachon recovery potential. Priority management recovery actions identified in NMFS (2017h) include: 1) establish a eulachon technical recovery and implementation team to develop an overall framework for funding, prioritization, implementation, and reporting of recovery actions; 2) develop outreach and education strategies regarding the ecological, economic, and cultural values of eulachon; 3) continue to work with the ocean shrimp trawl fisheries and the states of California, Oregon, and Washington to implement actions (e.g., fleet-wide implementation of light emitting diode lights, rigid grate bycatch reduction devices, and additional gear-type or operational modifications, to further reduce bycatch of eulachon in the ocean shrimp trawl fisheries); 4) continue to work with the states to implement a limited-opportunity eulachon fishery to:

> (1) provide essential context for interpreting historical harvest data to better understand trends and variability in eulachon abundance;
> (2) fill critical information gaps such as the length and age structure of spawning eulachon, as well as the temporal and spatial distribution of the run;
> (3) support the cultural traditions of Northwest tribes who rely on eulachon as a seasonally important food source; and
> (4) provide a limited public and commercial opportunity for eulachon harvest to maintain a connection between people and the eulachon resource.

5) continue to work with federal and non-federal entities that maintain and operate dams and channel-spanning water control structures to develop and implement actions to reduce the ecological effects caused by water management operations on riverine and estuarine habitats to support the full-range of biological requirements for eulachon; 6) continue to work with the U.S. Army Corps of Engineers to develop and implement actions to reduce impacts from dredging (e.g., entrainment, on eulachon); 7) continue to work with the states of California, Oregon, and Washington to implement programs that improve water quality for temperature; and 8) continue to work with federal agencies and the states of California, Oregon, and Washington to implement programs (e.g., revetment breaching and removal, to reduce the impacts of shoreline construction on eulachon and their habitats)..

Life History, Habitat Requirements, and Distribution

Pacific eulachon are an anadromous smelt endemic to the northeastern Pacific Ocean. They range from northern California to southwest and south-central Alaska and into the southeastern Bering Sea (NMFS 2013f). Adult eulachon usually spend three to five years in saltwater before returning to fresh water to spawn from late winter though early summer (NMFS 2009e). Eulachon generally spawn at night in rivers that are glacier-fed and/or have peak spring freshets, and it has been suggested that imprinting is confined to an estuary not a specific individual spawning river (Hay and McCarter 2000). The typical spawning temperature is from 4° to 10°C in the Columbia River and tributaries and from 0° to 2°C in the Nass River (NMFS 2009e).

Spawning time is mostly likely dependent on geographic location, with those individuals in the southern part of the range spawning earlier than their northern counterparts. Eulachon spawn earlier in southern portions of their range than in rivers to the north. River-entry and spawning begins as early as December and January in the Columbia River system (NMFS 2008c). Reports have indicated spawning beginning in January in rivers of the Copper River Delta of Alaska and in May in North California. Within coastal British Columbia, the typical pattern is reversed, with spawning occurring as early as February in the Nass River and the latest spawning occurring in April and May in the Fraser River. Data also supports the evidence of waves or runs of eulachon spawning in some basins (Hay and McCarter 2000). Most eulachon adults die after spawning.

Eulachon sexes must synchronize their activities closely because eulachon sperm remain viable for only a short time, estimated to be minutes (Hay and McCarter 2000). Eggs are fertilized in the water column, sink, and adhere to the river bottom typically in areas of gravel and coarse sand. Eulachon eggs hatch in 20 to 40 days, with incubation time dependent on water temperature. Shortly after hatching, the larvae are carried downstream and dispersed by estuarine and ocean currents (NMFS 2009e). After leaving estuarine rearing areas, juvenile eulachon move from shallow near shore areas to deeper areas over the continental shelf. Larvae and young juveniles become widely distributed in coastal waters, with fish found mostly at depths up to 15 meters (50 feet) but sometimes as deep as 182 meters (600 feet) (Hay and McCarter 2000). Eulachon larvae and post-larvae eat phytoplankton, copepods and their eggs, mysids, barnacle larvae, worm larvae, and other eulachon larvae (NMFS 2009e). Adults and juveniles commonly forage at moderate depths (15 to 182 meters) in inshore waters, feeding on zooplankton, primarily eating crustaceans (Hay and McCarter 2000). With their high lipid content and massing in estuaries and rivers during spawning migrations, eulachon are an important part of the Pacific coastal food web. Eulachon are prey to numerous fish, avian species, marine mammals, and terrestrial mammals (NMFS 2009e). Historically, eulachon distribution corresponds closely with the EPA's Coastal Range Ecoregion which extends from the Olympic Peninsula through the Coast Range and down to the Klamath Mountains and the San Francisco Bay Area. Streams within this region exhibit two distinct annual flow patterns: 1) streams draining coastal watersheds commonly experience winter rain events with periods of high flow; and 2) streams draining more interior areas, such as the Columbia and Cowlitz Rivers, have a distinct spring freshet period coinciding with snow melt. Eulachon production is highest in these latter interior systems (NMFS 2009e).

Population Status

The Columbia River has historically shown the largest returns of spawning population throughout the eulachon's range. A review of records has shown that eulachon spawning runs from California to southeastern Alaska have declined in the past 20 years, with a significant trend observed since the mid-1990s (Hay and McCarter 2000). From 1938 to 1992, the median commercial catch of eulachon in the Columbia River was approximately 1.9 million pounds. From 1993 to 2006, the median catch had declined to approximately 43,000 pounds, representing a 97.7 percent reduction in catch from the prior period. Despite a short increasing trend noted for the Columbia River from 2001-2003, recent catches remain lower than the historical median (Cowlitz Indian Tribe 2007).

Similar trends were noted by the Cowlitz Indian Tribe for tributaries of the Columbia River in Oregon and Washington, as well as Fraser River; a rapid decline in the mid-1990s, increasing returns during 2001-2003, and a recent decline to low levels (NMFS 2008c). The 2007 petition noted that the eulachon is most likely extirpated or nearly so in the Klamath River, Mad River, Redwood Creek, and Sacramento River (Cowlitz Indian Tribe 2007; NMFS 2008c).

Analysis of eulachon bycatch in ocean shrimp fisheries between 2007 and 2012 observed a greater than 40 percent annual increase in eulachon density, which was attributed to increasing population size (Ward et al. 2015). This same study also observed that coastal areas just south of Coos Bay are consistent hotspots for eulachon bycatch. This trend is supported by recent observations of increased eulachon population abundance (James et al. 2014).

Critical Habitat

Critical habitat for Pacific eulachon was designated in 2011 (NMFS 2011f). Critical habitat for eulachon includes freshwater creeks and rivers and their associated estuaries comprising approximately 335 miles of habitat within in 16 specific estuarine and freshwater areas in California, Oregon, and Washington. Essential to the conservation of the species are physical and biological features of freshwater spawning and incubation sites include water flow, water quality, water temperatures, suitable substrate for spawning and incubation, and migratory access for adults and juveniles. The physical and biological features of freshwater migration corridors include water flow, water quality and water temperatures to support larval and adult mobility; abundant prey items to support larval feeding (NMFS 2011f).

Activities that may affect the physical and biological features essential to the Southern DPS of eulachon include: 1) dams and water diversions; 2) dredging and disposal of dredged material; 3) in-water construction or alterations; 4) pollution and runoff from point and non-point sources; 5) tidal, wind, or wave energy projects; 6) port and shipping terminals; and 7) habitat restoration projects (NMFS 2011f). These activities may have an effect on one or more of the essential physical and biological features by altering alteration of one or more of the following: 1) stream hydrology, 2) water level and flow, 3) water temperature, 4) dissolved oxygen, 5) erosion and sediment input/transport, 6) physical habitat structure, 7) vegetation, 8) soils, 9) nutrients and chemicals, 10) fish passage, and 11) estuarine/marine prey resources (NMFS 2011f).

3.5.2.2 Environmental Baseline

Analysis Area

Two analysis areas are applicable to effects determinations for eulachon in the Southern DPS – the estuarine analysis area and the marine analysis area. Effects in the estuarine analysis area are associated with 1) operational activities by LNG carriers entering and exiting Coos Bay, 2) in-water construction activities including dredging and pile installation, and 3) the crossing of Coos Bay by the Pipeline. Eulachon occur within marine waters off-shore and within the marine analysis area where they could be affected by 1) underwater noise from LNG carriers, and 2) oil and fuel spills.

Species Presence

Although Coos Bay is within the historic range of the eulachon, south of the Columbia River mouth, eulachon have been identified in very few coastal streams (Cowlitz Indian Tribe 2007). Adults are found rarely in Coos Bay (NMFS 1999a) and spawning runs have not been documented for the Coos River. The BRT review of status of eulachon also concluded that their presence in Coos Bay was “rare” (NMFS 2008c). Observations of adult eulachon have been reported from the Umpqua and Rogue Rivers, Oregon (Emmett et al. 1991). Pelagic Tucker trawl samples over a 17-month period found larvae and small juveniles of a close relative, surf smelt, but no eulachon in the vicinity of the proposed terminal in Coos Bay (Shanks et al. 2011). Storch et al. 2014 reported that opportunistic sampling for eggs and larvae of eulachon was conducted in January and February 2011 in the Coos River, but nothing was found.

Coos Bay is known to occasionally support adult populations of eulachon (NMFS 1999a). When present, eulachon may utilize both shallow and deep water habitats within the estuary. Eulachon were captured in beach seine hauls in the Coos River estuary, June through September (NMFS 2008c). Based on current information, this analysis assumes that while adult eulachon may be infrequently present in Coos Bay, larvae are not present based on the lack of documented spawning in Coos Bay tributaries.

Critical Habitat

Small numbers of eulachon have been observed in a few coastal rivers and creeks in Oregon, including historical accounts of their occurrence in the Siuslaw River, Coos Bay, and Rogue River (NMFS 2008c). Critical habitat has been designated within the Lower Umpqua River. Eulachon apparently spawn and migrate within the lower Umpqua River from the mouth upstream to below the confluence with Mill Creek (NMFS 2011f). No critical habitat has been designated within the Coos Bay estuary or marine analysis area.

3.5.2.3 Effects of the Proposed Action

Some of the Project effects to Pacific eulachon, Southern DPS would be similar to those described above in section 3.5.1.3 for North American green sturgeon.

Direct and Indirect Effects – Marine Analysis Area

Project-related effects to the Southern DPS of Pacific eulachon within the marine analysis area could result from LNG carrier generated acoustic effects and oil, fuel, and gas spills.

<u>Acoustic Effects</u>

LNG carriers transiting the marine analysis area would produce underwater noise that may affect eulachon under certain circumstances. LNG carriers built in 2003 with 138,028 m^3 capacity were reported by Hatch et al. (2008) to produce sound levels (with 1 standard error) of 182 ± 2 dB re: 1 µPa @ 1 meter.

The criteria for noise levels considered harmful to fish are presented above in the green sturgeon discussion, but generally values less than 183 dB are not considered harmful to fish. As a result, only fish within about one meter (three feet) of the carrier would be in danger of direct noise harm. Eulachon, which tend to reside at midwater depths, would be highly unlikely to be within three feet of these carriers, and thus adverse effects to eulachon from LNG carrier noise are not expected.

<u>Fuel or Oil Spills at Sea</u>

The LNG carriers use either a steam or dual fuel diesel electric propulsion system that is primarily fueled by natural boil-off gas. Fuel (e.g., diesel) used for back-up generation for LNG carrier propulsion and oil or hydraulic fluids used for mechanical equipment could possibly leak or be spilled during waterway transits. The low volume of petroleum oils and fuel on LNG carriers greatly reduces chance of impacts in the marine environment from petroleum spills. The Federal Water Pollution Control Act, as amended by the CWA (33 U.S.C. 1251–1387), prohibits the discharge of oil upon the navigable waters of the U.S., Contiguous Zones (nine miles seaward of the three-mile limit), and, where it can be determined that the natural resources of the U.S. are impacted, out to the EEZ (200 miles). Also, LNG carriers calling on the LNG Terminal would be required by the Coast Guard to have a carrier response plan in order to be adequately prepared for accidental spills. Therefore, neither fuel nor oil leaks from LNG carriers transiting in the waterway to and from the LNG Terminal are likely to have adverse effects on aquatic resources including eulachon.

Direct and Indirect Effects – Estuarine Analysis Area

Potential project-related effects to the Southern DPS of Pacific eulachon within the estuarine analysis area are associated with: 1) turbidity from dredging, 2) turbidity from LNG carrier propeller wash and ship wake, 3) inadvertent return turbidity during the two HDD installations across the Coos Bay estuary, 4) stranding adult eulachon by LNG carrier wakes, 5) introduction of exotic, invasive species from ballast water, 6) entrainment and impingement of adult eulachon in LNG carriers' intake port, 7) elevated water temperature in the Terminal slip from the release of engine cooling water during LNG carrier cargo loading, 8) operational lighting, 9) underwater noise generated during LNG Terminal construction, 10) habitat modification from slip, access channel, NRI areas, and pile dike rock apron construction, and 11) restoration activities at the Kentuck Mitigation Site. Details on these potential effects would be similar to those discussed for green sturgeon in section 3.5.1.3.

Timing to Life History Functions

In-water construction of the JCEP Project within the Coos Bay estuary is planned from October 1 through February 15 following ODFW's recommendation. The two HDD installations may occur between March and December. Because eulachon spawning has not been documented in freshwater tributaries to Coos Bay, the estuary most likely only provides infrequently occupied habitats for eulachon. Seasonal presence of eulachon in the estuary has not been definitively documented but fish have been reported captured in the estuary from June through September (NMFS 2008c). If those reports are indicative of the seasonal presence of eulachon in Coos Bay, the timing of in-water construction would avoid such presence. The timing of HDD installation, however, may coincide with eulachon presence.

Turbidity

Turbidity would be generated at the LNG Terminal slip and access channel, Navigation Reliability Improvement sites, and Eelgrass Mitigation site; while peforming capital; and from the propeller wash of LNG carriers, tugs, and escort boats in the waterway during operation of the terminal (see discussion of direct impacts to green sturgeon within the estuarine analysis area in section 3.5.1.3, above). As discussed for green sturgeon above, turbidity in Coos Bay during dredging would be temporary, and there would be only limited areas where suspended sediment concentrations would be above ambient levels. Turbidity in Coos Bay caused by the Project is not likely to have significant adverse effects on eulachon. While dredging has been shown to have damaging effects on out-migrating eulachon larvae (NMFS 2017h), larvae are not expected to be present in Coos Bay based on the absence of documented spawning in Coos Bay tributaries. Similarly, no eggs are anticipated to be present in tributaries that could be smothered, entrained or damaged by proposed dredging activities. Should adult eulachon be present coincidental with LNG carrier traffic in the waterway, they would be expected to avoid the LNG carriers. Given the deep and shallow water habitats available, there is a low likelihood that temporary elevated levels of turbidity would result in significant impacts on adult eulachon in Coos Bay. It is possible, however, that individual adult eulachon could become entrained by hydraulic suction or clamshell dredging if they are present during the winter and early spring, but this is unlikely given the rare occurrence of the species in Coos Bay.

Similarly, individual adult eulachon could experience negative physiological and behavorial impacts from incremental increases of propeller wash at the new access channel and marine slip. These areas are expected to experience up to 0.5 feet of bed scour from propeller wash (Moffatt & Nichol 2017e).

Dredging at the four NRI sites will take place in deep subtidal habitat used by benthic organisms, macroinvertebrates, and demersal fishes (e.g., worms, clams, crustaceans, mollusks, flatfish, and Pacific sand lance) some of which serve as prey to green sturgeon. Entrainment from dredging could injure or kill these and other bottom-dwelling species that have limited mobility and move, rest, find shelter, and feed within the dredge prisms for these areas.

The NRI sites are located entirely within deep subtidal habitats along the FNC. Such habitat is less productive than shallow subtidal and intertidal habitats. Furthermore, the FNC is subject to periodic dredging and propeller scour which can disturb the associated benthic community. Benthic communities associated with mud substrates like those within Coos Bay, however, have been shown to recolonize to pre-dredging conditions within four weeks following dredging (Newell et al. 1998). Impacts to bottom-dwelling marine life where dredging is planned at the NRI sites, LNG terminal slip, and access channel, therefore, are expected to occur over a short-term duration. While it is anticipated that affected areas would recolonize by similar species within a month or two following dredging, the relative composition among species likely would be altered over the near term.

Direct mortality or injury from dredging is not expected for most pelagic fishes due to their swimming ability and behavioral tendency to avoid disturbance. Dredging could affect other bottom-dwelling fishes, however, such as Pacific sand lance, which frequently inhabit sands and fine-grain sediments for rest and predator avoidance. Sand lance are an important prey species for many marine mammals, birds, and fishes including marbled murrelet and Pacific salmon. While sand lance could be subject to mortality or injury from proposed dredging, the timing and extent of their presence in the lower bay at the NRI sites has not been confirmed.

At the Eelgrass Mitigation site, a total of 40,000 cy of dredge material will be removed most likely with a small hydraulic dredge. Modeled turbidity values were determined to range from 270 to 290 NTUs. The potential turbidity plume extents, defined by the simulated 10 NTU above background contour, from the excavator dredge area would be generally limited to between 340 and 360 feet in all directions (Moffatt & Nichol 2017c). Since the site is a more confined and shallow area with somewhat limited circulation, the turbidity plume would be maintained within the local area of excavation. The duration of suspended sediment settling, therefore, is expected to be very short with turbidity dissipating to background levels within an hour after dredge operations cease, depending on the tidal cycle.

Dredging is not anticipated to suspend or activate contaminants in the substrate that could have negative physiological effects on eulachon. A comprehensive sediment sampling and analysis plan (SAP) was completed in October 2006 in order to evaluate the grain size distribution and total volatile solids composition of sediments in the proposed dredge prism for the terminal access channel (SHN 2007). The testing that was conducted to determine whether the sediments meet Dredge Material Evaluation Framework (DMEF) guidelines, relative to Lower Columbia River Management Area, for in-water disposal. Since results of the study revealed that all samples were primarily composed of medium to fine grain sand and had a very low percentage of total volatile solids, no further chemical testing was required, and the sediments were considered suitable for in-water disposal per DMEF guidelines. Furthermore, the results indicate the sediment character should not result in significant increases in bioavailability of contaminants to fish and fish food organisms within the analysis area. Based on the results of the sediment sampling, there is little to no risk of contamination as a result of dredging the access channel.

Sediment evaluations conducted by the USACE in 2004 for the Coos Bay channel maintenance and improvement dredging along the Federal Navigation Channel (FNC) revealed only low levels of sediment contaminants, all below their respective DMEF screening levels. In 2011 and 2016, JCEP conducted geotechnical investigations at the NRI sites to support the JCEP's DMMP. Analysis of the physical character of sediments at the NRI sites determined that sediment composition consisted of sand, silty sand, sandstone, and siltstone. This is similar to sediments collected from the adjacent FNC and from within the footprint of the proposed LNG Terminal access channel. These sediments were generally described as coarse-grained with high sand content, which the Portland Sediment Evaluation Team (PSET) previously determined suitable for unconfined aquatic disposal. Due to their proximity to previous sampling locations in the FNC and access channel, sediments to be dredged from the NRI sites will have a similar chemical character which will be confirmed in future consultations with the PSET. Therefore, dredge materials from the NRI sites will also have a low likelihood of potential contaminants and be suitable for unconfined aquatic disposal.

<u>Turbidity Effects – Pipeline Construction with HDD</u>

Coos Bay would be crossed by two HDDs, one from MP 0.28 to MP 1.00 (West HDD), the other from MP 1.46 to MP 3.02 (East HDD). The Coos River (a tributary to the estuary) would also be crossed using HDD at MP 11.13. The horizontal crossing length of the West HDD would span 5,192 feet, extending from the North Spit to the southeast, crossing the Coos Bay navigation channel and terminating at North Point in North Bend, Oregon. The HDD profile would pass approximately 158 feet below the railroad trestle bridge and approximately 138 feet below the deepest part of the navigation channel. The depth and the locations of the railroad trestle foundations are unknown at this time (GeoEngineers 2017a). The feasibility analysis for the West HDD anticipates a relatively low risk of hydraulic fracture and drilling fluid surface releases occurring along most of the HDD alignment during construction. However, there would be a high risk of hydraulic fracture and drilling fluid surface release within about 150 feet of either end of the HDD due to the anticipated loose sand and decreased depth of cover. Installation of an oversized casing may be needed at both ends of the HDD path to assist in efficiently transferring axial loads to the drill bit, and to mitigate against hydraulic fracture and drilling fluid surface releases within the loose sand anticipated in the upper 30 feet (GeoEngineers 2017a).

The horizontal crossing length of the East HDD would span 8,972 feet extending from North Point in North Bend, Oregon eastward across Coos Bay and ending at the mouth of Kentuck Slough. Surface conditions at North Point at the west end of the HDD consist of a relatively flat ground surface covered with fill stockpiles. The east end of the HDD would be located within a flat grass vegetated area in Kentuck Slough Valley. The proposed depth of the Pipeline would be 210 feet below ground surface. Because of the length of the HDD, there would be an increased risk of drilling fluid surface release during reaming operations. This risk can be reduced by reaming the hole from both ends of the crossing. In general, GeoEngineers (2017a) expects the risk of drill hole instability along the HDD drill paths to be relatively low. Minor hole instabilities may be encountered within the very loose to loose soils expected along the upper portions of the HDD profile at the east end near Kentuck Slough, but that condition would not jeopardize the successful installation of the product pipe.

For construction using HDD across the Coos River (see appendix E), the design length of the Coos River HDD crossing would be approximately 1,602 feet. The proposed entry point would be located approximately 500 feet from the north bank of the Coos River and the the exit point approximately 630 feet from the south bank. The entry and exit points would allow for adequate depth beneath the Coos River. The preliminary design provides a minimum of 50.3 feet of cover below the Coos River. GeoEngineers' evaluation determined that the construction of the Coos River HDD crossing is likely feasible. GeoEngineers opined that there would be a relatively high risk of hydraulic fracture and drilling fluid surface releases along the first 500 feet and last 300 feet of the HDD, respectively. However, the risk of drilling fluid surface release to the Coos River would be relatively low.

Drilling requires use of a drilling mud for lubrication of the bit and removal of cuttings. A biodegradable bentonite clay mixture makes up drilling mud and is considered "practically non-toxic" (Reid and Anderson 1998). Because the drilling mud is under pressure during drilling, if the bit encounters substrate fractures or channels, it is possible for bentonite to escape from the hole (termed an "inadvertent return"). Bentonite can escape to the surface through fractures in the drilled substrate. However, bentonite is more likely to stay in suspension than settle if compared to common bottom sediment; therefore, in flowing water areas, effects to benthic organisms from burial from inadvertent return are likely to be low. The locations where any inadvertent return may occur in the Coos River would be affected less because of the dilution factor of the large volume of water from any spill. PCGP's *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations* (see appendix D) describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The HDD Contingency Plan also includes procedures for cleanup of drilling mud releases. If significant concentrations are found during monitoring as a result of a release, possible corrective measures would be taken as described in section 3.5.1.3 for North American green sturgeon.

Other Effects within the Estuarine Analysis Area

Other impacts on eulachon within the estuarine analysis area are not expected to be adverse, similar to the discussions for green sturgeons. Stranding of adult eulachon by ship wake is possible but unlikely given the low vessel speed of 4 to 6 knots that would occur during most of the transit route through Coos Bay. The size of adult eulachon that may infrequently enter the estuary is 20 to 30 cm (Moyle 2002), considerably larger than juvenile Chinook salmon (less than 9 cm) that were subject to stranding by ship wakes in the Columbia River (Pearson et al. 2006). As a result, eulachon that may be present in the estuary should not be susceptible to ship wake stranding.

The release of ballast water by LNG carriers during loading at the LNG Terminal should not introduce exotic, invasive species into Coos Bay. Nor should adult eulachon be entrained or impinged during the intake of engine cooling water by LNG carriers while at dock. The larger size and swimming ability of adult eulachon (no larvae would be present) would allow them to avoid the engine cooling water intake. Entrainment of eulachon from dredging activities is also unlikely due to the relatively large size and swimming ability of adult life stage, their likely low abundance, and mostly pelagic distribution in the bay. The release of engine cooling water by LNG carriers at the LNG Terminal would not significantly elevate water temperature in the slip, nor would eulachon be affected by operational lighting at the LNG slip.

Habitat effects of the proposed project, including potential effects of installation of riprap (such as at pile dike rock apron), will be less significant for eulachon, given their rarity in the bay.

Finally, increased underwater noise from pile driving and other construction related activities would be similar for adult eulachon as it is for green sturgeon, as discussed above. In-water pile driving would be limited to the approved in-water work window for the Project, which is October 1 through February 15. This window would minimize potential interaction with eulachon which, if present, would most likely be in the bay during spring and summer.

As discussed in section 3.5.1.3, Green Sturgeon, underwater noise can be generated by driving piles on land (dry piles). The propagation of underwater construction noise from the "dry" impact pile driving associated with the MOF was modeled for fish in several reports prepared by JASCO Applied Sciences (Wladichuk and MacGillivray, 2018; Wladichuk et al. 2018). Wladichuk et al. (2018) modeled potential impacts of land-based pipe pile driving on fish using both current guidelines (FHWG 2008) and new proposed guidelines (Popper et al. 2014). Previous noise studies investigated radii to marine mammal and fish threshold criteria from a pipe pile with the same diameter (36 inch (0.9 m)) but a shorter length (60 ft (18.3 m)), as well as different number of strikes in a 24-hr period and at 4 set-back locations behind the MOF (O'Neill and MacGillivray 2017, Wladichuk et al. 2017, Wladichuk and MacGillivray 2018). After receiving additional construction details, the most recent study examined the threshold radii from driving a 104.8 ft (31.9 m) pile at the MOF and at 98.4 ft (30 m) set-back distance behind the MOF using a reduced impact hammer energy of 65%. This study found that injury to fish from peak sound pressure levels (206 dB in current guidelines) would occur up to 37m from the face of the MOF. Also, this study predicted that injury to both small (less than 2 grams) and large (greater than or equal to 2 grams) fish from cumulative sound exposure levels (183 and 187 dB respectively under current guidelines) would occur up to 1,723 meters from the shoreline. This distance was the same for both 10,000 and 20,000 total impact strikes because in both cases this was the distance when the noise attenuated to the sound level considered effective quiet (150 dB). Under proposed guidelines (Popper et al. 2014), modeled distances to injury were considerably less, although the distance to temporary threshold shift (TTS) was the same – 1,723 meters. Based on the results of Wladichuk et al. 2018, installation of land-based piles at the MOF face would increase potential exposure of individual eulachon to underwater noise in an area encompassing the navigation channel from the MOF across the bay to the airport and southwest to the vicinity of Southport Lumber yard (Figure 3.5.1-2). Individual fish occurring in this area during pile driving could experience physiological effects sufficient to cause injury or mortality. Conservation measures may include sound attenuation to minimize risk of disturbance that may occur in the Project vicinity during construction as well as limiting land-based pile driving close to the MOF face to the in-water work window, which would minimize the risk of exposure of adult and migrating eulachon to increased noise. Finally, the larval life stage of eulachon, which would be most susceptible to barotrauma from increased sound pressures, is not expected to occur in the bay due to the lack of documented spawning populations in Coos Bay tributaries.

Cumulative Effects

The carriers transiting to and from the LNG Terminal would contribute to the ambient noise levels in the marine analysis area. However, the incremental increase in noise would occur within a context of diminishing traffic-related noise (Andrew et al, 2011), so the cumulative impact should be limited. Current commercial traffic into Coos Bay includes about 60 deep-draft cargo ships and 50 barges. While this may remain constant for the near term, in the future non-fishing commercial traffic into Coos Bay may increase if the Port is able to make its planned improvements to attract new customers. However, even with the addition of 120 LNG carriers per year visiting the LNG Terminal, commercial ship traffic into Coos Bay would probably not reach historic levels. In the mid-1990s, as many as 200 non-fishing commercial ships per year called on the Port. Therefore, increased ship traffic into Coos Bay is not likely to have significant adverse cumulative impacts on Pacific eulachon.

There is a reasonably foreseeable increasing trend for carrier traffic volume in the future. Unforeseen global events such as potential future economic crises, however, could influence such predictions. Although there would be a greater risk of noise to Pacific eulachon as a result of increased ship traffic, because Project effects are expected to be minor, cumulative effects in the marine analysis area are expected to be insignificant. In addition to noise, if the current trend of increasing pink shrimp harvest off the coast of Washington and Oregon continues, there could be an associated increase with eulachon bycatch (Wargo et al. 2014). However, this trend would operate independent of the ship traffic associated with the LNG Terminal.

The possibility exists for accidental releases of diesel fuel and/or gasoline from non-project related vessels in the foreseeable future. According to annual reports published by the Pacific States/British Columbia Oil Spill Task Force, ODEQ reported 34 spills from fishing vessels or other harbor craft in 2002, 38 spills in 2003, and 7 spills from fishing vessels plus spills from 27 other vessel types in 2004. Those relatively consistent incidences apparently increased in 2005 with 18 spills from fishing vessels 20 from recreational vessels, and 27 spills by other vessel types. By contrast in 2006, there were 3 spills from fishing vessels, 6 spills from recreational vessels, and only 6 spills from other vessel types. Though not known, it appears that the background rate of spills off the Oregon coast (incidence of spills in proportion to total vessel operation) by fishing vessels, recreation vessels, and other vessel types is generally low and expected to continue at low frequencies in the foreseeable future.

Considering the potential effects to eulachon in the marine and estuarine habitat described above, cumulative effects are likely to be minimal. This is based on the fact that factors that are not under other federal authorization, like shipping traffic within Coos Bay, spills of petroleum products at sea, estuarine development and dredging, and harvest rate of eulachon, are unlikely to change substantially in the foreseeable future.

Critical Habitat

Critical habitat has been designated for this species but none occurs within either the marine analysis area or the estuarine analysis area. No critical habitat would be affected by the proposed action.

3.5.2.4 Conservation Measures

Measures developed for application within the estuarine analysis area to conserve green sturgeon would also benefit the eulachon Southern DPS if they are present within the estuarine analysis area during construction and operation of the Project.

3.5.2.5 Determination of Effects

Species

The Project **may affect** Pacific eulachon (Southern DPS) because:

- adult eulachon may be present within the estuarine analysis area during construction and operation of the Project; and
- eulachon may occur within the marine analysis area during operation of the proposed action.

Project components are **not likely to adversely affect** Pacific eulachon (Southern DPS), because:

- no spawning population has been documented upstream of the project in tributaries to Coos Bay;
- eulachon larvae are not likely to be present in the action area due to lack of a documented spawning population in Coos Bay tributaries;
- individual eulachon adults are considered rare in the action area, and would most likely be present from late spring to late summer (i.e., June to September), outside the proposed in-water work window of October to February. Therefore, adult eulachon would not be exposed to elevated episodes of turbidity, underwater noise, contaminants, or other adverse effects;
- the proposed action may affect the abundance and diversity of potential food resources and water quality during the short-term durations of construction within the estuarine analysis area. These effects are discountable and insignificant given the species current status within the analysis areas;
- increased underwater noise from construction may affect adult eulachon in the unlikely event they are present in the estuarine analysis area during the in-water work period. This effect is discountable and insignificant given the species current status within the analysis area; and
- the proposed action may affect water quality during the long-term operation period within the marine analysis area. This effect is discountable and insignificant given the species current status within the analysis area.

Critical Habitat

The Project would have **no effect** on critical habitat for the Pacific eulachon (Southern DPS) because no designated critical habitat is present within the estuarine analysis area.

3.5.3 Coho Salmon (Southern Oregon Northern California Coast ESU)

3.5.3.1 Species Account and Critical Habitat

Status

The Southern Oregon Northern California Coast (SONCC) ESU coho salmon was listed as a threatened species in 1997 (NMFS 1997b). At the time of listing, NMFS estimated that there were less than 10,000 naturally reproducing SONCC coho (NMFS 1997b). The SONCC coho ESU includes all coastal tributaries to the Pacific Ocean between Punta Gorda, California and Cape Blanco, Oregon. It includes all naturally spawning populations as well as three artificial propagation programs, of which one, the Cole Rivers Hatchery (ODFW stock #52) located on the Rogue River, is within the Pipeline project area.

Threats

At the time the SONCC coho salmon ESU was proposed for listing, various factors were included as threats to West Coast salmon populations in general but were not specific to the SONCC ESU. Logging, agricultural practices, urbanization, stream channelization, dams, wetland loss, water withdrawals with unscreened diversions for irrigation, and mining were listed as development actions that threatened the survival of this ESU and two others (NMFS 1995). The result of these development practices caused increased soil erosion and stream sedimentation, degradation of riparian zones, increased water temperatures, decreased recruitment of LWD in streams, decreased habitat complexity, and damage to riparian vegetation. Overharvest by commercial and recreational fisheries, disease, drought, warming ocean temperatures, and artificial propagation with associated impact of hatchery populations on wild stock have been contributory threats to all West Coast salmon (NMFS 1995).

Prior to listing the species, NMFS published a status review in 1995 that included the SONCC coho salmon ESU (Weitkamp et al. 1995). In that document, all coho salmon populations in the ESU were depressed. In the Rogue River, wild coho salmon were heavily affected by hatchery production with little natural production in the mainstem. The declining trend of coho salmon was indicative that natural populations in the Rogue River and others within the ESU were not self-sustaining (Weitkamp et al. 1995).

NMFS' most recent status review was published in 2016 (NMFS 2016). The updated status review indicates that there has been no improvement in the status of SONCC coho in the last five years, and the ESU is at a heightened risk of extinction since the former status review conducted in 2011 (NMFS 2016b). Coho salmon populations continue to be depressed within the ESU as a whole, and the Rogue River stock has demonstrated a declining trend, though insignificant, since the last formal status reviews when an average increase in numbers of spawners had been observed (Good et al. 2005; Ly and Ruddy 2011). While the Rogue River run includes hatchery fish releases from the Cole Rivers hatchery, these hatchery fish are of Rogue River stock origin and are considered by NMFS as part of this ESU. Consequently, there is reduced genetic risk to wild stocks in the Rogue River. Ocean harvest of the Rogue-Klamath stock by commercial and recreational fishers has been controlled since 1999 (not to exceed 13 percent), and river harvest within the ESU has not been allowed since 1994 (with tribal harvests excepted).

NMFS (2016b) concluded that data collected at Huntley Park provide the best estimates of coho spawner abundance in the Rogue Basin. Long-term (35 years) analysis indicates that SONCC coho have had a significant increasing trend, but from 2001 to 2014 (12 years), the population showed a non-significant declining trend (NMFS 2016b). The current risk of extinction of SONCC coho in the Upper Rogue River is “Moderate,” as opposed to “High” for other populations in the Interior Rogue Stratum (NMFS 2016b). Other populations in the SONCC ESU appear to be decreasing, with negative trends have been thought to also be related to low marine survival (NMFS 2016d). Multiple projects conducted in the Oregon portion of the ESU have improved riparian habitats, decommissioned roads, treated stream crossings, improved fish passage by dam removal, and installed fish screens on diversions (NMFS 2016b).

Insufficient in-stream flow, limiting adequate habitat for juveniles rearing during summer, has become a greater risk factor as groundwater and surface water withdrawal have increased due to crop irrigation and residential use. Water temperatures throughout the ESU have likely increased in summer during the ongoing drought; higher temperatures can limit migration, reduce growth, stress fish, reduce reproductive success, inhibit smoltification, contribute to susceptibility to disease, and alter competitive dominance (NMFS 2016b). Absence of large wood has contributed to lack of floodplain and channel structure and, along with declines in beaver abundance, has reduced pool habitats utilized by juvenile coho for shelter and thermal refugia throughout the SONCC ESU.

NMFS (2014e) released a final recovery plan for SONCC coho salmon that identified ten stresses, or limiting factors, and 13 threats to various life-stages for coho in the Upper Rogue River population. Limiting factors or stresses that were determined to be very high to all life stages (see table 32-1 in NMFS 2014e) included 1) altered hydrologic function primarily due to reservoirs constructed to support irrigated cropland and ground water depletions for a variety of uses, and 2) impaired water quality, especially high water temperatures (from lower water flows and removal of riparian trees) with lower dissolved oxygen. Other stresses with high or very high severity effects to multiple life stages (from fry to adults) include 3) degraded riparian forest conditions caused by removal of large conifers, channelization, wetland drainage, and other alterations, ,4) lack of floodplain and channel structure (channelization and reduction of slow, cool edgewater habitats where coho fry and juveniles thrive), and to a lesser extent, 5) altered sediment supply from roads, timber harvest, and bank erosion following removal of riparian vegetation causing elevated fine sediment input (NMFS 2014e). In addition, barriers to upstream migrations by small temporary agricultural dams, large diversion dams, and seasonal loss of stream flow in tributaries such as Trail Creek are a key limiting factor for the population.

Threats to all life stages having very high or high severity rankings contribute to the limiting factors discussed, above. Severe threats to the Upper Rogue River population include 1) agricultural practices that include water withdrawals causing insufficient in-stream flows along with effects due to grazing, wetland filling, riparian removal, channel simplification, and chemical application, 2) roads and high road densities that cause chronic fine sediment and increase probabilities of landslides, 3) urban-residential-industrial developments that have led to channelization, increased non-point source storm water pollution, and resulted in loss of aquatic system function, 4) channelization-diking that has impaired floodplain functions, constricted channels, and reduced surface-groundwater connections, all of which adversely affect water temperatures and salmon carrying capacities, 5) timber harvest that has caused early seral stage forests and high road densities in riparian zones, 6) dams and diversions that impede upstream adult salmon passage or strand downstream-migrating juveniles, if fish screens are not in place, 7) channelization and confinement of mainstem and tributaries to the Upper Rogue River that diminish summer and winter habitat carrying capacity for coho, and 8) climate change that is projected to cause increased regional average temperatures over the next 50 years and is currently leading to ocean acidification, affecting numerous marine habitat conditions including prey availability (NMFS 2014e).

BLM and Forest Service evaluated habitat conditions in the four 5th field watersheds crossed by the Pipeline wherein SONCC ESU coho salmon inhabit waterbodies (see table 3.5.3-1). Summaries for three of these watershed analyses are provided in appendix B.3 of PCGP's Resource Report 3 (table B.3-1h, table B.3-1i, and table B.3-1j). In these three watersheds, streams lacked in-stream LWD, fish access was limited, sedimentation was excessive, and high flows degraded in-stream habitats. More recently, the Little Butte Creek Watershed Council conducted an assessment in 2003 and the Upper Rogue Watershed Association's assessment was done in 2006 (table 3.5.3-1). Both assessments relied, in part, on ODFW stream habitat data that are also analyzed below in section 3.5.3.2 (see table 3.5.3-8). Findings in the more recent assessments were consistent with the earlier BLM and Forest Service watershed assessments: overall lack of complex pools and LWD in lower reach channels. However, NMFS (2016b) noted improvements for fish access to upstream habitats in the Upper Rogue sub-basin, including the removal of three diversion dams on the main-stream Rogue River – the Gold Hill Dam removed in 2008, the Savage Rapids Dam in 2009, and the Gold Ray Dam in 2010.

TABLE 3.5.3-1

Watershed Assessments Conducted by Federal and State Agencies for
5th Field Watersheds Crossed by the Pipeline within the Upper Rogue Sub-basin

Sub-basins and 5th Field Watersheds	Watershed Analysis, BLM and/or Forest Service	Watershed Assessment, Oregon Watershed Enhancement Board
Trail Creek	● Trail Creek Watershed Analysis (Western Watershed Analysts and Maxim Technologies, Inc. 1999)	● Upper Rogue Watershed Assessment (Upper Rogue Watershed Association 2006)
Shady Cove-Rogue River	● Shady Cove-Rogue River Watershed Water Quality Restoration Plan (BLM 2011)	
Big Butte Creek	● Lower Big Butte Watershed Analysis (BLM 1999d)	
Little Butte Creek	● Little Butte Creek Watershed Analysis (BLM and Forest Service 1997a).	● Little Butte Creek Watershed Assessment (Little Butte Creek Watershed Council 2003)

Historically, the SONCC coho salmon ESU inhabited the Upper Klamath Basin, upstream from Iron Gate Dam to Spencer Creek, but various impediments to passage, principally hydroelectric projects, have occurred due to basin development activities, reducing access to these areas. Currently, the Upper Klamath River coho salmon population is not viable and at high risk of extinction according to the population viability criteria. Summer and winter rearing habitat is in poor condition in many areas and is limited in its extent and connectivity. Mainstem conditions during the summer are prohibitive for migration and rearing, and hatchery influences on the population are very high. The removal of the four mainstem Klamath River dams, Iron Gate, Copco 1, Copco 2, and J.C. Boyle dams, up to Keno Dam—would be the most significant action that can be taken to restore the viability of the Upper Klamath population unit. (NMFS 2014e). Until that occurs, the Upper Klamath River population of SONCC coho persists in about 64 miles of mainstem habitat and numerous tributaries downstream from the Iron Gate Dam to Portuguese Creek in California (NMFS 2014e).

In 2008 the Oregon Fish and Wildlife Commission approved a plan to initiate efforts to re-establish anadromous fish into the Oregon portion of the Klamath River Basin. Although there is no definite timetable, this could result in the ESA-listed SONCC coho salmon being present in the Klamath River system upstream from Keno Dam, at some point in the future. Actual introduction would be unlikely to occur prior to Pipeline construction.

Species Recovery

NMFS (2014e) released a final recovery plan that addressed limiting factors and threats to each coho population within the SONCC ESU, including those within the Upper Rogue River population (see discussion under Threats, above). The plan calls for immediate habitat restoration and threat reduction in areas currently occupied by coho salmon in Evans, Trail, Elk, Big Butte, and Little Butte creeks. The greatest factor limiting the recovery of coho salmon in the Upper Rogue River is the lack of suitable rearing habitat for juveniles (NMFS 2014e). Consequently, recovery actions to create and maintain juvenile rearing habitat must be restored by restoring flow, increasing habitat complexity within the channel, restoring off-channel rearing areas, and reducing threats to in-stream habitat.

The following actions have been proposed: 1) reconnecting channels with floodplains, 2) increasing channel complexity, 3) improving flow timing and volumes, 4) improving fish access, 5) improving large wood recruitment, bank stability, shading, and food subsidies, 6) reducing predation and competition from non-native fish species, 7) improving estuarine habitat, 8) managing fisheries consistent with recovery of SONCC coho salmon, 9) managing scientific collection consistent with recovery of SONCC coho salmon, 10) tracking population abundance, spatial structure, productivity, or diversity, 11) tracking habitat condition, 12) reducing delivery of sediment to streams, and 13) reducing pollutants.

Life History, Habitat Requirements, and Distribution

Five life phases are generally recognized for the coho salmon: juvenile rearing, juvenile migration, growth and development, adult migration, and spawning. Juvenile summer and winter rearing areas and spawning areas are often located in small headwater streams. Juvenile migration corridors, adult migration corridors, and spawning areas are found in tributaries as well as main-stream reaches and estuarine zones. Growth and development to adulthood happens primarily in near- and offshore marine waters. Final maturation takes place in freshwater tributaries when the adults return to spawn (NMFS 2014e). Typically, coho salmon begin their spawning migration at 3 years old in late summer and fall and spawn by mid-winter. Eggs incubate for 1.5 to 4 months and then hatch. Juveniles rear for about 15 months in freshwater before migrating in spring to the ocean. They generally spend two growing seasons within the ocean before migrating back to their natal stream to spawn (NMFS 2014e).

Adult coho salmon rarely migrate farther up freshwater streams greater than 150 miles and generally return to spawn at sites where they hatched. Returning to parental spawning grounds ensures repeated use of suitable redd sites (Sandercock 1991). Straying (movements in non-natal stream systems) has been documented. In streams with deteriorated habitat such as low water flow, straying rates up to 50 percent have been documented (Sandercock 1991).

Preferred water temperatures during adult coho salmon upstream migration range between 7.2°C and 15.6°C (45°F to 60°F) with an upper lethal limit for adult coho salmon of 25.8°C or 78°F (Table 3 in Laufle et al. 1986). Preferred coho salmon spawning temperatures range from 4.4°C to 9.4°C (40ºF to 49ºF) while temperatures between 4.4°C to 13.3°C (40°F to 56°F) during egg incubation are preferred; the warmer the temperature, the less time before eggs hatch. The preferred range for juvenile survival systems is between 11.8°C to 14.6°C (53°F to 58°F) (Laufle et al. 1986). Elevated temperatures in streams may lead to early smoltification and ultimately premature migration towards sea during unfavorable conditions for young coho salmon (McMahon 1983).

Productive coho salmon streams are those that have a riffle-to-pool ratio of close to 1:1. Smaller streams are preferred over larger rivers due to the higher proportion of slack water to midstream area (Sandercock 1991). Substrate composition and riffles are factors, along with terrestrial vegetation, that are important for producing aquatic and terrestrial insects, which are food for coho salmon. Benthic invertebrate production is best in rubble, followed by bedrock, gravel, and sand. Coho salmon parr abundance is greatest in larger deeper pools where they can find cover near the streambank from logs, roots, debris, undercut banks, and overhanging vegetation (McMahon 1983).

Adult coho salmon require minimum water depths of 0.18 meter or 7 inches (Laufle et al. 1986) during upstream migration. Redd sites are found in waters at least 15 cm (5.9 inch) deep, though once hatched, coho salmon fry and parr prefer water at least 0.30 meter (1 foot) deep (McMahon 1983). During adult migrations upstream to spawn, water velocities less than 2.44 meters per second (m/sec; 8 feet/sec) are most desirable. At spawning grounds, coho salmon select redd sites where flows range between 5.0 and 6.8 m^3/minute (177 to 240 cubic feet per minute [ft^3/minute] or from 3 to 4 cfs), and where stream width does not exceed 1 meter or 3.2 feet (Sandercock 1991). For adult migration upstream, DO concentrations exceeding 6.3 mg/l are preferred (McMahon 1983). Incubation of eggs is best near DO saturation concentrations, and weight gains by fry are maximized in water with DO concentrations between 4 and 9 mg/l (Laufle et al. 1986).

Spawning substrate is gravel size between 1.3 and 10.2 cm (0.5 to 4 inches) (Laufle et al. 1986). Gravels less than 16 cm (6.3 inches) account for 85 percent of redd sites (Sandercock 1991). Average coho salmon redd size is 2.8 m^2 (30 ft^2); the recommended area per spawning pair is 11.7 m^2 or 126 ft^2 (Laufle et al. 1986). Egg survival to fry emergence has a positive correlation with gravel sizes between 3.35 mm and 26.9 mm (0.13 to 1.06 inches). For successful fry emergence, not more than 15 percent of the substrate should be fine sediment (McMahon 1983) because higher concentrations of fines may lead to earlier fry emergence, smaller fry, and fry with more yolk (Sandercock 1991). Silt loads less than 25 mg/l are preferable for survival of eggs and juvenile coho salmon (Laufle et al. 1986).

Coho salmon diets in freshwater differ between locations and seasons, though young coho salmon feed mainly on aquatic and terrestrial insects, becoming more piscivorous as they grow (McMahon 1983). After emergence, fry feed mostly on various life stages of aquatic insects including dipterans (true flies), ephemeropterans (mayflies), plecopterans (stoneflies), and others as well as crustaceans and fish (Laufle et al. 1986). In the West Fork Smith River in Douglas County (Oregon), diets of juvenile coho salmon (from December through May) were mostly benthic invertebrates (larval dipterans, ephemeropterans, limnephilid caddisflies, and plecopterans), but also included salmon eggs, aquatic snails, salamanders, and terrestrial invertebrates (Olegario 2006).

Major rivers, estuaries, and bays known to support coho salmon within the range of the SONCC ESU include the Rogue River, Smith River, Klamath River, Mad River, Humboldt Bay, Eel River, and Mattole River (NMFS 1999b), of which the Rogue and Klamath Rivers are within the Pipeline area. Historically, SONCC coho inhabited the Upper Klamath Basin. However, construction of the Copco 1 Dam on the mainstem Klamath River in 1918, followed by construction of the Copco 2 Dam in 1925 and the Iron Gate Dam in 1962 created impassible barriers to anadromous fish. Prior to construction of the dams, anadromous fish including SONCC coho salmon potentially could utilize over 600 miles of spawning, incubation, and rearing riverine habitats upstream from Iron Gate Dam (Hamilton et al. 2005). The historical extent of coho salmon upstream from Iron Gate Dam is believed to be Spencer Creek (Hamilton et al. 2005), which would have coincided with the Pipeline if not for the downstream barriers.

Specific timings of life history phases for SONCC coho salmon within the Pipeline project area are shown in figure 3.5.3-1. Included are the Rogue River mainstem and Upper Rogue River tributaries from Marial Creek to Lost Creek. Evident in figure 3.5.3-1 is the general synchrony in life phases within the mainstem and tributaries. Peak occurrence of juvenile out-migration lasts longer in tributaries than in the mainstem. In general, adult coho migrate upstream beginning in September and October and spawn during November through January. Fry emergence occurs about one month after spawning, and juvenile rearing continues throughout the year with juvenile out-migration extending from February through early June.

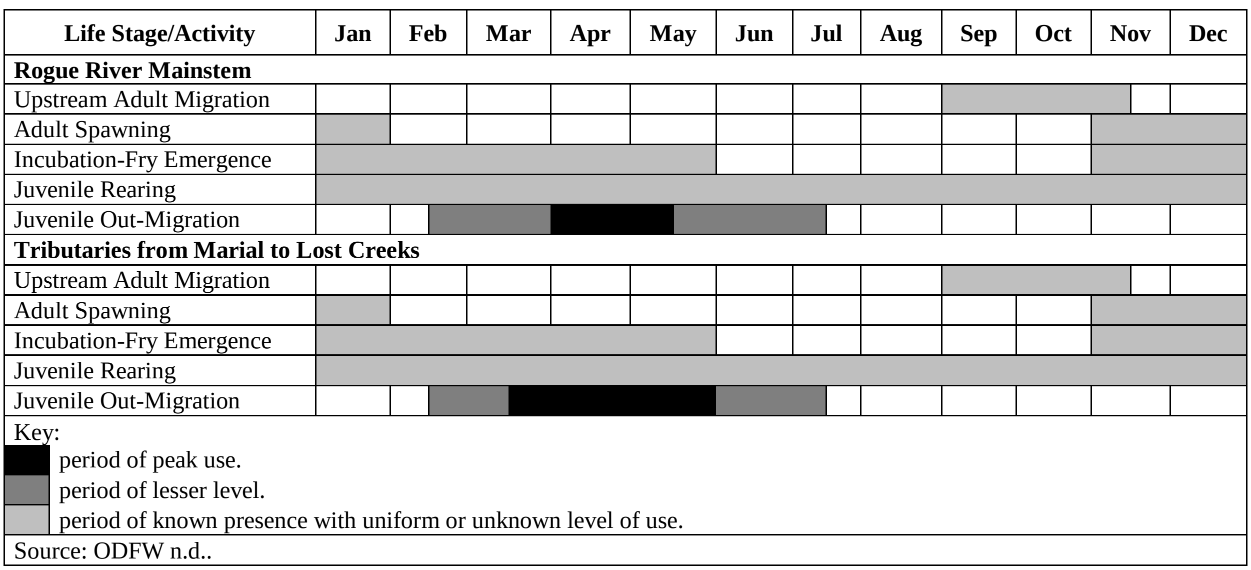


Figure 3.5.3-1 Approximate Timing of SONCC ESU Coho Salmon Use of the Rogue River Mainstem and Tributaries from Marial to Lost Creek

Coho in the SONCC ESU inhabit waterbodies in the following four fifth-field watersheds in the Upper Rogue Subbasin that would be crossed by the Pipeline: Trail Creek (HUC 1710030706), Shady Cove-Rogue River (HUC 1710030707), Big Butte Creek (HUC 710030704), and Little Butte Creek (HUC 1710030708). Table 3.5.3-2 summarizes the number of waterbodies within each fifth-field watershed crossed by the Pipeline that are known or assumed to support SONCC coho. Critical habitat is designated to include all river reaches accessible to listed coho within the range of the SONCC ESU. Critical habitat consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches in hydrologic units and counties identified in NMFS 1999b, including the Upper Rogue HUC 1700307. Accessible reaches are those within historical range of the ESUs that can still be occupied by any life stage of coho salmon. Consequently, waterbodies with critical habitat enumerated in table 3.5.3-2 include those in which coho juvenile-fry are assumed to occur.

TABLE 3.5.3-2

Number of Waterbodies Crossed by the Pipeline Project within the Upper Rogue Subbasin and Fifth-Field Watersheds with SONCC Coho Designated Critical Habitat and Coho Presence (Known or Assumed)

		Number of Waterbodies		
Subbasin and Fifth-Field Watersheds	**Hydrologic Unit Code**	**Critical Habitat a/**	**Coho Known b/**	**Coho Assumed c/**
Upper Rogue Subbasin	17100307			
Trail Creek	1710030706	3	3	0
Shady Cove-Rogue River	1710030707	1	1	1
Big Butte Creek	1710030704	2	2	0
Little Butte Creek	1710030708	2	2	2
	Total	**8**	**8**	**3**

a/ NMFS 1999b.
b/ ODFW 2017f.
c/ Assumed presence based on connectivity to occupied stream reaches.

Population Status

At the time NMFS proposed this ESU for listing, population estimates for naturally reproducing coho salmon in the SONCC ESU included escapement records from Gold Ray Dam on the upper Rogue River as well as some catch estimates from all Oregon rivers and estimates of run size in the Rogue River. During the 1940s, 2,000 adult coho salmon were counted at the Gold Ray Dam per year, but that number declined to fewer than 200 adults in the early 1970s (NMFS 1995). The Gold Ray Dam on the Rogue River was removed in August 2010. Prior to dam removal, ODFW (2012b) counted adult coho and other anadromous salmonids passing the Gold Ray Dam as they utilized a fish ladder between late September and January, with last recorded counts before removal in June 2010. Abundance of coho returning to the Upper Rogue River above Gold Ray Dam increased from 1996 to 2002 but significantly declined from 2002 through 2009, the last full year counted before the dam was removed (see figure 3.5.3-2).

Similar declines were demonstrated with counts made at Huntley Park, at RM 8 on the lower Rogue River over a similar period, using daily totals of seine counts from 1997 to 2016 (ODFW 2002 to 2017e). ODFW has been monitoring spawner abundance on a regular basis on the Rogue River by seine estimates conducted in the vicinity of Huntley Park. Numbers of coho counted at Huntley Park represent salmon in the Illinois, Middle, and Upper Rogue populations aggregated together. From 1980 to 2004, the trend for adult spawner abundance on the Rogue River consistently increased (Spence et al. 2005), mostly due to decreased harvest. However, the overall trend since 2004 has been decreasing but increased returns have been observed through 2016, suggesting some improvement in run status from the lows of 2008 (see figure 3.5.3-3. A similar trend was observed for Rogue River coho adults (wild and hatchery, combined) migrating upstream past Huntley Park, downstream from the Gold Ray Dam location on the Rogue River. The data from Huntley Park indicate a severe decline from 2002 through 2008 (only 572 total coho counted) with an increasing trend (not significant) from 2008 through 2016 in figure 3.5.3-3 (ODFW 2017e).

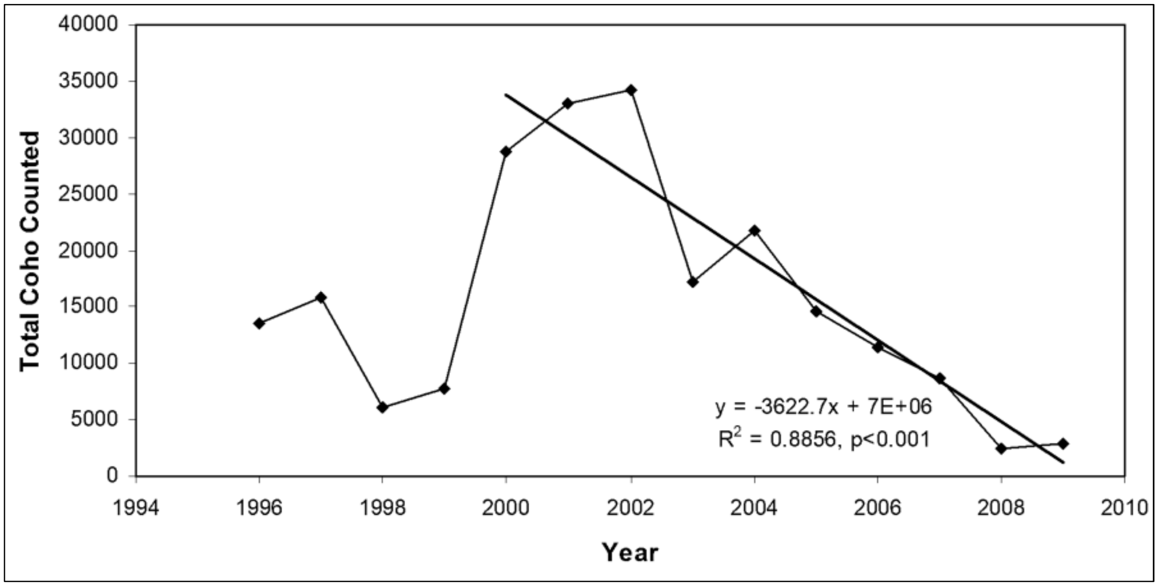


Figure 3.5.3-2 Total Number of SONCC Adult Coho Counted at the Gold Ray Dam Fish Ladder on the Middle Rogue River, from 1996 to 2009. The decreasing trend from 2001 through 2009 is significant (data from ODFW 2012b)

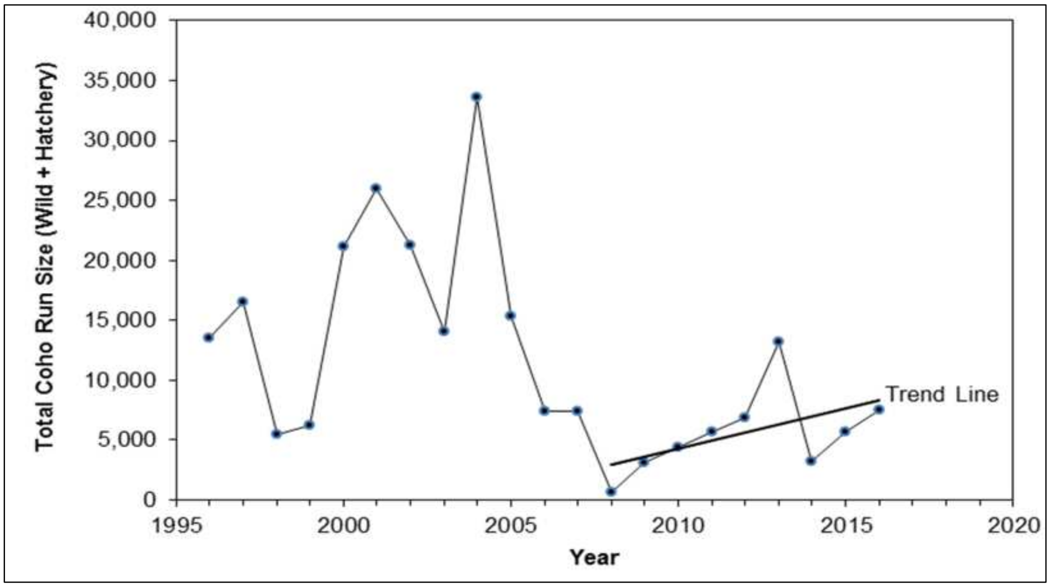


Figure 3.5.3-3 Total Number of SONCC Coho (Wild plus Hatchery-raised) Counted at Huntley Park (RM 8) on the Rogue River, from 2000 to 2016. The increasing trend from 2008 to 2016 (solid line) is not significant (data from ODFW 2017e)

Critical Habitat

Critical habitat for coho salmon in the SONCC ESU has been designated (NMFS 1999b) based on species' requirements such as space for growth and behavior, nutritional and physiological requirements, cover and/or shelter, reproduction sites, and habitats that are protected from disturbance or are representative of historically known population sites (NMFS 1999b). Other known essential physical and biological features considered essential for the conservation of the species, referred to as PCEs, are crucial to species conservation and critical habitat. These features include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation (NFMS 1999b).

Generally, riparian areas form the basis of healthy watersheds and impacts on them in turn affect these PCEs (NMFS 1999b). However, the PCEs that create healthy salmonid habitat vary throughout the coho salmon's range and the extant of the adjacent riparian zone may change accordingly. A site-potential tree height is a suitable benchmark for identifying a riparian zones in some cases, but in order to better assess the features of a specific locale, site-specific analyses provide the best means to characterize the riparian zone (NMFS 1999b). Spence et al. (1996) concluded that fully protected riparian management zones of one site-potential tree would adequately maintain 90 to 100 percent of most key riparian functions of Pacific Northwest forests (NMFS 1999b). Within that distance riparian zones provide the following functions: shade, sediment, nutrient or chemical regulation, streambank stability, and input of large woody debris or organic matter.

Critical habitat for coho salmon in the SONCC ESU includes the accessible reaches of all rivers (including water, substrate, and adjacent riparian zone of estuarine and riverine reaches) between the Mattole River in California and the Elk River in Oregon. Within the counties traversed by the Pipeline, critical habitat has been designated in USGS hydrologic unit Middle Rogue (HUC 17100308 – Jackson County) up to the Emigrant Lake Dam/Emigrant Lake; hydrologic unit Upper Rogue (HUC 17100307 – Jackson, Klamath, and Douglas Counties) up to the Agate Lake Dam/Agate Lake, Fish Lake Dam/Fish Lake, Willow Lake Dam/Willow Lake, and Lost Creek Dam/Lost Creek Reservoir; hydrologic unit Applegate (HUC 17100309 – Jackson County) up to Applegate Dam; and hydrologic unit Upper Klamath (HUC 18010206 – Jackson County) up to Irongate Dam (NMFS 1999b). The Pipeline would cross designated critical habitat within waterbodies of the Upper Rogue (HUC 17100307) hydrologic unit below the Lost Creek, Willow Creek, and Fish Lake Dams (NMFS 1999b). Eight waterbodies within the four fifth-field watersheds crossed by the Pipeline are known to support designated critical habitat for SONCC coho; five others are assumed to support SONCC ESU coho and are included as critical habitat in table 3.5.3-2.

3.5.3.2 Environmental Baseline

Analysis Area

Two analysis areas are applicable to coho salmon in the SONCC ESU: the marine analysis area and the riverine analysis area. The marine analysis area extends approximately 15 nmi offshore to the continental shelf. Within the marine analysis area, effects to coho salmon in coastal marine waters would be associated with LNG vessels entering and exiting the Port of Coos Bay from the Pacific Ocean.

The riverine analysis area includes two components: 1) the water column and substrate of all waterbodies crossed by the Pipeline within the Upper Rogue River watershed, from the point of crossing to the extent downstream where water quality is not adversely affected by suspended sediments generated during construction; and 2) riparian zones associated with waterbodies crossed by the Pipeline within the Upper Rogue River watershed affected in the short-term during construction and in the long-term by operation. Riparian zones widths are defined as the distance from each bank extending to one site-potential tree height.

The downstream extent of the riverine analysis area was determined by estimating the likely downstream extent that any stream crossing generated suspended sediment could equal ambient conditions within the Project area streams. The methods used to estimate this distance are explained below.

Total suspended solid (TSS) concentrations generated during wet open-cut construction have been estimated from models developed by Reid et al. (2004). Amounts of TSS produced during dry open-cut construction (fluming, dam-and-pump) adjustments are fractions of the concentrations produced during wet-open cuts (Reid et al. 2004). Estimates of TSS produced during dry open-cut construction across waterbodies in fifth-field watersheds are presented below in section 3.5.3.3. Average sediment percentages (grain sizes including gravel, sand, silt, and organics) for streams within each fifth-field watershed (see table 3.5.3-12 below in section 3.5.3.3 under Habitat and section 3.5.3.3 under Suspended Sediment by Pipeline Crossing Methods) were assumed to be fractions of the TSS generated during construction, and concentrations of each grain class at various distances downstream were estimated using a simple sediment transport model (Ritter, 1984). Distances at which concentrations near zero (settle out of suspension) differ considerably for the different grain sizes and are dependent on water depths and stream discharge rates at the time of construction (see table 3.4.3-17 and table 3.5.3-19 below in section 3.5.3.3 under Suspended Sediment by Pipeline Crossing Methods). Downstream settling distances would be much greater for deeper waterbodies with higher flow velocities than for shallow, slow flowing streams.

Using models noted above and data on the average sediment composition, stream depth, and average summer low flows for streams within range of SONCC coho that would be crossed by the Pipeline, the average downstream distance expected to be near assumed ambient concentrations of 2 mg/l of silt (0.0016 cm diameter, 0.023 cm/sec settling velocity) ranges from 699 meters (2,293 feet) in the Big Butte Creek Watershed to 1,235 meters (4,051 feet) in the Trail Creek Watershed. The average downstream distance expected to near assumed ambient concentrations of 2 mg/l of clay (0.0004 cm diameter, 0.0015 cm/sec settling velocity) ranges from 10,563 meters (34,647 feet) in the Big Butte Creek Watershed to 18,591 meters (60,978 feet) in the Trail Creek Watershed. These estimates are for average summer low flows likely to occur during construction within the ODFW (2008) allowed in-stream construction period. The estimated average downstream distance traveled of these very fine particles is a reasonable conservative limit to consider for the analysis area. The riverine analysis area for SONCC coho salmon has been conservatively estimated to distances ranging from 34,647 feet to 60,978 feet (6.6 to 11.5 miles) downstream from the point of crossing within the affected fifth-field watersheds in the range of SONCC coho salmon (see figure 3.5.3-4).

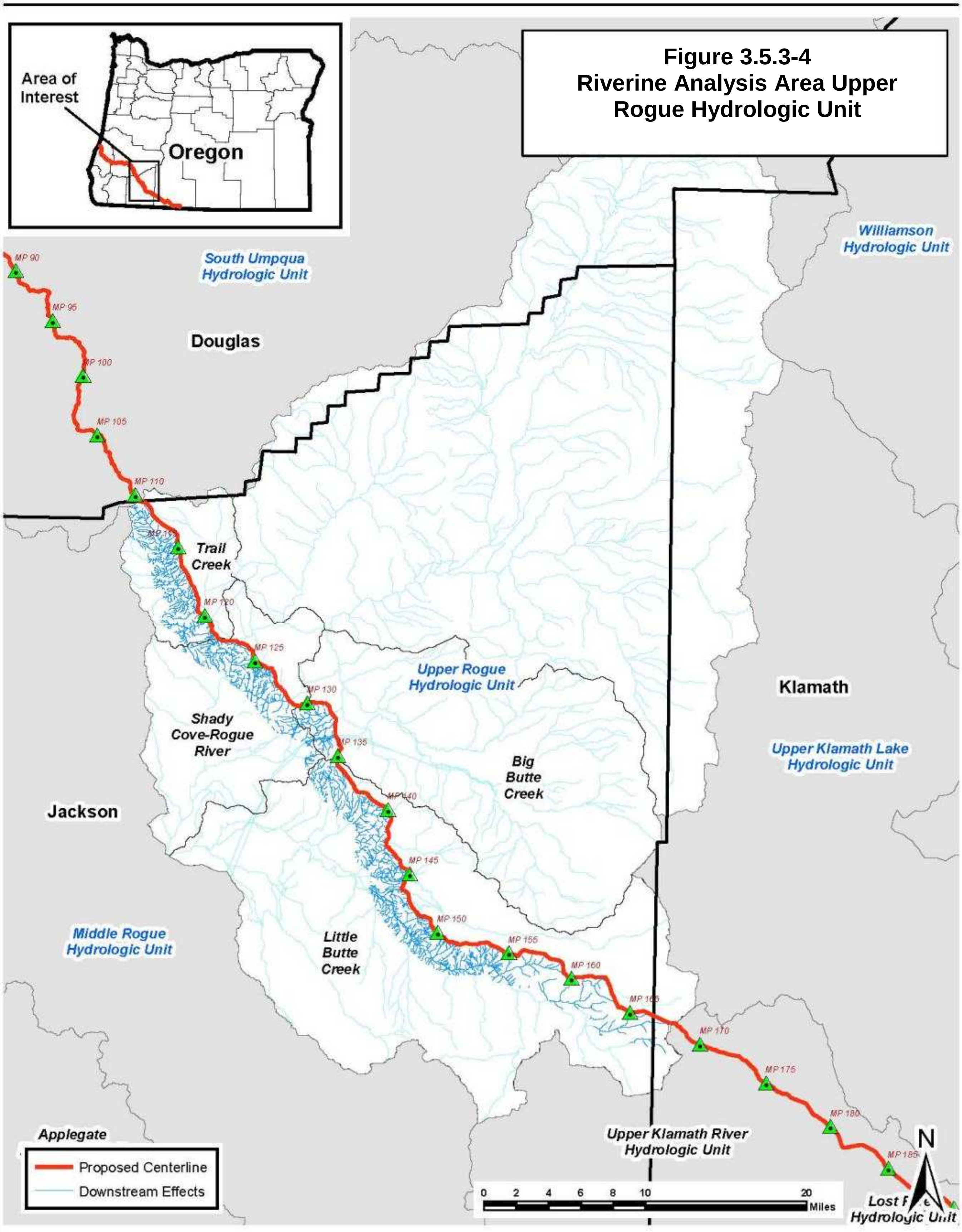


Figure 3.5.3-4
Riverine Analysis Area Upper Rogue Hydrologic Unit
Area of Interest
Oregon
South Umpqua Hydrologic Unit
Douglas
Williamson Hydrologic Unit
Trail Creek
Upper Rogue Hydrologic Unit
Shady Cove-Rogue River
Big Butte Creek
Klamath
Upper Klamath Lake Hydrologic Unit
Jackson
Middle Rogue Hydrologic Unit
Little Butte Creek
Applegate
Upper Klamath River Hydrologic Unit
Proposed Centerline
Downstream Effects
0 2 4 6 8 10 20 Miles
N
MP 90
MP 95
MP 100
MP 105
MP 110
MP 120
MP 125
MP 130
MP 135
MP 145
MP 150
MP 155
MP 160
MP 170
MP 175
MP 180

Species Presence

Coho salmon in the SONCC ESU are known or are expected to occur within the Upper Rogue River Hydrologic Unit (HUC 17100307) in some perennial and intermittent tributaries. The Pipeline would cross four fifth-field watersheds including Trail Creek (HUC 1710030706), Shady Cove-Rogue River (HUC 1710030707), Big Butte Creek (HUC 1710030704), and Little Butte Creek (HUC 1710030708). All affected waterbodies within the Upper Rogue Subbasin and within the range of SONCC coho salmon ESU proximate to the Pipeline are included in table 3.5.3-3. There are 90 waterbodies included in the table, of which 14 are perennial, 73 are intermittent, and three are ponds. Coho salmon are known to occur in eight of the waterbodies and are assumed to be present in three others based on connectivity to perennial streams known to support coho salmon, the presence of steelhead and/or resident salmonids, and/or information provided by fisheries biologists. Data in table 3.5.3-3 were revised based on ODFW (2017f) fish habitat distribution shapefiles and Oregon Department of Forestry (ODF 2018) Forest Practices statewide hydrography shapefiles that provide field evaluations for fish presence/absence in stream segments.

TABLE 3.5.3-3

Waterbodies Crossed or Adjacent to the Pipeline within the Upper Rogue Subbasin (HUC 17100307) and in the Range of the SONCC Coho Salmon ESU (updated March 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Upper Rogue (HUC 17100307) Subbasin, Trail Creek (HUC 1710030706) Fifth-Field Watershed, Jackson County							
Pond Trib. to W. Fork Trail Creek (EW-69)	Forest Service – Umpqua NF	110.57	Intermittent Pond	Within Pevine Quarry TEWA 110.73	None	None	Jun 15 to Sep 15
Trib. to W. Fork Trail Creek (ESI-68)	17100307018629 Forest Service – Umpqua NF	110.57	Intermittent	Within Pevine Quarry Adjacent to centerline within TEWA 110.73	None	None	Jun 15 to Sep 15
Trib to West Fork Trail Creek (SS-100-032)	17100307015563 Private	118.80	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
West Fork Trail Creek (ASP-202)	17100307000492 Private	118.89	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jun 15 to Sep 15
Trib. to Trail Creek (S1-06 (DA-16 (MOD))	17100307002143 Private	119.84	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Canyon Creek (NSP-11)	17100307000501 BLM-Medford District	120.45	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jun 15 to Sep 15
Trib. to Trail Creek (ASI-205)	17100307009101 Private	120.90	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Trail Creek (ASI-206)	17100307002356 Private	121.57	Intermittent	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jun 15 to Sep 15
Upper Rogue (HUC 17100307) Subbasin, Shady Cove-Rogue River (HUC 1710030707) Fifth-Field Watershed, Jackson County							
Trib. to Cricket Creek (ESI-71)	Private	121.87	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Cricket Creek (ESI-73)	Private	121.91	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Cricket Creek (ESI-72)	17100307002397 Private	121.96	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15

TABLE 3.5.3-3

Waterbodies Crossed or Adjacent to the Pipeline within the
Upper Rogue Subbasin (HUC 17100307) and in the Range of the SONCC Coho Salmon ESU (updated March 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Trib. to Cricket Creek (ESI-74)	17100307019333 Private	122.04	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Cricket Creek (ESI-70)	17100307002397 Private	122.07	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Rogue River (ASP-235)	17100307000156 Private	122.65	Perennial	HDD	Coho	Coho Rearing, Migration	Jun 15 to Aug 31
Trib. to Indian Creek (ASI-223)	17100307014756 Private	125.91	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Indian Creek (ASI-222)	17100307016576 Private	125.98	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Indian Creek (RS-4)	17100307008662 BLM-Medford District	126.53	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Indian Creek (ASI-221)	17100307008662 BLM-Medford District	126.56	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Ditch (ADX-287)	17100307015921 Private	127.21	Intermittent	Adjacent to ROW & TEWA	None	None	Jun 15 to Sep 15
Ditch (ADX-285)	17100307015921 Private	127.33	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Deer Creek (ASP-307)	17100307006079 Private	128.49	Perennial	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15
Indian Creek (AW-278)	17100307003031 Private	128.61	Perennial	Dry Open-Cut	Coho assumed	Unknown	Jun 15 to Sep 15
Trib. To Indian Creek (ASP-310)	17100307017016 Private	128.68	Perennial	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15
Trib. To Indian Creek (ASI-400)	BLM-Medford District	129.13	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. To Indian Creek (ASI306)	BLM-Medford District	129.21	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Indian Creek (ASI-277)	71003070174 44Private	129.46	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Upper Rogue (HUC 17100307) Sub-basin, Big Butte Creek (HUC 1710030704) Fifth field Watershed, Jackson County							
Trib. to Neil Creek (AW-245)	17100307011767 Private	130.81	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Neil Creek (SS-201-014a (AW-244))	17100307010117 Private	130.81	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Neil Creek (SS-201-14b (AW-244))	17100307010117 Private	130.83	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15
Trib. to Neil Creek (ASI246)	17100307010117 Private	130.86	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Neil Creek (ASI-251)	17100307018233 BLM-Medford District	131.37	Intermittent	Adjacent to within TEWA	None	None	Jun 15 to Sep 15

TABLE 3.5.3-3

Waterbodies Crossed or Adjacent to the Pipeline within the
Upper Rogue Subbasin (HUC 17100307) and in the Range of the SONCC Coho Salmon ESU (updated March 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Irrigation Ditch (Trib. to Neil Creek) (S2-02/(ADX-253)	Private	132.03	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Neil Creek (ASP-252)	17100307006088 Private	132.12	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho, Spawning, Rearing	Jun 15 to Sep 15
Ditch (EDX-75)	Private	132.26	Intermittent	Dry Open-Cut (Streambed – bedrock)	None	None	Jun 15 to Sep
Quartz Creek (ASI-265)	17100307000857 Private	132.75	Intermittent	Dry Open-Cut (Streambed-bedrock)	Coho	Coho, Spawning, Rearing	Jun 15 to Sep
Trib. to Quartz Creek (AW-264)	17100307000857 Private	132.77	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep
Trib. to Quartz Creek (ASP-241)	BLM-Medford District	133.35	Perennial	Dry Open-Cut	None	None	Jun 15 to Sep 15
Medford Aqueduct - Ditch 3 (ASP-240)	17100307006008 BLM-Medford District	133.38	Perennial	Conventional Bore	None	None	N/A
Upper Rogue (HUC 17100307) Sub-basin, Little Butte Creek (HUC 1710030708) Fifth field Watershed, Jackson County							
Whiskey Creek (ASI-207)	17100307000892 Private	137.48	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-208)	17100307012488 Private	138.26	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-9)	17100307020234 Private	138.36	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-10)	17100307003986 Private	138.44	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-210)	17100307003986 Private	138.50	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-11)	17100307000884 Private	138.55	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-12)	Private	138.57	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-211)	17100307008460 Private	138.71	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-13)	Private	138.74	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-14)	17100307008463 Private	139.07	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-216)	17100307015395 Private	139.19	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-15)	Private	139.21	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-16)	Private	139.28	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-217)	Private	139.42	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-226)	17100307019116 Private	139.59	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-227)	Private	139.63	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15

TABLE 3.5.3-3

Waterbodies Crossed or Adjacent to the Pipeline within the
Upper Rogue Subbasin (HUC 17100307) and in the Range of the SONCC Coho Salmon ESU (updated March 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Trib. to Lick Creek (ASI-228)	Private	139.68	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek SS-GM-43 (AW-230)	Private	139.75	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (SS-GM-19)	Private	139.91	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Lick Creek (ASI-233)	17100307000130 BLM-Medford District	140.27	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Ditch Trib. to Lick Creek (ADX-234)	17100307001378 BLM-Medford District	140.32	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Lick Creek (ASI-189)	17100307009921 Private	140.58	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15
Ditch Trib. to Lick Creek (ADX-186)	17100307001383 BLM-Medford District	140.94	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Star Lake Reservoir (Edge-1)	17100307005853 Private	141.01	Perennial	Adjacent to TEWA 140.98 Water Source	None	None	Jun 15 to Sep 15
Trib. to Salt Creek (ASI-187)	17100307014303 BLM-Medford District	141.18	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15
Trib. to Salt Creek (ASI-188)	17100307004291 BLM-Medford District	141.48	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jun 15 to Sep 15
Trib. to Salt Creek (RS-17)	17100307004291 BLM-Medford District	141.49	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Salt Creek (ESI-30)	17100307014306 Private	141.95	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Ditch (EDX-32)	Private	142.28	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Salt Creek (ESI-31)	17100307018645 Private	142.32 142.35	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Salt Creek (ESP-34)	17100307000121 Private	142.57	Perennial	Dry Open-Cut	Coho	Coho, Spawning, Rearing	Jun 15 to Sep 15
Ditch (EDX-36)	Private	142.65	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Salt Creek (ESI-37)	17100307014301 Private	143.12	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Long Branch Creek (ESI-38)	17100307009770 Private	143.51	Intermittent	Dry Open-Cut	Coho Assumed	Unknown	Jun 15 to Sep 15
Trib. to Long Branch Creek (ESI-39)	17100307011758 Private	143.74	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Stock Pond (EL-41)	Private	143.76	Stock Pond	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15
Trib. to Long Branch Creek (ESI-38)	17100307009083 Private	143.76	Intermittent	Adjacent to centerline within ROW	None	None	Jun 15 to Sep 15

TABLE 3.5.3-3

Waterbodies Crossed or Adjacent to the Pipeline within the
Upper Rogue Subbasin (HUC 17100307) and in the Range of the SONCC Coho Salmon ESU (updated March 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Trib. to Long Branch Creek (ESI-40)	17100307009083 Private	143.77	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to Long Branch Creek (ESI-38)	17100307000921 Private	144.11	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Irrigation Ditch (EDX-42)	17100307006072 Private	144.14	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to S. Fork Long Branch (GSP-5/ESP-48)	17100307004586 Private	144.70	Perennial	Dry Open-Cut	None	None	Jun 15 to Sep 15
South Fork Long Branch Cr (GSI-6/ESP-59)	17100307004616 Private	145.27	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Irrigation Ditch (NDX-107)	17100307001458 Private	145.32	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Irrigation Ditch (NDX-56)	Private	145.37	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Trib. to S. Fork Long Branch (ESI-61)	17100307004636 Private	145.54	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Irrigation Ditch (EDX-64)	Private	145.57	Intermittent	Dry Open-Cut (Bored)	None	None	Jun 15 to Sep 15
North Fork Little Butte Creek (ESP-66)	17100307000113 Private	145.69	Perennial	Dry Open-Cut	Coho	Coho, Spawning, Rearing	Jun 15 to Sep 15
Trib. to N. Fork Little Butte Creek (ESI-56)	17100307004681 Private	146.05	Intermittent	Dry Open-Cut	Coho assumed	Unknown	Jun 15 to Sep 15
Trib. to N. Fork Little Butte Creek (ESI-55)	17100307004702 Private	146.38	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
Irrigation Ditch (EDX-51)	17100307001489 Private	146.80	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15
South Fork Little Butte Creek (ASP-165)	17100307000108 Forest Service-Rogue River-Siskiyou NF	162.45	Perennial	Dry Open-Cut	None	None	Jun 15 to Sep 15
Daley Creek (ESI-76)	17100307000107 Forest Service-Rogue River-Siskiyou NF	166.21	Intermittent	Dry Open-Cut	None	None	Jun 15 to Sep 15

a/ Dry open-cut crossing methods include flume or dam-and-pump procedures. Dam-and-pump methods would be utilized where streambed blasting is anticipated to eliminate blasting around the flume. The dam-and-pump crossing method is the preferred crossing procedure in steep incised drainage valleys where worker safety may be compromised when placing ("threading") the pipe string under the flume pipe and where there is a risk of upsetting the flume during this operation. The dam-and-pump crossing method is also the preferred crossing method on small streams under low flow conditions during the ODFW-recommended in-water work period. PCGP proposes temporary/short-term fish passage restriction when completing dam-and-pump crossings within the ODFW-recommended in-water work period. Appendix M provides details of stream crossings.

b/ ODFW 2017f; ODF 2018

c/ Assumes fisheries construction windows only apply to those waterbodies flowing at the time of construction and windows do not apply to HDD crossings.

d/ Streambed bedrock based on PCGP's Wetland and Waterbody delineation surveys. Streambed bedrock may require special construction techniques to ensure pipeline design depth. Special construction techniques may include rock hammering, drilling and hammering, or blasting. The need for blasting would be determined by the construction contractor and would only be initiated after ODFW blasting permits are obtained.

In-stream construction of the Pipeline would occur before most SONCC coho begin upstream migration and spawning by adults (see figure 3.5.3-1). However, juvenile coho are expected to be rearing in many of those streams at the time of construction. Although there are no data on numbers of juveniles expected to be present in streams crossed by the Pipeline, the following estimation procedure was developed after an estimate for numbers of juveniles present in streams crossed was requested by NMFS (2015e).

Total stream miles occupied by coho salmon within the 4th Field HUCs in table 3.5.3-4 and each of the 5th Field HUCs crossed by the Pipeline in range of SONCC coho were derived with GIS by combining shapefiles of ODFW Fish Distribution data (ODFW 2017f) with watershed shapefiles from National Hydrography Dataset (USGS 2016). Stream miles with coho spawning habitats and coho rearing habitat in the range of SONCC coho were similarly derived; stream miles in those habitats were added to provide Stream Miles for Juvenile Fry Presence in table 3.5.3-4.

TABLE 3.5.3-4

Total Stream Miles with SONCC Coho Habitats in 4th Field and 5th Field Watersheds and Estimates of Streams with Juvenile Fry Coho.

Subbasin and Fifth-Field Watersheds	Total Stream Miles with Coho in HUC a/	Stream Miles with Spawning Habitat	Stream Miles with Rearing Habitat	Stream Miles for Juvenile Fry Presence b/
Upper Rogue Subbasin	**197.88**	**184.00**	**5.47**	**189.46**
Trail Creek	17.15	16.96	0.19	17.15
Shady Cove-Rogue River	35.46	30.58	4.88	35.46
Big Butte Creek	32.56	32.56	0	32.56
Little Butte Creek	60.95	60.95	0	60.95

a/ Total Stream Miles with Coho in HUC includes miles of Historical, Migration, Rearing, Spawning, and Unknown habitats.
b/ Stream Miles for Juveniles' Presence is the sum of Stream Miles for Spawning and Rearing Habitats in HUC
Source: StreamNet 2012; ODFW 2017f.

Numbers of redds and spawning adult coho salmon counted in fourth field watersheds over time are available on the StreamNet (2012) Database accessed through the ODFW Natural Resources Information Management Program. Only 20 spawning surveys were conducted within fifth field watersheds crossed by the Pipeline in range of SONCC coho. The most recent survey was conducted in 1999. In addition, the database provided only one record of a redd survey for SONCC coho in the Upper Rogue Subbasin. With so limited information available, numbers of adult coho salmon (not including jacks or subadults) reported as peak live or dead fish were used to estimate numbers of juvenile fry present in streams that would be crossed by the Pipeline. Data for numbers of adults counted per mile from StreamNet Database are summarized in table 3.5.3-5, below.

TABLE 3.5.3-5

Results of Coho Spawning Surveys a/ Conducted in Streams Crossed by the PCGP Project

Subbasin and Fifth-Field Watersheds	Number of Surveys	Year(s)	Average Adults per Mile Surveyed	90% Confidence Interval

TABLE 3.5.3-5

Results of Coho Spawning Surveys a/ Conducted in Streams Crossed by the PCGP Project

Subbasin and Fifth-Field Watersheds	Number of Surveys	Year(s)	Average Adults per Mile Surveyed	90% Confidence Interval
Upper Rogue Subbasin	25	1996-1999	8.16	± 3.15
Trail Creek	5	1996-1997	10.40	± 6.89
Shady Cove-Rogue River	0	N/A	0	0
Big Butte Creek	0	N/A	0	0
Little Butte Creek	15	1996-1999	9.51	± 4.50
Source: StreamNet 2012.				

The following assumptions have been applied to the adult spawning data in the Upper Rogue River Sub-basin coinciding with SONCC coho and Pipeline waterbody crossings:

- The male:female ratio of live or dead spawners is 1:1 (Knudsen et al. 2003),
- At low to moderate densities of spawners, there is 1 redd for each female (Lestelle and Weller 2002);
- Redds are only present in stream reaches classified as spawning habitat by ODFW (2014c);
- The average number of eggs per redd is between 300 and 1,200 with 800-900 eggs being most frequent (Sandercock 1991)
- Under average conditions, 15-27 percent of all eggs would survive during incubation (mean of 27.1 percent survival was observed in Oregon coastal streams (Sandercock 1991);
- Juveniles utilize spawning habitats during rearing as well as rearing habitats as classified by ODFW (2014c). Juveniles distribute themselves in uniformly spaced territories regardless of presence of pools, riffles or runs in the natal stream.

With those assumptions applied to data from the Upper Rogue River in table 3.5.3-6, there would be an average of 4.08 redds per mile (± 1.58 redds per mile) within all spawning habitats in the Upper Rogue River Sub-basin. That estimate along with the estimate of stream miles of spawning and rearing habitats in HUCs, and the assumptions above for eggs per redd and egg survival rates were used to estimate numbers of Juvenile Fry per Mile of Habitat in table 3.5.3-6 for each of the 5th Field HUCs crossed within range of the SONCC ESU. Values for redds per mile with 90% confidence intervals were not carried through the analyses in table 3.5.3-6. In reality, estimates of Juveniles per Mile of Habitat would vary from year to year showing at least as much variability as the Total Coho Run Size counted at Huntley Park from 2000 to 2016, shown in figure 3.5.3-3, above.

There would be some mortality between juvenile fry and juvenile smolt stages and during the period from fry emergence (through the end of May) before pipeline construction (beginning June 15). Therefore, estimates are very conservative. Waterbodies within the Upper Rogue Subbasin would be crossed between June 15 and September 15. Based on figure 3.5.3-1, instream construction could coincide with portions of the juvenile coho out-migration periods during June and July. Potentially, there could be some post-winter pre-smolt juvenile coho present during construction. However, very few are expected because reported over-winter survival rates of juvenile coho are <40 percent, at least in waterbodies studied within the Coos Bay Frontal-Pacific Ocean 5th field watershed (Weybright and Giannico 2017).

TABLE 3.5.3-6

Estimates of Juvenile Fry Coho in the SONCC ESU Present in 4th Field and 5th Field Watersheds Crossed by the Pipeline Project

Subbasin and Fifth-Field Watersheds	Total Redds in HUC a/	Total Eggs in HUC b/	Total Juvenile Fry Surviving in HUC c/	Juvenile Fry per Mile of Habitat d/
Upper Rogue Subbasin	751	638,100	172,925	913
Trail Creek	69	58,821	15,941	929
Shady Cove-Rogue River	125	106,047	28,739	810
Big Butte Creek	133	112,906	30,598	940
Little Butte Creek	249	211,369	57,281	940

a/ Total Redds in HUC = the Average Redds per Mile in 4th Field HUC multiplied by Stream Miles of Spawning Habitat in table 3.5.3-4.
b/ Total Eggs in HUC = average of 850 eggs per red (see assumptions) multiplied by Total Redds in HUC.
c/ Total Juvenile Fry Surviving in HUC = 27.1 percent average survival rate of eggs (see assumptions in text) multiplied by Total Eggs in HUC.
d/ Juveniles per Mile of Habitat = Total Juvenile Fry Surviving in HUC divided by Stream Miles of Juvenile's Presence in table 3.5.3-4.

Habitat

Existing conditions of aquatic habitats within the fifth-field watersheds in the Upper Rogue Subbasin that would be crossed by the Pipeline were evaluated with data collected by ODFW in their Aquatic Inventories Project (ODFW 2014c). In cooperation with other agencies, ODFW has conducted stream surveys throughout the state including streams within watersheds crossed by the Pipeline. Four types of habitat information can be used to deduce quantitative evaluations of the overall fish habitat condition within the fifth-field watersheds that would be crossed by the Pipeline: 1) pool habitat conditions, 2) riffle habitat conditions, 3) shade conditions, 4) woody debris habitat condition, and 5) riparian conifer habitat condition. ODFW (Foster et al. 2001) has developed benchmark criteria for each of these habitat conditions that would represent undesirable and desirable habitat conditions. The benchmarks are provided in table 3.5.3-7 along with the various aquatic habitat conditions to which they apply. The conditions of specific streams crossed by the Pipeline are assumed to be comparable to the average conditions for the sampled reaches in each of the corresponding four fifth-field watersheds. Compilations of ODFW stream-reach data (see appendix X) are summarized in table 3.5.3-8 for the four watersheds in the Pipeline project area occupied by SONCC coho. The percent of sampled stream reaches that are at or above desirable benchmark conditions and percent that are at or below undesirable conditions indicate the aquatic habitat conditions.

TABLE 3.5.3-7

Oregon Department of Fish and Wildlife Aquatic Inventory and Analysis Project Criteria for Aquatic Habitat Conditions and Benchmarks

Aquatic Habitat Condition	Benchmark Level for Condition	
	Undesirable	**Desirable**
Pools		
Pool Area (% total stream area)	<10	>35
Pool Frequency (channel widths between pools)	>20	5-8
Residual Pool Depth (m)		
Small Streams (<7m wide)	<0.2	>0.5
Medium Streams (≥7m and <15m width)		
Low Gradient (slope <3%)	<0.3	>0.6
High Gradient (slope >3%)	<0.5	>1.0
Large Streams (≥15m width)	<0.8	>1.5
Complex Pools (pools with ≥3 LWD pieces / km of reach length)	<1	>2.5
Riffles		
Width/Depth Ratio (active channel based)		
East Side	>30	<10
West Side	>30	<15
Gravel (% area)	<15	≥35
Silt-Sand-Organics (% area)	>20	<10
Volcanic Parent Material	>15	<8
Sedimentary Parent Material	>20	<10
Channel Gradient <1.5%	>25	<12
Shade (Reach Average, Percent)		
Stream Width <12 meters		
West Side	<60	>70
Northeast	<50	>60
Central-Southeast	<40	>50
Stream Width >12 meters		
West Side	<50	>60
Northeast	<40	>50
Central-Southeast	<30	>40
Large Woody Debris		
Pieces/100m Stream Length	<10	>20
Volume (m3)/100m Stream Length	<20	>30
"Key" Pieces (>60cm and 10m long)/100m	<1	>3
Riparian Conifers (30m From Both Sides of Channel)		
Number >20in DBH/1000ft Stream Length	<150	>300
Number >35in DBH/1000ft Stream Length	<75	>200

Source: Foster et al. 2001

TABLE 3.5.3-8

Aquatic Habitat Conditions from Samples Taken by ODFW in Stream Reaches
within Fifth-Field Watersheds of the Upper Rogue Subbasin Crossed by the Pipeline Project

	Mean Values (with Standard Errors) in Relation to Benchmark Conditions in Surveyed Reaches (by %) of Watersheds a/							
	Trail Creek HUC 1710030706		**Shady Cove-Rogue River HUC 1710030707**		**Big Butte Creek HUC 1710030704**		**Little Butte Creek HUC 1710030708**	
Aquatic Habitat Condition	**Mean (Standard Error)**	**Undesirable/ Desirable Conditions**	**Mean (Standard Error)**	**Undesirable/ Desirable Conditions**	**Mean (Standard Error)**	**Undesirable/ Desirable Conditions**	**Mean (Standard Error)**	**Undesirable/ Desirable Conditions**
Pools								
Pool Area (% total stream area)	15.2	42.1%	18.5	22.2%	20.0	34.1%	19.2	32.7%
	(3.0)	5.3%	(5.6)	22.2%	(2.4)	19.5%	(2.3)	11.5%
Pool Frequency (channel widths between pools)	41.5	26.3%	42.1	22.2%	20.4	39.0%	34.5	28.8%
	(13.5)	10.5%	(21.1)	22.2%	(2.2)	7.3%	(11.3)	21.2%
Residual Pool Depth (m) by stream size and gradient [2]	0.6	0.0%	0.4	0.0%	0.6	0.0%	0.6	0.0%
	(0.03)	68.4%	(0.07)	11.1%	(0.04)	48.8%	(0.09)	40.4%
Complex Pools (pools with ≥3 LWD pieces ≥3 per km of reach length	No	-	0.2	88.9%	0.2	87.8%	0.1	98.1%
	Data	-	(0.2)	0.0%	(0.1)	2.4%	(0.0)	0.0%
Riffles								
Width/Depth Ratio (active channel based)	13.6	0.0%	17.9	11.1%	13.9	0.0%	26.7	24.5%
	(1.0)	57.9%	(6.5)	77.8%	(0.7)	70.7%	(3.9)	43.4%
Gravel (% of area)	22.7	10.5%	29.6	0.0%	26.6	17.1%	35.8	9.8%
	(1.6)	5.3%	(4.1)	28.6%	(2.2)	14.6%	(2.1)	51.0%
Silt-Sand-Organics (% of area) by parent material and gradient [3]	21.3	57.9%	11.0	14.3%	21.9	46.3%	30.1	66.7%
	(1.6)	5.3%	(3.1)	42.9%	(2.6)	24.4%	(2.1)	2.0%
Shade								
Reach Average, % by stream width [4]	87.7	0.0%	56.9	55.6%	69.9	26.8%	75.5	23.7%
	(2.2)	90.0%	(4.2)	11.1%	(2.2)	46.3%	(2.9)	66.1%
Large Woody Debris								
LWD Pieces/100m of Stream Length	6.2	80.0%	4.0	88.9%	6.3	82.9%	7.5	64.4%
	(0.9)	0.0%	(1.2)	0.0%	(0.6)	0.0%	(0.9)	6.8%
LWD Volume (m^3)/100m of Stream Length	18.5	60.0%	4.8	88.9%	13.5	75.6%	10.3	81.4%
	(3.4)	20.0%	(2.1)	0.0%	(1.8)	9.8%	(1.7)	5.1%
Key Pieces (≥60cm D by ≥12m L)/100m of Stream Length [5]	1.3	55.0%	0.2	88.9%	0.7	73.2%	0.6	67.8%
	(0.4)	10.0%	(0.1)	0.0%	(0.1)	2.4%	(0.1)	1.7%
Riparian Conifers								
Number >20in DBH/1000ft of Stream Length	29.0	100.0%	14.3	100.0%	40.3	97.6%	43.8	89.8%
	(8.3)	0.0%	(9.4)	0.0%	(8.2)	0.0%	(9.7)	3.4%
Number >35in DBH/1000ft of Stream Length	6.9	100.0%	4.1	100.0%	8.2	97.6%	6.4	96.6%
	(3.4)	0.0%	(4.1)	0.0%	(2.9)	0.0%	(2.4)	0.0%

a/ Values unweighted by surveyed reach length.
b/ Assumes sedimentary parent material in all surveyed reaches.
c/ D= diameter, L = length

Benchmark conditions are not absolute, but they provide a method for comparing values of key aquatic habitat components (Foster et al. 2001). Pools provide refuges for fish during high and low stream flows, slow water habitats for adults and juveniles, over-wintering habitat for some fish species, habitat during periods of low summer flows, and, those associated with large woody debris, provide habitat complexity. Riffles provide spawning habitats for various salmonid species that construct nests or redds in gravels of various sizes, specific to salmonid species. Sand, silt, and organic debris can reduce suitability of spawning habitats by filling pores between gravel particles that are necessary for intergravel stream flows, availability of oxygen, and development of embryos; high percentages of sand, silt, and organic material in riffles indicate poor conditions as spawning habitat.

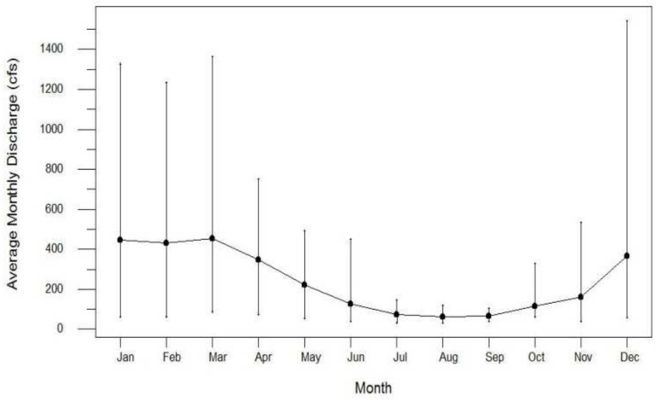
Riparian trees provide shade over stream channels which reduces deleterious effects of high summer water temperatures. Riparian vegetation stabilizes stream banks, contributes to development of bank undercutting (thermal and hiding cover), limits erosion and sedimentation from stream banks, and provides LWD as an important component of the aquatic habitat. LWD, especially contributed by riparian conifers, provides cover for fish, physical habitat complexity that influences stream flows and channel diversity, and biological complexity as substrates for macroinvertebrate communities that provide food for salmonids during different life stages (Foster et al. 2001).

BLM and Oregon Forest Industry Council surveyed 126 stream reaches in the four fifth-field watersheds within the Upper Rogue Subbasin that would be crossed by the Pipeline: 20 in the Trail Creek HUC 1710030706, 9 in the Shady Cove-Rogue River HUC 1710030707,41 in the Big Butte Creek HUC 1710030704, and 56 in the Little Butte Creek HUC 1710030708. Surveys were conducted during summers in different watersheds between 1994 and 1999.

For most of the stream reaches sampled in the four watersheds, habitat conditions related to pools (area, frequency, residual depths) were between moderate levels and desirable benchmarks. The majority of reaches were deficient in complex pools associated with LWD. Numbers of LWD pieces, LWD volume, and numbers of key pieces were below benchmark conditions in most stream reaches, which helps explain the poor state of pool complexity associated LWD. Related to low levels of LWD are the low numbers of large conifers (greater than 20 inches dbh) within sampled riparian zones. However, shade conditions are generally at moderate or desirable benchmark levels, primarily due to the narrow widths of most streams and the presence of broadleaf riparian red alders and cottonwoods that provide shade during summer months (Upper Rogue Watershed Association 2006).

In general, riffle habitat conditions are better than pool habitat conditions, but they are not at desirable conditions overall. For example, ratios of stream widths to depths in most stream reaches in the four watersheds were generally low, which indicates that streams are more narrow and deep than wide and shallow. Areas of gravel substrates were not at or above desirable benchmarks in most sample reaches, and areas of fine sediments in riffles generally exceeded the desirable benchmarks. However, some of this analysis is based on data from before the flood event of the winter of 1996-1997, and conditions could have changed significantly from what the data shows (Little Butte Creek Watershed Council 2003).

Monthly average stream discharges over the annual cycle are provided in figure 3.5.3-5 for two waterbodies within the Upper Rogue Subbasin, Big Butte Creek – a tributary to Rogue River with a 245 square mile watershed—and Elk Creek with a watershed area of 379 square miles.



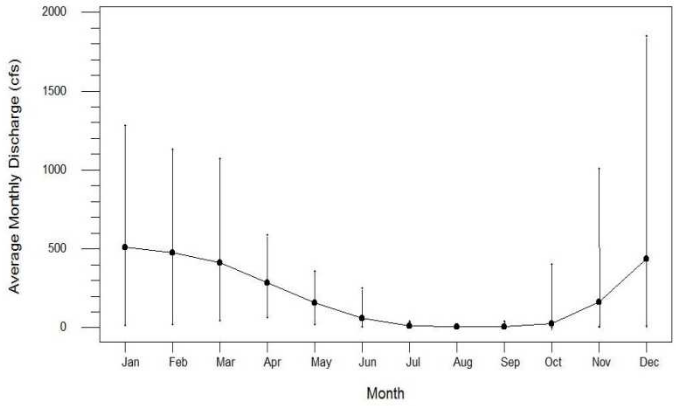


Figure 3.5.3-5 Average Monthly Discharge (cfs) in (A) Big Butte Creek (USGS Gage 14337500) from 1945 to 2016, and (B) Elk Creek (USGS Gage 1433800) from 1946 to 2015. Vertical lines show maximum and minimum discharges during the periods of record.

Monthly flows in the Upper Rogue River below Lost Creek Lake are heavily influenced by irrigation water withdrawals and are highly variable. Water is also diverted for use in hydroelectric power generation (Upper Rogue Watershed Association 2006). Monthly flows in Big Butte Creek and Elk Creek at the confluence with the Rogue River near Trail Creek were selected as representative because neither segment is influenced by dam releases for irrigation or hydropower. Precipitation falling as snow during winter months does not affect discharges until later in the year (April through May). Minimum flows tend to occur during June, July, August, and September. The ODFW (2008) in-stream construction window for Upper Rogue River and tributaries is June 15 to September 15, coinciding with low flows.

Critical Habitat

Critical habitat for coho salmon in the SONCC ESU (NMFS 1999b) includes "all waterways, substrate, and adjacent riparian zones below longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years)." The Pipeline crosses designated critical habitat associated with waterbodies in the Upper Rogue Subbasin (HUC 17100307), below the Lost Creek, Willow Creek, and Fish Lake Dams. Essential features of coho salmon critical habitat in those waterbodies include adequate 1) substrate, 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover and shelter, 7) food, 8) riparian vegetation, 9) space, and 10) safe passage conditions (NMFS 1999b).

Critical habitat for SONCC coho salmon is designated based on species requirements such as space for growth and behavior, nutritional and physiological requirements, cover and/or shelter, reproduction sites, and habitats that are protected from disturbance or are representative of historically known population sites (NMFS 1999b). Additionally, NMFS uses other known essential physical and biological features that are crucial to species conservation and critical habitat including spawning sites, food resources, water quality and quantity, and riparian vegetation (NFMS 1999b). Activities that may affect critical habitat and PCEs include, but are not limited to, timber sales, road building, mining, dredge and fill, and bank stabilization activities (NMFS 1999b).

Generally, riparian areas form the basis of healthy watersheds, and impacts on them in turn affect these PCEs (NFMS 1999b). However, the PCEs that create healthy salmonid habitat vary throughout the coho salmon's range, and the extant of the adjacent riparian zone may change accordingly. A site-potential tree height is a suitable benchmark for identifying a riparian zone in some cases, but in order to better assess the features of a specific locale, site-specific analyses provide the best means to characterize the riparian zone (NFMS 1999b).

Riparian areas provide the following functions: shade, sediment, nutrient or chemical regulation, streambank stability, and input of LWD or organic matter. In addition, critical habitat includes inaccessible headwater or intermittent streams which provide key habitat elements (e.g., LWD, gravel, water quality) crucial for coho salmon in downstream reaches (NMFS 1999b). Widths of adjacent riparian zones may vary by site-specific and/or landscape characteristics, but a distance of one site-potential tree height serves to define riparian zone widths in some cases (NMFS 1999b). With these considerations, all perennial and intermittent streams in table 3.5.3-3 are included in critical habitat within the riverine analysis area and have been summarized in table 3.5.3-9.

No specific geographic data have been developed for SONCC coho salmon critical habitat. Consequently, waterbodies identified with coho presence by ODFW (2014c) were assumed to provide critical habitat for SONCC coho, which includes suitable habitat believed to be used currently or historically by wild, natural, and/or hatchery coho fish populations. Additionally, ODFW winter steelhead GIS layers were reviewed and, if spatially near waterbodies crossed or adjacent to the Pipeline project, were included as "assumed" coho presence. These data were combined with distributions of SONCC coho in California (UC Davis Center for Watershed Sciences 2016). With distributions in Oregon and California, combined, there are 108 fifth field watersheds occupied by SONCC covering a total 16,423 square miles with 3,578 stream miles of current and/or historically occupied habitat. Absent any other information, critical habitat for SONCC coho is assumed to coincide with the total stream miles. Approximately 5.5 percent of stream miles with critical habitat for the SONCC coho ESU is within the Upper Rogue Subbasin and 4.1 percent is in the four fifth field watersheds crossed by the Pipeline. Eight waterbodies within the four fifth-field watersheds crossed by the Pipeline are known to support designated critical habitat for SONCC coho; five others are assumed to support SONCC ESU coho and are included as critical habitat in table 3.5.3-2.

TABLE 3.5.3-9

Critical Habitat – Stream Miles and Riparian Zones - Designated for SONCC Coho within Watersheds Crossed by the Pipeline Project

	Waterbodies with Coho Presence a/				Areas (acres) of Riparian Vegetation within Riparian Zone (1 SPTH)	
Subbasins and Fifth-Field Watersheds	Number of Waterbodies with Critical Habitat b/	Total Stream Miles with Critical Habitat	Proportion of Total Stream Miles in ESU b/	Riparian Zone Width (feet) (1 SPTH) c/	Within Subbasin or Watershed	Within 1 SPTH of waterbodies with Critical Habitat a/
Upper Rogue Subbasin	**94**	**197.9**	**0.055**	**167**	**624,272**	**7,850**
Trail Creek	15	17.2	0.005	159	35,338	657
Shady Cove-Rogue River	13	35.5	0.010	157	74,268	1,347
Big Butte Creek	16	32.6	0.009	187	158,243	1,466
Little Butte Creek d/	17	60.9	0.017	158	238,879	2,325

a/ Data from ODFW GIS database (ODFW 2017f).
b/ ODFW data combined with California SONCC distribution (UC Davis Center for Watershed Sciences 2016).
c/ 1 SPTH = one site-potential tree height.
d/ Includes the Key Watershed designated within the Little Butte Creek 5th field watershed

3.5.3.3 Effects of the Proposed Action

Analyses of effects are addressed separately for the marine analysis area and riverine analysis area for the SONCC coho salmon ESU.

Direct and Indirect Effects – Marine Analysis Area

Potential project-related effects to SONCC coho salmon within the marine analysis area include: 1) acoustic effects to coho from LNG carriers transiting the marine analysis area, and 2) oil and gas spills from LNG carriers at sea.

Acoustic Effects

Underwater noise may affect coho salmon in the SONCC ESU. LNG carriers transiting the marine analysis area would produce underwater noise. LNG carriers built in 2003 with 138,028 m^3 capacity were reported by Hatch et al. (2008) to produce sound levels (with 1 standard error) of 182 ± 2 dB re: 1 µPa @ 1 meter. Underwater noise levels are expected to vary by ship type and also by carrier length, gross tonnage, carrier speed, and, to some extent, carrier age—older carriers tended to be louder than newer carriers. Based on the general trend for higher underwater noise generated by larger carriers (McKenna et al. 2012), it is possible for some of the LNG carriers that would utilize the LNG Terminal to generate more noise than the LNG tanker built in 2003 with 138,028 m^3 capacity reported by Hatch et al. (2008) that produced sound levels (with 1 standard error) of 182 ± 2 dB re: 1 µPa @ 1 meter.

It is likely that any LNG carrier noise generated in the marine analysis area would be below thresholds for adverse effects to fish with the possible exception of those fish very near the hull for extended periods, which would be an unlikely event. The criteria for noise levels considered harmful to fish are presented above in the green sturgeon discussion (see section 3.5.1), but generally values less than 183 dB are not considered harmful to fish. As a result, only fish within about one meter (three feet) of the vessel would be in danger of direct noise harm. Noise from LNG carriers would likely increase the background noise within the marine analysis area, which is occurring globally (Slabbekoorn et al. 2010). While background levels are not specifically known in the marine analysis area, analyses of more recent vessel-traffic related noise shows that such levels along the US west coast are holding steady or increasing slightly offshore from Southern California but decreasing in the area off Oregon and Washington (Andrew et al. 2011). SONCC coho salmon would be highly unlikely to be within three feet of these vessels, and thus adverse effects to SONCC coho from LNG carrier noise are not expected.

Fuel or Oil Spills at Sea

Fuel (e.g., diesel) used for LNG carrier propulsion or oil used for mechanical equipment could possibly leak or be spilled while LNG vessels are en route in the waterway. The low amount of petroleum products on LNG carrier greatly reduces the chance of impacts in the marine environment from petroleum spills. The Federal Water Pollution Control Act, as amended by the CWA (33 U.S.C. 1251–1387), prohibits the discharge of oil upon the navigable waters of the U.S. LNG carriers calling on the LNG Terminal would also be required by the U.S. Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills. Therefore, neither fuel nor oil leaks from LNG vessels transiting in the waterway to and from the LNG Terminal are likely to have adverse effects on aquatic resources including coho salmon.

Direct and Indirect Effects – Riverine Analysis Area

The Pipeline would cross 13 waterbodies known or presumed to be inhabited by coho salmon in the SONCC ESU (see table 3.5.3-2). Effects could occur from freshwater in-water construction activities, terrestrial/riparian habitat modification, accidental spills or leaks of hazardous materials, and periodic maintenance of the Pipeline. Construction of the Pipeline project could directly and/or indirectly affect SONCC coho salmon and critical habitat through one or more of the following pathways:

- interference with key life history functions for native species;
- acoustic shock from blasting pipe trench through bedrock streambeds;
- underwater noise produced during use of a track hoe or impact hammer if fish are proximate to the construction site;
- suspended sediment (turbidity) generated during construction across waterbodies can adversely affect coho and aquatic habitats;
- inadvertent release of drilling mud during HDD construction;
- movement blockage during in-stream construction;
- salvaging fish that are entrained and/or entrapped;
- removal of riparian vegetation that can reduce shade (which could increase water temperatures), limit streambank stability, and affect recruitment of LWD;
- effects to aquatic habitats including freshwater stream invertebrates;
- hydrostatic testing and risk of test water entering streams;
- introduction and/or re-distribution of aquatic nuisance species;
- accidental release of fuels and entry of other petroleum products into surface waters can adversely affect coho and other aquatic organisms;
- risk of channel migration, avulsion, widening, and/or streambed scour;
- effects to hyporehic exchange and hyporehic zones;
- run-off from new permanent access roads, new temporary access roads, existing access roads and temporary extra work areas;
- run-off from contractor yards, rock source and disposal sites, and aboveground facilities; and/or
- application of herbicides to control noxious weeds near waterbodies may adversely affect coho.

All affected waterbodies proximate to the Pipeline that are within the range of SONCC coho salmon ESU are within the Upper Rogue River subbasin and four fifth-field watersheds. The route would include 72 direct waterbody crossings within the Upper Rogue River Subbasin (see table 3.5.3-3 and summarized below in table 3.5.3-10). Dry open-cuts using a flume would be utilized at 57 crossings if water is present at the time of construction. Blasting may be necessary for construction at 13 streams that would be crossed by dry open-cut methods (probably by dam-and-pump; see Pipeline project description in section 2.1.2) because the streambed of each is bedrock (see table 3.5.3-3 and table 3.5.3-10). An HDD crossing would be used at the crossing of the Rogue River (MP 122.7), and a conventional bore would be used at the Medford Aqueduct Ditch (MP 133.4). An additional 18 waterbodies summarized in table 3.5.3-10 would not be crossed by the Pipeline but are adjacent to the centerline in the right-of-way. Of the 90 waterbodies included in the table, 14 are perennial streams, 73 are intermittent streams, and 3 are ponds (see table 3.5.3-3, above).

TABLE 3.5.3-10

Proposed Pipeline Construction Methods for Crossing Waterbodies within
the Subbasin and Fifth-Field Watersheds Coinciding With the SONCC Coho Riverine Analysis Area

Subbasin and	**Number of Waterbodies with Construction Method**

Fifth-Field Watersheds	HDD or Direct Pipe	Bore	Wet Open-Cut	Diverted Open-Cut	Dry Open-Cut; Fluming	Dry Open Cut; Bedrock a/	Total Crossed	Adjacent Not Crossed b/
Upper Rogue Subbasin								
Trail Creek					4	2	**6**	2
Shady Cove-Rogue River	1				9	1	**11**	7
Big Butte Creek		1			3	5	**9**	3
Little Butte Creek					41	5	**46**	6
TOTAL	**1**	**1**	**0**	**0**	**57**	**13**	**72**	**18**

a/ Bedrock streambeds would be crossed by dry open-cuts (probably by dam-and-pump) but may require special construction techniques to ensure pipeline design depth including rock hammering, drilling and hammering, or blasting. The need for blasting would be determined by the contractor and would only be initiated after ODFW blasting permits are obtained.
b/ Waterbodies within the construction right-of-way that would not be crossed

Timing to Life History Functions

Waterbodies within the Upper Rogue Subbasin would be crossed between June 15 and September 15 (ODFW 2008), which partially coincides with adult upstream migrations of coho (see figure 3.5.3-1). In general, construction would be timed to miss periods of major juvenile or adult migrations and occur during low stream flows. The in-stream construction window coincides with coho juvenile rearing. Juvenile fry rear for about 15 months in freshwater before migrating in spring to the ocean. Consequently, juvenile fry present would likely be a combination of subadults from the previous year and juvenile fry several months old from the current year. Construction across waterbodies within the Upper Rogue Subbasin could occur during adult upstream migration, beginning in September, but would be completed before spawning in early November (see figure 3.5.3-1).

Acoustic Shock

There are 13 waterbody crossings within the SONCC coho ESU where shallow bedrock may occur, potentially requiring blasting and/or mounted impact hammers to construct a trench through bedrock substrates (see table 3.5.3-3 and summarized in table 3.5.3-10). Explosives detonated near water produce shock waves that can be lethal to fish, fish eggs, and fish larvae by rupturing swim bladders and addling egg sacs (British Columbia Ministry of Transportation 2000). Explosives detonated underground produce two modes of seismic waves: 1) body waves that are propagated as compressional primary (P) waves and shear secondary (S) waves; and 2) surface waves produced when a body wave travels to the earth surface and is reflected back (Alaska Department of Fish and Game - ADFG 1991). Shock waves propagated from ground to water are less lethal to fish than those from in-water explosions because some energy is reflected or lost at ground-water interface (ADFG 1991). Peak overpressures as low as 7.2 psi produced by blasting on a gravel/boulder beach caused 40 percent mortality in coho salmon smolts. Other studies revealed 50 percent mortality in smolts with peak overpressures ranging from 19.3 to 21.0 psi (ADFG 1991).

In 1991, the ADFG established a standard for blasting effects to anadromous fish that limited blast-induced overpressures in the water column. ADFG (1991) reported that a pressure change of 2.7 psi is the level for which no fish mortality occurs. ADFG (1991) calculated the straight line distances for a single shot explosive charge of given weight through rock and other materials to dissipate to an overpressure standard of 2.7 psi (non-lethal pressure for anadromous fish). Typical trench blasting scenarios use multiple 1- to 2-pound charges separated by an 8-milisecond delay to excavate the trench. With use of 1- to 2-pound charges in rock, the setback distance (at which 2.7 psi would occur) from the blast trench to the fish habitat is between 34 and 49 feet (see Table 3, in ADFG, 1991).

New research (Dunlap, 2009) and an in-depth review (Kolden and Aimone-Martin, 2013) of empirical studies of the physiological effects of blasting on adult salmonids and embryos prompted ADFG to revise the blasting standard (Timothy, 2013):

> *"The instantaneous pressure rise in the water column in rearing habitat and migration corridors is limited to no more the 7.3 psi where fish are present. Peak particle velocities in spawning gravels are limited to no more the 2.0 in/s during the early stages of embryo incubation before epiboly is complete."*

Application of the new standard for 7.3 psi in equations in ADFG (1991) was used to derive setback distances from water for 2-pound charges in rock. Based on these calculations, a distance of about 26 feet would result in the avoidance of adverse effects to salmonids in water. The setback distance used in PCGP's Fish Salvage Plan (appendix T) added 25 feet to each side of the construction right-of-way, totaling at least 50 feet from the blasting location at the trench. Application of the new ADFG blasting standard for a 2-pound charge in bedrock would indicate that the current setback distance is more than adequate to ensure that any blasting that does occur will not adversely affect ESA-listed coho salmon and other salmonid species.

Several approaches have been suggested to reduce risk of injury or mortality to fish in closest proximity to blasting locations (Wright and Hopky 1998):

- deployment of bubble curtains/air curtains to disrupt the shock wave;
- deployment of noise generating devices, such as an air compressor discharge line, to scare fish away from the site; or
- removal or exclusion of fish from the work area before the blast occurs.

To reduce impacts on resources, PCGP developed a *Blasting Plan* that incorporates many of these recommendations. The plan states that PCGP does not anticipate any in-water blasting in any streams crossed by the Pipeline. However, blasting may occur in uplands adjacent to streams or within dry streambeds. In those situations, PCGP would attempt to minimize shock waves from blasting that may affect aquatic resources by the types of explosives selected, the size of charges, and the sequences of firing. In addition, bubble curtains may be used. The details of specific site blasting actions would be determined in coordination with managing resource agencies. Lastly, fish may be removed from the crossing area, in accordance with PCGP's *Fish Salvage Plan (*see Conservation Measures below*)*.

The *Fish Salvage Plan* is provided in appendix T. The plan includes measures to exclude fish and prevent them from re-entering isolated portions within waterbodies crossed for distances sufficient to avoid or minimize adverse effects by blasting bedrock in streambeds. The specific plans would be approved by the managing resource agencies. Prior to any blasting, proper permits would be obtained and agencies notified as required by permits.

Of the 13 waterbodies where shallow bedrock may occur, potentially necessitating blasting and/or mounted impact hammers used to construct a trench, only four are known to support SONCC coho: two in the Trail Creek watershed (West Fork Trail Creek at MP 118.9 and Canyon Creek at MP 120.5) and two in the Big Butte Creek watershed (Neil Creek at MP 132.1 and Quartz Creek at MP 132.8). Dry open-cut construction, most likely by dam-and-pump procedures, would be used to cross the four streams. At some waterbody crossing sites the right-of-way would be "necked down" to 75 feet; in others the construction right-of way would be full the 95-foot width. Fish would be salvaged from within the 75-foot or 95-foot wide right-of-way crossing of each stream. The fish salvage area would be isolated by sand bag dams installed upstream and downstream of the centerline. As described in the *Fish Salvage Plan* (see appendix T), fish would be excluded from an area larger than the limits of the construction right-of-way width, isolated by sand bags. If blasting is required, fish would be excluded from an additional 25 feet on each side of the construction right-of-way. The plan includes measures to exclude fish and prevent them from re-entering isolated portions within waterbodies crossed for distances sufficient to avoid or minimize adverse effects by blasting bedrock in streambeds.

Estimates of juvenile coho present at crossing sites in streams with bedrock substrates were based on the following assumptions: 1) all rights-of-way are 95 feet wide at each stream crossing within which coho would be salvaged, and 2) coho would be excluded from an additional 50 feet (a total of 145 feet of stream length) from the right-of-way edges (25 feet from each edge). Numbers of juvenile coho potentially present or assumed to be present in the streams with bedrock substrates are provided in table 3.5.3-11. Construction of the Pipeline through bedrock at those streams is likely to require blasting and the estimates in table 3.5.3-11 represent numbers of juvenile coho (67 juveniles expected) that would be displaced and or salvaged prior to blasting. The estimates in table 3.5.3-11 are based on no fish being herded out of the work area prior to dewatering (see Fish Salvage Plan). The actual number that would be salvaged is expected to be much less.

TABLE 3.5.3-11

Worst Case Estimates of Juvenile Fry Coho Present or Assumed as Present at Streams with Bedrock Substrates and Juvenile Fry Salvaged Prior to Blasting during Construction of the Pipeline Project within the SONCC ESU

Subbasin and Fifth-Field Watersheds	Dry Open-Cut w/ Juvenil Fry Coho Present	Juvenile Fry Present at Each Crossing a/	Total Juvenile Fry Present b/	Juvenile Fry Salvaged at Each Crossing c/	Total Juvenile Fry Salvaged d/
Upper Rogue Subbasin					
Trail Creek	2	26	51	17	33
Shady Cove-Rogue River	0	N/A	0	N/A	0
Big Butte Creek	2	26	52	17	34
Little Butte Creek	0	N/A	0	N/A	0
TOTAL	**4**		**103**		**67**

a/ Juvenile Fry Present at Each Crossing based on Juveniles per Mile (see table 3.5.3-6) within a stream crossing length of 145 feet (95 feet construction right-of-way plus an additional 25 feet on each side, a worst case, see text).
b/ Total Juveniles Present (worst case) = number of Juveniles Present at Each Crossing multiplied by number of Dry Open-Cut crossings with potential for blasting and with Juvenile Fry Coho Present.
c/ Juvenile Fry Salvaged at Each Crossing based on Juvenile Fry per Mile (table 3.5.3-6) within a stream crossing length of 95 feet (worst case, see text), not salvaged within the additional 25 feet on each side.
d/ Total Juvenile Fry Salvaged (worst case) = number of Juvenile Fry Salvaged at Each Crossing multiplied by number of Dry Open-Cut crossings with blasting and Juvenile Fry Coho Present. The estimate is based on no fish being herded out of the work area prior to dewatering (see Fish Salvage Plan). The actual number that would be salvaged is expected to be much less.

Underwater Noise

Impulsive type sounds, sound generated by pile driving for example, create stress waves in the piling material that radiate sound throughout the surrounding media of substrate, air, and water and may propagate outward from the source through bottom sediment (Popper and Hastings 2009). Various studies have reported fish mortality, physical injury, auditory tissue damage, decreased viability of eggs, and decreased larval growth due to noise, mostly explosive blasts, seismic survey blasts, and air gun blasts (Hastings and Popper 2005).

State agencies in Washington, Oregon, and California, along with federal agencies have developed interim noise exposure threshold criteria for pile driving effects on fish (WSDOT 2011a; Popper et al. 2006).[3] The threshold noise levels are assumed to be applicable to noise from a mounted impact hammer operating on bedrock substrates for 13 waterbodies potentially affected by the Pipeline project in the Upper Rogue Subbasin (see table 3.5.3-3 and table 3.5.3-10).

Average maximum noise produced by mounted impact hammers due to impact on substrates (e.g., rock) has been reported at 90 dBA from 50 feet away in the air (see Table 7-4 in WSDOT 2011a).[4] Using a simplified conversion of dB between air and water (see footnote, below and Pacific Marine Environmental Laboratory 2012), the noise produced by the impact hammer in air would be equivalent to about 182 dB re: 1 µPa @ 1 meter in water. However, there is no information available to determine whether that noise level would be equivalent to peak sound levels or root mean square (RMS) levels, which are the basis for evaluating potential harm to fish, particularly related to cumulative sound exposure levels caused by multiple impact hammer strikes. However, using the most conservative criteria (cumulative levels which assume multiple impacts over a short period), an impact hammer value of 182 dB is at the limit of the current criteria considered to cause harm (i.e., 183 dB – see Noise section above).

Further, the estimate of noise produced by in-water use of an impact hammer in any waterbody would be influenced by water currents, water depth, and bottom material and topography, as well as configuration and materials of the river banks. The effects of these factors are unknown (WSDOT 2011a). However, noise propagation in any waterbody, upstream and downstream from the construction site would be limited by the stream channels' sinuosity since the propagation is limited to straight-line distance from the source (WSDOT 2011a). Noise produced by impact hammers would be much reduced if construction does not occur within the water column, similar to reduction set back distances from the blast trench to the fish habitat to reduce blast overpressures to below 2.7 psi, discussed above.

Sounds produced by a mounted impact hammer operating in dry conditions might be conducted through bedrock substrate to approach the hearing threshold of fish, as for example the Atlantic salmon, which is around 90 dB re: 1 µPa (see Figure 3 in Hastings and Popper 2005). It is assumed that salmonids in the Pipeline project area at the time of construction would have hearing thresholds similar to Atlantic salmon. With that assumption, listed and non-listed salmonids present at the time of construction might

[3] Interim noise exposure threshold criteria for pile driving effects on fish (Washington State Department of Transportation 2011a) include 1) a cumulative sound exposure level (SEL_{cum}) of 187 dB re 1 µPa² ● s for fishes more than 2 grams, 2) a SEL_{cum} of 183 dB re 1 µPa² ● s for fishes less than 2 grams, and 3) a single-strike peak level (SPL_{peak}) of 206 dB re 1 µPa for all sizes of fishes (WSDOT 2011a).

SEL_{cum} is the cumulative sound pressure squared, integrated over time, and normalized to one second. SEL_{cum} is calculated as SEL (single strike at 10 meters from the pile) + 10 Log(number of strikes).

[4] For consistency, the maximum noise level (L_{max} of the impact hammer at 1 meter (3.28 feet) is computed as:

$$L_{max} = \text{Construction } L_{max} \text{ at 50 feet} - 25 \text{ Log}(D/D_o) = 119.58 \text{ dBA at 1 meter (3.28 feet)}.$$

Where Construction L_{max} = 90 dBA, D = distance from the noise source (3.28 feet) and D_o = the reference measurement distance (here, 50 feet). Noise measured on the A-weighted decibel scale is based on the reference pressure of 20 micro-Pascal (µPa), where one Pascal is the pressure (force of 1 newton) exerted over an area of 1 square meter and applies to sound in the air. Sound in water is referenced (abbreviated as "re:" in reference expressions) to 1 µPa instead of 20 µPa referenced in air.

The characteristic impedance of sound in water (related to the density of water and speed of sound) is approximately 3,600 times the impedance in air, so conversion for the intensity of sounds of equal pressures in air compared to water is 10 Log(3,600) = 36 dB (Pacific Marine Environmental Laboratory 2012). Taking into account the different reference pressures for sound in air and in water (20 µPa and 1 µPa), the intensity measurements for sound of equal pressures differ by 26 dB + 36 dB = 62 dB (Pacific Marine Environmental Laboratory 2012). Using this simplified conversion of dB between air and water, the noise produced by the impact hammer in air (120 dB re: 20 µPa @ 1 m) would be equivalent to about 120 dB + 62 dB = 182 dB re: 1 µPa @ 1 m in water.

detect the noise produced by an impact-hammer striking bedrock, but the noise is not expected to be of sufficient intensity to cause them injury as would SELs produced by pile driving.

Dry open-cut construction, more than likely dam-and-pump methodology, would be used at sites where blasting and/or mounted impact hammers would be required to construct a trench through bedrock substrates. When using the dam-and-pump stream crossing methodology, the typical right-of-way distribution of an isolated streambed (dry open-cut) would be no less than 25 feet on one side of the pipe trench and at least 50 feet or more on the opposite side of the pipe trench depending on whether it is a 75- or 95-foot-width crossing. Therefore, an area within the waterbody crossing equivalent to length of the blasting trench and approximately 25 feet wide (in the worst-case scenario) would be exposed to instantaneous hydrostatic pressure changes above 2.7 psi. In reality, the distance in water affected outside of the 25 feet on land would be less than an additional 25 feet because water does not transmit energy pressure waves as well as rock (only about 70 percent of the distance away from the charge relative to rock, the most conductive substrate of pressure waves; see calculations in ADFG 1991, which the maximum distance is based upon. As noted above (see the Acoustic Shock subsection), a *Fish Salvage Plan* is in place that would result in any fish present being removed from the area within this 25-foot potential effect area, eliminating potential noise effects from stream crossings.

There would be no in-water blasting, and no in-water noise monitoring has been proposed. Procedures for conducting blasting in-the-dry have been provided in the *Blasting Plan* (appendix C to the POD). Monitoring for efficacy of each stream crossing and fish salvage would be conducted throughout the entire process, including function of upstream block nets to exclude fish from areas where they might be affected by blasting in the dry, thus eliminating potential noise effects to fish during stream crossings. In situations where blasting occurs in uplands adjacent to streams or within dry streambeds, PCGP would attempt to minimize shock waves from blasting that may affect aquatic resources by optimizing variables such as the types of explosives selected, the size of charges, and the sequences of firing. In-air noise due to blasting would be mitigated in all noise-sensitive areas as described in PCGP's *Blasting Plan* (see appendix C to the POD).

Suspended Sediment by Pipeline Crossing Methods

The three crossing methods that would be used for crossings where SONCC coho salmon may occur include dry crossing, conventional direct bore, and HDD. Dry crossing methods including diverted open cut would result in minimal impacts, including temporary increases in suspended sediments in restricted areas. Bores and HDDs would be installed without in-water work and would not directly affect the aquatic environment and associated species, except in the case of an inadvertent return during an HDD crossing, which could affect stream suspended sediment levels as discussed below.

Suspended Sediment – Dry Open-Cut

Pipeline crossings of surface waterbodies would cause some downstream turbidity and sedimentation. The type of crossing and stream sediment characteristics can affect turbidity and suspended sediment in streams. All streams in the range of SONCC coho salmon ESU would be crossed using the dry open-cut method (flume and dam-and-pump) (table 3.5.3-3 and table 3.5.3-10), except for two waterbodies crossed by HDD and bore. Within the range of the SONCC ESU, the Rogue River would be crossed with an HDD, while the Medford Aqueduct would be crossed by a bore. Turbidity and sedimentation impacts from the dry open-cut methods are associated with: 1) installation and removal of the upstream and downstream dams used to isolate the construction area; 2) water leaking through the upstream dam and collecting sediments as it flows across the work area and continues through the downstream dam; 3) movement of in-stream rocks and boulders to allow proper alignment and installation of the flume and dams; and 4) when streamflow is returned to the construction work area after the crossing is complete and the dams and flume are removed. Both "dry" techniques produce much less sediment in the water than alternative "wet" open cut methods (Reid and Anderson 1999; Reid et al. 2002; Reid et al. 2004, Reid et al. 2008, Harper 2012). Therefore, if properly installed and maintained during construction and restoration, dry open-cut construction across waterbodies would produce minor levels of sediment and turbidity.

PCGP would minimize impacts on surface waters and aquatic resources by implementing the waterbody crossing and erosion and sediment control measures as described in the Pipeline project-specific ECRP. Actions described in GeoEngineers (2017d) would also be used to determine level of stream crossing risk. GeoEngineers, using a combination of field data and GIS data, rated proposed stream crossings based on the matrix along the entire route, including 20 streams in the range of SONCC coho. The matrix has two axes rating the crossing based on the Pipeline impact potential at the crossing and the relative stream response potential at the crossing. Each crossing was rated as low, medium, or high for each of the two axes (all stream crossings were placed into one of nine categories, such as Low–Low, Low–Medium, and Medium–High). Crossings of all streams except for Neil Creek were evaluated as having sensitive streambed, banks, or riparian revegetation conditions that would require site-specific measures to maintain channel stability or replace disturbed habitat (GeoEngineers 2017d) at each stream crossing. The crossing of Neil Creek would require typical stream crossing methods to reduce impacts to waterbody crossings. PCGP would stabilize the construction site, including the streambanks, immediately following installation of the Pipeline. PCGP would also install and maintain throughout construction sediment barriers, such as silt fence and straw/hay bales, to prevent sedimentation from surface runoff into a stream.

Construction across waterbodies would be completed as quickly as possible to shorten the duration of sedimentation and turbidity. If channels are dry during construction, small streams (less than 10 feet) are projected to be crossed in less than 24 hours, and intermediate streams (10 to 100 feet) usually in less than 48 hours. Times may be longer when flow diversion is required. Reid et al. (2004) noted that in flowing streams they monitored, in-stream work averaged 38 and 64 hours for dam-and-pump and flumed crossings, respectively. If circumstances required a construction delay, adequate site stabilization measures would be employed in accordance with the ECRP and permit conditions. However, failure of flow sealing and other in-stream structures at upstream diversions structures can occur from a variety of malfunctions such as pump failure, dam and flume failure, poor dam seal and others. Reid et al. (2004) noted seal failures of monitored diverted open cut crossing in one of 23 dam-and-pump projects and five of 12 for flumed projects. Should these occur, suspended sediment would be relatively elevated over those without failure, but immediate repair work could reduce the magnitude and duration of elevated suspended sediment.

Alternatively, Harper (2012) modeled sediment entrained during wet open-cut pipeline crossings of six major (width >100 feet), 46 intermediate (widths >10 feet and <100 feet), and 227 minor waterbodies (widths <10 feet) in New Hampshire. In-stream duration of suspended sediment generation varied by major waterbody (30 hours), intermediate waterbody (12 hours), and minor waterbody (8 hours). In addition, modeling included suspended sediment generated following dry open-cut crossing of intermediate and minor waterbodies but was restricted to a one hour period of duration associated with a "quick-flush" that occurs after a pipe is installed, the trench is backfilled, and water barriers, upstream and downstream from the workspace, are removed and turbulent, high energy flow across the backfilled trench suspends sediments which are expected to last for one hour (Harper 2012). The effect on suspended sediment from planned dry crossings and unintended wet cuts crossings with repairs are discussed below in this subsection.

Severity of Effects from Suspended Sediment

Salmonids exposed to moderate to high levels of suspended sediment for extended periods could be adversely affected. At high levels, turbidity directly affects survival and growth of salmonids and other species, interferes with gill function, and adversely affects substrate for egg development (reviewed and compiled by Bash et al. 2001). Turbidity can also reduce macrophyte cover (over the long-term) by limiting photosynthesis (Goldsborough and Kemp 1988), as well as adversely affecting fish vision, which is a requisite for social interactions (Berg and Northcote 1985), feeding (Vogel and Beauchamp 1999; Gregory and Northcote 1993), and predator avoidance (Meager et al. 2006; Miner and Stein 1996).

Salmonids may avoid areas of increased turbidity levels at 20 mg/l suspended sediment, and possibly lower concentrations depending on length of exposure (Newcombe and Jensen 1996). The elevated suspended sediment conditions would be short-term during pipeline installation and would not be continuous at any one location. This would reduce the chances of continuous elevated exposure for fish that are relatively sedentary. . Some other studies have found varied effects including lesser effects at these concentrations, with overall effects related to both duration as well as concentration (Newcomb and Jensen 1996).

Sediment stirred into the water column can be redeposited on downstream substrates, which could bury aquatic macroinvertebrates (an important food source for salmonids, and other fish in estuarine areas). Additionally, downstream fine particle sedimentation could affect spawning substrate habitat, spawning activities, eggs, larvae, and juvenile fish survival, as well as benthic community diversity and health (reviewed and compiled by Bash et al. 2001). Because the effects of increased sedimentation and turbidity are often limited to the period of in-stream work, the duration of these effects are usually relatively short. However, specific site characteristics including flow, substrate composition, relative disturbance and other factors could make the duration of construction effects last longer. One long-term study (during construction through three years after construction) of multiple pipeline crossings of coldwater streams found no measurable effect to fish or benthic resources or their habitat within 2 months to 3 years of construction (Blais and Simpson 1997) and Gartman (1984) reported rapid recolonization of benthic organisms on 30 pipeline projects post-construction.

Dry open-cut construction methods have the potential to alter fish abundance over the short-term. Reid et al. (2002) found that fish abundance downstream of dam-and-pump or flumed crossings reduced immediately after construction in two of four sampled sites. Mean sediment concentrations during construction at these four sites were all less than 100 mg/l (range 8 to 86 mg/l). Two sites sampled one month later had downstream reductions in fish abundance including brook trout. However, Reid et al. (2002) concluded, based on limited physical sediment-related stream changes, observed differences in fish abundance for most sampling were likely the result of factors other than project-generated sediment, such as low flow generated from water diversion actions and fish sampling methodsOne year after construction, Reid et al. (2002) found no difference in fish abundance below these two sites from preconstruction levels.

Newcombe and Jensen (1996) compiled research from many sources that demonstrate effects to anadromous and resident salmonids by various levels of suspended sediment and exposure over time. This modelling process is used to assess the possible effects to salmonid resources in the project area from in-stream pipeline construction based on estimates of TSS concentration and exposure duration.

The developed models that approximate the level of effect are based on known levels of suspended sediment concentration and duration of exposure to that concentration in a stream. In order to use these models to estimate effects to salmonids, an estimate of these two parameters is needed.

Output from each model provides severity-of-ill-effects (SEV) scores that are summarized below. Values range from 0 to 14, where an SEV of 0 indicates no effects, an SEV between 1 and 3 indicates behavioral effects, an SEV from 4 to 8 indicates sublethal effects, and an SEV from 9 through 14 indicates lethal and paralethal effects (see Table 1 in Newcombe and Jensen 1996).

<u>Behavioral Effects SEV scores</u>

1 = Alarm reaction
2 = Abandonment of cover
3 = Avoidance response

<u>Sublethal Effects SEV scores</u>

4 = Short-term reduction in feeding rates and/or feeding success
5 = Minor physiological stress (increase coughing rate and/or increased respiration rate)
6 = Moderate physiological stress
7 = Moderate habitat degradation; impact on homing
8 = Major physiological stress; long-term reduction in feeding rate- feeding success; poor condition

<u>Lethal and Paralethal Effects SEV scores</u>

9 = Reduced growth rate, delayed hatching, and/or reduced fish density
10 = 0 to 20 percent mortality, increased predation, and/or moderate to severe habitat degradation
11= >20 to 40 percent mortality
12= >40 to 60 percent mortality
13= >60 to 80 percent mortality
14= >80 to 100 percent mortality

SEV scores are complex interactions of TSS concentrations and time of exposure to those concentrations where higher concentrations and longer exposures result in higher SEV scores and greater impact to fish. Effects of high concentrations may be ameliorated by brief exposures and conversely effects of low concentrations may be exasperated by prolonged exposures. In the analyses, downstream effects of TSS are primarily caused by very fine sand, silt and clay particles; coarser sediments settle out of suspension over relatively short distances downstream, closer to the crossing site. Specific information about each waterbody crossing is required to predict amounts of suspended sediment that would be generated, transported, and deposited downstream. That information includes: 1) stream width and depth, 2) water velocity, 3) streambed roughness, 4) grain size of excavated materials, and 5) background (ambient) levels of suspended sediment (Reid et al. 2008). Once total suspended sediment (TSS) concentrations generated by in-stream activities have determined, they are applied in the dose-response assessments of sediment exposure, the SEV models by Newcombe and Jensen (1996).

<u>Estimates of Likely Effects from Suspended Sediment</u>

<u>Average Channel Characteristics.</u> PCGP incorporated site data, regional data, and available literature based models to provide an estimate of both suspended sediment levels and extent of effects to SONCC coho salmon ESU from construction across streams. Specific channel characteristics for streams crossed by the Pipeline are not available. However, data provided in the ODFW (2014c) stream

surveys included bankfull channel widths, bankfull depths, and stream gradients, in addition to substrates (Sand-Silt-Organics) noted in table 3.5.3-8 above, for multiple streams within fifth-field watersheds crossed by the Pipeline (see table 3.5.3-12). Those data were used to develop stream channel characteristics in each fifth-field watershed crossed that are assumed to apply to the actual streams that would be crossed in each of the watersheds.

TABLE 3.5.3-12

Channel Conditions for Streams Sampled during the Aquatic Habitat Inventory (ODFW 2014c) in Four Watersheds within the SONCC ESU that would be Crossed by Pipeline Project

Subbasin and Fifth-Field Watersheds	Number of Stream Reaches Surveyed a/	Average Values for Streams Sampled in Watershed a/			
		W = Bankfull Width (meters)	D = Bankfull Channel Depth (meters)	S = Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate
Upper Rogue Subbasin					
Trail Creek	20	7.97	0.70	6.95	19.70
Shady Cove-Rogue River	9	11.81	0.74	5.37	11.89
Big Butte Creek	41	8.70	0.57	3.88	25.22
Little Butte Creek	56	9.11	0.58	5.37	30.36

a/ Stream-specific values are provided in appendix Y.

Estimates of Bankfull Flows. Sediment transport in streams depends, in part, on stream channel characteristics. Stream-specific values that were averaged in table 3.5.3-11 were used to determine stream discharged rate (Q) and water velocity (V_A). Manning's Formula (Limerinos 1970; Arcement and Schneider 1989) was used to estimate Q, the stream discharge rate (cubic meters per second):

$$Q = A\ (k/n)\ (R^{2/3})\ (S^{1/2})$$

with estimates of A, the cross-sectional area of a stream (square meters); R, the hydraulic radius (meters, where R = A/P, and P is the wetted perimeter in meters); S, the slope of channel (channel gradient); the constant *k* equals 1.486 if English units are used or 1 with metric units; and n, Manning's roughness coefficient. Stream-specific Aquatic Habitat Inventory data (see sppendix Y) were used to estimate the stream channel cross-section shape and cross-section area. If the predominant depth was greater than half the bankfull width, the cross-section channel shape was assumed to be a V. If the bankfull depth was less than half the bankfull width, the cross-section channel shape was assumed to be a trapezoid with each bank as a 1:1 slope, dependent on predominant depth (bottom = W – 2 D). If the bankfull depth was equal or greater than half the bankfull width, the cross-section channel shape was assumed to be a V. Manning's n was estimated from various sources (Chow 1959; Limerinos 1970; Arcement and Schneider 1989) and ranged from n = 0.060 for floodplain channels with light brush and trees in summer, to n = 0.050 for channels with pools, shoals and stones, to n = 0.045 for mountain streams with bottom gravels, cobbles, and boulders and no vegetation in the channel (Chow 1959).

Estimates of Q derived with Manning's Formula are assumed to be measures of the carrying capacity (bankfull flow) of a particular channel section (Arcement and Schneider 1989). Carrying capacity of a channel section is assumed to occur during periods of high flow, generally during winter months in the project area. Stream flow rate or discharge rate, Q, is related to cross-sectional area (A) and average streamflow velocity (V_A):

$$Q = A \cdot V_A\text{, alternatively } V_A = Q / A$$

Estimates of variables used to derive Q and V_A are provided in table 3.5.3-13, averaged by watershed.

TABLE 3.5.3-13

Estimates Used to Derive Bankfull Flow and Bankfull Velocity in Four Watersheds within the SONCC ESU that would be Crossed by Pipeline Project

Subbasin and Fifth-Field Watersheds	Average Estimates for Streams Sampled in Watershed a/				
	A = Channel Cross Sectional Area (meter^2)	P = Wetted Perimeter (meters)	R = Hydraulic Radius (meters)	Q = Bankfull Flow (meter^3/sec)	V_A = Bankfull Velocity (meter/sec)
Upper Rogue Subbasin					
Trail Creek	5.40	8.54	0.59	19.10	3.79
Shady Cove-Rogue River	9.65	12.43	0.65	31.06	3.24
Big Butte Creek	4.74	9.17	0.48	11.01	2.45
Little Butte Creek	5.68	9.58	0.50	15.87	2.86

a/ Stream-specific estimates are provided in appendix Y.

Seasonal Discharge. Pipeline construction across waterbodies would occur during ODFW (2008) in-stream construction windows (see section Timing to Life History Functions, above). Hydrographs of monthly discharges of waterbodies within the Upper Rogue Subbasin to be crossed by the Pipeline (see figure 3.5.3-5) show peak seasonal flows during winter months, December through February. Lowest flows occur during summer months, coinciding with the ODFW construction windows. Assuming that high winter stream flows correspond to the bankfull carrying capacities of channel sections (Arcement and Schneider 1989), in-stream flows during the ODFW construction window would be some fraction of the winter flows. Those fractions are included in table 3.5.3-14 with the mid-point which is used to adjust bankfull flows and velocities to low flows and velocities for each of the sampled reaches in the ODFW Aquatic Habitat Inventory data (see appendix Y).

TABLE 3.5.3-14

Recorded High Flows During Winter and Average Low Flows During the ODFW In-stream Construction Window in Hydrographic Data within the Upper Rogue Subbasin Crossed by the Pipeline Project

Hydrograph	High Flow (cfs) (Month)	In-stream Construction Window	Average Low Flows (cfs) During Window	Percent of High Flow During Window	Percent Mid-Point
Big Butte Creek	372 (Jan)	Jun 15- Sep 15	62.1	16.7	9.65
Elk Creek	537 (Jan)	Jun 15- Sep 15	13.7	2.6	

The 10-year average of low water stream flows in the Upper Rogue Subbasin during the ODFW in-stream construction window are assumed to be 9.65 percent of high winter flows (see table 3.5.3-15), based on discharge data for Big Butte Creek and Elk Creek during December (see figure 3.5.3-5). Stream depths for all waterbodies within the Upper Rogue Subbasin were reduced by the same proportion through iterations that reduced bankfull flows by 9.7 percent in all streams in the Aquatic Habitat Inventory samples. Reduced stream depths generate reduced values of A, P, and R in Manning's Formula. Stream-specific estimates of Q and V_A during low water flow conditions were likewise derived and are provided in table 3.5.3-15, averaged by watershed. Reduced stream depths generated reduced values of A, P, and R in Manning's Formula.

TABLE 3.5.3-15

Estimates Used to Derive Low Water Flows and Velocities During In-stream Construction

in Four Watersheds within the SONCC ESU that would be Crossed by Pipeline Project					
	Average Estimates for Streams Sampled in Watershed a/				
Subbasin and Fifth-Field Watersheds	**A = Channel Cross Sectional Area (meter^2)**	**P = Wetted Perimeter (meters)**	**R = Hydraulic Radius (meters)**	**Q = Low Water Flow (meter^3/sec)**	**V_A = Low Water Velocity (meter/sec)**
Upper Rogue Subbasin					
Trail Creek	1.23	7.05	0.16	1.84	1.63
Shady Cove-Rogue River	2.25	10.84	0.18	3.00	1.36
Big Butte Creek	1.10	7.96	0.13	1.06	1.05
Little Butte Creek	1.32	8.35	0.14	1.53	1.20
a/ Stream-specific values are provided in appendix Y.					

Background Turbidity and Suspended Sediment. Turbidity, generally reported in NTUs, is a measure of the lack of transparency (cloudiness) of water caused by suspended or dissolved substances that cause light to be scattered and adsorbed. Turbidity is often measured on-site using a turbidity meter that measures the scattering of light in a water sample relative to a known range of turbidity standards. Turbidity is directly related to the concentration of sediments suspended in water, but the relationship between turbidity and suspended sediment is complicated by sediment particle size, particle composition, and water color (ODEQ 2010).

GeoEngineers (2017f) evaluated the potential risk of turbidity increasing during construction of the Pipeline across waterbodies. The qualitative evaluation was based on each affected waterbody's hydroperiod, presence of erodible clay and loam soils in streambanks, presence of clay in streambed (suspended clay contributes to turbidity disproportionally to its erodibility), long-term stability of stream channels, and level/duration of construction effort and stabilization measures likely added at the time of construction. The turbidity risk was scored from 1 (low) to 5 (high). Of 86 waterbodies evaluated within range of SONCC coho, 58 were scored with a low risk (score of 1 or 2) of turbidity increase over a 24-hour period, and 27 were scored with a moderate risk (score of 3 or 4), generally due to soil erosion potential, presence of clay or mud, and/or the presence of steep slope or an incised channel that would require construction of a deep trench (GeoEngineers 2017f). The evaluation concluded that turbidity generated during construction may exceed Oregon water quality standards for short distances and short durations downstream from each stream crossing, either coinciding with construction across perennial waterbodies or in intermittent streams coincidental with autumn precipitation.

Ambient turbidity was not addressed by GeoEngineers (2017f). Turbidity (NTU) has been evaluated by ODEQ (2013) and retrieved from Laboratory Analytical Storage and Retrieval (LASAR) Web Application in 2013 before ODEQ discontinued support of the site (ODEQ 2017), making the data unavailable. Turbidity within individual streams may be highly variable, but during the period coinciding with ODFW (2008) in-stream construction windows, reported turbidity was minimal and of low variability in streams for which data exists (see table 3.5.3-16).

The majority of ODEQ LASAR data were turbidity measurements (in NTU) taken in the field. TSS values were occasionally reported but mostly without measuring the corresponding turbidity. Relationships between turbidity and suspended solid concentrations are best if determined on a stream-by-stream basis (Downing 2008). However, since stream-specific data for turbidity and TSS were not available, four available literature-generated models were used to supply a reasonable range of the possible relationships. Relationships are reported for streams in Alaska (Lloyd 1987; Lloyd et al. 1987) and streams in the Puget Lowlands (Packman et al. 1999); the models are non-linear. At low turbidity levels (see table 3.5.3-16), conversions of NTUs to TSS are relatively consistent among the models. Based on these conversions, an overall background level of 2 mg/l is assumed for TSS concentrations for all streams crossed by the Pipeline during the ODFW in-stream construction window. Turbidity data (NTU) from the stations included in the table averaged for July, August, and September yielded an average of 1.3 NTUs. When converted to TSS using the models in the table, the conversion yields an average of 1.9 mg/l as a background level within range of the SONCC coho. In support of that assumption, ODEQ (2010) reported that during dry seasons, background turbidity levels are relatively low and consistent in small streams throughout Oregon. A background TSS concentration of 2 mg/l during summer is also consistent with measurements reported by USGS in Myrtle Creek, Big Butte Creek, and the Rogue River mainstem during summers 1977, 1978, and 1979 (historical data provided by the Forest Service). Results from the ODEQ data analysis and other sources reported above support using 2 mg/l as ambient TSS levels during the in-stream crossing period including all or portions of July, August, and September.

TABLE 3.5.3-16

Turbidity (NTU) Records Measured by ODEQ during Periods of ODFW In-stream Construction Windows (July to September) in Waterbodies Proximate to the Pipeline Project in the Upper Rogue Subbasin and Conversion to TSS by Available Models

				Model Conversion to TSS (mg/l) a/			
Waterbody	**Number of Records**	**Period of Record**	**Mean Turbidity (NTU) (Maximum) (Minimum)**	**Model 1 Mean TSS (Maximum) (Minimum)**	**Model 2 Mean TSS (Maximum) (Minimum)**	**Model 3 Mean TSS (Maximum) (Minimum)**	**Model 4 Mean TSS (Maximum) (Minimum)**
Trail Creek	6	1998-2000	1.8 (2) (1)	5.3 (5.8) (2.6)	2.1 (2.3) (1.1)	1.1 (1.3) (0.5)	2.6 (2.9) (1.2)
West Fork Trail Creek	7	1998-2002	3.0 (5) (0.9)	9.6 (17.0) (2.3)	3.5 (5.9) (1.0)	2.3 (4.2) (0.4)	5.2 (9.7) (1.0)
South Fork Little Butte Creek	11	1998-2000	2.0 (4) (1)	5.9 (13.1) (2.6)	2.3 (4.7) (1.1)	1.3 (3.2) (0.5)	3.0 (7.2) (1.2)
South Fork Little Butte Creek	6	2001	0.9 (1) (0.7)	2.3 (2.6) (1.7)	1.0 (1.1) (0.7)	0.5 (0.5) (0.3)	1.0 (1.2) (0.7)

a/ Models used to convert Turbidity (T) to Suspended Solids Concentration (SSC) or Total Suspended Solids (TSS) in waterbodies crossed or proximate to the Pipeline project. Turbidity information source: ODEQ (2013) included data collected prior to 2013.
Model 1 (Lloyd 1987; Lloyd et al. 1987) applicable to waters throughout Alaska: $T = 0.44\ (SSC)^{0.858}$
Model 2 (Lloyd 1987; Lloyd et al. 1987) applicable to interior Alaskan streams: $T = 1.103\ (SSC)^{0.968}$
Model 3 (Packman et al. 1999) Rutherford Creek, King County, Washington: $\ln(TSS) = 1.32 \ln(NTU) - 0.68$
Model 4 (Packman et al. 1999) nine streams sampled in the Puget Lowlands, Washington: $\ln(TSS) = 1.32 \ln(NTU) + 0.15$

NTU – nephelometric turbidity unit

Particle Transport. Sediment particles would be transported distances downstream (L, in meters) based on 1) the particle size and settling velocity (V_S, - centimeters per second – in water at 20°C, see for example the Wentworth Grain Size Chart, USGS 2003), 2) the average streamflow velocity (V_A - meters per second), and 3) the average depth of flow (D, meters) downstream, using the following "velocity-distance-time" equation;

$$L = V_A\ (D / V_S)$$

Estimates of transport distances (L, meters) for various sediment particles ranging in sizes from clay to coarse gravel are provided, as examples, in table 3.5.3-17 for three waterbodies in the Pipeline project vicinity for which data are available. Particle sizes deleterious to salmonids (250 µm or less in the models of Newcombe and Jensen 1996, above) could settle out of suspension less than 1 meter (0.2 feet) downstream (e.g., medium sand in low flows for Tributary to Catching Creek). Alternatively, particles could remain suspended for 4.7 kilometers (2.9 miles) or more (very fine silt in Willis Creek).

TABLE 3.5.3-17

Estimated Downstream Transport Distances for Particles (ranging from Very Fine Silt to Coarse Gravel) in Three Streams (as examples).

Particle Description	Particle Diameter a/	Settling Velocity (V_S)	Estimated Particle Transport Distance (L) Downstream b/		
			Tributary to Catching Creek	Steele Creek	Willis Creek
Coarse Gravel	1.60 cm	90 cm/s	0 m	0 m	0 m
Very Coarse Sand	0.1 cm	15 cm/s	0 m	0 m	0 m
Coarse Sand	0.05 cm	8 cm/s	0 m	0 m	1 m
Medium Sand	0.025 cm	3 cm/s	0 m	0 m	2 m
Fine Sand	0.0125 cm	1.25 cm/s	0 m	1 m	5 m
Very Fine Sand	0.0062 cm	0.329 cm/s	1 m	4 m	20 m
Coarse Silt	0.0031 cm	0.085 cm/s	3 m	16 m	78 m
Medium Silt	0.0016 cm	0.023 cm/s	9 m	59 m	289 m
Very Fine Silt-Clay	0.0004 cm	0.0014 cm/s	153 m	977 m	4,742 m

a/ note that 0.025 cm = 250 µm

b/ Parameter values used to estimate L:

Trib. Catching Creek: V_A =0.27 m/s; D = 0.01 m.
Steele Creek: V_A = 0.53 m/s; D = 0.03 m.
Willis Creek: V_A = 0.66 m/s; D = 0.1 m.

Sediment Generated During Pipeline Construction. Modeled concentrations of TSS produced in waterbodies during wet open-cut pipeline construction were developed from empirical data collected during construction across 15 to 19 streams in North America (Reid et al. 2004). Models were developed to predict mean TSS concentrations immediately downstream (approximately 50 meters) of pipeline construction sites. Models included TSS generated by all construction activities and by trenching, pipe lowering, and backfilling. The models predicting mean TSS generated by all activities (including trenching, pipe lowering, and backfilling) had the highest correlation coefficients (Reid et al. 2004). The model predicting mean TSS ($\boldsymbol{C}_{\mathbf{av}}$) at about 50 meters downstream by all activities associated with wet open-cut pipeline construction is:

$$C_{av} = 1.5 \text{ x } 10^6\ U^{1.09}\ d_{50}^{0.95}\ P_f^{0.35}\ q^{-1}$$

where U = mean flow velocity (m per second) at the crossing location during the construction period, equivalent to V_A derived using Manning's Formula (table 3.5.3-14 and appendix Y); d_{50} = the median sediment size (m) of the excavated material by weight, P_f = percentage of fines (silt and clay) in the excavated material (%) and is assumed to equal the percent of silt and organics in surface substrates for all streams within a given fifth-field watershed (estimated as 2/3 of the Percent Sand, Silt, Organics in Substrate tabulated in table 3.5.3-12); q = the width adjusted stream flow rate where $q = Q/B$, (m^2 per second) with B = the watercourse width (m) adjusted for a particular flow rate and Q = stream flow rate (m^3 per second) derived using Manning's Formula (values for Q are in table 3.5.3-15 and appendix Y). Values for d_{50} in these analyses were derived by regressing values of d_{50} and P_f provided in Table 2 of Reid et al. (2004); the relationship of d_{50} to P_f from that study is d_{50} = 38.12 e $^{-0.0963\ Pf}$ (r^2 = 0.636, P<0.001).

In these simulations, Q is related to B through Manning's Formula and as B increases numerically, Q also increases but at a faster numerical rate (as a power function). If all other model parameters are held constant in the Reid et al. (2004) model, increased width adjusted stream flow rate, q (due high flow, Q, and proportionally smaller watercourse widths, B) would decrease the TSS concentration (C_{av}) because *q* is factored as q^{-1} in the equation. Conversely, lower *q* values would generate higher C_{av} with all other parameters in the equation held constant. Stream-specific estimates of U, d_{50}, P_f, q^{-1}, and C_{av} during low water flow conditions are provided in appendix Y and averaged by watershed in table 3.5.3-18.

TABLE 3.5.3-18

Estimates Used to Predict TSS Concentrations at 50 meters Downstream from Wet Open-Cut Pipeline Construction in Four Watersheds within the SONCC ESU that Would Be Crossed by Pipeline Project

	Average Estimates for Streams Sampled in Watershed a/					
Subbasin and Fifth-Field Watersheds	U Low Water Velocity (m/sec)	d_{50} Median Sediment Size (m)	P_f Percent Fines (Silt, Clay)	q Width Adjusted Stream Flow (m^2/sec)	B Watercourse Width (m)	C_{av} Predicted TSS Concentration at 50 meters (mg/L)
Upper Rogue Subbasin						
Trail Creek	1.63	0.034	13.13	0.27	6.91	803.88
Shady Cove-Rogue River	1.36	0.236	7.93	0.25	10.69	712.46
Big Butte Creek	1.05	0.027	16.81	0.16	7.85	1,111.54
Little Butte Creek	1.21	0.005	20.24	0.17	8.24	1,197.51

a/ Stream-specific values are provided in appendix Y.

In addition to developing predictive models of TSS concentrations generated by wet-open cut pipeline construction, Reid et al. (2004) measured TSS downstream from 12 flumed pipeline crossings and 23 dam-and-pump crossings (dry open-cut or isolated pipeline construction crossings) with comparisons to 11 wet open-cut construction crossings. By accounting for flow, background TSS concentrations, sampling distance downstream, and duration of construction, Reid et al. (2004) determined that mean TSS concentrations generated during dry open-cut construction by fluming were 3.7% of the wet open-cut concentrations and were 0.85% of the wet open-cut concentrations for dam-and-pump construction. These relationships were used in table 3.5.3-19 to adjust average TSS concentrations estimated at 50 meters downstream from wet open-cut pipeline crossings to average TSS concentrations at flumed pipeline crossings and dam-and-pump pipeline crossings.

<u>Estimated Downstream Concentration of Suspended Sediments</u>. Ritter (1984) provided a variant of the "velocity-distance-time" equation, above to estimate concentrations of suspended sediments (C_X, as mg/L) some distance (x) downstream from a pipeline trench being constructed across a waterbody. Ritter's model for downstream sediment transport distance during construction across minor streams, with complete mixing of sediment particles, estimates the concentration downstream C_X by:

$$C_X = C_O\, e^{-(vs/d)(x/u)}$$

where C_O (mg/L) is the initial concentration of suspended solids in the water column at the trenching site, vs = the settling velocity (m/second) of sediment particles, d = stream depth (m), and u = stream current velocity (m/second).

The formula for estimating the concentration downstream (Ritter 1984) is used to estimate the distance downstream for TSS concentrations at 50 m (C_O) to equal assumed ambient concentrations (C_X = 2 mg/l). The estimate is calculated by solving for x (distance) in the equation with appropriate transformations and inclusion of only the estimated clay fraction as TSS concentration since the silt fraction would have settled out of suspension:

$$x = (\ln(C_X) - \ln(C_O)) + (d / vs)\, u$$

where x = distance (m) downstream, C_O = the initial concentration (mg/l) of suspended solids in the water column at the trenching site, vs = the settling velocity (m/second) of the clay fraction, d = stream depth (m), u = stream current velocity (m/second), and x = distance (m) downstream. The distances x for TSS generated by wet open-cut construction techniques to attenuate to ambient TSS (C_X) is provided in table 3.5.3-19.

TABLE 3.5.3-19

Estimates of TSS Concentrations Generated during In-stream Construction and Estimated Downstream Distance from Wet Open-Cut Construction to Attenuate to Ambient TSS in Four Watersheds within the SONCC ESU that Would Be Crossed by Pipeline Project

	Average Estimates for Streams Sampled in Watershed a/			
Subbasin and Fifth-Field Watersheds	**Wet Open–Cut TSS (mg/l) at 50 m**	**Fluming TSS (mg/l) at 50 m**	**Dam & Pump TSS (mg/l) at 50 m**	**Distance (m) for TSS (Clay Fraction) to Equal Ambient (= 2 mg/l)**
Upper Rogue Subbasin				
Trail Creek	804	30	7	18,591
Shady Cove-Rogue River	712	27	6	16,534
Big Butte Creek	1,112	41	9	10,563
Little Butte Creek	1,198	45	10	11,439

a/ Stream-specific values are provided in appendix Y

Inverse relationships between TSS concentrations produced at 50 meters from in-stream construction and TSS concentrations at variable distances downstream were evaluated for each of the three pipeline crossing techniques by nonlinear regressions of distance downstream (from 1 to 1000 m) and total TSS concentrations at distance x, solving for x in the above equation [$x = (\ln(C_X) - \ln(C_O)) + (d / vs) u$]. Best fit regressions were selected (exponential vs. logarithmic) to model the inverse relationships between distance and TSS concentration for data averaged in each watershed. Those regression equations provided in table 3.5.3-20 define the nonlinear relationships between y = concentration (mg/l) and x = downstream distance (m).

TABLE 3.5.3-20

Nonlinear Regression Equations (with Coefficients of Determination, r^2) for Estimating TSS Concentrations (y, mg/l) at Distances Downstream (x, m) during In-stream Construction in Four Watersheds within the SONCC ESU to Be Crossed by the Pipeline Project

Subbasin and Fifth-Field Watersheds	**Wet Open–Cut Regression TSS = y Distance (m) = x**	**Fluming Regression TSS = y Distance (m) = x**	**Dam & Pump Regression TSS = y Distance (m) = x**
Upper Rogue Subbasin			
Trail Creek	$y = 531.19\ e^{-0.0004x}$ $r^2 = 0.994$	$y = 19.77\ e^{-0.0004x}$ $r^2 = 0.994$	$y = 4.54\ e^{-0.0004x}$ $r^2 = 0.994$
Shady Cove-Rogue River	$y = 467.58\ e^{-0.0005x}$ $r^2 = 0.988$	$y = 17.40\ e^{-0.0005x}$ $r^2 = 0.988$	$y = 3.99\ e^{-0.0005x}$ $r^2 = 0.988$
Big Butte Creek	$y = 692.19\ e^{-0.0008x}$ $r^2 = 0.947$	$y = 25.76\ e^{-0.0008x}$ $r^2 = 0.947$	$y = 5.90\ e^{-0.0008x}$ $r^2 = 0.947$
Little Butte Creek	$y = 742.68\ e^{-0.0007x}$ $r^2 = 0.958$	$y = 27.64\ e^{-0.0007x}$ $r^2 = 0.958$	$y = 6.33\ e^{-0.0007x}$ $r^2 = 0.958$

Suspended Sediment Downstream Effects. Newcombe and Jensen (1996) developed six different models assessing effects of TSS on various fish and habitat groupings. As noted above, the model addressing effects on both adult and juvenile stages of salmonids (Model 1) provides the best overall assessment of general level of severity of effects for juvenile and adult coho salmon in project area streams at the time of instream construction. Input for the model includes TSS concentration (mg/l) and duration (hours) of exposure to the suspended sediments and has the form:

$$z = a + b\,(\log_e x) + c\,(\log_e y)$$

where z = SEV score, x = duration of exposure in hours, and y = concentration of suspended sediment in mg/l. Constants a, b, and c were empirically derived for Model 1, used here, and other models (see Table 3, in Newcombe and Jensen 1996). If duration of exposure is known, and z (SEV) is set as a defined value, TSS concentration for that defined SEV score can be computed as:

$$y = e^{((z - a) - b\,(\log e\ x))\,/\,c} \text{ or } y = \exp\,(((z - a) - (b\,(\log_e x)))\,/\,c$$

In any of the Newcombe and Jensen models, there is a nearly consistent range for the whole number z, varying from z – 0.5 to z + 0.49. For example, if SEV = 3, the range for that score in the exponential equation, above would be between 2.50 and 3.49; for SEV = 5, the range is 4.5 to 5.49, and so on. For any given duration of exposure (x), the TSS concentration (y) is minimized using (z – 0.5) in the solution. Using the minimum TSS concentration for any given SEV score maximizes the predicted downstream distances for that concentration when solving the regression equations in table 3.5.3-20 for each of the three waterbody crossing methods in each of the four watersheds.

Duration of Exposure. Following recommendations by NMFS (2017i), personnel with pipeline contractor EnSite USA were asked to provide typical durations, based on their experience, for in-stream time requirements for placing and removing isolation structures for streams in different width categories. High pulses of sediment suspended during dry open-cut procedures are generated during installation and removal of isolation structures prior to and after fluming or dam-and-pump installation, trenching, pipe installation, and trench backfilling. EnSite provided the following durations of typical sediment pulses for four stream width classes during installation of stream-crossing structures: for widths ≤10 feet, 2 hours; widths >10 feet to ≤25 feet, 4 hours; >25 feet to ≤50 feet, 5 hours; and >50 feet to ≤100 feet, 6 hours. EnSite also provided the following durations of sediment pulses for the same four width classes during removal of dry open-cut crossing structures: for widths ≤10 feet, 2 hours; widths >10 feet to ≤25 feet, 3 hours; >25 feet to ≤50 feet, 4 hours; and > 50 feet to ≤100 feet, 5 hours. Numbers of streams in range of SONCC coho and streams with assumed coho presence within those four width categories that would be crossed by the Pipeline in each watershed are provided in table 3.5.3-21 using the worst case of structure installation. In general, there are very few streams with widths >25 feet.

TABLE 3.5.3-21

Numbers of Streams in Range of SONCC Coho within Four Width Classes that Would Be Crossed by Dry Open-Cuts (Fluming and Dam-and-Pump) and Estimated Durations (Worst Case) for In-stream Sediment Generating Actions

Subbasin and Fifth-Field Watersheds	Total Number of Streams Crossed	Total Streams Crossed with Coho a/	Number by Width Class and Instream Duration b/ ≤10 ft 2 hours	>10 to ≤25 ft 4 hours	>25 to ≤50 ft 5 hours	>50 ft 6 hours
Upper Rogue Subbasin						
Trail Creek	6	3	4	2	0	0
Shady Cove-Rogue River	11	2	9	1	0	0
Big Butte Creek	9	2	6	1	1	0
Little Butte Creek	46	4	30	11	5	0

a/ Includes assumed presence from table 3.5.3-3
b/ Durations for structure installation by width class provided by personnel with pipeline contractor EnSite USA

SEV Scores Downstream. Durations for in-stream sediment generating actions provided by EnSite USA from table 3.5.3-21 are used in table 3.5.3-22 with minimumTSS concentrations for specific SEV scores ranging from minor behavioral effects (SEV = 1, alarm reaction) to extreme sublethal effects (SEV = 8, major physiological stress) to estimate the maximum downstream distances at which those severity of ill effects would occur to SONCC coho by in-stream construction across streams in the four watersheds.

Failures of isolation structures to exclude streamflow during fluming or dam-and-pump would result in suspended sediment entrained downstream, assumed to be equal to TSS levels generated during wet open-cut in table 3.5.3-22. Scenarios of exposures as long as six hours could occur while work crews repair the failed isolation structures. Six-hour exposure would cause SEV = 7 (moderate habitat degradation, impaired homing) for all stream widths but would not cause major physiological stress (SEV = 8) to SONCC coho. Longer exposures could be required if dry open-cut construction (flume or dam- and-pump) is abandoned, and the waterbody crossing is completed using wet open-cut construction.

Values of 0, in columns associated with specific SEV scores and TSS concentrations in table 3.5.3-22, indicate that there are no distances downstream from construction by wet open-cut or dry open-cut (flume or damp-and-pump) that the specified TSS concentration and exposure duration during a particular crossing method would generate the SEV score for that column in that watershed. For example, there is no distance downstream for construction during fluming in the Trail Creek watershed at which a SEV score = 5 if the TSS value is 59.4 mg/l and the exposure duration is 2 hours.

TABLE 3.5.3-22

Maximum Distances Downstream to Attain SEV Scores 1 to 8 with TSS Concentrations and Durations due to Wet Open-Cut, Flumed, and Dam-and-Pump Crossing Procedures in Each Watershed within the SONCC Coho ESU to be Crossed by the Pipeline Project

Construction Method Stream Widths	Duration a/	Concentration	SEV=1	SEV=2	SEV=3	SEV=4	SEV=5	SEV=6	SEV=7	SEV=8
Wet Open Cut										
All Stream Widths	**6 hours**	**TSS (mg/L) =**	**0.11**	**0.41**	**1.60**	**6.21**	**24.1**	**93.2**	**361**	**1,399**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Trail Creek			21,279	17,893	14,507	11,122	7,736	4,351	965	0
Shady Cove-Rogue River			16,768	14,060	11,351	8,643	5,934	3,225	517	0
Big Butte Creek			10,970	9,278	7,585	5,892	4,199	2,506	813	0
Little Butte Creek			12,638	10,704	8,769	6,834	4,900	2,965	1,030	0
Fluming										
Widths ≤10 ft =	**2 hours**	**TSS (mg/L) =**	**0.26**	**1.02**	**3.95**	**15.3**	**59.4**	**230**	**9,520**	**12,906**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Trail Creek			10,794	7,409	4,023	637	0	0	0	0
Shady Cove-Rogue River			8,380	5,672	2,958	250	0	0	0	0
Big Butte Creek			5,728	4,035	2,342	649	0	0	0	0
Little Butte Creek			6,647	4,712	2,778	843	0	0	0	0
Widths >10 ft to ≤25 ft =	**4 hours**	**TSS (mg/L) =**	**0.15**	**0.58**	**2.24**	**8.67**	**33.6**	**130**	**504**	**1,952**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Trail Creek			12,218	8,833	5,447	2,061	0	0	0	0
Shady Cove-Rogue River			9,520	6,811	4,102	1,394	0	0	0	0
Big Butte Creek			6,440	4,747	3,054	1,362	0	0	0	0
Little Butte Creek			7,461	5,526	3,591	1,657	0	0	0	0
Widths >25 ft to ≤50 ft =	**5 hours**	**TSS (mg/L) =**	**0.12**	**0.48**	**1.86**	**7.21**	**28**	**108**	**419**	**1,625**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Trail Creek			12,677	9,291	5,905	2,520	0	0	0	0
Shady Cove-Rogue River			9,886	7,178	4,469	1,761	0	0	0	0
Big Butte Creek			6,669	4,976	3,284	1,591	0	0	0	0
Little Butte Creek			7,723	5,788	3,853	1,919	0	0	0	0
Dam-and-Pump										

TABLE 3.5.3-22

Maximum Distances Downstream to Attain SEV Scores 1 to 8 with TSS Concentrations and Durations due to Wet Open-Cut, Flumed, and Dam-and-Pump Crossing Procedures in Each Watershed within the SONCC Coho ESU to be Crossed by the Pipeline Project

Construction Method Stream Widths	Duration a/	Concentration	SEV=1	SEV=2	SEV=3	SEV=4	SEV=5	SEV=6	SEV=7	SEV=8
Widths ≤10 ft =	**2 hours**	**TSS (mg/L) =**	**0.26**	**1.02**	**3.95**	**15.3**	**59.4**	**230**	**9520**	**12,906**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Trail Creek			7,118	3,733	347	0	0	0	0	0
Shady Cove-Rogue River			5,433	2,724	16	0	0	0	0	0
Big Butte Creek			3,886	2,193	500	0	0	0	0	0
Little Butte Creek			4,542	2,607	672	0	0	0	0	0
Widths >10 ft to ≤25 ft =	**4 hours**	**TSS (mg/L) =**	**0.15**	**0.58**	**2.24**	**8.67**	**33.6**	**130**	**504**	**1,952**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Trail Creek			8,542	5,157	1,771	0	0	0	0	0
Shady Cove-Rogue River			6,572	3,863	1,155	0	0	0	0	0
Big Butte Creek			4,598	2,905	1,212	0	0	0	0	0
Little Butte Creek			5,355	3,421	1,486	0	0	0	0	0
Widths >25 ft to ≤50 ft =	**5 hours**	**TSS (mg/L) =**	**0.12**	**0.48**	**1.86**	**7.21**	**28.0**	**108**	**419**	**1,625**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Trail Creek			9,001	5,615	2,229	0	0	0	0	0
Shady Cove-Rogue River			6,939	4,230	1,522	0	0	0	0	0
Big Butte Creek			4,827	3,134	1,441	0	0	0	0	0
Little Butte Creek			5,617	3,683	1,748	0	0	0	0	0

a/ Durations for wet open-cut indicate time to repair isolation structures after failure. Durations for dry open-cut from table 3.5.3-21.

b/ Maximum downstream distances from solving SEV equation ($Y = e^{((z-a)-b(\log_e x))/c}$) for concentration (Y) by minimizing SEV scores (Z -0.5) and using durations (hours) from table 3.5.3-21. Concentrations derived from appropriate equations, table 3.5.3-20.

The modeling results provided in table 3.5.3-22 reveal the maximum downstream distances that TSS generated by each of the crossing methods would attenuate to the concentrations shown (rows labeled TSS (mg/L) with specific durations based on stream width (groupings labeled with width category and hours) that would yield a specific SEV score (columns SEV=1 to SEV=8) for fluming or dam-and-pump crossing methods. Using estimates for fluming in streams <10 feet wide within the Little Butte Creek watershed as an example, for the range from distance = 0 (actually 50 meters downstream from the trench as applied in the Reid et al. 2004 model for average TSS generated by all activities) to distance = 843 m, SEV =4 with TSS concentration = 15.3 mg/l and duration = 2 hours. Other estimates include:

- From downstream distance = 843 m to distance = 2,778 m, SEV = 3 with TSS concentration = 3.95 mg/l and duration = 2 hours.
- From downstream distance = 2,778 m to distance = 4,712 m, SEV = 2 with TSS concentration = 1.02 mg/l and duration = 2 hours.
- From downstream distance = 4,712 m to distance = 6,647 m, SEV = 1 with TSS concentration = 0.26 mg/l and duration = 2 hours.
- Past distance = 6,647 m downstream, SEV = 0.

Evident from examining table 3.5.3-22, no flumed crossings in any of the four watersheds would yield SEV scores greater than 4 (sublethal effects including short-term reduction in feeding rates and/or short-term reduction in feeding success) for any of the stream crossing width categories. Likewise, no crossings with dam-and-pump procedures applied would cause SEV scores greater than 3 (behavioral effects, specifically avoidance response) for any of the stream crossing width categories. Except for possible failures of isolation structures that would cause TSS concentrations similar to wet open-cut procedures with exposures as long as 6 hours (discussed above), no in-stream construction would cause minor or major physiological stress (SEV scores 5 to 8, respectively; see Newcombe and Jensen 1996) or cause lethal conditions for juvenile and adult salmon. A failure of crossing isolation structures lasting for 6 hours or more would cause an SEV score of 7 or higher for at least 965 m downstream from dry open-cut crossings within three streams with critical habitat crossed in the, in the Trail Creek watershed, for at least 517 for one stream with critical habitat cross in the Shady Cove-Rogue Rive watershed, for 813 m downstream within two streams with critical habiats in the Big Butte Creek watershed, and for 1,030 m downstream within two streams with critical habitats in the Little Butte Creek watershed. To ensure an SEV score less than 7 (moderate habitat degradation; impact on homing), in-stream work to repair a failed containment structure would likely have to be restricted to less than 4 hours.

Similar analyses were conducted for individual streams to be crossed in each watershed that provide critical habitat and fresh water EFH for SONCC coho salmon. Based on stream width-specific durations of exposure to TSS (table 3.5.3-21) and the minimum TSS concentrations and concomitant maximum distances downstream produced by fluming or dam-and-pump to equate to specific SEV scores (table 3.5.3-22), the greatest risk to SONCC coho would be 1,919 m downstream during fluming in streams >25 but ≤50 feet wide within the Little Butte Creek watershed (in Salt Creek) and 1,394 m downstream during fluming streams >10 but ≤25 feet wide within the Shady Cove-Rogue River watershed (in Indian Creek, table 3.5.3-23). At those distances, SEV = 4, causing a short-term reduction in feeding rates and/or short-term reduction in feeding success for juvenile or adult coho within the distances.

TABLE 3.5.3-23

Waterbodies with Critical Habitat and Known or Assumed to Support SONCC Coho with Risks of TSS Effects Downstream Generated during Crossing and Risks of TSS Effects Generated by Crossing Nearest Neighbor Waterbodies.

Waterbodies Supporting SONCC Coho, Critical Habitat, and EFH								**Nearest Neighbor with Risk of Downstream Effects to Coho**				
Waterbodies Crossed and Waterbody ID	**Pipeline Milepost (MP)**	**Critical Habitat**	**EFH**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS Downstream During Crossing (rationale) a/**	**Maximum Distance (m) Downstream from Crossing with Highest SEV Score b/**	**Crossing Distance (m) from Coho Stream c/**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS at Confluence by Crossing Nearest Neighbor (rationale) a/**	**Maximum Distance (m) Downstream from Nearest Neighbor with Highest SEV Score b/**
Upper Rogue (HUC 17100307) Subbasin, Trail Creek (HUC 1710030706) Fifth-Field Watershed, Jackson County												
West Fork Trail Creek (ASP-202)	118.89	Yes	Spawning, Rearing	Dam-and-Pump	24	None-Low (bedrock)	1,771 SEV= 3	145	Fluming	2	None-Low (intermittent)	637 SEV= 4
Canyon Creek (NSP-11)	120.45	Yes	Spawning, Rearing	Dam-and-Pump	4	None-Low (bedrock)	347 SEV= 3	724	Fluming	5	None-Low (intermittent)	4,023 SEV= 3
Trib. to Trail Creek (ASI-206)	121.57	Yes	Spawning, Rearing	Fluming	8	None-Low (intermittent)	637 SEV= 4	1,079	Fluming	5	None-Low (intermittent)	4,023 SEV= 3
Upper Rogue (HUC 17100307) Subbasin, Shady Cove-Rogue River (HUC 1710030707) Fifth-Field Watershed, Jackson County												
Rogue River (ASP-235)	122.65	Yes	Rearing, Migration	HDD	50	None (HDD)	N/A	5,248	Fluming	4	None-Low (distance)	5,667 SEV= 2
Indian Creek (AW-278)	128.61	No	Assumed	Fluming	12	Moderate-High (perennial)	1,394 SEV= 4	113	Dam-and-Pump	15	None-Low (bedrock)	1,155 SEV= 3
Upper Rogue (HUC 17100307) Sub-basin, Big Butte Creek (HUC 1710030704) Fifth field Watershed, Jackson County												
Neil Creek (ASP-252)	132.12	Yes	Spawning, Rearing	Dam-and-Pump	5	None-Low (bedrock)	500 SEV = 3	145	Fluming	2	None-Low (intermittent)	649 SEV = 4
Quartz Creek (ASI-265)	132.75	Yes	Spawning, Rearing	Dam-and-Pump	1	None-Low (bedrock)	500 SEV = 3	32	Dam-and-Pump	1	None-Low (bedrock)	500 SEV = 3
Upper Rogue (HUC 17100307) Sub-basin, Little Butte Creek (HUC 1710030708) Fifth field Watershed, Jackson County												
Salt Creek (ESP-34)	142.57	Yes	Spawning, Rearing	Fluming	40	Moderate-High (perennial)	1,919 SEV = 4	129	Fluming	1	None-Low (intermittent	843 SEV = 4
Trib. to Long Branch Creek (ESI-38)	144.11	No	Assumed	Fluming	1	None-Low (intermittent)	843 SEV = 4	48	Fluming	3	None-Low (intermittent)	843 SEV = 4
NF Little Butte Creek (ESP-66)	145.69	Yes	Spawning, Rearing	Fluming	49	Moderate-High (perennial)	1,919 SEV = 4	193	Fluming	2	None-Low (intermittent)	843 SEV = 4
Trib. to NF Little Butte Ck. (ESI-56)	146.05	No	Assumed	Fluming	17	None-Low (intermittent)	1,657 SEV = 4	531	Fluming	3	None-Low (intermittent)	843 SEV = 4

a/ Risks from downstream TSS by crossing all streams with bedrock substrate are considered None to Low; risks of downstream TSS crossing intermittent streams are considered None to Low; risks from downstream TSS by crossing perennial streams are considered Moderate to High.
b/ Highest SEV scores for each given crossing method and stream width category in specific watershed provided in table 3.5.3-22
c/ Distance for confluence of nearest neighbor stream with coho stream is assumed to be the same as the distance between the two stream crossing sites, forming an equilateral triangle.

The possibility for known or assumed salmon-bearing streams to be affected by TSS generated during dry open-cutting neighboring streams was also explored at the request of NMFS (2017i). Distances of nearest neighboring streams from each salmon-bearing stream are included in table 3.5.3-23. Nearest-neighbor streams are only considered for effects if they are within the same fifth field watershed as the targeted stream. Distance for the confluence of a nearest neighbor stream with a coho-bearing stream is assumed to be the same as the distance between the two stream crossing sites, forming an equilateral triangle. For each neighboring stream, downstream distances for TSS concentrations that produced the highest SEV score were computed with the same procedure described and available in table 3.5.3-22. If a nearest neighbor stream had bedrock substrate, dam-and-pump crossing was assumed, otherwise a flumed crossing was assumed. If the nearest neighbor distance to a salmon-bearing stream exceeded the maximum distance with highest SEV score downstream from the neighbor stream, then "None-Low" of TSS to the salmon-bearing stream produced during construction of the neighboring stream is assumed. In table 3.5.3-23, the nearest neighbor to the Rogue River is 5,248 m away which is with the downstream distance of 5,667 m at which the TSS concentration would cause a SEV score of 2 during construction across that nearest neighbor stream. Consequently, there would be no effects from crossing the nearest neighbor stream to the Rogue River. In table 3.5.3-23, risks from downstream TSS by crossing any stream with a bedrock substrate are considered "None-Low" because fine sediment (silt and clay) would not be mobilized in the water column; risks of downstream TSS crossing intermittent streams are considered "None-Low" because those streams would likely be dry during the in-stream construction period (ODFW 2008); risks from downstream TSS by crossing perennial streams are considered "Moderate-High" because flowing water would be present at the time of construction. In all other cases, construction across nearest neighbors could generate some level of risk for elevated TSS concentrations in the known or assumed salmon-bearing streams crossed in the range of SONCC coho although no severity of ill effects would exceed SEV = 4 for sediment produced in a coho-bearing stream by crossing a nearest neighbor stream. However, the estimated TSS concentration at any nearest neighbor tributary confluence would be diluted by greater flow rates and water volumes in larger receiving streams occupied by coho and therefore the estimated SEV in the coho stream would be considerably less than at the confluence.

A similar analysis of sediment effects on EFH streams known to support SONCC coho that are not directly crossed by the Pipeline but have a tributary that would be crossed and which could have an effect on the EFH fish-bearing stream is provided in Section 4.2.3.2. However, conducting the analysis required a different methodology than used in the nearest neighbor analysis provided for SONCC coho, above.

Suspended Sediment - HDD

An HDD crossing would be used on the Rogue River at MP 122.7. An HDD involves drilling a pilot hole, then enlarging that hole through successive reaming. High pressure drilling fluids, usually consisting of a slurry made of bentonite clay mixed with water, would be jetted at the drill head to advance the hole. Pipe sections long enough to span the entire crossing would be staged and welded along the construction work area on the opposite side of the waterbody, hydrostatically tested, and then pulled through the drilled hole. The right-of-way between the entry and exit hole of an HDD would generally not need to be cleared or graded, except for the area of the guide wires, and direct impacts on the waterbody, adjacent riparian vegetation, and associated aquatic resources would be avoided through an HDD. An HDD should not result in an increase of suspended sediments into the stream crossed, unless there is an "inadvertent return" or release of drilling mud, as discussed below.

According to GeoEngineers' (2017h) Feasibility Analysis for construction using HDD across the Rogue River (see appendix E), the design length of the Rogue River HDD crossing is approximately 3,050 feet. The proposed entry point is located in a relatively flat, lightly wooded area east of Rogue River and west of Old Ferry Road, approximately 650 feet from the east river bank. The exit point and pipe-stringing area are located within uplands approximately 2,100 feet west of the river within a drainage basin that drains to the river south of the crossing. The HDD exit location was extended away from the west river bank to avoid affecting several roads including State Highway 62, which is between the river bank and the exit. .. The HDD design indicates 56 feet of streambed cover in the river channel over the pipe. Based on the evaluation, an HDD crossing is feasible from geologic, land use, and geotechnical perspectives.

A qualitative hydraulic fracture and drilling fluid surface release analysis to characterize the risk of hydraulic fracture and drilling fluid surface release was conducted. However, a numerical analysis was not conducted because the vast majority of the HDD path is located within bedrock, and the numerical analysis method (cavity expansion theory) generally applies to soil materials rather than hard rock. There is a relatively low risk of drill hole collapse along the portions of the HDD profile that are located within the bedrock, although there is a moderate risk for localized hole instability along the HDD profile, specifically within about 50 to 100 feet of the entry and exit points where the HDD profile passes through alluvial and colluvial soils, and the cover between the HDD profile and the ground surface is relatively thin. As is typical with most HDD installations, the risk of drilling fluid surface release within about 100 feet of the entry and exit points is relatively high (GeoEngineers 2017h). The potential disturbance of riparian vegetation at the Rogue River HDD would be limited to incidental trimming of vegetation using hand tools directly over the pipeline along an approximately five-foot-wide footpath. This minor clearing is required to facilitate the temporary deployment of HDD guidance (telemetry) cables along the ground during construction and to perform a leakage survey after installation and commissioning. This is a relatively small area along the riparian zone of any stream and would have minimal adverse effect on aquatic resources.

Inadvertent Release of Drilling Mud (Inadvertent Return)

The HDD installation method is considered an effective technique for avoiding in-stream impacts by eliminating the need for in-stream excavation (Reid and Anderson 1998; Reid et al. 2004). Even with this technique, there is a potential for impact as a result of the HDD process. Drilling requires use of a drilling mud for lubrication of the bit and removal of cuttings. A non-toxic, biodegradable bentonite clay mixture makes up drilling mud. Because the drilling mud is under pressure during drilling, if the bit encounters substrate fractures or channels, it is possible for bentonite to escape from the hole (termed an "inadvertent return"). Bentonite can escape to the surface through fractures in the drilled substrate.

Bentonite by itself is generally considered a non-toxic drilling mud (Breteler et al. 1985; Hartman and Martin 1984; Sprague and Logan 1979), although according to Reid and Anderson (1998), the toxicity of bentonite (sodium montmorillonite) in fresh water ranges from 5,000 to 19,000 ppm (mg/liter) based on 96-hour tests for LC50 (the concentration at which 50 percent of the test population dies after 95 hours of exposure) on rainbow trout. The toxicity classifications based on LC50 values ranged from “slightly toxic” (5,000 ppm) to “practically non-toxic” (19,000 ppm) (Reid and Anderson 1998). In other tests, toxicities to lake whitefish and rainbow trout demonstrated threshold concentrations of 16,613 and 49,838 ppm (mg/l), respectively (Reid and Anderson 1998). More recently, toxicity to rainbow trout (LC50, 96-hour) was reported to be 19,000 mg/l (ClearTech 2015). LC50 concentrations >10,000 ppm would be considered “practically non-toxic” (Reid and Anderson 1998)..

Bentonite, as with any fine particulate material, can interfere with oxygen exchange by the gills of aquatic organisms (EPA 1986). The degree of interference generally increases with water temperature (Horkel and Pearson 1976). Impacts would be localized and would normally be limited to individual fish in the immediate vicinity of the inadvertent return. The majority of highly mobile aquatic organisms, such as fish, would be able to avoid or move away from turbidity spots and plumes (Reid and Anderson 1999). Other less mobile or immobile organisms, such as mussels and other macroinvertebrates, would incur direct mortality. Bentonite can smother macroinvertebrates and adversely affect filter-feeders (Falk and Lawrence 1973 in Hair et al. 2002 and Land 1974 in Cameron et al. 2002). Bentonite can also exacerbate or enhance the effects of toxic compounds to fish and aquatic invertebrates if those compounds are present in aquatic habitats (Hartman and Martin 1984). Similar to other fine-grained particulates, bentonite in flowing water is more likely to remain in suspension longer than in standing water. Consequently, effects to coho salmon by a release of bentonite into a waterbody would ultimately depend on volume of the release, volume of water present, and current.

The effects of an in-stream inadvertent return on spawning habitat, eggs, and juvenile survival depend on the timing of the release. If spawning habitat is nearby, redds could be affected in the vicinity of inadvertent return (Reid and Anderson 1999). While spawning would not occur during the crossing, effects may possibly occur within the immediate future unless high flows flush residual bentonite from the spawning areas. During establishment of the spawning bed, a minor addition of sediment would likely be cleaned out by the female as part of the normal preparation behavior. However, a heavy sediment load dispersing downstream could settle into spawning beds and clog interstitial spaces, reducing the amount of available spawning habitat, which could be a limiting factor in areas of already reduced habitat. When redds are active, eggs could be buried, disrupting the normal exchange of gases and metabolic wastes between the egg and water (Anderson 1996). The impacts of sediment intrusion into the redd on larval survival are more severe during the earlier embryonic stages than following development of the circulatory system of larvae, possibly because of a higher efficiency in oxygen uptake by the older fish (Bash et al. 2001). Clogging of interstitial spaces also reduces cover and food availability for juvenile salmonids (Cordone and Kelley 1961). Benthic organisms, which coho salmon would feed on, could also be affected by burial. However, bentonite is more likely to stay in suspension than settle like common bottom sediment; therefore, in flowing water areas, effects to benthic organisms from burial due to inadvertent return are likely to be low. The location where any inadvertent return may occur is the Rogue River, which would be affected less because of the dilution factor of large volume of water from any spill.

Reid and Anderson (1998), the Canadian Pipeline Water Crossing Committee (1999), and Reid et al. (2008) reported that 13 of 30 HDD stream crossings had drilling mud releases (citing Harder Associates 1996). The statistic is based on drilling mud releases during the early days of HDD technology (first conducted in 1971). The summary by Reid and Anderson (1998) provides a substantive description of the causes of inadvertent returns and subsequent effects to streams and habitat; drilling mud releases during HDD construction can result from:

1. Circulation losses through highly permeable gravels;
2. Mud migration along rock joints or fractures that intersect with the river bottom;
3. Loss of pilot hole directional control resulting in the intersection with the river bottom or approach slope;
4. Drilling mud pressures exceeding ground stress, widening existing or creating new fractures (hydraulic fracturing), allowing for mud migration;
5. Substantially different elevations of entry and exit drill locations. Resulting pressure head differences can cause substantial upland leakages of drilling muds once the drill bit nears the ground surface or when it breaks the surface.

Drilling mud releases may surface through river and streambeds, wetland bottoms, or at upland locations. The volume of mud released to the surface would depend on:

1. Porosity of the substrate transporting the mud;
2. Extent and size of the porous material;
3. Pressure exerted on the mud by the hydraulic system;
4. Viscosity of the mud at the time of exposure;
5. Whether mud circulation can be maintained.

Magnitude of effects by mud releases to fish, streams and habitat would depend on the following (page numbers referenced from Reid and Anderson, 1998):

1. Toxicity of the drilling mud components and additives (pages 57-59; also Table 1);
2. Increased sediment loads (page 59);
3. Effects to hydrological conditions that would cause poor conditions for wetland plant establishment and growth (pages 59-60);
4. Release into streams and rivers could cause increases in the downstream drift of stream macroinvertebrates (page 60);
5. Level of exposure to fish (e.g., concentration), duration of exposure, lifestage of fish present, timing of release, and ability of the watercourse to remove or incorporate the released muds without degrading existing habitats (page 61).

The report by Reid and Anderson (1998) summarizes the general effects, known or hypothesized, associated with drilling mud releases, but does not provide specific effects associated with each of the 13 instances cited.

Likewise, Canadian Pipeline Water Crossing Committee (1999) reported that drill mud seepage occurred in 36 of 146 cases of HDD cases reviewed with most significant leakage occurring at the drill entry or exit points due to different pressure heads with large differences in elevation between the two points. Leakage also occurred during reaming or pull-back. However, the report did not describe the effects to fish, streams and habitat in the cases with leakages or inadvertent returns. Potential inadvertent returns are more common near the HDD drill entry and exit locations; however, impacts to waterbodies are minimized by locating the drill entry and exit points away from the waterbody. The probability of an inadvertent return may increase when the drill bit is working nearest the surface (see GeoEngineers 2017h) but is dependent on numerous factors including substrate characteristics, head pressure of the drilling mud, topography, elevation, and subsurface hydrology. PCGP has proposed an HDD crossing of the Rogue River and designed this crossing such that areas of greatest risk from inadvertent return are on uplands and not adjacent to the waterbodies where much greater depth would be achieved and inadvertent return potential reduced.

Hydraulic fracture typically occurs when the drill path passes through relatively weak cohesive soils with low shear strength or very loose granular soils. Loose and silty sands and soft to medium-stiff silts and clays typically have a higher hydraulic fracture potential. Medium dense to dense sands and gravels and very stiff to hard silts and clays have a low to moderate hydraulic fracture potential. Unfractured rock, because of its high shear strength, typically has a low potential for hydraulic fracture. HDD installations with greater depth or in formations with higher shear strength may reduce the potential for hydraulic fracturing (see appendix E).

In the event an inadvertent return occurs into the river, drilling fluid would enter the waterway causing short-term, temporary water quality impacts downstream of the Pipeline project area including sedimentation and turbidity. In the event drilling fluid is inadvertently released into the river, the behavioral avoidance response of SONCC coho is presumed to be triggered within the immediate vicinity of the release, and the fish are expected to return and utilize the affected area shortly after the inadvertent release has been halted. PCGP developed its *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations* (see appendix D), which describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The HDD Contingency Plan also includes procedures for cleanup of drilling mud releases. If significant concentrations are found during monitoring as a result of a release, the following possible corrective measures would be taken:

- Deployment of containment structures, if feasible, and removal of drilling mud from substrate and streambanks, if possible.
- Increase the drilling fluid viscosity in an attempt at sealing the point at which fluid is leaving the drilled hole. The drilling operation may be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the higher viscosity drilling fluid.
- If increasing the drilling fluid viscosity is ineffective, lost circulation materials (LCM) may be introduced into the hole by incorporating them in the drilling fluid and pumping the material down-hole. The drilling operation may again be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the lost circulation materials.
- Depending on the location of the fractured zone, a steel casing may be installed that is of sufficient size to receive the largest expected down-hole tools for the crossing. This casing installation provides a temporary conduit for drilling fluids to flow while opening the remaining section of the hole to a diameter acceptable for receiving the proposed pipe sections. To alleviate future concerns with the steel casing after the HDD installation is completed, the casing is generally extracted from the hole prior to or just after completing the HDD installation. However, there have been instances when attempts at extracting the steel casing were unsuccessful.
- In the event drilling fluid flow is not regained through the annulus of the drilled hole and a steel casing installation is not utilized, the HDD contractor may elect to install a grout mixture into the drilled hole in an attempt to seal the fractured zone. The down-hole drilling assembly is generally extracted, and the existing hole is re-drilled to the point at which it had previously been drilled prior to having encountered the loss of drilling fluid.

- In addition, a grouting program may be implemented from the surface in the event that the installation of grout into the drilled hole is unsuccessful. This approach is only practical in areas where drilling rigs with vertical drilling capabilities can access the HDD alignment. If a surface grouting program is utilized, the HDD drilling assembly is extracted from down-hole. Multiple holes are then drilled vertically on either side and along the HDD alignment to allow for grout slurry to be pumped into the fracture zone where the drilling fluid had previously been lost from the drilled hole. This process can take several days to complete in order to insert the grout in a grid pattern that covers the full fractured zone, during which time the HDD operation is suspended. Upon completion of the surface grouting program, the HDD operation would resume and the pilot hole would be reestablished through the grouted formation.

In some instances, it may be determined that the existing hole encountered a zone of unsatisfactory soil material, and the hole may have to be abandoned. If the hole is abandoned, it would be filled with cuttings and drilling fluid.

Overall at the site of any inadvertent return, the amount of drilling mud released into a waterbody would be low. The HDD location on the Rogue River has large volumes of water and swift flows, where the drilling mud would be diluted. In the unlikely event of an inadvertent release of drilling mud from an HDD in the Rogue River, there would be minor short-term adverse effects to aquatic resources including coho salmon.

Suspended Sediment – Conventional Boring

A direct bore method would be used at crossing of the Medford Aqueduct Ditch at MP 133.7. There are different kinds of boring methods, including jack and bore, slick bore, and hammer bore. The type of method to be used at specific locations has not yet been determined by PCGP. During a standard boring operation, pits are excavated on both ends, with spoil from the bore passed into the pit and removed by trackhoe. The walls of the bore pits may have to be supported by trench boxes or metal sheet piling. If groundwater seeps in to the bore or bore pits, a dewatering system would need to be used. Pipe would be welded in the pit, and passed through the bore hole. Bores should not result in increasing suspended sediments into the streams crossed. Although there may be some risks of failure associated with conventional boring (examples include cobble, gravel other substrates incapable of supporting the bore hole, deflection of the bore by undetected buried wood or boulders, and high water tables risking collapse of bore work pits), taking into consideration that the crossing is at an aqueduct that does not contain the listed coho salmon and that active BMPs and monitoring would be used during crossing operations, no adverse effects are expected to occur to SONCC coho from the direct bore even if some boring mishap were to occur.

Movement Blockage

Of the 13 waterbodies with confirmed or assumed presence of SONCC coho salmon, all but one (Rogue River) will be crossed by dry open-cut. Dry open-cut construction is expected to block upstream movement by adult salmonids, as well as within stream movements of juvenile coho. Restrictions on migration could occur from short-term elevation of sediment and method of water diversion around the stream crossing area. As discussed above, fish are expected to abandon cover and/or avoid turbidity plumes generated by in-stream construction. In-stream construction would be completed prior to most upstream migrations by SONCC coho.

In addition, block nets would be employed at all waterbody crossings in which water is present at the time of construction. Procedures to exclude fish from the construction right-of-way, maneuvering fish downstream of the crossing site, isolating and dewatering the construction site, removing fish from within the isolated construction site during dewatering, fish handling, holding and release, and monitoring with documentation are described in the Fish Salvage Plan in appendix T. The Fish Salvage Plan was reviewed by BLM, Forest Service, and Bureau of Reclamation, and each agency submitted documentation to PCGP stating that the plan was complete.

Flumes would maintain streamflow and fish might move upstream or downstream through the flume. With the dam and pump method, coho would not be able to move upstream or downstream through the work area until the dams have been removed. Flumes and isolation structures (e.g., dams) would be removed as soon as possible following backfilling of the trench. Overall, the presence of temporary physical structures would not cause meaningful delays to adult upstream migrating coho salmon resulting in unsubstantial affects to coho salmon individuals.

Newcombe and Jensen's (1996) Severity of ill Effect (SEV) scale includes avoidance behavior (SEV = 3), a behavioral effect that changes the activity patterns or alters the kinds of activity usually associated with an undisturbed environment (Muck 2010) and may indicate juvenile and/or adult coho instream movements would be affected. Likewise, an SEV score of 3 indicates a "measured change in habitat preference" in models developed by Anderson et al. 1996. SEV scores of 3 and higher due to elevated TSS concentrations are assumed to block or interfere with fish movements during durations of exposure to the suspended sediment downstream (provided in table 3.5.3-21). Downstream distances at which SEV $\geq$ 3 during fluming or dam-and-pump construction in each 5th field watershed were provided in table 3.5.3-22.

Entrapment

Waterbody crossings using the "dry" crossing methods, flume or dam-and-pump, may result in some fish being entrapped in streams. Flumes and dams would be completely installed and functioning before any in-stream trenching disturbance occurs. Construction across a waterbody would take up to four days using dry open-cut methods, but less for small and intermediate streams.

For typical crossings, once streamflow is diverted through the flume pipe or pumped drains, but before trenching begins, fish trapped in any water remaining in the work area between the dams would be removed and released (salvaged) using the *Fish Salvage Plan* (see appendix T). Salvage methods could include seines, and/or dip nets and electrofishing (see Conservation Measures). Seining would be the primary method used to salvage fish but electrofishing methods may be used if all fish cannot be removed from the area potentially dewatered (see appendix T). All methods of capture and holding have risks of stress, injury, or mortality of fish. Fish inadvertently left within the dammed-off construction zone could be killed by impingement on pump intakes used to dewater the construction zone or would likely die once all water was removed. To eliminate or greatly reduce these effects, PCGP would contract with either ODFW or a qualified consultant to capture the fish. Fish removal personnel would be approved by ODFW and NMFS for this listed species. Personnel that would handle and/or remove fish on federal lands would also be approved by the Forest Service or the BLM or be done directly by agency personnel if approved by ODFW. Overall, some listed juvenile fry coho salmon are likely to suffer injury or mortality, but with the implementation of project conservation measures the numbers would be slight.

There are 70 waterbodies that would be crossed by dry open-cut procedures in the Upper Rogue Subbasin (table 3.5.3-3), including 13 with bedrock streambeds that may necessitate blasting and/or use of mounted impact hammers (discussed above under Acoustic Shock). However, only seven of these are known to support SONCC coho, and five others are assumed to be occupied by coho. The 12 streams (see table 3.5.3-23, excluding the Rogue River) include three in the Trail Creek watershed, one in the Shady Cove-Rogue River, two in the Big Butte Creek watershed, and six in the Little Butte Creek watershed.

The width of the construction right-or-way across waterbodies would either be 75 feet or 95 feet. Fish would be salvaged from within the 75-foot or 95-foot wide right-of-way crossing of each stream where blasting is not expected. The fish salvage area would be isolated by sand bag dams installed upstream and downstream from the centerline.

Estimates of juvenile fry coho present in at crossing sites in streams were based on all rights-of-way being 95 feet wide at each stream crossing within which coho would be salvaged. Numbers of juvenile fry coho potentially present or assumed to be present in the streams with crossed by dry open-cut (no blasting) are provided in table 3.5.3-24 and do not include numbers within streams with bedrock substrates that were provided in table 3.5.3-11. In the 10 waterbodies known or assumed to be inhabited by SONCC coho, 167 juvenile fry coho would be displaced and or salvaged prior to construction, which does not include the 67 juvenile fry coho that would be salvaged from streams with bedrock prior to blasting (table 3.5.3-11). The estimates in table 3.5.3-24 are based on no fish being herded out of the work area prior to dewatering (see Fish Salvage Plan). The actual number that would be salvaged is expected to be much less.

TABLE 3.5.3-24

Worst Case Estimates of Juvenile Fry Coho Present or Assumed as Present at Streams Crossed by Dry Open-Cut (No Blasting Assumed) and Juvenile Fry Salvaged Prior to Construction of the Pipeline Project within the SONCC ESU

Subbasin and Fifth-Field Watersheds	Dry Open-Cut w/ Juvenile Fry Coho Present, Assumed	Juvenile Fry Present at Each Crossing a/	Total Juvenile Fry Present b/	Juvenile Fry Salvaged at Each Crossing c/	Total Juvenile Fry Salvaged d/
Upper Rogue Subbasin					
Trail Creek	1	17	17	17	17
Shady Cove-Rogue River	1	15	15	15	15
Big Butte Creek	2	17	34	17	34
Little Butte Creek	6	17	101	17	101
TOTAL	**10**		**167**		**167**

a/ Juvenile Fry Present at Each Crossing based on Juveniles per Mile (see table 3.5.2-5) within a stream crossing length of 95 feet (worst case, see text).
b/ Total Juvenile Fry Present (worst case) = number of Juvenile Fry Present at Each Crossing multiplied by number of Dry Open-Cut crossings with Juvenile Fry Coho Present or Assumed.
c/ Juvenile Fry Salvaged at Each Crossing based on Juvenile Fry per Mile (table 3.5.3-5) within a stream crossing length of 95 feet (worst case, see text).
d/ Total Juvenile Fry Salvaged (worst case) = number of Juvenile Fry Salvaged at Each Crossing multiplied by number of Dry Open-Cut crossings with Juvenile Fry Coho Present. The estimate is based on no fish being herded out of the work area prior to dewatering (see Fish Salvage Plan). The actual number that would be salvaged is expected to be much less.

Riparian Vegetation Removal and Modification

Vegetated areas adjacent to waterbodies have been classified/defined in different ways depending on the resource and/or management objective being analyzed. Analyses conducted for SONCC coho have considered effects to riparian vegetation present within a one site-potential tree height (1SPTH) buffer on either side of a waterbody on both federal and non-federal lands. This analysis area was determined in discussions with NMFS, USFWS, and other federal agencies during Interagency Task Force meetings.

Riparian Reserves are areas that are managed to protect habitat for fish species, as well as other riparian-dependent plants and animals on federal lands (BLM and Forest Service lands). Riparian Reserves include areas that range in size from 1SPTH to 2SPTH buffers on either side of a waterbody, depending on the waterbody type. Analyses to coho salmon here do not consider effects to Riparian Reserves because those effects would be limited to certain federal lands and analyses provided below consider effects on all lands, hence the analysis of effects to Riparian Zones rather than to Riparian Reserves. This analysis considered all intermittent and perennial waterbodies crossed and adjacent to the Pipeline in the range of SONCC coho and also included waterbodies that are not assumed to have coho present.

Aquatic resources could be affected as a result of removal of vegetation and habitat at the waterbody crossing sites as required for construction. Short-term, physical habitat disruption would occur during trenching activities. Long-term degradation of habitats could occur if the stream contours are modified in the area of the crossing; the flow patterns are changed; and if erosion of the bed, banks, or adjacent upland areas introduces sediment into the waterbody. Loss of riparian vegetation along the banks would reduce shade, potentially increasing water temperatures, remove sources of terrestrial food for aquatic organisms, decrease LWD and the associated reduction in habitats, and potentially increase mass slope failures adjacent to waterbodies.

Much of the impact to coldwater anadromous and resident fisheries by past land uses have been alterations of riparian habitats by logging, road building, agriculture, or other developments such as residences and utility corridors. A total of 94.06 acres of vegetation with riparian zones one site-potential tree height wide (ranging from 159 feet wide for Trail Creek, to 157 feet wide for Shady Cove-Rogue River, 187 feet wide for Big Butte Creek, and 158 feet wide in Little Butte Creek watersheds) associated with waterbodies within range of SONCC coho ESU would be directly affected by all construction related activities. Less than half of the affected vegetation (41.59 acres) would be non-forested vegetation, but 20.24 acres of late successional-old growth forest and 17.97 acres of mid-seral forest would be removed within riparian zones (see table 3.5.3-25a). As discussed in section 3.5.3.2, Habitat, and presented in table 3.5.3-8, the LWD components of most aquatic habitats in watersheds occupied by SONCC coho and crossed by the Pipeline are LWD-deficient and below benchmark conditions established by ODFW.

In forested habitats, conifer trees would be replanted within the construction right-of-way and TEWAs outside of the 30-foot-wide maintenance corridor, which would revert to their pre-construction state over time. The 30-foot-wide maintenance corridor centered over the pipeline would be maintained in an herbaceous/shrub state during the life of the Pipeline, assumed to be 50 years (see table 3.5.3-25b). Over the long-term, 5.02 acres through riparian late successional-old growth forest and 3.78 acres through mid-seral forest would be maintained in an herbaceous/shrub state within riparian zones associated with SONCC coho (see table 3.5.3-25b).

In areas of riparian vegetation, PCGP would neck down to a 75-foot-wide construction right-of-way at most waterbody crossings and maintain a setback between waterbody banks and TEWAs in forested areas. Following construction, PCGP would implement measures to replant native trees and shrubs where they had been before in riparian areas and would minimize vegetation maintenance by providing a riparian strip at least 25 feet wide to be permanently revegetated on private lands and 100 feet wide on federally-managed lands as measured from the edge of the waterbody. In forested areas, replanting of native trees would occur beyond the 25- and 100-foot-wide areas, respectively. Following planting, vegetation monitoring would occur for two to three years to ensure successful revegetation. If vegetation does not meet designated goals, additional planting would occur and monitoring would continue until the desired revegetation is achieved. Within the 30-foot-wide pipeline corridor, the plants would be maintained by periodic vegetation maintenance. As required by the FERC's *Upland Plan*, PCGP consulted with the NRCS, BLM, and Forest Service regarding specific seeding dates and recommended seed mixtures for the Pipeline project area (see PCGP's Resource Report 7). The recommendations have been incorporated into the Pipeline project-specific ECRP (see appendix F). The ECRP describes the procedures that would be implemented to minimize erosion and enhance revegetation success for the entire Pipeline project.

For the Rogue River, which would be crossed by HDD, the potential disturbance in riparian areas would be incidental trimming of vegetation using hand tools directly over the pipeline along an approximately five-foot-wide footpath. This minor clearing is required to facilitate the temporary deployment of HDD guidance (telemetry) cables along the ground during construction and to perform a leakage survey after installation and commissioning. This is a relatively small area along the riparian zone of any stream and would have minimal adverse effect on aquatic resources.

Overall, restricting the low-growth vegetation area to a small portion of the total riparian right-of-way clearing would allow much of ecological function of the riparian conditions relative to coho salmon needs (e.g., shade, future LWD and organic input) to return more quickly. This would limit the overall long-term impacts of loss of riparian habitat to a small portion of each stream crossed reducing future negative effects to coho salmon resources. Some limited intermediate-term adverse effects to coho salmon habitat function would remain relating primarily to LWD reduction. The effects of riparian vegetation removal on water temperature and LWD is presented below.

A series of tables (M-2 through M-5, provided in appendix M) identify the areas (acres) of vegetation within riparian zones (1SPTH) affected by construction and operation of the Pipeline project across or adjacent to waterbodies with expected Oregon Coast and SONCC coho presence, by 5th field watershed. The tables identify general vegetation (forested by ageclass/ non-forested) within riparian zones that would be affected from the Pipeline crossing the waterbodies or from waterbodies adjacent to the Pipeline, as well as identify the acres of vegetation affected within the riparian zone that is federally designated critical habitat. Tables M-2 and M-4 identify areas (acres) of vegetation affected within Riparian Zones of waterbodies known or suspected to have Oregon Coast coho salmon presence, and tables M-3 and M-5 identify acres of vegetated affected within Riparian Zones of waterbodies known or suspected to have SONCC coho salmon presence.

Effects to waterbodies and Oregon Coast and SONCC coho due to removal of riparian vegetation and maintenance within the construction and operation corridor adjacent to but not crossed by the Pipeline project would be similar to effects to riparian vegetation for streams crossed by the Pipeline:

- Loss of riparian vegetation along the banks would reduce shade potentially increasing water temperatures.
- Decreased LWD recruitment in streams and on adjacent uplands, although current conditions of LWD in 5th field watersheds crossed by the Pipeline are generally undesirable.
- Removal of an important source of terrestrial food for aquatic organisms.
- Potentially increase mass slope failures and/or erosion due to surface runoff adjacent to waterbodies that could increase sediment in the waterbody.

Where vegetation is cleared from the riparian zone of a waterbody not crossed but adjacent to the Pipeline, a vegetation buffer (of some width but less than 1SPTH) adjacent to the waterbody is expected to remain. Consequently, effects from the Pipeline would be even less than those described for riparian zones and associated waterbodies that would be crossed. Riparian vegetation within 1SPTH that would be maintained in a herbaceous state within the 30-foot maintenance corridor during the life of the Pipeline is included in tables M-4 and M-5; the majority of riparian vegetation affected by the Pipeline is associated with waterbodies crossed by the right-of-way (61 percent with potential Oregon Coast coho presence and 81 percent with potential SONCC coho presence) not riparian vegetation associated with waterbodies adjacent to the right-of-way.

TABLE 3.5.3-25a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide) Adjacent to Perennial and Intermittent Waterbodies within Range of SONCC Coho Crossed by and Adjacent b/ to the Pipeline Project

	Forest Habitat c/					Other Habitat c						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Landowner	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Trail Creek (HUC 1710030706)												
BLM-Medford District	1.24	0.64	0	0	**1.88**	0	0	0.20	0	0	**0.21**	**2.09**
Forest Service-Umpqua National Forest	0	1.47	0	0	**1.47**	0	0	0	0	2.45	**2.45**	**3.92**
Non-Federal	0.86	1.93	0.02	0	**2.82**	0	0	1.48	0	0.47	**1.96**	**4.77**
Watershed Total	**2.10**	**4.04**	**0.02**	**0**	**6.17**	**0**	**0**	**1.69**	**0**	**2.93**	**4.61**	**10.78**
Shady Cove-Rogue River (HUC 1710030707)												
BLM-Medford District	2.74	0.12	0	0	**2.86**	0	0	0.75	0	0	**0.75**	**3.62**
Non-Federal	1.19	3.48	0.48	0	**5.15**	0	0.32	7.68	0	0.35	**8.35**	**13.5**
Watershed Total	**3.93**	**3.6**	**0.48**	**0**	**8.01**	**0**	**0.32**	**8.43**	**0**	**0.35**	**9.10**	**17.12**
Big Butte Creek (HUC 1710030704)												
BLM-Medford District	3.97	0.07	0	0	**4.04**	0	0	0.88	0	0.04	**0.92**	**4.96**
Non-Federal	0	1.70	0	0	**1.70**	0.08	0.29	2.20	0	0.72	**3.30**	**5.00**
Watershed Total	**3.97**	**1.77**	**0**	**0**	**5.74**	**0.08**	**0.29**	**3.08**	**0**	**0.77**	**4.22**	**9.96**
Little Butte Creek (HUC 1710030708)												
BLM-Medford District	3.80	0	0	0	**3.8**	0	0	4.12	0	0.20	**4.32**	**8.12**
Forest Service-Rogue River National Forest	0.63	0.12	1.07	0	**1.82**	0	0	0.19	0	0	**0.19**	**2.01**
Non-Federal	5.82	8.45	1.79	0	**16.06**	0	4.31	24.77	0	0.92	**30.01**	**46.07**
Watershed Total	**10.24**	**8.56**	**2.87**	**0**	**21.67**	**0**	**4.31**	**29.09**	**0**	**1.12**	**34.53**	**56.2**
All Fifth-Field Watersheds and Jurisdictions												
BLM-Medford District	11.75	0.83	0	0	12.58	0	0	5.95	0	0.24	6.20	18.79
Forest Service-Umpqua National Forest	0	1.47	0	0	1.47	0	0	0	0	2.45	2.45	3.92
Forest Service-Rogue River National Forest	0.63	0.12	1.07	0	1.82	0	0	0.19	0	0	0.19	2.01
Federal Subtotal	**12.38**	**2.42**	**1.07**	**0**	**15.87**	**0**	**0**	**6.14**	**0**	**2.69**	**8.84**	**24.72**
Non-Federal Subtotal	**7.87**	**15.56**	**2.29**	**0.00**	**25.73**	**0.08**	**4.92**	**36.13**	**0.00**	**2.46**	**43.62**	**69.34**
Overall Total	**20.24**	**17.97**	**3.37**	**0.00**	**41.59**	**0.08**	**4.92**	**42.29**	**0.00**	**5.17**	**52.46**	**94.06**

a/ Project components considered in calculation of habitat "Removed:" PCGP construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Includes riparian zones of adjacent streams within the construction right-of-way that are not crossed but listed in table 3.5.3-3 and streams off the right-of-way, not included in table 3.5.3-3.

c/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

TABLE 3.5.3-25b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained during the Pipeline Project within Riparian Zones (One Site-Potential Tree Height Wide) on Federal and Non-Federal Lands within Range of SONCC Coho Crossed by and Adjacent to b/ the Pipeline Project

	Forest Habitat c/					**Other Habitat c/**						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Landowner	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Trail Creek (HUC 1710030706)												
BLM-Medford District	0.35	0.20	0	0	**0.55**	0	0	0.06	0	0	**0.06**	**0.61**
Forest Service-Umpqua National Forest	0	0	0	0	**0**	0	0	0	0	0	**0**	**0**
Non-Federal	0.23	0.62	0	0	**0.85**	0	0	0.29	0	0.13	**0.42**	**1.27**
Watershed Total	**0.58**	**0.83**	**0**	**0**	**1.41**	**0**	**0**	**0.35**	**0**	**0.13**	**0.48**	**1.89**
Shady Cove-Rogue River (HUC 1710030707)												
BLM-Medford District	0.72	0.01	0	0	**0.73**	0	0	0.33	0	0	**0.33**	**1.06**
Non-Federal	0.42	0.50	0.13	0	**1.05**	0	0.09	0.68	0	0.02	**0.79**	**1.84**
Watershed Total	**1.14**	**0.51**	**0.13**	**0**	**1.78**	**0**	**0.09**	**1.01**	**0**	**0.02**	**1.12**	**2.9**
Big Butte Creek (HUC 1710030704)												
BLM-Medford District	0.75	0.01	0	0	**0.76**	0	0	0.16	0	0.01	**0.17**	**0.92**
Non-Federal	0	0.39	0	0	**0.39**	0.02	0.10	0.50	0	0.07	**0.69**	**1.08**
Watershed Total	**0.75**	**0.40**	**0**	**0**	**1.15**	**0.02**	**0.10**	**0.66**	**0**	**0.07**	**0.85**	**2**
Little Butte Creek (HUC 1710030708)												
BLM-Medford District	0.93	0	0	0	**0.93**	0	0	1.06	0	0.02	**1.09**	**2.01**
Forest Service-Rogue River National Forest	0.18	0.04	0.36	0	**0.58**	0	0	0.06	0	0	**0.06**	**0.64**
Non-Federal	1.45	2	0.74	0	**4.18**	0	0.79	6.28	0	0.17	**7.24**	**11.42**
Watershed Total	**2.55**	**2.04**	**1.09**	**0**	**5.68**	**0**	**0.79**	**7.41**	**0**	**0.19**	**8.39**	**14.08**
All Fifth-Field Watersheds and Jurisdictions												
BLM-Medford District	2.75	0.22	0	0	2.97	0	0	1.61	0	0.03	1.65	4.6
Forest Service-Umpqua National Forest	0	0	0	0	0	0	0	0	0	0	0	0
Forest Service-Rogue River National Forest	0.18	0.04	0.36	0	0.58	0	0	0.06	0	0	0.06	0.64
Federal Subtotal	**2.93**	**0.26**	**0.36**	**0**	**3.55**	**0**	**0**	**1.67**	**0**	**0.03**	**1.71**	**5.24**
Non-Federal Subtotal	**2.10**	**3.51**	**0.87**	**0.00**	**6.47**	**0.02**	**0.98**	**7.75**	**0.00**	**0.39**	**9.14**	**15.61**
Overall Total	**5.02**	**3.78**	**1.22**	**0.00**	**10.02**	**0.02**	**0.98**	**9.43**	**0.00**	**0.41**	**10.84**	**20.87**

a/ Considers terrestrial habitats that were present prior to construction within the 30-foot wide maintenance corridor.

b/ Includes riparian zones of adjacent streams within the construction right-of-way that are not crossed but listed in table 3.5.3-3 and streams off the right-of-way, not included in table 3.5.3-3.

c/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

Water Temperature

Clearing the right-of-way would remove shading vegetation from uplands and riparian areas, exposing the land and water to increased sunlight, potentially resulting in direct increases in water temperatures. Additionally, indirect increases in stream water temperatures may occur as water flows over the warmer land surface and eventually reaches the waterbody (Beschta and Taylor 1988).

The effects of water temperature on salmonid life stages have been extensively reviewed by McCullough (1999) and Richter and Kolmes (2005). Maximum water temperatures ranging from 22 to 24°C (71.6 to 75.2°F) limit distribution of many salmonid species. No salmonids can survive water temperatures exceeding 25°C (77°F) for extended periods (Ice 2008). High water temperatures can cause migratory species (including anadromous salmonids) to delay upstream migration (Bjornn and Reiser 1991), can decrease survival of spawners by increasing metabolic rates (Ice 2008), and can positively influence rates of embryo development and emergence but negatively influence dissolved oxygen concentrations, which alternatively limit rates of embryo development (Bjornn and Reiser 1991). High temperatures inversely influence solubility of oxygen in water (Ice 2008) so that introduction of organic matter with decomposition by microorganisms reduces dissolved oxygen, exacerbated by high temperatures. Along with increased fines (suspended silt and clay) and decreased relative rate of oxygen input to water (reaeration) through reduction in stream flows (Ice 2008), high temperatures can adversely affect various salmonid life stages. Coho upstream migration water temperature requirements range from 7.2 to 15.6°C (46.0 to 62.1°F), spawning requirements from 4.4 to 9.4°C (42.9 to 52.9°F), and for incubation from 4.4 to 13.3°C (42.9 to 61.9°F); preferred temperature is 12.1°C (60.8°F) and upper lethal temperatures range from 26.0 to 28.8°C (86.8 to 92.8°F), depending on previous acclimation temperatures (Bjornn and Reiser 1991).

Vegetative cover that provides shade, especially during summer, is one factor that regulates water temperature. Construction across waterbodies would necessitate removal of trees and riparian shrubs at the crossing locations that may influence stream temperature. Available information on the effects of pipeline construction in other regions on water temperature has found no or immeasurable change in temperatures. The total width of riparian area affected by shade tree removal would be small (less than 100 feet) relative to the length of any stream crossed. In one study, construction across two coldwater, fish-bearing streams in Alberta required removing forested riparian vegetation; water temperatures at construction sites and downstream did not increase above temperatures at control sites upstream from construction (Brown et al. 2002). In the Alberta study, the highest water temperature recorded was 66°F (19°C in August). In the New York study, the highest temperature was 79°F (26°C) sometime between August and October. Similarly, water temperatures measured at four coldwater streams in New York before and during pipeline construction and for three years following construction showed no short- or long-term effects on water quality parameters, including water temperature, even though such effects were expected because streambank vegetation had to be cleared, which reduced shading (Blais and Simpson 1997).

Another recent right-of-way clearing study in Oregon found little to no effect from existing and proposed right of clearing on coldwater Cascade mountain streams (Tetra Tech 2013). Monitoring of 22 existing cleared right-of-ways for transmission lines in the Cascade region along the upper North Santiam River averaging 244 feet wide found no significant temperature (peak daily average, and daily maximum) change across the clearings compared to existing uncleared areas on each of these streams. While temperature changes did occur across the clearing (average of peak daily maximum change 0.19°F/100 feet of stream), these increases were no different from the temperature changes in the uncleared wooded areas just upstream of these clearing. While these streams did retain some vegetation in the right-of-way, they were kept relatively low to ensure no issues with the power lines. Modeling of these streams using the Stream Segment Temperature Model (SSTEMP; Bartholow 2002) estimated some relatively small increases, which were generally greatest for smallest streams. The model assumed all or most vegetation would be removed from banks over a 150-foot-wide projected clearing. The results for both existing (summer 2012) and projected worst-case (likely maximum summer air temperature) environmental conditions with very conservative shade assumptions (0 and 25 percent for entire 150-foot clearings) showed an average increase of about 1.1°F (median of about 0.4°F) in the modeled maximum and maximum daily mean temperature across the assumed future clearing of these 22 streams. The small size of the streams in this study affected the model results. All but three of the streams had flow less than 1 cfs and width less than 10 feet. The three larger streams had modeled maximum temperature changes ranging from 0.0 to 0.2°F. Most of these streams had relatively low to moderate temperatures (mean maximum about 55°F); therefore, these low temperature increases were generally not expected to affect fish resources (Tetra Tech 2013).

Following requests by the Forest Service, PCGP had temperature models run by North State Resources (NSR) on six different stream segments on NFS lands in the Umpqua River basin on tributaries to East Fork Cow Creek (five crossings) and on the upper Rogue River basin on Little Butte Creek (NSR 2009). While not all of these streams are in the range of SONCC coho salmon, they are suitably representative of likely temperature changes that could be expected of streams of similar characteristics (i.e., width, flow, slope, vegetation, etc.) in regions where the ESU is located using these model parameters. Of the three smallest streams (with base flows <0.1 cfs, widths ≤3 feet), modeled average temperature increases ranged from 1.0 to 8.6°C (1.8 to 15.4°F) right after construction. Because these streams were so small they likely also would have temperatures reduced rapidly downstream of the clearing from ground water inflow and likely would have no measurable effects on streams they flow into downstream. The two five- and six-foot-wide streams would have estimated maximum increases ranging from 0.4 to 0.5°C (0.7 to 0.9°F) with maximum temperature remaining at or below 15.6°C (60.1°F) in these two streams just downstream of the crossing. These temperatures would remain well within suitable range for salmonids. The largest stream (22 feet wide) increase was estimated to be 0.02 to 0.1°C (0.04 to 0.2°F) depending on the temperature model. The modeled results, based on assumptions used about rate of vegetation regrowth, found that most temperature increases remained within the first 5 years but were approaching pre-project temperatures within 10 years. Conditions at other streams along the pipeline route may vary from these due to site-specific differences, but these results may be fairly representative of changes that may occur at forested streams along the route. Overall results suggest that, other than the very smallest streams where fish resources would be limited, changes in temperature from vegetation removal are likely to remain small and immeasurable having unsubstantial effects on fish resources.

Similarly, GeoEngineers (2017c) modeled thermal impacts within 4th Field Watersheds where streams would be crossed by the Pipeline where riparian shading vegetation would be removed within the 75-foot wide construction corridor and would be affected within the 30-foot maintenance corridor over the long-term (see table 3.5.3-25b, above). Model results show a maximum predicted increase of 0.16°C at one 75-foot clearing. The analysis showed that elevated water temperatures would return to ambient levels within a maximum distance of 25 feet downstream of the pipeline corridor, based on removal of existing riparian vegetation over a cleared corridor width of 75 feet (GeoEngineers 2017c). The results are similar to the more geographically-limited results obtained by North States Resources (NSR 2009), which suggested more thermal impact. The conclusion drawn by GeoEngineers (2017c) was that the magnitude of thermal impact caused by construction would not be expected to cause a thermal barrier to fish migration.

GeoEngineers (2017c) used the SSTEMP model by Bartholow (2002) to estimate potential temperature effects at 15 proposed crossing locations (each a 75-foot-wide clearing) along the whole route. A total of 12 of these were in the watershed range of Oregon Coast coho salmon ESU and two were in the range of SONCC coho salmon ESU. These sites would be generally representative of watershed habitat conditions where project area coho salmon may be present along the project route, although not necessarily where coho salmon are directly present. The streams selected varied from 2 to 85 feet wide (average 29 feet), moderately large streams, with only eight of these having a less than 10-foot flowing width. Conditions modeled were based on conditions measured during late August 2010 and did not consider maximum potential air temperatures though they were likely representative of summer conditions. The average modeled increase for these 15 streams was 0.03°F, and the maximum increase among the streams was 0.3°F. Overall, these estimated changes are relatively low. They are lower than the NSR (2009) estimates for one comparable stream, but model conditions were slightly different. The GeoEngineers model assumed a 75-foot-wide clearing, whereas the NSR model assumed a 95-foot-wide clearing and other parameter differences that would contribute to the different results.

As a rule, the effect of water temperature of a non-fish-bearing tributary on water temperature of a fish-bearing receiving stream is determined as the weighted mean of the two water temperatures, weighted by respective volumes or in-stream flows. If T_1 = temperature of tributary with F_1 = flow rate, and T_2 = temperature of receiving stream with F_2 = flow rate, then the resulting water temperature T_R at the confluence of the two waterbodies would be:

$$T_R = (T_1\ F_1 + T_2\ F_2) / (F_1 + F_2)$$

For example, Hydrofeature N is an unnamed tributary to East Fork Cow Creek crossed at MP 111.01. Pipeline construction would increase the water temperature by 8.6°C (15.5°F) from its base temperature of 11°C (51.8°F) (see NSR 2009). The water temperature would be increased to 19.6°C (67.3°F), but its reported summer base flow is 0.002 cfs. ODEQ measured water temperature within East Fork Cow Creek during September 1998, reported at 13.5°C (56.3°F). No in-stream flow data are available for East Fork Cow Creek, but the USGS (Gage 14309500) has measured flows in West Fork Cow Creek, reporting an average flow of 11.4 cfs during September. Using those data to illustrate how water temperatures would be combined by the weighted average, the resulting water temperature of Hydrofeature N and the receiving stream would be T_R = (19.6°C x 0.002 cfs + 13.5°C x 11.4 cfs) / (0.002 cfs + 11.4 cfs) = 13.501°C (56.302°F). The increase of water temperature in the receiving stream by the tributary water temperature would be immeasurable [in this illustration the increase would be 0.001°C (0.002°F)].

PCGP has proposed supplemental riparian plantings as outlined in the ECRP (see appendix F) to help ensure that the core cold-water habitat temperature criteria are not exceeded at the maximum point of impact. These measures are designed to speed up the rate of riparian area recovery and provide more effective shade immediately following construction. Much of the riparian area would be allowed to regrow from plantings with herbaceous plants (only 10 feet wide would be maintained without some growth) and conifer and other trees (all but 30-foot width). On small streams and to a lesser extent on larger streams, even 10- to 15-foot-high trees would supply shade, reducing solar heating effects on streams. Thus, plantings and vegetation regrowth in riparian areas would help moderate potential temperature increases in the short-term (a few years). PCGP would install supplemental transplanted trees on the Umpqua National Forest within the riparian areas of East Fork Cow Creek (i.e., 15 to 20 feet tall with full crowns) to increase riparian area canopy closure and placing LWD and boulders to create micro-topography within the wetted stream channel (see the ECRP). Shading from transplanted vegetation and micro-topographic features incorporated into the final grading plan are likely to reduce the heat load enough to reduce the likelihood of measurable water temperature increases. PCGP modeled the potential benefit of post project effective shade created by these mitigation measures on the Umpqua National Forest. The results of the 10-year post-project modeling time step was used to predict the benefits of the mitigation measures because the trees that would be transplanted provide at least the same shade values as predicted for this time step. The predicted water temperature changes are small, with less than a 0.3°C (0.5°F) change at the point of maximum impact, with no increase at the stream network scale (NSR 2009). Thus, based on the model, the slight effects of solar heating from clearing would gradually be reduced or completely eliminated over time, at most between 5 and 10 years. Inclusion of the measures improves the certainty that riparian area clearance and stream channel disturbance activities within the construction right-of-way would not cause measurable water temperature increases at the maximum point of impact or at the stream network scale.

Based on available information, any changes in water temperature related to the 75-foot-wide right-of-way vegetation clearing at waterbody crossings are likely to be very small and undetectable through measurements, except for possibly the very smallest and often intermittent flowing streams. Any temperature changes that may occur would gradually be reduced or eliminated over time as most riparian vegetation, from plantings and natural vegetation growth, increases in size and thus increases stream shading. Adverse effects on coho salmon resources along the route would be discountable due to limited distribution of any measurable changes to regions within the 13 waterbodies with confirmed or assumed presence of SONCC coho.

Large Woody Debris

A potential effect on fisheries that would result from forest clearing at pipeline crossings of waterbodies is the reduction of LWD in streams and on adjacent uplands (Harmon et al. 1986; Sedell et al. 1988). Large logs provide in-stream hydraulic complexity, which contributes to habitat complexity and the formation and maintenance of pools, riffles and other habitats which are critical to salmonid spawning and juvenile rearing. As the size of individual logs or accumulations of logs increases, the size and stability of pools that are created also increase (Beschta 1983). Riparian forests that undergo harvesting of large trees take on secondary-growth characteristics and contribute lower quantities of woody debris than unmanaged, old-growth forests (Bisson et al. 1987). However, sufficiently wide, carefully managed riparian buffers that retain a full complement of ages, sizes, and species of native trees and vegetation can ensure adequate recruitment of LWD to streams (Bisson et al. 1987; Murphy and Koski 1989).

Existing conditions associated with riparian vegetation within all fifth-field watersheds in the Upper Rogue Subbasin crossed by the Pipeline (see discussion related to table 3.5.3-8) are generally undesirable. Streams in the watersheds are deficient in numbers of LWD pieces per length of stream channel, in volume of LWD, and in numbers of key pieces (60 cm or greater in diameter by 12 meters or greater in length) per unit of stream length. There are too few large conifers along most stream reaches and LWD numbers, volume, and presence of key pieces tend to be below benchmark levels. The Pipeline project would remove 18.08 acres of late successional-old growth (LSOG) forest and 17.47 acres of mid-seral forest within riparian zones in watersheds occupied by SONCC coho (see table 3.5.3-25a), which would affect recruitment of LWD at those sites. Of the total riparian forest affected (including regenerating forest stands), 6.11acres would be removed in the Trail Creek watershed, 7.93 acres within the Shady Cove-Rogue River watershed, 4.80 acres within the Big Butte Creek watershed, and 19.97 acres within the Little Butte Creek watershed.

PCGP has proposed to use on-site mitigation for impacts to waterbodies by installing LWD at agency and land owner-approved and appropriate areas within the construction right-of-way across certain waterbodies (see section 3.5.3.4, Conservation Measures). The use of LWD as a mitigation measure for impacts associated with in-stream construction has been documented as an effective means of creating in-stream habitat heterogeneity, reducing streambank erosion, reducing sediment mobilization (Bethel and Neal 2003), and enhancing local fish abundance (Scarborough and Robertson 2002). Placement of LWD on the streambanks and in the streams can provide slight shade and increase bank stability while vegetation is maturing following construction. Additionally, placement of LWD in streams or on streambanks can provide habitat as substrate for benthic invertebrates, an important food source for salmonids and also increase habitat for forage species with the creation of pools and enhancement of the salmonid rearing potential of an area (Cederholm et al. 1997; Slaney et al. 1997). Long-term losses of LWD input would largely be mitigated through riparian replanting of conifers in the right-of-way as discussed under Riparian Vegetation and Removal above. While there may be some reduction in total stream LWD between short and long-term, the amount would be relatively small considering that, at most, 75 to 95 feet of the channel would be affected and that mitigation and enhancements would be implemented (see section 3.5.3.4, Conservation Measures). As a result, LWD changes would result in only minor intermediate-term adverse effects to SONCC coho salmon.

<u>Streambank Erosion and Streambed Stability</u>

The clearing and grading of vegetation during construction could increase erosion along streambanks resulting in higher turbidity levels in the waterbodies crossed. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. Streambank erosion, sedimentation, and higher turbidity levels related to the Pipeline project could affect aquatic resources, as discussed above. The degree of impact on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size.

The rootwad network of trees adjacent to stream supplies bank stability. Those networks within 25 feet of the stream are considered most important at providing the root source aiding in bank stability (WDNR 1997). To aid in maintaining this bank stability, PCGP would cut most trees near the bank, except those in the trench line, at ground level, leaving the root systems in place helping to maintain riparian stability. Roots would be removed over the trench line or from any steam banks that would need to be cut down or graded to accomplish the pipeline crossing.

To minimize these impacts, PCGP would use temporary equipment bridges, mats, and pads to support equipment that must cross the waterbody (perennial, intermittent, and ephemeral if water is present) or work in saturated soils adjacent to the waterbody. PCGP would also install sediment barriers, such as silt fence and straw/hay bales, across the right-of-way at the edge of waterbodies throughout construction except for short periods when the removal of these sediment barriers is necessary to dig the trench, install the pipe, and restore the right-of way. Practices to minimize streambank erosion are provided in the ECRP (see appendix F).

The FWS expressed concerns that more detailed site-specific information on bank material, streambed composition, shoreline vegetation and other information is needed to adequately ensure that actions occurring at a stream crossing do not significantly increase streambank erosion and streambed instability. PCGP, in response to these requests, conducted an initial assessment of crossing conditions of all streams suitable for analysis based on the FWS risk matrix (GeoEngineers 2017d). GeoEngineers, using a combination of field and GIS data, rated proposed stream crossings based on the matrix along the entire route including 20 streams in the range of SONCC coho, included in table 3.5.3-3. Each crossing was rated as low, medium, or high for each of the two axes based on the Pipeline impact potential at the crossing and the relative stream response potential at the crossing (all of the 20 stream crossings were placed into one of nine categories, such as Low–Low, Low–Medium, and Medium–High). Crossings of all streams except for Neil Creek were evaluated as having sensitive streambed, banks, or riparian revegetation conditions that would require site-specific measures to maintain channel stability or replace disturbed habitat (GeoEngineers 2017d). The crossing of Neil Creek would require typical stream crossing methods because it is rated as a low level of sensitivity. No crossing was rated as having both high risk of project impact potential and high risk of stream and site response potential.

In the range of SONCC coho, Project-typical BMPs would be applied to all streams, while site-specific BMPs would be applied to 19 stream crossings based on their rated category of risk as having sensitive streambed, banks, or riparian revegetation conditions. Stream crossings that are unstable can ultimately adversely affect aquatic resources through loss of local habitat and impacts to downstream habitat from the addition of highly unstable sediment, increasing the recovery time of the specific site to stable conditions.

In addition, substrate characteristics and physical habitat features would be determined through pre-construction surveys, and the upper one foot of existing substrate would be replaced and other physical conditions matched during reconstruction after pipe installation. Clean spawning gravel would be top dressed as appropriate and composition would be based on pebble counts or other appropriate methods on a site-specific basis. PCGP would make some exceptions to this in difficult to access areas, in which case native material comparable to the existing substrate would be used. Many of these actions would be determined prior to construction based on results of the pre-construction survey (see below) and determined by a qualified EI or suitably trained professional who would have the authority to select appropriate site-specific BMP construction methods, bank stability actions, revegetation types, and methods to help reduce the risk of instability of the crossing and potential for future erosion (GeoEngineers 2017d).

A pre-construction survey would be conducted by a technically qualified team on all stream crossings to confirm and clarify conditions developed in the aforementioned matrix analysis. This team would be professionals qualified to assess terrestrial and aquatic habitat and the geotechnical and geomorphic conditions relative to construction across stream channels and ditches. Following these surveys, if significant changes were to occur to parameters of the risk matrix for a crossing, changes would be made to risk level and appropriate final methods of crossing and BMPs applied at each stream crossing. If any crossing is moved into the "high" impact and "high" stream response risk matrix category, a site-specific crossing design would be developed for that site. Project construction would then move forward as described in the permit documents including implementation of special additional BMPs, as described in GeoEngineers (2017d, 2017e, and 2018a), depending on individual site conditions. For waterbodies evaluated as having Low to Moderate Project Impact Potential and Low Site or Stream Response Potential in the Risk Matrix Evaluation (the Blue Management Category, with PCGP Project Typical Construction), BMPs potentially utilized for post-construction site restoration include seeding, planting, and hydromulch or erosion control blankets to minimize surface erosion while new vegetation becomes established, as outlined in the ECRP (see appendix F). Typical site revegetation and backfill will be used to address habitat issues at these sites.

For waterbodies evaluated as having Low to Moderate Project Impact Potential and Moderate Site or Stream Response Potential in the Risk Matrix Evaluation (the Yellow Management Category, having sensitive bed, bank or riparian revegetation conditions selected by the Environmental Inspector or PCGP representative during construction), special, more robust BMPs (in addition to Project Typical BMPs noted in the paragraph above) would include those targeting the streambed component (stratified backfill for high gradient streams, structural fill placement, bank graded/terraced to 3:1, geotextile reinforced slope, fiber rolls) and the streambank component (stream barbs/flow deflectors, toe rock placement, riprap placement, biotechnical "vegetation" riprap, tree revetments). As indicated in GeoEngineers (2017e), typical BMPs were developed for sites in the Yellow management category to address risks posed by bed and bank instability or degradation to existing high quality aquatic habitat. These site-specific BMPs were developed based on field observations of natural analog structures and widely accepted techniques for bank restoration, bed restoration, and aquatic habitat restoration techniques; typical designs of these BMPs are provided in Appendix B to GeoEngineers (2017e).

Waterbodies evaluated as having Low to Moderate Project Impact Potential and High Site or Stream Response Potential in the Risk Matrix Evaluation (the Orange Management Category, having sensitive bed, bank or riparian revegetation conditions selected by qualified professional prior to construction based on site-specific information from pre-construction evaluation) have the highest potential risk for short and long-term channel stability. As described in GeoEngineers (2018a), site-specific restoration plans were developed for crossings that were assessed to be within the Orange management category based on the findings of the preconstruction surveys. The need for site-specific designs is due to more complex geomorphic or hydraulic features that increase risk of channel response to the pipeline or unique, high-value habitat features. Site-specific designs were developed using results of the preconstruction surveys, including geomorphic/hydraulic/habitat observations, topographic cross sections, and profiles collected using a hand level and stadia rod. A written description of site-specific features and restoration priorities, and design drawings are presented for each crossing in Appendix C to GeoEngineers (2017e).

For waterbodies evaluated as having High Project Impact Potential and Low to Moderate Site or Stream Response Potential in the Risk Matrix Evaluation (the Green Management Category, applying Project Typical BMPs with habitat enhancement BMPs) PCGP would use Project Typical Construction BMPs (see above). Channels in this category typically are those that disturb a greater proportion of the existing floodplain or – in narrower streams – potentially disturb more varied aquatic habitat. During site restoration, however, particular effort will be made for opportunistic habitat enhancement BMPs as detailed from observations obtained during the pre-construction survey. These enhancements could include riparian planting to improve existing habitat conditions in the floodplain, placement of large wood or rock to improve in-stream habitat, or modification of existing riprap to improve habitat. A number of the typical BMPs included in Appendix B to GeoEngineers (2018a) were designed to maintain or enhance the aquatic habitat present in the stream. These structures will often act to create complexity in the channel by scouring pools and sorting gravels as well as by providing refugia for juvenile fish. Site-specific restoration plans are provided in Appendix C (GeoEngineers 2018a).

As a follow-up measure to help ensure crossing actions would not adversely affect stream bank and channel structure, PCGP would monitor stream crossings to ensure long-term success of the restoration, maintenance of fish passage, and to identify channel erosion, scour or migration that could destabilize the site or expose the pipeline. As requested by FERC, PCGP developed a monitoring plan (GeoEngineers 2018a) following consultation with representatives from FWS and NMFS (Castro 2015). The monitoring plan would be customized, where necessary, to address risks of stream crossings identified in the Risk Analysis and those identified in subsequent preconstruction surveys.

Monitoring would consist of:

- Annual visits to all stream crossings, regardless of risk level, as part of PCGP's monitoring of pipeline integrity. These visits would be completed by PCGP staff and would note any obvious signs of channel erosion, pipeline exposure, or major shifts in restoration elements. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.
- Aerial reconnaissance would be completed annually for the life of the Pipeline, and stream crossings would be reviewed for major landscape changes such as channel migration and excessive erosion. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.
- Quarterly site visits to all sites in the Orange management category (sites with low-moderate project impact potential and high site or stream response potential, see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-

sectional area.

- Annual site visits to 15 percent of all sites in the Blue management category (sites with low-moderate project impact potential and low site or stream response potential) and 100 percent of all sites in the Yellow management category (sites with low-moderate project impact potential and moderate site or stream response potential, see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual site visits to 50 percent of the sites in the Yellow and 100 percent of sites in the Orange management category (see GeoEngineers 2018a) by a geo-professional in Years 3, 5, 7, and 10 to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the project, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Observations would be made during all site visits on the effects of cattle/elk browsing on restoration success and of impacts associated with recreational use.
- Revegetation planning along the right-of-way is detailed in the ECRP. The ECRP describes monitoring and performance standards for revegetation.
- Records would be maintained annually to document any significant hydrologic events (flow or rainfall) that occur in between site visits. This shall be done to better understand the site response to moderate or large flood events. As gauging stations are extremely limited over the majority of the crossings along the Pipeline route, rainfall records would be used to identify the potential flooding that may occur in between scheduled monitoring events. These climatic events would be considered during annual monitoring when evaluating site response.
- Unscheduled site visits may be completed at stream crossings on BLM and USFS jurisdiction following localized rainfall events exceeding a 25-year rainfall intensity to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual reporting in Years 1, 2, 3, 5, 7, and 10 following construction would be provided to outline observations of stream crossings and any remedial action taken to restore site conditions.
- Monitoring frequency and locations may be modified in response to demonstrating site restoration success in the Annual Monitoring reports.

Overall, these actions would reduce potential adverse effects from bank and bed stability to discountable levels to listed coho salmon.

Crossing of Unstable Slopes

Potential impact to waterbodies by deep-seated landslides and shallow, rapidly moving landslide hazards on unchannelized slopes is difficult to evaluate. Slope failure near the waterbody during pipeline operation could result in soil and sedimentation falling into the waterbody. PCGP evaluated all likely unstable areas during selection of the proposed route, and moved the route as necessary to areas considered to have low risk (GeoEngineers 2017k). No surveyed unstable areas have been detected within the route crossing fifth-field watersheds containing the SONCC coho salmon ESU, so adverse effects from slope failure from landslide areas are unlikely.

Aquatic Habitat

There also are potential indirect effects to aquatic habitat from increased suspended sediment from stream crossings. The same approach utilizing TSS concentration and exposure to evaluate levels of risk to fish (Newcombe and Jensen 1996) was applied to quantifying effects of sediment on fish habitat, termed the harmful alteration, disturbance or destruction (HADD) of habitat by Anderson et al. (1996). HADD risk includes concentration and exposure to sediment along with sensitivity of the habitat affected. Most likely, suspended sediment would increase embeddedness of spawning gravels with increasing adverse habitat effects closer to the construction location.

Anderson et al. (1996), adopting the approach of Newcombe and Jensen (1996), used sediment concentration and duration to model the level of adverse effects to fish habitat based on empirical studies.

Anderson et al. (1996) described five severity of ill effect (SE) ranks to habitat:

SE 3: Measured change in habitat preference.
SE 7: Moderate habitat degradation measured by a change in the invertebrate community.
SE 10: Moderately severe habitat degradation as defined by measurable reductions in the productivity of habitat for extended periods (months) or over a large area (kilometers).
SE 12: Severe habitat degradation as measured by long-term (years) alterations in the ability of existing habitats to support fish or invertebrates.
SE 14: Catastrophic or total destruction of habitat in the receiving environment.

The Anderson et al. (1996) HADD model utilizes the same form as the Newcombe and Jensen (1996) models, that is:

$$z = a + b\,(\log_e x) + c\,(\log_e y)$$

where z = SE score, x = duration of exposure in hours, and y = concentration of suspended sediment in mg/l. However, constants a, b, and c in Newcombe and Jensen's Model 1 for juvenile and adult salmonids (a=1.0642, b=0.6068, and c=0.7384) differ in the Anderson et al., (1996) multivariate model for SE to habitat (a=0.032, b=1.008, and c=0.978). As a consequence, for any given duration of exposure (from 2 hours to 6 hours, see table 3.5.3-22), the TSS concentration that would produce a SEV = 3 in the Newcombe and Jensen Model 1 is less than the TSS concentration that would produce a SE = 3 in the Anderson et al. HADD habitat model. Because of nonlinearities in both models, the TSS concentration that would produce a SEV = 7 in the Newcombe and Jensen Model 1 is more than the TSS concentration that would produce a SE = 3 in the Anderson et al., habitat model. The SEV and SE scores are more closely aligned at lower TSS concentrations than at higher concentrations for any given duration of exposure.

Based on the models for suspended sediment concentration and duration of exposure discussed above (see tables 3.5.3-22 and 3.5.3-23), estimates were made for effects to habitat of SONCC coho salmon. Calculated values less than SEV 7 would likely be considered to have little or no substantial effect to functional habitat, while those equal to or greater than SEV 7 likely would be substantial relative to changes in functional habitat conditions for coho salmon. Similar levels of effect due to TSS concentrations and durations of exposure are assumed to apply to coho salmon.

During a failure of dry open-cut construction, TSS concentrations of up to 361 mg/l over background TSS concentrations could last for 6 hours, based on the Newcombe Jensen Model 1 during a wet open-cut (see table 3.5.3-22). If that same concentration is applied in the Andersone et al., HADD model with duration of 6 hours, the SE score is >7 but <8, indicating slightly more damage to habitat than "moderate habitat degradation measured by a change in the invertebrate community." To ensure a SEV score less than 7 for either model, in-stream work to repair a failed containment structure would likely have to be restricted to less than 4 hours. In cases of uninterrupted dry open-cut construction, no substantive adverse effects to coho salmon habitats downstream are expected to occur from sediment generated during stream crossings.

Freshwater Stream Invertebrates

Substrates downstream from in-stream construction sites could be impacted by sediments. Mayflies, caddisflies, and stoneflies prefer large substrate particles in riffles and are adversely affected by fine sediment deposited in interparticulate spaces (Cordone and Kelley 1961; Waters 1995; Harrison et al. 2007). Fish and benthic macroinvertebrate abundance downstream of pipeline construction sites have been reported as short-term reductions following construction-generated suspended sediment (Reid and Anderson 1999). Macroinvertebrate abundance and community composition are highly related to the degree to which substrate particles are embedded by fine material (Birtwell 1999).

Fish emigrate from construction sites and benthic taxa drift downstream to sites where sediment deposition has not affected habitat suitability (Reid and Anderson 1999). In Ontario, stream crossing construction using fluming produced less turbidity and sediment concentrations downstream than construction by wet open cutting streams; wet open cutting resulted in a significant decrease in aquatic invertebrates downstream three days post-construction (Baddaloo 1978 cited in Gartman 1984). One year after construction, there were no significant differences in benthos numbers. Reid et al. (2008) summarized the results of nine wet open-cut pipeline stream crossing studies and noted all measured effects to downstream stream invertebrate population abundance or diversity (six of nine studies) were less than a year in duration with three studies having no measured effects on invertebrate abundace. In general, the percentage of types of stream benthos and invertebrate taxa affected by construction would be in proportion to their abundance during the season of construction, which is likely to be relatively high as crossings would occur during the summer growing season.

Although the discussed studies indicate pipeline construction reduces downstream benthic organism presence, rapid colonization by benthic organisms of disturbed substrate following pipeline construction has been demonstrated elsewhere. In Pennsylvania, samples taken before and 30 days after pipeline construction revealed rapid recolonization of the disturbed and newly-exposed stream substrate by benthic macroinvertebrates (Gartman 1984). Similarly, the number and diversity of aquatic invertebrate taxa in coldwater streams in New York State were unchanged two to four years following pipeline construction from those measured prior to construction (Blais and Simpson 1997). Additionally, most studies of effects on stream invertebrates are based on wet open-cut crossings, which normally have much higher suspended sediment concentrations than the isolated dry stream crossing methods that would be used by the proposed project. Therefore, the overall level of effect of the pipeline crossings on freshwater stream invertebrates, unless crossing sealing failures occur, would be even less than those noted by literature and would not result in substantial reduction in growth or survival of listed coho salmon individuals.

Hydrostatic Testing

Water would be required to hydrostatically test the pipeline. Potential impacts associated with hydrostatic testing include entrainment of fish, transfer of exotic organisms between basins, reduced downstream flows, and impaired downstream uses if test water is withdrawn from surface waters, and erosion, scouring, and a release of chemical additives occur as a result of test water discharge. PCGP would obtain its hydrostatic test water from commercial or municipal sources or surface water rights owners, the sources of which are lakes, impoundments, and streams.

There are four potential locations within the range of SONCC coho ESU where water would be withdrawn for hydrostatic testing and/or dust control. SONCC coho are present in the Rogue River from which an estimated 1,951,591 gallons would be withdrawn from critical habitat. SONCC coho are also present at North Fork Little Butte Creek, which is also critical habitat and from which 2,847,495 gallons would be withdrawn. SONCC coho are assumed to be present in South Fork Little Butte Creek, which drains Fish Lake. An estimated 2,847,495 gallons would be withdrawn from Fish Lake. The fourth water source is the Medford Aqueduct, but no SONCC coho are known or assumed to be present.

There are ten proposed hydrostatic test break sections where test water would be discharged that are within range of SONCC coho ESU. Of the ten, seven hydrostatic test break sections are farther than 0.5 mile from any waterbodies supporting SONCC coho and the other three are farther than 760 feet from coho critical habitat. There would be little to no risk of discharged hydrostatic test water accidentally entering the waterbodies with designated critical habitat.

Discharge volume at each site ranges from about 0.2 to 3.3 million gallons at rates ranging from several hundred to several thousand gallons per minute. Total water used would be about 62 million gallons, with about half from impoundments or lakes, and the rest from streams, including South Umpqua River, Rogue River, North Fork Little Butte Creek, and Klamath River. Within the range of SONCC coho salmon, there are three potential water sources: the Rogue River, North Fork Little Butte Creek, and the impoundment (Fish Lake), and there are 15 potential discharge locations, 14 of which occur within the right-of-way.

PCGP would minimize the potential effects of hydrostatic testing on these watersheds by adhering to the measures in its *Hydrostatic Testing Plan* (see appendix U), including screening intake hoses to prevent the entrainment of fish and other aquatic organisms, meeting NMFS screening criteria, and regulating the rate of withdrawal to avoid adverse impact on aquatic resources or downstream flows. Where test water cannot be returned to its withdrawal source, the water would be treated with a mild chlorine treatment and discharged to an upland location (at least 150 feet from streams with no direct discharge features) through a dewatering structure at a rate to prevent scour and erosion and to promote infiltration. PCGP would obtain all necessary appropriations, withdrawal, and discharge permits through the Oregon Water Resources Department (OWRD). With the implementation of the *Hydrostatic Testing Plan* and BMPs, and obtaining required permits, adequate measures would be in place to prevent direct or indirect effects to SONCC coho salmon that may be in these stream systems.

One of the responsibilities of the EI is to ensure compliance with the requirements of FERC's Upland Plan and Wetland and Waterbody Procedures, and all other environmental permits and approvals, including the multiple plans comprising the POD (see Section 4.0 in the ECRP in appendix F). This would include compliance with the Oregon Department of Water Resources water appropriation permit conditions, which would specify water withdrawal rates and volumes. The EI would ensure that these permit conditions are followed and ensure that water withdrawal pumps used to withdraw surface water would be screened according to NOAA Fisheries screening criteria to prevent entrainment of aquatic species. When pumping water from a source, the pump head would be submerged and maintained on average at the center of the water column so as to prevent sucking in sediments and/or algae lying at the water level surface or sediments resting on the bed of the waterbody. The EI would also ensure that the targeted ramping rate would be managed such that there is no significant decrease of river flows.

Aquatic Nuisance Species

Nonindigenous Aquatic Species (NAS) are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Currently, there are 180 reported NAS in Oregon, of which 134 are documented within the USGS hydrologic basins crossed by the proposed Pipeline (USGS 2017).

In the riverine environments crossed by the Pipeline, largemouth and smallmouth bass, introduced as recreational species, prey on juvenile sockeye, coho, and Chinook salmon (Tabor et al. 2007). Management priorities in Oregon concentrate on the NAS whose current or potential impacts on native species and habitats, and economic and recreational activity in Oregon, are known to be significant (Hanson and Sytsma 2001). Some of the major potential freshwater invasive species are mussels, including the zebra and quagga mussels (*Dreissena polymorpha*, and *Dreissena rostriformis bugenisis*), as well as Chytrid fungus and other species of concern.

Aquatic nuisance species could potentially be introduced into Pipeline project area waters by basin transfer through hydrostatic testing or be carried on equipment that is moved from outside of the region or between basins. PCGP has developed BMPs and guidelines to avoid the potential spread of the aquatic nuisance species and pathogens of concern (see *Hydrostatic Testing Plan*, appendix U) in consultation with the BLM and Forest Service as well as the Center for Lakes and Reservoirs and Aquatic. If determined to be feasible for hydrostatic testing requirements, all water used in hydrostatic testing would be returned to its withdrawal source location after use; however, cascading water from one test section to another to minimize water withdrawal requirements may make it impractical to release water within the same watershed where the water was withdrawn. If it is not possible to return the water to the same water basin from where it was withdrawn, PCGP would employ an effective and practical water treatment method (chlorination, filtration, or other appropriate method) to disinfect the water that would be transferred across water basin boundaries. The hydrostatic test water would be treated after it is withdrawn and prior to hydrostatic testing.

PCGP would implement a three-step BMP treatment process to prevent the potential spread of invasive species and forest pathogens from non-municipal surface water sources used during hydrostatic testing. The hydrostatic test water treatment process would incorporate screening/filtration during water withdrawal, chlorine treatment, and upland discharge at least 150 feet from wetlands or waterbodies with no direct discharge to these features. All hydrostatic test water would be released through a dewatering device such as a straw bale structure or sediment bag, in a manner to promote infiltration. Further, all hydrostatic release locations would be monitored after construction to ensure noxious weeds have not become established.

As explained in the Hydrostatic Test Plan (see appendix U), PCGP proposes to use a treatment of 2 ppm or 2 mg/L of free chlorine residual with a detention time of 30 minutes to treat all non-municipal surface waters that would be used as a water source for hydrostatic testing purposes. Chlorinated water would be released according to ODEQ criteria to prevent water quality impacts, potential effects to aquatic species, and to minimize potential impacts to sensitive areas.

Fuel and Chemical Spills

Fisheries habitats could be adversely affected if petroleum products were accidentally discharged into aquatic environments. Such materials are toxic to algae, invertebrates and fish. Of the products likely to be present during construction, data compiled from a wide range of sources indicate that diesel fuels and lubricating oils are considerably more toxic to aquatic organisms than other, more volatile products (gasoline) or heavier crude oil (Markarian et al. 1994). Release of diesel fuel in freshwater habitats significantly reduced aquatic invertebrate densities and species richness at least 3 miles downstream, but invertebrate densities recovered within a year (Lytle and Peckarsky 2001). Impacts to aquatic habitats that primarily affect aquatic substrates – spawning, incubating and rearing habitats – can remain for much longer periods (Markarian et al. 1994).

Equipment used for construction across waterbodies could potentially release hydraulic fluid comprised of a variety of compounds, the most common of which are mineral oil-based, organophosphate esters, and polyalphaolefins (HHS 1997). Release from machinery can occur through faulty seals, hoses, sumps and reservoirs, or general system failure. Components of mineral oil and polyalpaolefins do appear to bioaccumulate in animals whereas larger molecular constituents in organophosphate esters can concentrate in fish, primarily partitioning in fat tissue (HHS 1997). In general, toxicity of organophosphate esters is greater than either mineral oil or polyalphaolefin-based hydraulic fluids when inhaled, ingested, and in contact with the skin for humans. Toxicities have not been clearly described for aquatic invertebrates or fish and would be dependent on specific chemical components (HHS 1997).

Inadvertent spills of fluids used during construction, such as fuels and lubricants, could contaminate wetland soils and vegetation if not sufficiently contained. To minimize the potential for spills and any impacts from such spills, PCGP's SPCC Plan (see appendix L) would be implemented. In general, hazardous materials, chemicals, fuels, and lubricating oils would be not be stored, nor would refueling operations or concrete-coating activities be conducted within 100 feet (150 feet on BLM and NFS lands) of a wetland or waterbody in accordance with FERC's *Procedures* (see appendix C) and the SPCC Plan (see appendix L), except where no reasonable location is possible and additional containment steps have been taken. The SPCC Plan would be updated with site-specific information prior to construction. Adherence to these plans and procedures would results in effects to the SONCC ESU coho salmon that would be discountable.

Streambed Scour

Fluvial erosion represents a potential hazard to the Pipeline where streams are capable of exposing the pipe as a result of channel migration, avulsion, widening, and/or streambed scour. The principal hazard resulting from channel migration and streambed scour is complete or partial exposure of the Pipeline within the channel from streambed and bank erosion or within the floodplain from channel migration and/or avulsion. To address this potential hazard, PCGP completed a channel migration and scour analysis (GeoEngineers 2017i and GeoEngineers 2018b). In this analysis, stream crossings along the route were evaluated with respect to potential future risk to the Pipeline that could result from channel bed scour and/or lateral migration. The evaluation was conducted in two phases: Phase I involved a desk top evaluation and small field investigation in which all stream crossings were ranked for potential risk; Phase II involved detailed field investigation and analyses of those stream crossings that were concluded to pose risk to the Pipeline based on the Phase I study.

Minimizing the effects of migration and scour hazards to the Pipeline can be accomplished with the following (GeoEngineers 2017i and GeoEngineers 2018b):

- At each channel crossing, bury the pipe below the estimated depth of streambed scour. Where bedrock is encountered at shallower depths than the estimated scour depth, the elevation of competent bedrock represents the limit of scour.
- Where feasible, place the pipe into bedrock.
- Within floodplains adjacent to migrating channels, bury the pipe below the projected depth of the channel thalweg within the 50-year channel migration zone.

The Pipeline will be designed to protect the integrity of the pipe, which may include increasing the depth of cover to more than the 5-foot minimum to accommodate the potential for long-term scour and bank stabilization. At a minimum, PCGP will design all waterbody crossings to meet U.S. Department of Transportation standards (CFR 49 Part 192). Additional depth will be evaluated and considered based on GeoEngineers' (2018b) Channel Migration and Scour Analysis or other site-specific investigations, considering the final route alignment. From the results of the Channel Migration and Scour Analysis (GeoEngineers 2018b), PCGP would bury the pipe below the estimated 100-year scour depth or into competent bedrock, whichever is shallower.

Effects to Hyporheic Exchange

The hyporheic zone is defined by the extent of surface-subsurface mixing, the hyporheic exchange that moves surface water into the surrounding alluvium and back to the river again through the porous sediment surrounding a river (Tonina and Buffington 2009). The downwelling flows of surface water supply the wetted hyporheic zone with dissolved oxygen, which sustains organisms in the aerobic environment but decomposition of organic materials in the hyporheic zone may deplete oxygen concentrations in return flows to the surface (Findlay et al. 1993; Tonina and Buffington 2009). Alternatively, nutrient enrichment to surface waters occurs with hyporheic exchange by upwelling flows (Valett et al. 1990). For example, hyporheic flow is important for surface water/groundwater interactions that influence bull trout spawning sites and use of other habitats (e.g., juvenile rearing, migration) (FWS 2005h) and presumably those of other salmonids.

GeoEngineers (2017j) developed a ranking procedure to qualitatively evaluate site conditions at waterbody crossings and the probable influence on hyporheic flow and whether a stream channel will have an active and functional hyporheic zone. The procedure assigns a value of 1 to 5 for different criteria: alluvial vs. bedrock substrate, substrate sediment size, stream flow period, presence of an upstream drainage basin, and channel gradient vs. percent drainage area contribution to the 5th field HUC upstream from the pipeline crossing. The procedure includes weighting factors emphasizing importance of some criteria over the others. In the range of SONCC coho, there was a total of 62 stream crossing evaluated in the four 5th field watersheds affected in the Upper Rogue Subbasin. Of those, four crossings (1 in Big Butte Creek and 3 in Little Butte Creek watersheds) were evaluated as having high sensitivities to hyporheic zone alterations while 20 crossings (2 in Trail Creek, 1 in Rogue River-Shady Cove, 2 in Big Butte Creek, and 15 in Little Butte Creek watersheds) had moderate sensitivities. The remaining 38 crossings scored low sensitivity to hyporheic zone alterations.

Construction of the pipeline using dry open cut construction would require removal of native stream bed and bank material from the stream. The subsequent burial of the pipeline would involve replacing those native materials back in the streambed and stream banks. At crossings with steep natural stream banks (e.g., slopes steeper than 3H:1V [horizontal to vertical]), additional stabilization measures such as compaction of backfill may be required that could locally alter stream bank permeability from pre-construction conditions. Removal and replacement of native stream material has the potential to locally disrupt the structure and organization of the hyporheic zone in the immediate area of the pipeline crossing. However, such alterations are expected to be minimal relative to adjacent unaffected streambed and stream banks and could either increase or decrease permeability over an extremely narrow segment of a stream channel, up to 12 feet in width at the maximum trench width. Local disruption of hyporheic function by construction and presence of the pipeline would not be expected to result in measureable effects to dissolved oxygen and/or nutrient enrichment and would not adversely affect coho.

BMPs that reduce the potential impacts to the hyporheic zone include the following:

- Native material that is removed from the pipeline trench during excavation across stream channels will be used to backfill once the pipe is in place in order to minimize potential changes to preconstruction permeability.
- Trench plugs will be installed at the base of slopes adjacent to wetlands and waterbodies and where needed to avoid draining of wetlands or affecting the original wetland or waterbody hydrology.

While the potential impact of pipeline construction on hyporheic exchange is considered to be low at all stream crossings considering the proposed construction methods, PCGP proposes these additional measures to further reduce the potential for even localized impacts to water quality from hyporheic exchange at the stream crossings identified as having high hyporheic sensitivity (Appendix A to GeoEngineers 2017j):

- Document streambed stratigraphy prior to construction if possible, or if not possible, during construction to aid in site restoration. Such documentation will be conducted by staff trained in recognizing and observing river channel processes. If done during construction, this may be performed by the EI after receiving suitable training.
- Segregate active streambed gravels and cobbles from underlying streambed materials (including fractured bedrock) to their natural depth and replace gravels/cobbles to this natural pre-construction depth.
- Below active stream gravels, replace native material in a manner to match upstream and downstream stratigraphy and permeability to the maximum extent practicable.

Runoff from Permanent, Temporary, Existing Access Roads (PARs, TARs, EARs), and TEWAs

Run-off from PARs, TARs, EARs, and TEWAs can result in sediment delivery affecting stream supporting SONCC coho. PCGP proposes to construct three new TARs and four new PARs within the range of SONCC coho (table 3.5.3-26). Potential for sediment delivery to streams following construction of the roads was evaluated by applying sediment and drainage assessment components of the Washington Road Surface Erosion Model or WARSEM (Dube et al. 2004) which has been previously applied in Oregon (Surfleet et al. 2011). Specific individual WARSEM modelling components have been used to evaluate levels of risk for delivery of sediment to streams nearest each TAR and PAR as well as nearest streams supporting ESA-species. Two TARs have low risks of sediment delivery to any stream but only one TAR has a low risk of delivery to an ESA stream – North Fork Little Butte Creek which supports SONCC coho with designated critical habitat. None of the other proposed TARs and PARs have any risk of sediment delivery to streams closest to new road sites.

Similar risk analyses were conducted for portions of EARs that are known to occur within 1SPTH of streams with designated critical habitat for coho and other streams known or assumed to provide habitat for coho in the two ESUs. Finally, TEWAs that are proposed within 1SPTH of critical habitat for coho were evaluated for risks of sediment delivery to coho critical habitat. BMPs proposed by PCGP that would be applied to PARs, TARs, EARs, and TEWAs to prevent sediment delivery in coho critical habitats and other coho-bearing streams are summarized from the Erosion Control and Revegetation Plan (ECRP – appendix F to the APDBA).

The risk analysis utilizes four modelling components required for sediment and drainage assessment as applied in WARSEM. The components that were evaluated for each TAR/PAR include:

- Dominant lithology – information source: Oregon Department of Geology and Mineral Industries, Oregon Geologic Data Compilation 6 (OGDC-6 geodatabase) available from http://www.oregongeology.org/sub/ogdc/index.htm. Dominant lithology coinciding with locations of each PAR or TAR was evaluated at each location.
- Road gradient – evaluated gradient at each PAR or TAR on topographic map using contour lines (rise divided by run) if road gradient >5 percent grade. If less than 5 percent, gradient was noted as 0 – 5%.
- Annual rainfall – information source: Western Regional Climate Center, Western U.S. Climate Historical Summaries available from https://wrcc.dri.edu/Climsum.html. Annual

rainfal at each location was evaluated by adjusting the average total precipitation for snowfall during the period of record for National Weather Station closest to each PAR or TAR.

- Delivery – evaluated closest distance of each PAR or TAR to any stream segment (perennial or intermittent, using National Hydrography Dataset, available at https://nhd.usgs.gov/data.html) and to each stream segment supporting ESA-listed fish using ODFW Oregon Fish Habitat Distribution Data available at https://nrimp.dfw.state.or.us/nrimp/default.aspx?pn=fishdistdata. In addition, distances of nonforested and forested vegetation intervening between road and stream segment were measured using GIS.

Technical documentation (Appendix A) in Dube et al. (2004) was used to evaluate levels of risk for erosion and sediment delivery contributed by each of these four site-specific components at each proposed PAR or TAR.

In addition to site-specific conditions, PCGP has specified road lengths and widths for each proposed PAR or TAR. Although road surfacing has not been specified, PCGP has proposed surfacing enhancements as necessary in Section 2.3 of the Transportation Management Plan (see POD). Road length, width, and surfacing are required components for use in WARSEM as well as daily average traffic volume, which is currently unknown but may be hypothesized using categorical traffic levels in technical documentation for WARSEM (Appendix A, in Dube et al. 2004) and a road age factor which is irrelevant to the evaluation of risk for sediment production since none of the proposed roads have been constructed.

The following components required for WARSEM cannot be evaluated for the PARs and TARs: and were not included in this risk analysis:

- Road prism geometry
- Cuttslope height
- Cuttslope cover
- Drainage ditch width
- Drainage ditch condition

WARSEM estimates the average annual amount of road surface erosion that is delivered to a stream from each road segment modeled by using calculations based on empirical relationships derived from road erosion research (Dube et al. 2004). The model uses the following formulas to calculate road surface erosion and sediment delivery to a stream:

Total Sediment Delivered to a Stream from each Road Segment (in tons/year) = (Tread & Ditch Sediment + Cutslope Sediment) x Road Age Factor

Tread & Ditch = Geologic Erosion Factor x Tread Surfacing Factor x Traffic Factor x Segment Length x Road (Tread + Ditch) Width x Road Gradient Factor x Rainfall Factor x Delivery Factor

Cutslope = Geologic Erosion Factor x Cutslope Cover Factor x Segment Length x Cutslope Height x Rainfall Factor x Delivery Factor

New TARs and PARs. Some of the relevant information used to derive various "Factors" necessary for WARSEM are provided in the tables, below. Percent gradient at locations of proposed TARs and PARs and the associated Road Slope Factor is provided in table 3.5.3-26. The gradient of a road segment influences the erosion rate. Three Road Slope Factors are used in WARSEM and apply to gradients estimated in table 3.5.3-26. The steepest gradient estimated for any proposed road was 9% for TAR-143.19 which corresponds to a Road Slope Factor of 1.0. Except for that road and TAR-141.10, the other the proposed road locations are on relatively flat terrain with gradients estimated from 0 to 5% and Road Slope Factors of 0.2.

TABLE 3.5.3-26

Location and Physical Characteristics for Proposed TARs and PARs in Range of SONCC Coho.

Road Identification	Fifth Field Watershed	Latitude	Longitude	Length (feet)	Width (feet)	Surface Area (acres)	Gradient (Road Slope Factor) a/
TAR-141.10	Little Butte Creek	42°29'6.129 N	122°36'41.25"W	471	25	0.44	7% (1.0)
TAR 143.19	Little Butte Creek	42°27'30.095"N	122°36'14.968"W	146	20	0.07	9% (1.0)
TAR 145.60	Little Butte Creek	42°25'36.74"N	122°35'31.543"W	391	20	0.18	0 to 5% (0.2)
PAR-113.66	Trail Creek	122°53'7.115"W	42°44'43.236"N	73	25	0.04	0 to 5% (0.2)
PAR-122.18	Shady Cove-Rogue River	122°49'4.483"W	42°38'43.179"N	181	25	0.10	0 to 5% (0.2)
PAR-132.46	Big Butte Creek	122°40'51.653"W	42°34'38.274"N	271	25	0.16	0 to 5% (0.2)
PAR-150.70	Little Butte Creek	122°32'20.863"W	42°22'58.585"N	282	25	0.16	0 to 5% (0.2)

a/ Road Slope Factors: 0.2 for gradients of <5%; 1.0 for gradients of 5-10%; 2.5 for gradients >10%. See Table A-6, Appendix A, Dube et al. 2004

Erodibility of a road segment is related to soil characteristics at the site location which are related to the parent lithology and weathering. Relative erodibility for different rock types of different geologic ages that are associated with proposed TARs and PARs are provided in table 3.5.3-27 as the Geologic Erosion Factor corresponding to each lithology. The highest Geologic Erosion Factor (5) is associated with Quaternary and Tertiary volcanic ash and tuff as well as with weathered granite and other intrusive rocks. Deeply weathered sedimentary rocks that degrade to silt and sand also have the highest Geologic Erosion Factor. Weathered schist or gneiss from the Tertiary and older formations have moderate Geologic Erosion Factor (2), and others in table 3.5.3-27 have low Geologic Erosion Factor (1).

Rainfall strongly influences erosion and sediment transport. Instead of using the PRISM climatic model as applied applied in WARSEM), data from NWS cooperating stations closest to each proposed TAR and PAR were used to evaluate average annual rainfall (average monthly precipitation adjusted for average monthly snowfall, described in Equation 6, Appendix A, Dube et al. 2004) for each station's period of record. That information is provided in table 3.5.3-27. A Rainfall Factor, derived from the average annual rainfall at the closest NWS station, is computed from Equation 7, Appendix A, Dube et al. (2004) and provided in table 3.5.3-27. In general, average annual rainfall and Rainfall Factors for proposed TARs and PARs decline with distance along the Pipeline route from west to east.

TABLE 3.5.3-27

Surface Lithology and Average Annual Total Rainfall Estimated at the National Weather Service Station (NWS) Closest to Each Proposed TAR and PAR in Range of SONCC Coho.

Road Identification	Dominant Lithology a/	Geologic Erosion Factor b/	Closest NWS Station (NWS Number) c/	Period of Record	Station Distance to Road (miles)	Average Annual Rainfall d/ (inches)	Rainfall Factor e/
TAR-141.10	Oligocene/Miocene basaltic andesite	low (1)	Lake Creek 5 SE (354534)	1955-2009	8.7	23.84	1.9
TAR 143.19	Oligocene/Miocene basaltic andesite	low (1)	Lake Creek 5 SE (354534)	1955-2009	6.9	23.84	1.9
TAR 145.60	Oligocene/Miocene basaltic andesite	low (1)	Lake Creek 5 SE (354534)	1955-2009	5.0	23.84	1.9
PAR-113.66	Eocenet tuff volcaniclastic rocks	high (5)	Trail 12 NE (358588)	1951-1970	11.2	41.03	4.2
PAR-122.18	Eocene intermediate and silicic ash flow tuff	high (5)	Lost Creek Dam (355055)	1970-2016	6.8	32.98	3.0
PAR-132.46	Oligocene/Miocene basalt, basaltic andesite and andesite	low (1)	Lost Creek Dam (355055)	1970-2016	6.2	32.98	3.0
PAR-150.70	Miocene basaltic andesite	low (1)	Lake Creek (354634)	1955-2009	1.2	23.84	1.9

a/ Dominant Lithology evaluated from Oregon Department of Geology and Mineral Industries, Oregon Geologic Data Compilation 6. Available from http://www.oregongeology.org/sub/ogdc/index.htm.
b/ Geologic Erosion Factor surmised from Figure A-1 and Table A-1 in Appendix A, Dube et al. 2004.
c/ Closest NWS Station (with Cooperator Number) based on coordinates provided in individual station data, available from Western Regional Climate Center, Western U.S. Climate Historical Summaries (available from https://wrcc.dri.edu/Climsum.html).
d/ Average Annual Rainfall derived from average monthly precipitation adjusted for average monthly snowfall, described in Equation 6, Appendix A, Dube et al. (2004).
e/ Rainfall Factor derived from the average annual rainfall at the closest NWS station, computed using Equation 7, Appendix A, Dube et al. (2004).

The Delivery Factor is a key component of WARSEM and subsequent estimation of risks by erosion and road-generated sediments to aquatic resources. Sediment transport is dependent on the slope of the hillside, infiltration capacity of the soils, volume and depth of runoff water, and obstructions on the hillside (e.g., effectiveness of vegetative buffers at trapping sediment) that would slow runoff water and trap the sediment (Dube et al. 2004). While roads farther than 200 feet from a stream are assumed not to deliver sediment to streams unless a gully exists that allows for transport of sediment from the road to the stream, roads within 100 to 200 feet of a stream are assumed to allow for delivery of 10 percent of produced sediment; roads <100 feet from a stream allow for delivery of 35 percent of produced sediment, and drainage from a road to a stream allows for 100 percent of produced sediment (see Table A-10, Appendix A, Dube et al. 2004).

This simplified scheme identifies four levels for the Road Delivery Factor in WARSEM: 0, 10, 35, and 100 (see table 3.5.3-28). Although vegetation characteristics are not factors in WARSEM, distances through nonforested and forested vegetation that intervene between each proposed road and the closest stream (and closest stream supporting ESA species) are included in table 3.5.3-28. The highest Road Delivery Factor in table 3.5.3-28 is 35 (indicating delivery of 35 percent of sediment produced by the new road) for PAR-122.18 which is 36 feet from Cricket Creek, a waterbody that does not support SONCC coho at the road location but is assumed to support SONCC coho 1,385 feet downstream from the road. TAR-145.60 is 111 feet from North Fork Little Butte Creek which provides critical habitat for SONCC coho but the Road Delivery Factor is 10, indicating delivery of 10 percent of sediment produced by the new PAR.

TABLE 3.5.3-28

Estimated Risks for Sediment Delivery to Any Closest Stream and Closest Stream with ESA Species from Each Proposed TAR and PAR in Range of SONCC Coho with Distances of Vegetation Intervening between Road and Stream

Road Identification	Closest Stream (distance)	Flow a/	Intervening Vegetation (distance)	Road Delivery Factor b/	Closest ESA Stream (distance)	Intervening Vegetation (distance)	Road Delivery Factor b/
TAR-141.10	Star Lake (210 ft)	pond	Nonforested (210 ft) Forested (0 ft)	0	Lick Creek (9,000 ft)	Nonforested (1400 ft) Forested (7600 ft)	0
TAR 143.19	Trib. to Salt Creek (290 ft)	I	Nonforested (210 ft) Forested (0 ft)	0	Salt Creek c/ (3,660 ft)	Nonforested (460 ft) Forested (3200 ft)	0
TAR 145.60	N. Fk. Little Butte Ck. c/ (111 ft)	P	Nonforested (0 ft) Forested (111 ft)	10	N. Fk. Little Butte Ck.c/ (111 ft)	Nonforested (0 ft) Forested (111 ft)	10
PAR-113.66	Dead Horse Creek (2,500 ft)	P	Nonforested (1020 ft) Forested (1480 ft)	0	None	N/A	N/A
PAR-122.18	Cricket Creek (36 ft)	P	Nonforested (36 ft) Forested (0 ft)	35	Cricket Creek d/ (1085 ft)	Nonforested (525 ft) Forested (560 ft)	0
PAR-132.46	Trib. to Quartz Creek (270 ft)	I	Nonforested (270 ft) Forested (0 ft)	0	Quartz Creek c/ (830 ft)	Nonforested (830 ft) Forested (0 ft)	0
PAR-150.70	Trib. S. Fk. Little Butte Ck. (877 ft).	I	Nonforested (570 ft) Forested (307 ft)	0	S. Fk. Little Butte Ck c/ (6,800 ft)	Nonforested (3680 ft) Forested (3120 ft)	0

a/ Flow: P = Perennial, I = Intermittent/Ephemeral
b/ Road Delivery Factor: in WRSEM = 0, 10, 35, and 100 see Table A-10, Appendix A, Dube et al. (2004).
c/ Supporting SONCC ESU Coho and Critical Habitat
d/ Supporting summer steelhead with assumed presence of SONCC Coho

The products of three site-specific erodibility factors - Road Slope, Rainfall, and Geologic Erosion factors – are provided in table 3.5.3-31. The product of the three factors is assumed to represent a level of risk for erosion from each road's surface and has been ranked as Low (product <1), Moderate (product from 1 to 5), and High (product >5). The largest three factor product is 4.2 for PAR-113.66 due to a high Rainfall Factor and relatively high Geologic Erosion Factor. Table 3.5.3-29 also includes the Road Delivery Factor for any stream closest to each proposed road. The four factor products (including the three Site Erodibility Factors and Road Delivery factor for any closest stream) have been ranked as None (product of 0), Low (product >0 to 20), Moderate (product >20 to 50), and High (product >50).

The risk analysis indicates PAR-122.18 has a high risk of sediment delivery to any stream located near it but, because of distance, poses no risk to a stream with listed fish or designated habitat. TAR-145.60 has a low risk of sediment delivery to an ESA stream, to the North Fork Little Butte (nearest stream), which is designated critical habitat for SONCC coho. None of the other new TARs and PARs in table 3.5.3-29 pose any risk for sediment delivery to any stream.

TABLE 3.5.3-29

Summary of New Road Erosion Risks and Risks of Sediment Delivery to any Stream and ESA Stream Closest to Proposed TARs and PARs in Range of SONCC Coho

	New Road Site Erodibility Factors					Any Stream Closest to New Road			ESA Stream Closest to New Road		
Road Identification	Road Slope Factor a/	Rainfall Factor b/	Geologic Erosion Factor b/	Three Factor Product	Road Erosion Risk	Road Delivery Factor c/	Four Factor Product with Delivery	Risk of Sediment Delivery to Any Stream	Road Delivery Factor c/	Four Factor Product with Delivery	Risk of Sediment Delivery to ESA Stream
TAR-141.10	1.0	1.9	1	1.9	Moderate	0	0	None	0	0	None
TAR-143.19	1.0	1.9	1	1.9	Moderate	0	0	None	0	0	None
TAR-145.60	0.2	1.9	1	0.4	Low	35	13	Low	35	13	Low
PAR-113.66	0.2	4.2	5	4.2	Moderate	0	0	None	N/A	N/A	N/A
PAR-122.18	0.2	3.0	5	3.0	Moderate	35	105	High	0	0	None
PAR-132.46	0.2	3.0	1	0.6	Low	0	0	None	0	0	None

TABLE 3.5.3-29

Summary of New Road Erosion Risks and Risks of
Sediment Delivery to any Stream and ESA Stream Closest to Proposed TARs and PARs in Range of SONCC Coho

Road	New Road Site Erodibility Factors					Any Stream Closest to New Road			ESA Stream Closest to New Road		
PAR-150.70	0.2	1.9	1	0.4	Low	0	0	None	0	0	None

a/ Slope Erosion Factors from table 3.5.3-26.
b/ Rainfall Factor and Geologic Erosion Factor from table 3.5.3-27.
c/ Road Delivery Factor from table 3.5.3-28.

EARs. A similar analysis was conducted for EARs that could potentially be utilized during project construction, accessing the construction right-of-way and other project components. The following analysis is limited to segments of EARs that are within 1SPTH from streams within range SONCC coho, including designated critical habitats. EARs include federally-managed roads located on federally-managed lands and privately-owned lands that will be used/authorized during timber removal, construction, and operations to access the construction and operational right-of-way.

There are 65 EARs totaling 3.66 miles within 1SPTH of waterbodies within range of SONCC coho. Of those, 14 are paved, 13 are graveled, and 38 have dirt surfaces. Three EARs with dirt surfaces and two with gravel survaces are within 1SPTH of waterbodies with critical habitat for SONCC coho and included in table 3.5.3-30. Risk estimates for sediment delivery from each of those EARs to four streams with critical habitat in range of SONCC Coho are summarized in table 3.5.3-30 utilizing the same data sets and factors (Road Slope Facto, Rainfall Factor, Geologic Erosion Factor, and Road Delivery Factor) described above for streams closest to new proposed TARs and PARs. In addition, the Road Surface Factor (1 for dirt, 0.5 for gravel) is included in a Five Factor Product is assumed to represent a level of risk for erosion from each road's surface and has been ranked as Low (product <10), Moderate (product from 10 to <100), and High (product >100) in table 3.5.3-30.

The largest five factor product in table 3.5.3-30 is 225 for the EAR within 1SPTH of Canyon Creek due to its dirt surface, relatively high Rainfall and Geologic Erosion factors, and direct delivery of sediment assumed since the road crosses Canyon Creek. The EAR within 1SPTH of Salt Creek also crosses the waterbody but five factor product is 28 with a moderate risk due to a lower Rainfall Factor and lower Geologic Erosion Factor due to Oligocene/Miocene basaltic andesite lithology even though the EAR has a dirt surface.

TABLE 3.5.3-30

Summary of New Road Erosion Risks and Risks of Sediment Delivery to
Streams with Coho Critical Habitat by Existing Dirt and Gravel Surfaced Roads within 1 SPTH in Range of SONCC Coho

Watershed and Critical Habitat with EAR	Number of EARs	Road Surface	Total Road Length (miles)	Road Surface Factor a/	Road Slope Factor b/	Rainfall Factor c/	Geologic Erosion Factor d/	Road Delivery Factor e/	Five Factor Product	Risk of Sediment Delivery to Critical Habitat
Trail Creek										
Canyon Creek	2	Dirt	0.15	1	0.2	2.2	5	100	225	High
Shady Cove-Rogue River										
Rogue River	1	Gravel	0.01	0.5	0.2	2.2	5	10	11	Moderate
Little Butte Creek										
Salt Creek	1	Dirt	0.12	1	0.2	1.4	1	100	28	Moderate

North Fork Little Butte Creek	1	Gravel	0.03	0.5	0.2	1.4	1	35	5	Low

a/ Road Surface Factors: 0.5 for gravel, 1.0 for dirt. See Table A-3, Appendix A, Dube et al. 2004
b/ Road Slope Factors: 0.2 for gradients of <5%; 1.0 for gradients of 5-10%; 2.5 for gradients >10%. See Table A-6, Appendix A, Dube et al. 2004
c/ Rainfall Factor derived from the average annual rainfall at the closest NWS station, computed using Equation 7, Appendix A, Dube et al. 2004.
d/ Geologic Erosion Factor surmised from Figure A-1 and Table A-1 in Appendix A, Dube et al. 2004 based on Dominant Lithology evaluated from Oregon Department of Geology and Mineral Industries, Oregon Geologic Data Compilation 6. Available from http://www.oregongeology.org/sub/ogdc/index.htm.
e/ Road Delivery Factor: Distance from stream, >200 feet = 0, 100 to 200 feet = 10, <100 feet = 35, and direct delivery = 100. See Table A-10, Appendix A, Dube et al. 2004.

TEWAs. Construction will primarily use a 95-foot wide construction right-of-way corridor and associated TEWAs. However, in specified areas such as wetlands, sensitive visual areas and residential areas, the construction right-of-way will be reduced to 75 feet wide to minimize disturbance. In most cases, except where topographical constraints occur, TEWAs have been located at least 50 feet away from wetland boundaries to minimize potential impacts to wetland buffers and riparian areas. Where TEWAs are located closer than 50 feet from a waterbody and the adjacent upland does not support cultivated or rotated cropland or other disturbed land, a modification from FERC's Wetland and Waterbody Procedures (Section V.B.2.a. & b.) has been requested.

Distances of TEWAs to Waterbodies within 1 SPTH of designated critical habitat for SONCC Coho were measured using GIS and digitized waterbody streambanks and TEWA polygons. Consequently, distances could change once boundaries of TEWAs are surveyed on the ground. From these estimates, there are there are seven waterbodies with a total of 21 TEWAs within 1SPTH of critical habitat for SONCC coho, totaling 3.96 acres.

Risk estimates for sediment delivery from each of TEWAs similar to that described above for TARs, PARS, and EARs were not conducted since the procedures in WARSEM modeling is not applicable to TEWAs except for the road delivery factor (distance from a TEWA to a stream). All TEWAs in table 3.5.3-31 that are within 1 SPTH of waterbodies with designated critical habitat are closer than 200 feet to streams, two TEWAs are less than 200 feet but >100 feet to streams, and 19 TEWAs within 1SPTH of waterbodies with designated critical habitat are <100 feet from the streams; 12 TEWAs are within 50 feet of designated critical habitat and sediment delivery to critical habitat has the greatest potential from those 12 TEWAs and a portion of TEWA 128.55-N overlaps critical habitat, potentially capbable of direct sediment delivery based on the sediment delivery distance categories in WARSEM (Table A-10, Appendix A, Dube et al. 2004).

TABLE 3.5.3-31

Individual TEWAs within One Site-Potential Tree Height of Streams with Critical Habitats in Watersheds within Range of SONCC Coho

Watershed	Waterbody with Critical Habitat	TEWA ID	Distance (feet) to Critical Habitat	TEWA Area (acres) in 1 SPTH
Trail Creek	West Fork Trail Creek	TEWA 118.70-N	25	0.05
		TEWA 118.83-W	10	0.25
		TEWA 118.89-W	17	0.16
	Canyon Creek	TEWA 120.29-W	31	0.18
		TEWA 120.48-W	64	0.10
Shady Cove-Rogue River	Rogue River	TEWA 122.62-W	10	0.77
	Indian Creek	TEWA 128.55-N	0	0.09
		TEWA 128.55-W	139	0.03

TABLE 3.5.3-31

Individual TEWAs within One Site-Potential Tree Height of Streams with Critical Habitats in Watersheds within Range of SONCC Coho

Watershed	Waterbody with Critical Habitat	TEWA ID	Distance (feet) to Critical Habitat	TEWA Area (acres) in 1 SPTH
		TEWA 128.63-W	72	0.07
Big Butte Creek	Neil Creek	TEWA 131.88-N	10	0.07
	Quartz Creek	TEWA 132.72-W	130	0.08
		TEWA 132.79-W	76	0.07
Little Butte Creek	Salt Creek	TEWA 142.17-N	12	0.47
		TEWA 142.51-W	45	0.38
		TEWA 142.58-W	18	0.12
		TEWA 142.58-N	46	0.12
	Trib. to Long Branch Ck	TEWA 144.12-W	84	0.06
	NF Little Butte Creek	TEWA 145.58-N	40	0.14
		TEWA 145.58-W	50	0.16
		TEWA 145.70-W	85	0.31
		TEWA 145.70-N	65	0.28

Erosion of new road surfaces, existing road surfaces, and exposed surfaces of TEWAs within 1 SPTH have the potential for sediment delivery to streams and could lead to adverse effects on fish and fresh water benthic invertebrates similar to those described above. As discussed in Section 2.3 of PCGP's Transportation Management Plan (see POD), PCGP will perform road surfacing structural capacity assessments and place additional road surfacing (aggregate or bituminous as appropriate) as needed for the planned use to minimize the potential for both road-related and off-road resource damage. In WARSEM modeling, the Road Tread Surfacing Factor is 1 for roads with native materials surface but is 0.2 for a gravel (aggregate) surface and 0.03 for an asphalt (bituminous) surface. Application of surfacing materials to any of the new TARs and PARs in table 3.5.3-29 with low to high risks of sediment delivery to streams would decrease levels of erosion and quantities of sediment delivered. Surfaces of all new PARs would be graveled thereby decreasing their erosion potential. Further, PARs and TARs would meet land-managing agencies' engineering design and road management standards consistent with the intended use of the road and all applicable agency BMPs; all applicable agency BMPs for erosion control will be implemented. In addition, PCGP will install appropriate erosion and sediment control BMPs along the access roads as determined necessary by PCGP's EI in cooperation with applicable agency officials. All land-managing agency roads are subject to short-term traffic restrictions and/or closures due to seasonal or unusual weather conditions, user safety or when necessary to prevent facility or resource damage.

PCGP's ECRP also identifies mitigation measures that may be required to minimize potential impacts to existing culverts prior to access road use, to allow safe construction equipment travel and prevent damage to the culverts. PCGP has completed an assessment to identify where proposed road improvements or where new permanent or temporary access roads would cross waterbodies and culvert installations would be required. The assessment used PCGP's wetland survey data where access was available. Where access was not available, the assessment used

FWS' National Wetland Inventory (NWI) data[5], USGS National Hydrography Dataset (NHD) data[6], ODF statewide streams data[7], LiDAR data, and aerial photography to interpret waterbody crossings. Identified waterbody crossings were also correlated with PCGP's preliminary access road improvement plans that were completed to evaluate improvements necessary to accommodate trucks hauling pipe (Dyer Partnership 2015). The access road improvement plans (Dyer Partnership 2015) were based on field investigations and identified locations where new culverts or culvert extensions would be necessary.

The new culverts needed to cross waterbodies are located on small intermittent headwater streams where there is no fish presence. The measures outlined in PCGP's Culvert Crossing Best Management Practices (see attachment F to the ECRP in appendix F of the POD) and appropriate erosion control and revegetation measures outlined in the ECRP would be implemented during any road improvement activities. As indicated in the Culvert Crossing BMP, prior to construction, existing culverts will be investigated along all private roads and federally authorized roads (i.e., BLM and Forest Service) identified for access to the construction right-of-way. These investigations would occur on access roads where PCGP is authorized to be and/or where PCGP has negotiated an access use agreement or easement. The investigation will determine the condition and integrity of existing culverts and identify any location that may require mitigative measures to ensure construction activities do not damage or impair the existing function of the culverts. Mitigative measures may be required prior to access road use to allow safe construction equipment travel and prevent damage to the culverts. In select locations, replacement and/or modification of a culvert may be necessary. As noted above, PCGP has completed an assessment to identify where proposed road improvements would cross waterbodies and culvert installations would be required. The new culverts identified are located on small intermittent headwater streams where there is no fish presence.

The ECRP also describes the application of sediment barriers, temporary slope breakers, mulch, dust control, and permanent erosion control measures that will further minimize sediment discharges from a site after construction is complete. In forested areas, during timber clearing/right-of-way grading operations slash-filter windrows may be constructed on the downhill edge of the construction right-of-way and TEWAs, as directed by the EI. Slash-filter windrows will be constructed of logging slash, including cull logs, tree tops, limbs, and branches laid parallel to the right-of-way to effectively filter sediment, reduce runoff velocities, and prevent stream sedimentation. Sediment barriers would generally be placed as follows:

- at the base of slopes adjacent to road, wetland and waterbody crossings where sediment could flow from the construction right-of-way onto the road surface or into the wetland or waterbody;adjacent to wetland and waterbody crossings, as necessary,
- to prevent sediment flow in the wetland consistent with the requirements of FERC's Wetland and Waterbody Procedures; and
- on the down slope side of the right-of-way where it traverses steep side slopes.

[5] https://www.fws.gov/wetlands/nwi/overview.html
[6] https://nhd.usgs.gov/data.html
[7] http://www.oregon.gov/ODF/AboutODF/Pages/MapsData.aspx

The EI will inspect temporary erosion control structures at least on a daily basis in areas of active construction and equipment operation. In areas where active construction and equipment operation are not occurring, inspections will be made at least weekly. All structures will be inspected by the EI within 24 hours of 0.5 inch or greater of rainfall. The EI will be responsible for ensuring that ineffective temporary erosion control measures are repaired as soon as possible but no more than 24 hours after discovery, unless prohibited by exigent circumstances in which case repair will be effectuated as soon as possible. Whenever possible, the EI will inspect erosion control measures in advance of predicted storm events and take preventative measures to minimize the potential for off right-of-way sedimentation.

Temporary sediment barriers will be maintained in place until permanent revegetation measures are determined successful or until the upland areas adjacent to wetlands, waterbodies or roads are stabilized. The structures will be removed once the area has been successfully restored.

Mulch (certified weed free) will be applied if construction and restoration activities are interrupted for extended periods, such as when seeding cannot be completed due to seeding period restrictions. In these areas mulch will be applied uniformly over the area to cover the ground surface at a rate of two tons/acre of straw or hay or its equivalent. In addition, the mulch application rate will also be increased to 3 tons/acre on all slopes within 100 feet of waterbodies and wetlands. The mulch will consist of certified weed-free straw or wood fiber hydromulch. On federal lands, in the event that construction activities are extended beyond the dry season (i.e., May 1 to October 31), soil disturbance in excess of 0.5 acre will have effective ground cover provided or other effective BMPs will be utilized as discussed in the ECRP to prevent sedimentation beyond the approved construction right-of-way and associated TEWAs or into wetlands and waterbodies.

These provisions from the Transportation Management Plan and ECRP are consistent with BMPs identified in Appendix C to Dube et al. (2004) and will ensure that potential sediment delivery from the PARs and TARs is eliminated or minimized resulting in minimal effects to fish and freshwater benthic invertebrates.

Runoff from Facility Surfaces

There are three contractor and pipe storage yards, four rock source and disposal sites, three new temporary access roads, two new permanent access roads, and four aboveground facilities within the range of SONCC coho. One yard, Rogue Aggregates in the Gold Hill-Rogue River Watershed, is within 100 feet of the Rogue River. None of the rock source and disposal sites are near waterbodies inhabited by SONCC coho and no new PARs are near coho habitat. .

Stored materials at the yards may include: construction mats, fencing materials, fuel and lubricants, stormwater control materials (straw bales, erosion control fabric, silt fence materials, etc.), and other construction materials. The yards would also be used for contractor office trailers and employee parking facilities. Although the yards are previously disturbed industrial sites, there is some unknown level of risk that stored materials and surface runoff could enter SONCC coho critical habitat.

PCGP has consulted with the BLM, the Forest Service, and the NRCS regarding erosion control and revegetation specifications. Other appropriate agencies have been consulted as well. The Oregon Department of Agriculture (ODA) Noxious Weed Control Program, as well as the BLM and the Forest Service, have been contacted regarding recommendations for the prevention and spread of noxious weeds with those incorporated into the Pipeline project-specific ECRP. Pursuant to FERC's Wetland and Waterbody Procedures (see section IV.A), PCGP has prepared a SPCC Plan (see appendix L). The Plan includes identifying all potential spill hazards at the facility (including oil) and lists the appropriate response actions and contacts for facility and emergency response personnel. All station technicians would be trained for proper handling, storage, disposal, and spill response of hazardous).

Operation and Maintenance Activities

Once installed, maintenance of the pipeline would include activities such as aerial inspections, gas flow monitoring, visual inspection of surrounding vegetation for signs of leaks, and integrity management, which includes smart pigging to investigate the interior surface of the pipe for any signs of stress cracking, pitting, and other anomalies (see the ECRP, appendix F). All of the proposed maintenance activities would be outlined in the Operations and Maintenance Plan that would be prepared according to operating regulations in DOT 49 CFR Subpart L, Part 192 and would be completed prior to going in-service. These general maintenance activities would require only surface activities and usage of the existing right-of-way, such as insertion of the pig at one of the pig launching facilities.

Potential stream channel disturbance would occur if an integrity issue with the pipeline was found. If this were to occur, the pipeline would need to be unearthed within the right-of-way and repair work done in-water. Within stream sites, repair work could require isolated flow from the section of pipe that is to be exposed. Typically, repairs would be made to the pipe within the right-of-way (within the trench) or, depending on the site-specific conditions and nature of the repair needed, a reroute around the affected section may be considered.

Impacts would be similar to those discussed above for initial installation except on a much smaller scale, because they would only involve one crossing compared to many streams. However, should repairs be needed out of the standard stream crossing window (i.e. during periods of fish spawning or egg incubation) there would be additional adverse effects to key fish resources at the specific site. The actions would include all relevant BMPs and mitigation, dependent upon site conditions and land ownership. Any future repairs would require additional permit approval from appropriate state and federal agencies that would determine the acceptable parameters of these actions. Such pipeline integrity-based in-water projects are very infrequent.

Vegetation maintenance would be limited adjacent to waterbodies to allow a riparian strip to permanently revegetate with native plant species across the entire right-of-way. To facilitate periodic pipeline corrosion/leak surveys, a corridor centered on the pipeline and up to 30 feet wide would be maintained in an herbaceous state, with shrubs outside of this 30-foot corridor. In addition, trees that are located within 15 feet of the pipeline may be cut and removed from the right-of-way. No vegetation or tree limitations would occur beyond the 30-foot wide corridor in riparian areas (i.e., up to 100 feet of streams on federal lands, and 25 feet on non-federal lands).

<u>Herbicide Application</u>

Herbicides have the potential to cause toxic effects to different salmonid life stages and to other aquatic species, causing direct impacts, if used improperly. When herbicides are properly used according to label restrictions and BMPs to control noxious weeds, there is little to no chance of causing injury or mortality to fish or other aquatic organisms.

PCGP would not use herbicides for routine vegetation maintenance. However, following construction, PCGP would implement the integrated pest management plan (IPM ,see appendix N to PCGP's POD), which addresses control of noxious weeds and invasive plants across the Pipeline project which would include the selective use of herbicides where necessary to control noxious weeds by limited application from the ground, where allowed by landowners. The plan was developed in consultation with the ODA, BLM, and Forest Service. Herbicides have the potential to cause toxic effects to different salmonid life stages and to other aquatic species, causing direct impacts, if used improperly

The BMPs would minimize the potential spread of invasive species and minimize the potential adverse effects of control treatments. Herbicides would not be applied by aerial or broadcast spraying. Noxious weeds would be removed only by manual methods in the riparian zone defined as one site-potential tree height and within Riparian Reserves that are defined as being greater than 150 feet in most areas along the route. PCGP would not directly spray, or otherwise apply, herbicides in waterbodies or in riparian zones. The risk of drift would be avoided by selectively applying herbicides from the ground.

Where weed control is necessary along the construction right-of-way, PCGP's first priority would be to employ hand and mechanical methods (pulling, mowing, biological, disking, etc.) applicable to the species to prevent the spread of potential weed infestations, where feasible. To determine if an herbicide is to be used over other control methods, PCGP would base the decision on weed characteristics and integrated weed management principles (Forest Service 2005). If herbicides are used to control noxious weed infestations, they would be used when they are the most appropriate treatment method. Spot treatments and the use of selective herbicides would be utilized to minimize impact to native or non-target species. Permits or approvals for the use of herbicides and adjuvants on federal lands would be obtained prior to use/treatment, as detailed in the IPM (see appendix N to the POD). Considering the potential for limited use of herbicides along the route, and precautions that would be in place to prevent entry into waters, meaningful negative effects to SONCC coho salmon from herbicides would be unlikely to occur.

Cumulative Effects

Cumulative effects in the marine analysis area were presented in the green sturgeon section (3.5.1.3) and would be similar for SONCC coho salmon. These effects include increased boat traffic in coastal Pacific Ocean and the associated potential for increases in noise and fuel and oil spills. The increase in vessel traffic would be slight, as noted in section 3.5.1.3. The slight increase would result in a greater risk of noise impacts on SONCC coho salmon; however, because Project effects are expected to be minor, cumulative effects in the marine analysis area are expected to be insignificant. It appears that the background rate of spills (oil, diesel fuel) off the Oregon coast (incidence of spills in proportion to total vessel operation) by fishing vessels, recreation vessels, and other vessel types is generally low. Based on existing information, future rates of off-shore releases are also expected to be low, and therefore, the potential for SONCC coho salmon to be affected by oil and other pollutants is not expected to increase above existing levels.

Cumulative effects to SONCC coho salmon in the riverine analysis area would be generated by timber harvesting on non-federal lands because there is no federal nexus requiring ESA consultations. Areas of LSOG forest have been monitored as a component of the NWFP. In

Oregon, LSOG was evaluated in 1996 (Moeur et al. 2005), in 2006 (Moeur et al. 2011), and in 2013 (Davis et al. 2015). Differences in areas of LSOG forests were described in the four physiographic provinces that coincide with the Pipeline project; from 1993 to 2012, there was an overall net loss of LSOG on non-federal lands within the Coast Range, Klamath, and Western Cascades and Eastern Cascades provinces (see Table 7 in Davis et al. 2015). During that period, areas of LSOG on non-federal lands decreased by 29 percent within the Trail Creek Watershed but increased by 51 percent within the Shady Cove-Rogue River Watershed, increased by 34 percent in the Big Butte Creek Watershed, and increased by 148 percent in the Little Butte Creek Watershed. These changes in areas of LSOG from 1993 to 2012 are clearly evident in figure 3.5.3-6 and are somewhat anomalous compared to other areas with the NWFP. For example, LSOG forest decreased by 26.8 percent between 1993 and 2012 in the Oregon Coast Range physiographic province, decreased by 22.3 percent in the Oregon Western Cascades, decreased by 10.1 percent in the Klamath, and decreased by 14.1 percent in the Oregon Eastern Cascades provinces (Table 7 in Davis et al. 2015).

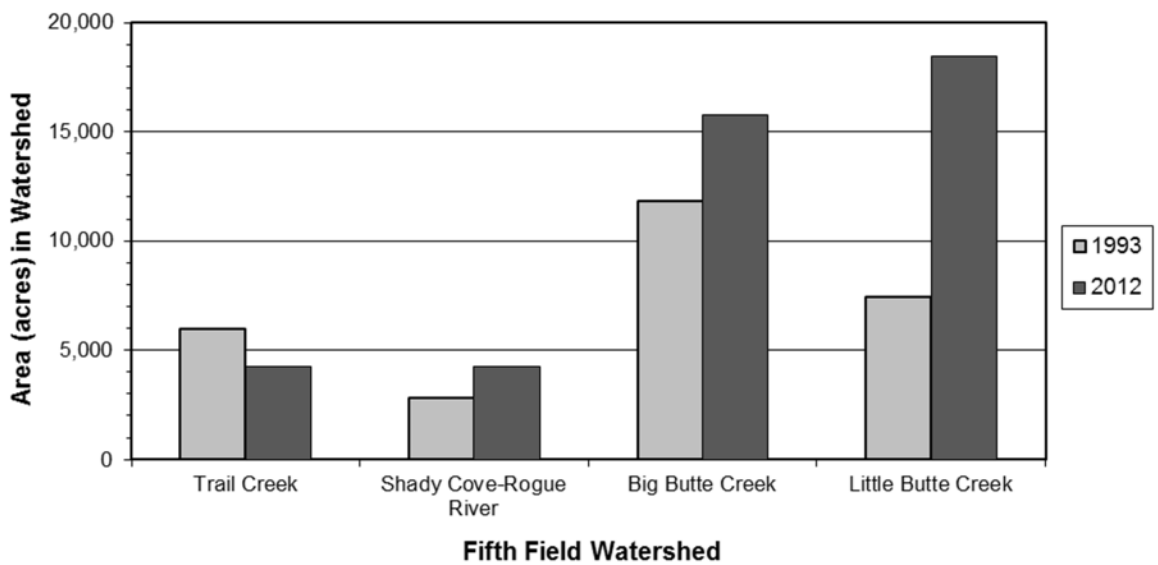


Figure 3.5.3-6 Total Areas (acres) of Late Successional-Old Growth Forests on Non-Federal Lands in 1993, and 2012 within Four Fifth-Field Watersheds in the Range of SONCC Coho Salmon that would be Crossed by the Pipeline Project. (Data from NWFP Interagency Regional Monitoring Program 2017)

Declines in LSOG were as dramatic or more pronounced on non-federal lands in the physiographic provinces during that same period from 1993 to 2012 (Table 9 in Davis et al. 2015). However, based on the past trend, there would be more LSOG 80 years and older on non-federal lands in the foreseeable future due to forest succession (Davis et al. 2015) within three of the four watersheds, including more LSOG within riparian zones. Changes in LSOG within riparian zones on non-federal land would be a reasonably foreseeable cumulative impact through the year 2020 (potentially the Project start). Based on the information provided by Davis et al. (2015), the amount of LSOG on non-federal land through 2020 would be expected to change at the same rate (acres per year) as the amounts that have changed (increased or decreased) between 1993 and 2012. Changes in area of LSOG within the four fifth field watersheds by the same rate of change observed between 1993 and 2012 were used to predict areas of LSOG in 2020, which, depending on the watershed, are expected to decrease or increase within the four watersheds crossed within the range of SONCC coho (see table 3.5.3-32).

TABLE 3.5.3-32

Estimates for Areas of Late Successional-Old Growth Forest in 2020 on Non-Federal Lands in Fifth-Field Watersheds Crossed by the Pipeline Project

Subbasins and Fifth-Field Watersheds	Area (acres) of LSOG on Non-Federal Land: 1993 a/	2012 b/	Change in Area from 1993 to 2012	Proportional Change in LSOG per year since 1993	Estimated Area (acres) of LSOG in 2020
Upper Rogue Subbasin					
Trail Creek	5,963	4,222	-1,742	-0.015	3,351
Shady Cove-Rogue River	2,796	4,232	1,435	0.027	4,949
Big Butte Creek	11,801	15,773	3,972	0.018	17,759
Little Butte Creek	7,447	18,447	10,999	0.078	23,946

a/ Data from Regional Ecosystem Office 2017 and Moeur et al. 2005.
b/ Data from NWFP Interagency Regional Monitoring Program 2017 and Davis et al. 2015.

Amounts of LSOG within the Pipeline project area that would be affected by construction and amounts of LSOG that would be affected within riparian zones (e.g., see table 3.5.3-25a) have been determined. The areas (acres) of all LSOG on non-federal lands within riparian zones 1 SPTH wide are provided in table 3.5.3-25a for each watershed. The data were derived by buffering all streams within each watershed (data from National Hydrography Dataset, USGS 2016) by the 1 SPTH riparian zone widths in table 3.5.3-25a in combination with old growth, 80 years and older spatial data in 2012 (NWFP Interagency Regional Monitoring Program 2017 and Davis et al. 2015) and land ownership. The amounts of LSOG forest within non-federal lands in riparian zones that would be removed during Pipeline construction were provided above in table 3.5.3-25a and included in table 3.5.3-33. The Pipeline project would affect less than one percent of the amount of LSOG (estimated for 2017) on non-federal lands in riparian zones for all streams in each fifth field watershed. With the estimates for areas of LSOG present in 2020, based on proportional changes in areas observed between 1993 and 2012 (table 3.5.3-32), an estimate for area of LSOG on non-federal lands in riparian zones for all streams in each fifth field watershed in 2020 is included in table 3.5.3-33. With the overall increase in LSOG expected between 2017 and 2020, the relative effects of Pipeline construction on available riparian LSOG would be expected to decrease from current estimates on nonfederal lands in the foreseeable future.

TABLE 3.5.3-33

Potential for Cumulative Effects within Late Successional and Old-Growth Riparian Forests on Non-Federal Lands within the SONCC Coho Salmon ESU Riverine Analysis Area

SONCC ESU Fifth-Field Watershed	Area (acres) of Riparian LSOG on Non-Federal Land in 2012 a/	Area (acres) of Riparian LSOG Present on Non-Federal Land in 2017 b/	Area (acres) of Riparian LSOG Affected on Non-Federal Land in 2017 c/	Percent of Riparian LSOG Affected by Project in 2017 d/	Area (acres) of Riparian LSOG Estimated in 2020 b/	Percent of Riparian LSOG Affected by Project in 2020 e/
Trail Creek	362.25	334.41	0.86	0.26%	306.56	0.28%
Shady Cove-Rogue River	305.91	347.24	1.19	0.34%	388.57	0.31%
Big Butte Creek	1,460.89	1.590.29	0	0.00%	1,719.68	0.00%
Little Butte Creek	1,288.76	1.789.68	5.82	0.33%	2,290.59	0.25%

TABLE 3.5.3-33

Potential for Cumulative Effects within Late Successional and Old-Growth Riparian Forests on Non-Federal Lands within the SONCC Coho Salmon ESU Riverine Analysis Area

SONCC ESU Fifth-Field Watershed	Area (acres) of Riparian LSOG on Non-Federal Land in 2012 a/	Area (acres) of Riparian LSOG Present on Non-Federal Land in 2017 b/	Area (acres) of Riparian LSOG Affected on Non-Federal Land in 2017 c/	Percent of Riparian LSOG Affected by Project in 2017 d/	Area (acres) of Riparian LSOG Estimated in 2020 b/	Percent of Riparian LSOG Affected by Project in 2020 e/
Total Area	**3,417.81**	**4,061.61**	**7.87**	**0.19%**	**4,705.41**	0.17%

a/ Data from NWFP Interagency Regional Monitoring Program 2017.
d/ Based on the Proportional Change in LSOG per year since 1993 in table 3.5.3-32
c/ Data from table 3.5.3-25a.
d/ For comparison to effects in 2020.
e/ Based on Area of riparian LSOG Estimated in 2020 that would be affected by Pipeline project on non-federal land in 2020.

Critical Habitat

Eight waterbodies known to support coho within table 3.5.3-3 that would be affected by construction of the Pipeline are within designated critical habitat for coho salmon in the SONCC ESU. Critical habitat is designated to include all river reaches accessible to listed coho within the range of the SONCC ESU. Critical habitat consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches in hydrologic units and counties identified in NMFS (1999b), including the Upper Rogue HUC 1700307. Accessible reaches are those within historical range of the ESUs that can still be occupied by any life stage of coho salmon.

Riparian Zone Effects. Similar analyses to those above under Riparian Vegetation Removal and Modification were conducted for effects to riparian zones associated with each waterbody supporting coho critical habitat and waterbodies that are assumed to provided coho in each watershed. Areas of forested and non-forested habitats that would be affected within the riparian zones of each waterbody during construction are provided in table 3.5.3-34a and areas affected during operation are provided in table 3.5.3-34b and summarized in table 3.5.3-34c. The tables also include riparian zone areas affected by landowner, similar to tables 3.5.3-25a and 3.5.3-25b.

TABLE 3.5.3-34a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of SONCC Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat or Assumed Habitat	**MP**	**Coho Critical Habitat**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Trail Creek (HUC 1710030706)															
			BLM-Medford District					**0**			0.20			**0.20**	**0.20**
West Fork Trail Creek (ASP-202)	118.89	Yes	Non-Federal		0.02			**0.02**			1.31			**1.31**	**1.33**
			Riparian Zone Total	**0**	**0.02**	**0**	**0**	**0.02**	**0**	**0**	**1.51**	**0**	**0**	**1.51**	**1.53**
			BLM-Medford District	0.58				**0.58**						**0**	**0.58**
Canyon Creek (NSP-11)	120.45	Yes	Non-Federal	0.51				**0.51**			0.02			**0.02**	**0.53**
			Riparian Zone Total	**1.09**	**0**	**0**	**0**	**1.09**	**0**	**0**	**0.02**	**0**	**0**	**0.02**	**1.11**
			BLM-Medford District	0.31				**0.31**						**0**	**0.31**
Trib. to Trail Creek (ASI-206)	121.57	Yes	Non-Federal	0.10	0.52	0.02		**0.64**			0.02			**0.02**	**0.66**
			Riparian Zone Total	**0.41**	**0.52**	**0.02**	**0**	**0.95**	**0**	**0**	**0.02**	**0**	**0**	**0.02**	**0.97**
Shady Cove-Rogue River (HUC 1710030707)															
			Federal					**0**						**0**	**0**
Rogue River (ASP-235)	122.57	Yes	Non-Federal		0.32			**0.32**			0.82		0.03	**0.85**	**1.17**
			Riparian Zone Total	**0**	**0.32**	**0**	**0**	**0.32**	**0**	**0**	**0.82**	**0**	**0.03**	**0.85**	**1.17**
			Federal					**0**						**0**	**0**
Indian Creek (AW-278)	128.60	No	Non-Federal					**0**		0.32	0.70			**1.02**	**1.02**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**0.32**	**0.70**	**0**	**0**	**1.02**	**1.02**
Big Butte Creek (HUC 1710030704)															
			Federal					**0**						**0**	**0**
Neil Creek (ASP-252)	132.12	Yes	Non-Federal		0.24			**0.24**		0.05			0.11	**0.16**	**0.40**
			Riparian Zone Total	**0**	**0.24**	**0**	**0**	**0.24**	**0**	**0.05**	**0**	**0**	**0.11**	**0.16**	**0.40**
			Federal					**0**						**0**	**0**
Quartz Creek (ASI-265)	132.75	Yes	Non-Federal		0.53			**0.53**	0.01					**0.01**	**0.54**
			Riparian Zone Total	**0**	**0.53**	**0**	**0**	**0.53**	**0.01**	**0**	**0**	**00**	**0**	**0.01**	**0.54**
Little Butte Creek (HUC 1710030708)															
			Federal					**0**						**0**	**0**
Salt Creek (ESP-34)	142.57	Yes	Non-Federal					**0**			0.90			**0.90**	**0.90**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.90**	**0**	**0**	**0.90**	**0.90**

TABLE 3.5.3-34a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of SONCC Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat or Assumed Habitat	MP	Coho Critical Habitat	Landowner	Late Successional Old Growth Forest	Mid-Seral Forest	Regenerating Forest	Clearcut, Forest	Forest Total	Forested Wetland	Nonforested Wetland	Unaltered Nonforested Habitat	Agriculture	Altered Habitat	Other Total	Total Riparian Zone Impact (acres)
Trib. to Long Branch Creek (ESI-38)	143.51	No	Federal					**0**						**0**	**0**
			Non-Federal		2.09			**2.09**			0.55		0.13	**0.68**	**2.77**
			Riparian Zone Total	**0**	**2.09**	**0**	**0**	**2.09**	**0**	**0**	**0.55**	**0**	**0.13**	**0.68**	**2.77**
North Fork Little Butte Creek (ESP-66)	145.69	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.52			**0.52**		0.42	1.32		0.01	**1.75**	**2.27**
			Riparian Zone Total	**0**	**0.52**	**0**	**0**	**0.52**	**0**	**0.42**	**1.32**	**0**	**0.01**	**1.75**	**2.27**
Trib. to NF Little Butte Ck. (ESI-56)	146.05	No	Federal					**0**						**0**	**0**
			Non-Federal		3.16			**3.16**			0.55		0.13	**0.68**	**3.84**
			Riparian Zone Total	**0**	**3.16**	**0**	**0**	**3.16**	**0**	**0**	**0.55**	**0**	**0.13**	**0.68**	**3.84**
All Fifth-Field Watersheds and Jurisdictions															
			Federal Subtotal	**0.98**	**0**	**0**	**0**	**0.98**	**0**	**0**	**0.20**	**0**	**0**	**0.20**	**1.18**
			Non-Federal Subtotal	**0.61**	**7.33**	**0.02**	**0**	**7.96**	**0.01**	**1.69**	**5.28**	**0**	**0.41**	**7.39**	**15.35**
			Total	**1.59**	**7.33**	**0.02**	**0**	**8.94**	**0.01**	**1.69**	**5.48**	**0**	**0.41**	**7.59**	**16.53**

a/ Project components considered in calculation of habitat "Removed:" PCGP construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture, and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

TABLE 3.5.3-34b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained over the Pipeline within Riparian Zones
(One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of SONCC Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat or Assumed Habitat	**MP**	**Coho Critical Habitat**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Trail Creek (HUC 1710030706)															
West Fork Trail Creek (ASP-202)	118.89	Yes	BLM-Medford District					**0**			0.06			**0.06**	**0.06**
			Non-Federal					**0**			0.26			**0.26**	**0.26**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.32**	**0**	**0**	**0.32**	**0.32**
Canyon Creek (NSP-11)	120.45	Yes	BLM-Medford District	0.13				**0.13**						**0**	**0.13**
			Non-Federal	0.13				**0.13**			0.01			**0.01**	**0.14**
			Riparian Zone Total	**0.26**	**0**	**0**	**0**	**0.26**	**0**	**0**	**0.01**	**0**	**0**	**0.01**	**0.27**
Trib. to Trail Creek (ASI-206)	121.57	Yes	BLM-Medford District	0.14				**0.14**						**0**	**0.14**
			Non-Federal	0.04	0.15			**0.19**						**0**	**0.19**
			Riparian Zone Total	**0.18**	**0.15**	**0**	**0**	**0.33**	**0**	**0**	**0**	**0**	**0**	**0**	**0.33**
Shady Cove-Rogue River (HUC 1710030707)															
Rogue River (ASP-235)	122.57	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.07			**0.07**			0.07			**0.07**	**0.13**
			Riparian Zone Total	**0**	**0.07**	**0**	**0**	**0.07**	**0**	**0**	**0.07**	**0**	**0**	**0.07**	**0.13**
Indian Creek (AW-278)	128.60	No	Federal					**0**						**0**	**0**
			Non-Federal					**0**		0.09	0.18			**0.27**	**0.27**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**0.19**	**0.18**	**0**	**0**	**0.27**	**0.27**
Big Butte Creek (HUC 1710030704)															
Neil Creek (ASP-252)	132.12	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.08			**0.08**		0.02			0.05	**0.07**	**0.15**
			Riparian Zone Total	**0**	**0.08**	**0**	**0**	**0.08**	**0**	**0.02**	**0**	**0**	**0.05**	**0.07**	**0.15**
Quartz Creek (ASI-265)	132.75	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.13			**0.13**						**0**	**0.13**
			Riparian Zone Total	**0**	**0.13**	**0**	**0**	**0.13**	**0**	**0**	**0**	**0**	**0**	**0**	**0.13**
Little Butte Creek (HUC 1710030708)															
Salt Creek (ESP-34)	142.57	Yes	Federal					**0**						**0**	**0**
			Non-Federal					**0**		0.19				**0.19**	**0.19**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0.**	**0**	**0.19**	**0**	**0**	**0**	**0.19**	**0.19**

TABLE 3.5.3-34b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained over the Pipeline within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of SONCC Coho Crossed by the Pipeline

				Forest Habitat b/					**Other Habitat b/**						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat or Assumed Habitat	**MP**	**Coho Critical Habitat**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Trib. to Long Branch Creek (ESI-38)	143.51	No	Federal					**0**						**0**	**0**
			Non-Federal		0.48			**0.48**			0.13		0.02	**0.15**	**0.64**
			Riparian Zone Total	**0**	**0.48**	**0**	**0**	**0.48**	**0**	**0**	**0.13**	**0**	**0.07**	**0.15**	**0.64**
North Fork Little Butte Creek (ESP-66)	145.69	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.10			**0.10**		0.07	0.33			**0.39**	**0.49**
			Riparian Zone Total	**0**	**0.10**	**0**	**0**	**0.10**	**0**	**0.07**	**0.33**	**0**	**0**	**0.39**	**0.49**
Trib. to NF Little Butte Ck. (ESI-56)	146.05	No	Federal					**0**						**0**	**0**
			Non-Federal		0.27			**0.27**						**0**	**0.27**
			Riparian Zone Total	**0**	**0.27**	**0**	**0**	**0.27**	**0**	**0**	**0**	**0**	**0**	**0**	**0.27**
All Fifth-Field Watersheds and Jurisdictions															
			Federal Subtotal	**0.27**	**0**	**0**	**0**	**0.27**	**0**	**0**	**0.06**	**0**	**0**	**0.06**	**0.33**
			Non-Federal Subtotal	**0.17**	**1.28**	**0**	**0**	**1.45**	**0**	**0.37**	**0.98**	**0**	**0.07**	**1.41**	**2.86**
			Total	**0.44**	**1.28**	**0**	**0**	**1.72**	**0**	**0.37**	**1.04**	**0**	**0.07**	**1.47**	**3.19**

a/ Project components considered in calculation of habitat "Removed:" PCGP construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture, and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

Effects to water temperature (shade) during construction and operation within the riparian zone of each waterbody assumed to support coho or with coho critical habitat are assumed to be directly related to areas of riparian forest removed during construction (riparian forest within the construction right-of-way, TEWAs, TARs, and PARs) and to areas of riparian forest that would be removed within the 30-foot wide operational easement for the life of the Pipeline. Riparian forest that is not in the operational easement would be restored over time, presumably attaining mid-seral status (40-80 years old) at the end of the 50-year life of the Pipeline. Magnitude of impact to riparian shade associated with each waterbody with critical habitat and assumed to be occupied by coho is directly related to the absolute and relative amounts of riparian forest removed during construction, amounts removed permanently by the operational easement, and amounts of riparian forest that would be restored within affected riparian zones.

Table 3.5.3-34c below, summarizes tables 3.5.3-34a and 3.5.3-34b. The greatest absolute impact to shade within riparian zones associated with critical habitats for SONCC coho would occur at Canyon Creek with removal of 1.09 acres of riparian forest. Riparian zones of Canyon Creek and Tributary to Trail Creek, both within the Trail Creek Watershed, and Quartz Creek within the Big Butte Creek watershed would have relatively large amounts of riparian forest affected during construction but relatively large areas of forest restoration following construction would partially offset the effects of construction. Absolute and relative impact to forests within riparian zones (with concomitant effects to water temperature and shade) associated with other affected waterbodies with critical habit for SONCC coho would be more modest (or nearly zero). The longest-term effects to riparian forest would occur at Canyon Creek and Tributary to Trail Creek (Trail Creek Watershed) where 1.09 acres and 0.50 acre of late successional-old growth forest would be removed, respectively.

TABLE 3.5.3-34c

Summary Table for Effects to Riparian Zones
Associated with Critical Habitats and Assumed Occupied Habitat for SONCC Coho

5th Field Watershed and Waterbody with Critical Habitat	Coho Critical Habitat	Total Riparian Area Affected (acres)	Riparian Forest Removed by Construction (acres) a/	Riparian Forest Removed During Operation (acres) b/	Riparian Forest Restored After Construction (acres)	Percent Riparian Forest Removed	Percent Riparian Forest Removed Permanently	Percent of Riparian Zone with Restored Forest
Trail Creek (HUC 1710030706)								
West Fork Trail Creek	Yes	1.53	0.02	0.00	0.02	1%	0%	1%
Canyon Creek	Yes	1.11	1.09	0.26	0.83	98%	23%	75%
Trib. to Trail Creek	Yes	0.98	0.97	0.33	0.64	99%	34%	65%
Shady Cove-Rogue River (HUC 1710030707)								
Rogue River	Yes	1.17	0.32	0.07	0.25	27%	6%	21%
Indian Creek	No	1.02	0.00	0.00	0.00	0%	0%	0%
Big Butte Creek (HUC 1710030704)								
Neil Creek	Yes	0.50	0.24	0.08	0.16	60%	20%	40%
Quartz Creek	Yes	0.54	0.53	0.13	0.40	98%	24%	74%
Little Butte Creek (HUC 1710030708)								
Salt Creek	Yes	0.90	0.00	0.00	0.00	0%	0%	0%
Trib. to Long Branch Ck.	No	2.77	2.09	0.48	1.61	75%	17%	58%
NF Little Butte Creek	Yes	2.27	0.52	0.10	0.42	23%	4%	19%
Trib. to NF Little Butte Ck.	No	3.84	3.16	0.27	2.89	82%	7%	74%

a/ Summarized from table 3.5.3-25a
b/ Summarized from table 3.5.3-25b

Effects to LWD during construction and operation within the riparian zone of each waterbody assumed to support coho or with coho critical habitat are assumed to be directly related to areas of riparian forest removed during construction (riparian forest within the construction right-of-way, TEWAs, TARs, and PARs) and to areas of riparian forest that would be removed within the 30-foot wide operational easement for the life of the Pipeline. Riparian forest that is not in the operational easement would be restored over time, presumably attaining mid-seral status (40-80 years old) at the end of the 50-year life of the Pipeline. Magnitude of impact to LWD recruitment associated with each waterbody with critical habitat and assumed to be occupied by coho is directly related to the absolute and relative amounts of riparian forest removed during construction, amounts removed permanently by the operational easement, and amounts of riparian forest that would be restored within affected riparian zones. The Pipeline project would result in adverse effects to freshwater critical habitat for the SONCC ESU of coho salmon. Most effects would be short-term, but some would be intermediate to long-term. Minor short-term effects would occur from sedimentation during construction actions. Minor intermediate-term effects would occur from a reduction in riparian habitat due to construction and operation. Sediment disturbance at stream crossings would affect food sources for rearing fish in the short-term, and riparian plant removal would reduce LWD supply affecting habitat quality and quantity in the intermediate to long-term over small stream areas (i.e., within the less than 75 to 95-foot stream length clearing area per crossing).

Within the range of the SONCC ESU, the coho life cycle can be separated into five essential habitat types: 1) juvenile summer and winter rearing areas; 2) juvenile migration corridors; 3) areas for growth and development to adulthood; 4) adult migration corridors; and (5) spawning areas. Within these areas, essential features of coho salmon critical habitat include: adequate 1) substrate, 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) safe passage conditions (NMFS 1999b). Each element or feature defined for critical habitat could be adversely affected by the proposed action. Those effects have been quantified to the extent possible in the foregoing analyses and summarized below in table 3.5.3-35.

Project effects to freshwater spawning sites would likely occur prior to coho spawning in the year of construction, and there would be no effects to spawning, incubation, and larval development by suspended sediment although Pipeline project-generated sediment could increase gravel embeddedness downstream. Those effects would depend on precipitation and in-stream flow (potential freshets) following construction that would likely flush fines downstream. The Pipeline project would remove small areas of riparian forest that would provide recruitment of LWD. The Pipeline project would temporarily decrease water quality downstream from construction sites by entrainment of sediments and temporarily limit in-stream migration during in-stream construction. In all instances, habitat suitability (HADD, Anderson et al. 1996) would temporarily decrease, though not necessarily to levels that would cause moderate habitat degradation (SEV = 7).

TABLE 3.5.3-35

Summary of Project Effects to Critical Habitat Designated for SONCC Coho within Watersheds Crossed by the Pipeline Project

Subbasins and Fifth-Field Watersheds	Total Waterbodies Crossed in Watershed	Waterbodies with Coho Affected a/			Riparian Zone Width (feet) b/	Areas (acres) of Riparian Vegetation Removed in Critical Habitat c/		
		Documented	Assumed	Total with Critical Habitat /b		Forested Habitat	Non-forested Habitat	Total
Upper Rogue Subbasin								
Trail Creek	6	3	0	3	159	2.08	1.34	3.42
Shady Cove-Rogue River	11	1	1	1	157	0.32	0.85	1.17
Big Butte Creek	9	2	0	2	187	1.06	1.02	2.09
Little Butte Creek d/	46	2	2	2	158	0.52	3.21	3.73
Total	**72**	**8**	**2**	**8**		**3.99**	**6.42**	**10.41**

a/ Data from ODFW GIS database (ODFW 2017f).
b/ Based on presence and potential presence (assumed) of SONCC coho.
c/ Riparian width of 1 SPTH, one site-potential tree height.
d/ Includes the Key Watershed designated within the Little Butte Creek 5th field watershed.

3.5.3.4 Conservation Measures

Appendices N and O include a complete list of conservation measures proposed by JCEP and PCGP. Conservation measures proposed by PCGP to minimize construction and operation impacts to waterbodies and riparian zones within the riverine analysis area are listed in tables 1 and 2C in appendix N. PCGP has also proposed measures to rectify, repair, rehabilitate, and otherwise reduce impact to waterbodies and riparian zones once construction of the Pipeline is complete. Those measures have been compiled in table 3C in appendix N. Details of some of the major conservation measures applicable to SONCC ESU to be implemented by PCGP are summarized below.

Erosion Control

Many of the conservation measures in table 3C in appendix N focus on erosion control to prevent sediment from entering surface waters. Temporary erosion controls would be installed immediately after vegetation clearing and grading and would be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration is complete. At a minimum, the following temporary erosion control structures would be installed: temporary slope breakers, sediment barriers, mulch, and erosion control fabric. PCGP would install permanent slope breakers consistent with the requirements of FERC's *Plan*. Part of long-term erosion control would include a final cleanup including final grading and installation of permanent erosion control structures. Final cleanup of an area would generally occur within 10 days after backfilling the trench and not be delayed beyond the end of the next recommended seeding season. During final cleanup, PCGP would remove all construction debris and grade disturbed areas to preconstruction grades to the extent practicable. An adequate seedbed would be prepared at the conclusion of cleanup.

<u>Temporary Slope Breakers</u>

PCGP would install temporary slope breakers over the backfilled, recontoured construction right-of-way as specified in FERC's *Plan*. The outfall of each temporary slope breaker would be to a stable, well-vegetated area or to an energy-dissipating device at the end of the slope breaker off the construction right-of-way. Slope breakers reduce runoff velocity, thereby intercepting sediment and allowing it to drop out of suspension. They also can effectively divert runoff away from a disturbed site to a stable outlet (Goldman et al. 1986).

Sediment Barriers

PCGP would primarily rely upon silt fence and staked hay or straw bales to confine sediment to the construction right-of-way. These structures would be used adjacent to wetland and waterbody crossings consistent with the requirements of FERC's *Procedures*. Straw bales and filter fabric (silt fence) can be used together to create a highly effective sediment barrier, a combination that compensates for the limitations of each used in isolation; straw bales provide extra support and the fabric provides greater filtering capability (Goldman et al. 1986).

All straw or hay bales used for sediment barriers would be certified as weed-free. Temporary sediment barriers would be maintained in-place until permanent revegetation measures are successful or until the upland areas adjacent to wetlands, waterbodies or roads are stabilized. The structures would be removed once vegetation in the area has been successfully restored.

Erosion Control Fabric

PCGP would install erosion control fabric (such as jute or excelsior) on waterbody banks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. Although there are no measures specific to pipeline construction, data related to cut-and-fill slopes treated during construction of forest roads indicate varying effectiveness of different types of stabilization measures designed to control surface erosion (EPA 2001). On fill slopes, combining straw mulch and netting decreased erosion by 99 percent. Excelsior mulch alone decreased erosion by 92 percent on fill slopes. On cut slopes, straw mulch by itself decreased erosion in a range from 32 to 97 percent (EPA 2001). Applications of mulches and/or fabric are effective measures promoting slope stabilization until vegetation can successfully be reestablished. These measures also promote plant growth (EPA 2001).

Fish Salvage Plan

All waterbodies that would be crossed by dry open-cut construction would be done prior to adult coho salmon upstream migration, within ODFW in-stream construction windows. A *Fish Salvage Plan* has been provided in appendix T. The plan has been developed to minimize adverse effects to listed salmonids (SONCC coho salmon, Oregon Coast coho salmon), non-listed salmonids (Chinook salmon, steelhead, and cutthroat trout) and listed catostomids (Lost River sucker, shortnose sucker). The portions of the plan relevant to salvaging salmonids were adapted from the protocol developed by WSDOT (2012). The protocol specifies procedures to 1) isolate the work area; 2) remove fish and dewater the work area; 3) handle, hold and release fish; 4) document fish that have been captured, handled, held, and released; and 5) notify NMFS and FWS. Only trained professionals would conduct electroshocking and fish removal.

Revegetation

As required by FERC's *Plan*, PCGP has identified procedures for the preparation and planting of live stakes or sprigs and for the planting bare root tree seedlings. Those procedures are included in appendix R. Within the range of SONCC coho salmon, construction of the Pipeline would remove 41.59 acres of riparian forested habitats of which 20.24 acres are late-successional (mature) old-growth, 17.97 acres are mid-seral forests, and 0.08 acres are forested wetlands. Within the Trail Creek watershed 6.17 acres of riparian forest would be removed; 8.01 acres within the Shady Cove-Rogue River watershed; 5.74 acres within the Big Butte Creek watershed; and 21.67 acres within the Little Butte Creek watershed (see table 3.5.3-25a).

Existing forested riparian zones in which forest would be removed during construction would be re-planted with conifers to within 15 feet of each side of the centerline. Permanent effects – persisting longer than the assumed 50-year life of the Pipeline – would occur by removing 16.86 acres of late-successional (mature) old-growth riparian forest. Even though the riparian zone would be replanted, the newly planted trees would not attain late-successional or old-growth status within 50 years. Permanent effects would also last along the 30-foot-wide maintenance corridor centered on the Pipeline. Those effects to former late-successional (mature) old-growth riparian forest, mid-seral riparian forest and other existing riparian vegetation are included in table 3.5.3-25b. Due to a maintenance access route in the right-of-way that would not be allowed to grow trees for the life of the Pipeline project, replanting conifers in the remaining affected forested riparian zone would still leave an estimated 10.02 acres of non-forested vegetation within former forested riparian zones over the long-term or permanently (see table 3.5.3-25b).

OHV Barriers

Limiting OHV vehicle access would reduce potential increased sedimentation to streams and human access to sensitive fish areas. In accordance with FERC's *Plan*, the applicant would offer to install and maintain measures to control unauthorized vehicle access to the right-of-way to each landowner or manager of forested lands. Such measures may include signs; fences with locking gates; slash and timber barriers, pipe barriers, or a line of boulders across the right of way; and conifers or other appropriate trees or shrubs across the right-of-way. If allowed by the landowner, and if available, slash, stumps and or logs would be placed on the right-of-way within the riparian zones to discourage OHV crossings of streams and provide carbon and nutrients. If not allowed, PCGP would discuss with the landowner the use of other methods, as noted above. At a minimum the area would be revegetated and re-seeded.

Streambank Stability

The root network of trees adjacent to streambanks is essential to maintaining streambank stability (WDNR 1997). Because root strength decreases significantly at distances beyond one-half the tree crown diameter, trees promoting streambank stability lie within half a tree crown diameter from the streambank. Trees within 25 feet of the streambank are assumed to promote streambank stability (WDNR 1997). Generally, trees that must be removed during construction would be cut at ground level with the roots left in place, except where located within the trench line. Although roots would decay overtime, streambank stability would be retained by their presence until revegetation is successful.

Streambank Restoration

PCGP's ECRP (see appendix F) describes the measures that would be used to stabilize streambanks crossed by the Pipeline. PCGP would not use riprap to stabilize streambanks. The alignment has been designed at waterbody crossings to be as perpendicular to the axis of the waterbody channel, as engineering and routing constraints allow, minimizing streambank disturbance and avoiding parallel stream alignments or multiple stream crossings. Immediately after installation of a waterbody crossing, the contours of the streambed, shoreline, and streambanks would be restored to preconstruction configurations (i.e., contour/elevations) to restore the physical integrity/condition of these features and to minimize the loss of stream complexity.

PCGP has completed a scour analysis that would be used to ensure that appropriate pipeline burial depths and cover design parameters beneath channel streambeds and adjacent floodplains are utilized, so that the effects on natural stream processes would be avoided or minimized (GeoEngineers 2017i).

PCGP would install erosion control fabric (such as jute or excelsior) on streambanks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. The erosion control fabric to be used on streambanks would be designed for the proposed use and would be approved by PCGP's EIs.

Consistent with the FERC's *Procedures* (section V.C.3.), during streambank restoration/recontouring, the streambanks would be returned to their preconstruction contours or to a stable configuration. Streambank revegetation measures, including supplemental riparian planting procedures are also outlined in the ECRP. The shrubs and trees planted at each site would be determined at the time of planting based on the moisture regimes and site-specific conditions at each planting location and landowner requirements.

In-stream Gravel

Waterbodies supporting fisheries would be backfilled with material removed from the trench with the upper 1 foot of the trench backfilled with clean gravel or native cobbles. PCGP has requested a variance from section V.C.1. of FERC's *Procedures* in fish-bearing streams that do not have gravel, cobble, or other rock substrates prior to construction. This variance was requested because many of the streams crossed by the Pipeline are remote and are located in steep valley or ravine bottoms. Therefore, hauling rock to these steams is impractical, especially where these streams do not have gravel or cobble substrate characteristics prior to construction. The bottom and banks would be returned to preconstruction contours; banks would be stabilized; and temporary sediment barriers would be installed before returning flow to the waterbody channel.

Large Woody Debris

As discussed in the Direct and Indirect Effects section above, mitigation would contribute to restoring an aquatic habitat indicator's functional level, such as placement of LWD within and/or adjacent to streams and placing LWD on floodplains, where appropriate, to provide microsites for riparian vegetation and/or vegetation protection during flood events. Placement of LWD in streams and/or on streambanks has been one focal point of recent stream rehabilitation procedures (Slaney and Martin 1997; Cederholm et al. 1997; EPA 2001) and is further described in the *Large Woody Debris Plan* (appendix O).

As indicated in table 3.5.3-8, baseline watershed conditions crossed by the Pipeline are lacking in LWD due to historical disturbance, and LWD presence is typically below benchmark thresholds to be properly functioning. LWD is an important habitat feature providing in-stream structure, channel and habitat complexity, among other benefits, and one that promotes salmonid productivity. If approved by land owners, PCGP proposes to install LWD on-site during construction as an appropriate habitat enhancement feature to mitigate for potential impacts and to benefit watershed conditions, which are generally lacking.

LWD placement would be in addition to the conservation measures (see appendix N) that have been designed to minimize the potential effects, including utilizing dry open-cut crossing methods, applying in-stream construction timing restrictions, and implementing erosion control measures and revegetation methods. Because of the overall lack of LWD in the affected watersheds, LWD also provides an appropriate mitigation model for the potential waterbody crossing impacts that are temporary, short-term, and unavoidable (see the *Large Woody Debris Plan* in appendix O). The LWD would also serve to mitigate for potential long-term impacts—impacts lasting for the 50-year life of the Pipeline—such as the loss of forested riparian vegetation within the 30-foot operational corridor (see table 3.5.3-25b). Even though the riparian zone would be replanted, the planted trees would not attain late-successional or old-growth status within 50 years. Placement of LWD would, in some measure, reduce, though not eliminate, the impact due to the removal of LSOG riparian forest.

For low-gradient streams, Cederholm et al. (1997) suggest using logs with diameters at least 18 inches (less in areas of low velocity) placed by vertical angling into the stream channel. Logs could be used to create a stepped-channel profile with the rootwads and encourage woody debris accumulations in pool margins. For streams with steeper gradients, Cederholm et al. (1997) suggest that logs with smaller diameters might be used if larger logs are unavailable. Near headwaters, LWD is often suspended over the channel so that it can become functional during periods of maximum runoff. Smaller debris may be retained during those periods and help develop pools that would be functional during summer (see Cederholm et al. 1997).

Guidelines for LWD placement, provided by ODF and ODFW (1995), suggest using the following: 1) larger diameter wood pieces because they are more effective at creating pools and complex channels which improve fish populations (see table 3.5.3-36 for minimum diameter LWD per bankfull width); 2) LWD that are at least twice the length of the waterbody bankfull width (1.5 times the bankfull width if the rootwad is attached) to increase the likelihood that the LWD would remain in place; and 3) conifer logs, especially western red cedars if available, because they are more durable. In larger waterbodies, smaller diameter, shorter LWD could be used if bundled and anchored together to provide the same benefits of the longer, larger diameter LWD (ODF and ODFW 1995).

TABLE 3.5.3-36

Minimum Diameter LWD for Placement in Waterbody Based on Bankfull Width

Bankfull Width (feet)	Minimum Diameter LWD (inches)
0 to 10	10
10 to 20	16
20 to 30	18
Over 30	22

Source: ODF and ODFW 1995.

Trees classified as late successional or old growth are assumed to have attained heights equal to the site-potential tree heights that are included above in table 3.5.3-35 as Riparian Zone Widths. Site-potential tree heights range from 157 feet (for example, the Shady Cove-Rogue River Watershed) to 187 feet (as in the Big Butte Creek Watershed). If Douglas-fir trees in the Oregon Cascades grow in height at the rate of 20 inches per year and in diameter by 0.25 inch per year (Cox 2008), a 20-inch-tall seedling planted the year after construction would be an estimated 85 feet tall and 12 to 13 inches in diameter (assumed dbh) after 50 years. Trees with those dimensions would provide suitable LWD for streams with bankfull widths from 0 to 10 feet but not larger streams (see table 3.5.3-36). Even in these streams recruitment of wood may be reduced as the rate for natural mortality of the young forest would be less relative to older trees. Although, recruitment of wood is not solely dependent on natural tree mortally and includes important contributing factors such as bank erosions, disease, fires, slides, and windthrow (Reeves et al. 2003; Martin and Benda 2001; Gregory et al. 2003). LWD contribution would occur from these areas even though natural mortality contribution would be reduced.

The Pipeline would cross 13 perennial streams within the range of SONCC ESU coho salmon. Twelve of those perennial streams have existing riparian forest ranging from clear-cut forest to mid-seral stage (approximately 40 to 80 years old) and older late-successional and old-growth stages; 6.91 acres of existing riparian forest associated with perennial streams would be removed by construction. One additional perennial stream would also be crossed but construction would not affect riparian forest vegetation (see table 3.5.3-37). In addition, the Pipeline would cross 52 intermittent streams, 41 of which support riparian forest, and would affect riparian forest of 19 other intermittent streams; 41.68 acres, total, of riparian forest at perennial and intermittent streams would be removed. Seventeen intermittent streams with no riparian forest would also be crossed (see table 3.5.3-37).

To offset impact from removal of riparian trees (reducing LWD recruitment potential) and to provide an overall benefit by enhancing stream habitat with no potential for LWD recruitment, PCGP proposes to place LWD at the waterbody flow types identified by watershed in table 3.5.3-37 (see the *Large Woody Debris Plan* in appendix O), based on the following applications:

- four pieces for each perennial stream crossed with riparian forest removed (two pieces in-stream and/or keyed into the streambank, two pieces within riparian zone on the bank);
- two pieces for each intermittent stream and unknown stream crossed with riparian forest removed (one or both LWD pieces placed in-stream, keyed into the bank, or placed on the bank);
- two pieces for each perennial, intermittent, and unknown stream crossed but with no riparian forest removed (one or both LWD pieces paced in-stream keyed into the bank, or placed on the bank); and
- one piece each for a perennial, intermittent, and unknown stream not crossed but adjacent to the construction right-of-way, with or without riparian forest removed (LWD placed on bank).

Because the construction right-of-way at stream crossings would be 75 to 95 feet wide, PCGP anticipates only enough space for two pieces of LWD, preferably with rootwads attached, either placed in-stream or with stems keyed into streambanks. Unless site-specific conditions dictate otherwise, the preferable location for each in-stream LWD is downstream from the pipeline to prevent scour of the pipe. LWD would also be placed near or adjacent to streambanks within riparian zones to provide for and/or enhance microsites for riparian vegetation and/or vegetation protection during flood events.

The LWD plan includes placing from 1 to 4 pieces of LWD per stream crossed in the stream or on the bank, depending on forest conditions, stream flow, and landowner approval. This number of pieces, if no other LWD were present in the stream reach affected by clearing, would be in the range of what is considered "desirable" by ODFW (Foster et al. 2001) for forested streams. Foster et al.

(2001) noted that more than 20 LWD pieces/100 meters of stream length (i.e., 4.6 pieces/75 feet of right-of-way clearing) with more than 3 "key" pieces/100 meters (i.e., 0.7 "key" pieces/75 feet right-of-way clearing) is considered "desirable" in forested streams in Oregon. The sizes of LWD pieces to be installed are shown in table 3.5.3-36 above in streams to meet habitat needs for specific stream sizes and number of streams crossed.

In all, PCGP proposes 173 pieces of LWD for placement within the four fifth-field watersheds that coincide with SONCC ESU coho salmon and designated critical habitat. Placement of LWD is subject to approval by each affected landowner. If a landowner rejects the proposed placement of LWD, the number of pieces that would have been applied onsite would be reserved and provided to appropriate watershed councils for their use and placement, preferably elsewhere within the affected fifth-field watershed.

PCGP anticipates that during construction, in some cases, the waterbody size, landowner restrictions, or construction constraints would limit LWD placement according to the proposed LWD schedule provided in table 3.5.3-37. Further, the overall benefit of installation of LWD at some waterbody crossings (i.e., intermittent headwater streams) may not warrant LWD placement. In these situations, PCGP's EI would record the uninstalled LWD as a deficit during construction. After construction is completed, unutilized LWD would be provided to local watershed conservation organizations or agencies for use in local enhancement projects within the affected watersheds. (Also see the discussion on the use of LWD for mitigation in appendix O.)

TABLE 3.5.3-37

Proposed Application of Large Woody Debris to Waterbodies and Riparian Zones Affected by Construction of the Pipeline within the Range of Southern Oregon Northern California Coast Coho Salmon

Fifth-Field Watershed	Watershed Parameter a/	Waterbody Type: Perennial Crossed	Perennial Adjacent	Intermittent Crossed	Intermittent Adjacent	Unknown Crossed	Unknown Adjacent	Total in Watershed	Pieces of LWD Applied to Fifth-Field Watershed b/: Crossed	Adjacent	Total
Trail Creek (HUC 1710030706)	Area (acres) of Riparian Forest	1.11	0	3.59	1.47	0	0	6.17			
	Total Number of Waterbodies	2	0	4	1	0	0	7			
	With Riparian Forest	2	0	4	1	0	0	7	16	1	17
	No Riparian Forest	0	0	0	0	0	0	0	0	0	0
Shady Cove-Rogue River (HUC 1710030707)	Area (acres) of Riparian Forest	0.91	0	4.13	3.13	0	0	8.17			
	Total Number of Waterbodies	4	0	6	9	0	0	19			
	With Riparian Forest	3	0	6	5	0	0	14	24	5	29
	No Riparian Forest	1	0	0	4	0	0	5	2	4	6
Big Butte Creek (HUC 1710030704)	Area (acres) of Riparian Forest	3.19	0	1.24	1.23	0	0	5.66			
	Total Number of Waterbodies	3	0	5	3	0	0	11			
	With Riparian Forest	3	0	4	3	0	0	10	20	3	23
	No Riparian Forest	0	0	1	0	0	0	1	2	0	2
Little Butte Creek (HUC 1710030708)	Area (acres) of Riparian Forest	1.71	0	17.84	2.13	0	0	21.68			
	Total Number of Waterbodies	4	0	37	6	0	0	47			
	With Riparian Forest	4	0	31	4	0	0	35	78	4	82
	No Riparian Forest	0	0	6	2	0	0	12	12	2	14
Total Fifth-Field Watersheds For SONCC Coho	Area (acres) of Riparian Forest	6.91	0	26.80	7.96	0	0	41.68			
	Total Number of Waterbodies	13	0	52	19	0	0	84			
	With Riparian Forest	12	0	41	13	0	0	66	138	13	151
	No Riparian Forest	1	0	11	6	0	0	18	16	6	22
								Total LWD	**154**	**19**	**173**

a/ Riparian Forest assumed to be coniferous, deciduous, or mixed forest 40 years old and older.
b/ Proposed schedule for applying LWD to different waterbody types, subject to landowner approval:
– 4 pieces for each perennial stream crossed with riparian forest removed (2 pieces in-stream, 2 pieces within riparian zone on the bank);
– 2 pieces for each intermittent stream and unknown stream crossed with riparian forest removed (one or both pieces placed in-stream or on bank);
– 2 pieces for each perennial, intermittent, and unknown stream crossed but with no riparian forest removed (one or both pieces paced in-stream or on bank);
– 1 piece each for perennial, intermittent, and unknown stream not crossed but adjacent to ROW with or without riparian forest removed (placed on bank).

Stream Crossing Monitoring

PCGP's Stream Crossing Risk Analysis (GeoEngineers 2017d, 2017e and 2018a/appendix O.2 to PCGP's Resource Report 2) provides site-specific BMPs to restore streambed and banks for long-term stability and to restore aquatic habitat. This Risk Analysis also provides a stream crossing monitoring plan to ensure long-term success of stream restoration, maintenance of fish passage, and identification of channel erosion, scour or migration that could destabilize the site or expose the pipeline. Streambank revegetation measures are outlined in section 10.0 of the Risk Analysis. Appropriate restoration BMPs, outlined in the Site-Specific Stream Crossing Prescriptions for the Perennial Streams on BLM and National Forest lands (North State Resources 2014), would also be incorporated during construction and restoration in consultation with the agency's authorized representative and PCGP's EI or authorized representative. Monitoring would be conducted at streams based on levels of risk and described in the section Streambank Erosion and Streambed Stability, above.

3.5.3.5 Determination of Effects

Species

The Project **may affect** coho salmon in the SONCC ESU because:

- several life stages and activities of coho salmon (upstream adult migration, juvenile fry rearing, and juvenile smolt out-migration) are expected to occur at various locations in the riverine analysis area during construction and operation of the proposed action.

While several Project actions are not likely to cause adverse effects, effects from Project components that are **likely to adversely affect** coho salmon in the SONCC ESU include those listed below.

- TSS could adversely affect juvenile coho salmon. Exposure of juvenile fry to TSS concentrations during dry open-cut construction (fluming or dam-and-pump) from 2 to 5 hours (see table 3.5.3-21) could potentially exceed SEV 3 (avoidance effects) or SEV 4 (effects to feeding rate) for an estimated 347 to 1,919 meters downstream (see table 3.5.3-23). Such an effect could cause minor physiological stress in juvenile coho salmon (SEV 3) or a short-term reduction in feeding rate and short-term reduction in feeding success (SEV 4).
- If a failure occurs while dry open-cut construction is underway, possible effects to juvenile coho (SEV = 7) could include moderate habitat degradation and impaired homing by fish.
- Construction requiring blasting at 13 streams could cause mortality to fish by rupturing swim bladders. Adult and juvenile fry coho salmon would be removed and/or prevented from being within 50 feet of blasting sites to the maximum extent possible. A worst-case estimate of 67 juvenile fry coho could potentially be salvaged from streams that require blasting.
- Fish salvage would occur within isolated construction sites when adult and juvenile fry coho salmon are present. Coho salmon are considered vulnerable to electrofishing and could be subject to injury and mortality. Fish salvage would primarily rely on

seining but may require electrofishing if other methods are ineffective (refer to the *Fish Salvage Plan*). Seining, electrofishing, and handling may adversely affect SONCC coho salmon. A worst-case estimate of 167 juvenile fry coho could potentially be salvaged from streams crossed by dry open-cut procedures that did not require blasting.

- Lack of LWD is a limiting factor in most streams within range of SONCC coho salmon. Removal of mid-seral riparian forest (40-80 years old) would have long-term effects to recruitment of LWD, and removal of LSOG forest (≥80 years old) would have permanent effects to recruitment of LWD because planted conifers would not attain that age class within the 50-year life of the Project.

Critical Habitat

The Project **may affect** designated critical habitat for coho salmon in the SONCC ESU because:

- the Pipeline crosses designated critical habitat within waterbodies of the Upper Rogue hydrologic unit (HUC 17100307) below the Lost Creek, Willow Creek, and Fish Lake Dams.

Project components are **likely to adversely affect** designated critical habitat for coho salmon in the SONCC ESU because:

- approximately 8.9 acres of native riparian vegetation (forest, wetlands, and unaltered nonforested habitats) and of altered habitat would be removed during construction within riparian zones associated with designated critical habitat. Adverse effects to riparian zones associated with critical habitat would be long-term or permanent depending on whether mid-seral riparian forests (2.1 acres) or LSOG riparian forests (1.6 acres) are removed (provided in table 3.5.3-34a); and
- a failure of crossing isolation structures lasting for 4 hours or more would cause an SEV score of 7 or higher for at least 132 m downstream from dry open-cut crossings within three streams with critical habitat in the Trail Creek watershed (West Fork Trail Creek, Canyon Creek and tributary to Trail Creek, see table 3.5.3-23), at least 397 m downstream within two streams with critical habitat in the Big Butte Creek watershed (Neil Creek and Quartz Creek, see table 3.5.3-23), and at least 554 m downstream in two streams with critical habitat in the Little Butte Creek watershed (Salt Creek and North Fork Little Butte Creek). SEV of 7 would not occur within designated critical habitat in the Shady Cove-Rogue River watershed (Indian Creek) by a failure lasting for 4 hours but could occur if the duration lasted 5 hours or more.

3.5.4 Coho Salmon (Oregon Coast ESU)

3.5.4.1 Species Account and Critical Habitat

Status

The NMFS (1995) conducted a status review of coho salmon in 1995 that led to a proposed listing of several ESUs as threatened, including the Oregon Coast ESU, in 1995. The final listing was delayed due to disagreements about conclusions drawn from available information and the original proposal to list as threatened was withdrawn in 1997. In 1998, the District Court for Oregon determined that NMFS' 1997 withdrawal of the proposed listing status was arbitrary and capricious and vacated the determination. Following the Court decision, NMFS issued a final rule to list the Oregon Coast ESU as threatened in August 1998. That determination was based entirely on information collected prior to the proposed rule in 1997. However, the District Court set aside the 1998 final rule determining threatened status for the Oregon Coast ESU (a result of the Alsea ruling) and NMFS undertook an updated status review of 27 West Coast salmon ESUs in 2003, which included the coho salmon Oregon Coast ESU. During the status review, the Biological Review Team considered the uncertainty of the ESU becoming endangered. Nevertheless, NMFS again proposed listing the coho salmon Oregon Coast ESU as threatened in June 2004 based on the review (NMFS 2006d).

In December 2004, critical habitat was also proposed. NMFS designated critical habitats for several salmon ESUs in a final rule published in September 2005 but critical habitat for the coho salmon Oregon Coast ESU was not included because there had not been a final rule listing the ESU as threatened. In that new proposed rule, the ODFW was conducting an assessment of the population viability of Oregon Coast coho salmon. From that, ODFW concluded that Oregon Coast coho salmon are "inherently resilient at low abundance" and such response would prevent extinction. With that information and other products from the ODFW *Oregon Coastal Coho Assessment,* NMFS withdrew its proposals to list Oregon Coast coho salmon as threatened and to designate critical habitat in January 2006 (NMFS 2006d). In that decision to withdraw the proposed rules, NMFS declared that listing under ESA was not warranted at the time but the decision was challenged in Oregon District Court, which ruled that NMFS' withdrawal be invalidated and remanded to NMFS (Lohn 2007). The present listing status for the Oregon Coast coho salmon ESU is threatened with corresponding critical habitat (NMFS 2008d). After proposing the ESU for listing, withdrawing the proposal, and re-proposing listing the ESU as threatened under scrutiny of Oregon federal district court, NMFS issued a final rule in 2011 (NMFS 2011d) retaining the threatened listing for the coho in the Oregon Coast ESU.

Threats

At the time the Oregon Coast ESU was first proposed for listing as threatened in 1995, threats to West Coast salmon populations were discussed in general but were not specific to the Oregon Coast ESU. The same factors noted above as threats to coho salmon in the SONCC ESU applied to coho salmon in the Oregon Coast ESU.

NMFS published a more recent status review in 2005 (Good et al. 2005). The U.S. District Court found NMFS' 1998 decision, listing the Oregon Coast coho salmon ESU, as unlawful because the ESU includes hatchery and naturally spawned coho salmon but NMFS only considered naturally spawned fish in their decision (Lawson 2005). Following the delisting, multiple parties petitioned NMFS to re-list all stocks within the Oregon Coast ESU as threatened based on new information about coho salmon abundance, variability in survival and abundance, threats to genetic integrity of stocks, and stochastic events including El Niño conditions and floods (Lawson 2005).

The short-term trend in escapement of adult spawners within the Oregon Coast ESU increased substantially in 2001 and 2002, including trends within the Umpqua, Coos, and Coquille Subbasins due to increased marine survival and considerable restrictions on ocean harvests (Lawson 2005, and see discussion below). Alternatively, trends in short-term recruitment were less positive within the ESU, especially in the Coos and Coquille Rivers (Lawson 2005).

In 1994, most coho salmon harvest was prohibited and has been restricted since then, though mortalities still occur coincidentally with Chinook salmon fisheries for hatchery (marked) coho salmon (Lawson 2005). Subsequent analyses indicated that management for a proportional maximum harvest rate of 35 percent resulted in lower risk of extinction for the ESU than management for an escapement goal or quota of 200,000 spawners ESU-wide. As expected, a harvest of zero further reduces extinction risk (Lawson 2005).

Freshwater restoration projects to improve water quality and watershed conditions have been implemented throughout the Pacific Northwest since the late 1990s (e.g., the Coastal Salmon Restoration Initiative in 1997), though measurable results would take time (Lawson 2005). Poor marine survival for Oregon coho salmon began with climatological changes detected in the mid-1970s and worsening in the 1990s. Those conditions ameliorated in the late 1990s and extend into the early 2000s so that coho salmon marine survival improved. Such fluctuations have occurred in the past as variable cycles but future cycles would likely be within the context of global warming, which would likely prohibit predictions from past conditions (Lawson 2005).

Recently, NMFS (2016c) conducted a 5-year status review of Oregon Coast coho, concluding that there have been positive improvements to the Oregon Coast ESU including long-term abundance trends and escapement due, in part, to reduced harvest and hatchery releases coupled with high marine survival. In the Umpqua Stratum (defined by the Oregon and Northern California Coasts Technical Recovery Team to evaluate population recovery) that includes coho in the South Umpqua Sub-basin, there have been numerous efforts to acquire and restore conditions in watersheds including placement of large wood, road maintenance, improvements in fish passage, riparian plantings, and culvert replacements that reduce habitat degradations caused by human use and development (NMFS 2016c). In the Mid-South Coast Stratum, which includes coho in the Coos and Coquille sub-basins, there have been multiple projects similar to those in the Umpqua Stratum, as well as side channel reconnections implemented through watershed councils. In both strata, issues of continuing loss of beavers with concomitant loss of coho salmon rearing habitat, primary productivity, nutrient retention/cycling, floodplain connectivity, fish passage, and stream flow moderation remain ongoing habitat concerns for Oregon Coast coho (NMFS 2016c).

Compared to the Oregon Coast ESU as a whole, the proportion of escapements by coho salmon produced in hatcheries to wild spawners has been quite low in the Umpqua, Coos, and Coquille Rivers (Table 71 in Lawson 2005), though correct identification of hatchery and wild fish has been an issue in such surveys. As noted above, decreasing the proportion of hatchery spawners benefits wild stock.

NMFS (1996) developed an approach and criteria for evaluating human-related effects to anadromous salmonid habitats which focuses on the following six pathways of potential impact: 1) water quality, 2) habitat access, 3) habitat elements, 4) channel condition and dynamics, 5) flow/hydrology, and 6) watershed condition. BLM and Forest Service developed watershed analyses, in part to meet requirements of their respective land management plans, specifically to comply with the objectives of the ACS in the NWFP. In addition to federal agencies, watershed assessments have been developed by local watershed councils and Oregon's natural resource agencies and are available through the Oregon Watershed Enhancement Board. Watershed assessments provide evaluations of fish habitats and water quality and describe how natural process and human activities are affecting those resources (Governor's Watershed Enhancement Board 1999). Available watershed analyses developed by these sources are listed in table 3.5.4-1 for the fifth-field watersheds crossed by the Pipeline.

Summaries for three of the watershed analyses are provided in appendix B.3 to PCGP's Resource Report 3 (table B.3-1a through table B.3-1g). As a rule, streams lacked in-stream LWD, fish access was limited, sedimentation was excessive, and habitats had been affected by high flows that degraded in-stream habitats. NMFS' (2016c) review of habitat conditions within the range of the Oregon Coast coho ESU and the Coos, Coquille, and South Umpqua subbasins was discussed, above. The updated status review indicates that there has been improvement in the biological status of Oregon Coast coho in the last five years but factors related to persistence of coho in the ESU have not significantly changed since the former status review conducted in 2012 (NMFS 2016c).

TABLE 3.5.4-1

Watershed Assessments Conducted by Federal and State Agencies for 5th Field Watersheds Crossed by the Pipeline

Sub-basins and Fifth Field Watersheds	Watershed Analysis, BLM and/or Forest Service	Watershed Assessment, Oregon Watershed Enhancement Board
Coos Sub-basin		
Coos Bay-Frontal Pacific Ocean	● Catching-Beaver Watershed Analysis (BLM 2010)	● Coos Bay Lowland Assessment and Restoration Plan (Coos Watershed Association 2006) ● Catching Slough, Daniel's Creek and Heads of Tide Sub-basin Assessment and Restoration Opportunities (Coos Watershed Association 2008)
Coquille Sub-basin		
North Fork Coquille River	● North Fork Coquille Watershed Analysis (BLM 2001a)	● Coquille River Sub-basin Plan (Coquille Indian Tribe, 2007)
East Fork Coquille River	● East Fork Coquille Watershed Analysis (BLM 2000)	
Middle Fork Coquille River	● Upper Middle Fork Coquille Watershed Analysis (BLM, 1999a) ● Middle Fork Coquille Watershed Analysis (BLM 2007)	
South Umpqua Sub-basin		
Olalla Creek-Lookingglass Creek	● Olalla-Lookingglass Watershed Analysis (BLM 1999b)	● Olalla/Lookingglass Watershed Assessment and Action Plan (DeVore and Geyer 2003).
Clark Branch-South Umpaqua River	● Middle South Umpqua Watershed Analysis (BLM 1999c)	● Middle South Umpqua Watershed Assessment and Action Plan (Geyer 2003a).
Myrtle Creek	● Myrtle Creek Watershed Analysis and Water Quality Restoration Plan (BLM 2002)	● Myrtle Creek Watershed Assessment and Action Plan (Geyer 2003b)
Days Creek-South Umpqua River	● South Umpqua Watershed Analysis and Water Quality Restoration Plan (BLM 2001b)	● South Umpqua River Watershed Assessment and Action Plan (Geyer 2003c)
Upper Cow Creek	● Cow Creek Watershed Analysis. (Forest Service 1995)	● Upper Cow Creek Watershed Assessment and Action Plan (Geyer 2003d)
Little Butte Creek	● Little Butte Creek Watershed Analysis (BLM and Forest Service 1997b).	● Little Butte Creek Watershed Assessment (Little Butte Creek Watershed Council 2003)

BLM and/or the Forest Service evaluated habitat conditions in the ten 5th field watersheds crossed by the Pipeline; most of the evaluations were conducted around 2000 (see table 3.5.4-1). More recently, various watershed associations, Native American tribes, and/or watershed councils conducted new assessments listed in table 3.5.4-1, including the Umpqua Basin Watershed Council (authored by Geyer 2003). The watershed assessment of the larger South Umpqua Sub-basin (HUC 17100302) included the Days Creek–South Umpqua River and Elk Creek watersheds. These more recent watershed assessments use ODFW Aquatic Inventory and Analysis data, which were also summarized below in table 3.5.4-10a and table 3.5.4-10b.

Species Recovery

NMFS (2016b) released a final recovery plan that addressed limiting factors and threats to each coho population within the Oregon Coast ESU including those within the Coos, Coquille, and

Umpqua River systems. Primary limiting factors in the Coos and Coquille populations include stream complexity with water quality the secondary limiting factor. In the South Umpqua population, the primary limiting factor is water quantity with stream complexity and water quality as secondary limiting factors.

Among other actions, the plan calls for protection and restoration of tidally influenced habitats in the Coos estuary by reconnecting intertidal wetlands and tidal channels by removing dikes, levees, and tidegates. The plan also calls for monitoring predation by non-native fish in the Coquille and Coos River and reducing populations of predaceous non-native species in the Coquille River. Recovery of Oregon Coast coho in those two population areas is also dependent on improving riparian forests to increase shade and reduce stream temperatures and improve water quality. Additionally, the plan directs increased habitat complexity that would restore winter habitat refuge areas in the floodplains in freshwater ecotones of upper tidal areas of the Coos estuary.

Key recovery strategies and potential actions that would improve coho populations and habitats in the Mid-South Coast Stratum, including the Coos and Coquille populations include: improvement of riparian conditions on state and private timber lands, improve water quality on rural (residential and agricultural) lands, maintain the aquatic conservation strategy on federal lands, manage beavers to increase habitats associated with beaver ponds and dams, restore estuary and tidal lands, evaluate instream flows with focus on connectivity, water temperatures, and riparian protections to support salmon.

The recovery plan also addresses predation on Oregon Coast coho by non-native smallmouth bass and largemouth bass in the South Umpqua population. Recovery of the South Umpqua population is also dependent on restoration of watershed processes that promote winter and summer rearing habitats (e.g., wood recruitment, habitat complexity, floodplain connectivity). Key recovery strategies and potential actions that would improve coho populations and habitats in the Umpqua Stratum, including the South Umpqua population includes: evaluate instream flows with focus on connectivity, water temperatures, and riparian protections to support salmon, improvement of riparian conditions on state and private timber lands, improve water quality on rural (residential and agricultural) lands, maintain the aquatic conservation strategy on federal lands, manage beavers to increase habitats associated with beaver ponds and dams, and improve fish passage at dams, culverts and other identified barriers.

Life History, Habitat Requirements, and Distribution

Miller and Sadro (2003) found that approximately one-half of each brood of coastal coho salmon in Winchester Creek/South Slough (which empties into Coos Bay approximately 5 miles south of the LNG Terminal) in 1999 and 2000 moved to the estuary as sub-yearlings (age 0). A portion of these juveniles lived in the ecotone between freshwater and saline portions of the estuary for up to 8 months and then moved back upstream to overwinter. Fish that moved to the ecotone in fall and winter had a mean residency of 48 days in 1999 and 64 days in 2000. Some of these fish resided in an off-channel beaver pond. In spring, age 1 smolts had a mean residence time in the ecotone of only 18 days and a mean residence time in the estuary of 5.8 days. Coastal coho salmon smolts would not be expected to utilize the more saline waters near the LNG Terminal area for the extended periods of time as they were shown to reside in the ecotone.

Radiotelemetry studies conducted by Oregon State University researchers (Schreck et al. 2002) in the Nehalem River estuary indicate that coho salmon smolts spend about 2 weeks in the estuary before moving into the ocean. Fish monitoring in Tillamook Bay (approximately 170 miles to the north) indicated that coho salmon smolts (age 1+) were rarely found in shallow edge habitat during their residency period in the bay (Ellis 1999, 2002a, 2002b). Most of the yearling smolts appear to move quickly through the estuarine environment to the ocean. ODFW seining surveys conducted at the McCullough Bridge and Trestle sampling sites in summer 2005 and 2006 did capture juvenile coho salmon (ODFW 2006c), but coho salmon smolts are not expected to rear within the estuarine analysis area in the estuary for significant periods of time. Coho salmon smolts resided in the stream-estuary ecotone of South Slough for a range of 12 to 40 days (Miller and Sadro 2003).

Figure 3.5.4-1 provides the typical timing of use for coho salmon in the estuarine analysis area and riverine analysis areas. Within the estuary, some coho salmon rearing occurs but most juvenile use is during migration to the ocean (Gray 2007). During the period between October 1 and February 15 when all in-water construction would occur, juvenile coho salmon in the estuary and lower Coos River are likely to be absent but adult coho salmon would be holding and/or migrating upstream (see figure 3.5.4-1).

Life stage requirements of coho salmon within freshwater habitats in the Oregon Coast ESU are expected to be similar to those described above for coho salmon in the SONCC ESU (see section 3.5.3.1). Within the entire ESU, adults generally enter coastal streams in the fall and spawn from November through possibly March. Peak spawning is during December or January (NMFS 2004). After hatching in spring, parr inhabit areas of slow flows and spend a second winter in freshwater before outmigration to the ocean as smolts, generally March through June (NMFS 2004).

Specific timings of life history phases for Oregon Coast coho salmon are shown in figure 3.5.4-1 within the in-stream portion of the Pipeline project area are available for individual rivers or tributaries in the vicinity of waterbodies crossed by the Pipeline. Smolt outmigration in the Umpqua River mainstem and tributaries lasts from March through June, with peak outmigration from April through mid-May. Similarly, peak outmigration in the Coquille River is from late March to early May, although the duration of outmigration is shown in figure 3.5.4-1 to extend from mid-February to mid-June.

Peak timing of river entry by adults to the Umpqua, Coos, and Coquille is early to mid-October although adults begin entrance to all three drainages in early September through January. Spawning in the Umpqua River begins in early October, and lasts through January, peaking in November and December (see figure 3.5.4-1). Though not shown in figure 3.5.4-1, spawning in the Coos River lasts from mid-November through late January, peaking in mid-December as well as in the Coquille River though spawning there lasts from mid-November through early February (Weitkamp et al. 1995, see Appendix Table C-4). In-stream construction within tributaries to the Coos, Coquille, and South Umpqua Rivers and within range of the Oregon Coast ESU would be from July 1 through September 15. Coho salmon adult upstream migration would be occurring during the end of the in-stream construction window but spawning would not yet have started. Incubation and fry emergence from gravel, juvenile fry rearing and juvenile smolt out-migration would not be occurring between July 1 and September 15 (see figure 3.5.4-1).

Based on genetic data and recoveries of tagged fish, the Oregon Coast coho ESU extends to Pacific Ocean tributaries from Cape Blanco north to the Columbia River. Coho in the ESU inhabit waterbodies in the following nine fifth-field watersheds that would be crossed by the Pipeline: Coos Bay-Frontal Pacific Ocean (HUC 1710030403), North Fork Coquille River (1710030504), East Fork Coquille River (HUC 1710030503), Middle Fork Coquille River (HUC 1710030501), Olalla Creek-Lookingglass Creek (HUC 1710030212), Clark Branch-South Umpqua River (HUC 1710030211), Myrtle Creek (HUC 1710030210), Days Creek-South Umpqua River (HUC 1710030205), and Upper Cow Creek (HUC 1710030206). Table 3.5.4-2 summarizes the number of waterbodies crossed within the Pipeline project area that are known or assumed to support Oregon Coast coho.

Life Stage/Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coos Bay Estuary and Coos River to the Confluence of Millicoma – South Fork Coos River												
Upstream Adult Migration												
Adult Holding												
Juvenile Rearing												
Juvenile Out-Migration												
Coquille River and Tributaries												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												
South Umpqua River Mainstem												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												
South Umpqua Tributaries												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												

Key:
period of peak use.
period of lesser use.
period of known presence with uniform or unknown level of use.

Source: ODFW n.d..

Figure 3.5.4-1 Approximate Timing of Oregon Coast ESU Coho Salmon Use of the Coos Bay Estuary, Coos River and Tributaries, Coquille River and Tributaries, and South Umpqua River and Tributaries

TABLE 3.5.4-2

Number of Waterbodies Crossed by the Pipeline Project within River Subbasins and Fifth-Field Watersheds with Oregon Coast Coho ESU Designated Critical Habitat and Coho Presence (Known or Assumed)

Subbasins and Fifth-Field Watersheds	Hydrologic Unit Code	Number of Waterbodies		
		Critical Habitat a/	Coho Known b/	Coho Assumed c/
Coos Subbasin	17100304			
Coos Bay-Frontal Pacific Ocean	1710030403	11	13	0
Coquille Subbasin	17100305			
North Fork Coquille River	1710030504	3	3	0
East Fork Coquille River	1710030503	2	2	6
Middle Fork Coquille River	1710030501	0	0	1
South Umpqua Subbasin	17100302			
Olalla Creek-Lookingglass Creek	1710030212	2	2	3
Clark Branch-South Umpqua River	1710030211	4	4	0
Myrtle Creek	1710030210	3	3	2
Days Creek-South Umpqua River	1710030205	4	4	0
Elk Creek d/	1710030204	0	0	0
Upper Cow Creek	1710030206	0	0	0
	Total	**29**	**31**	**12**

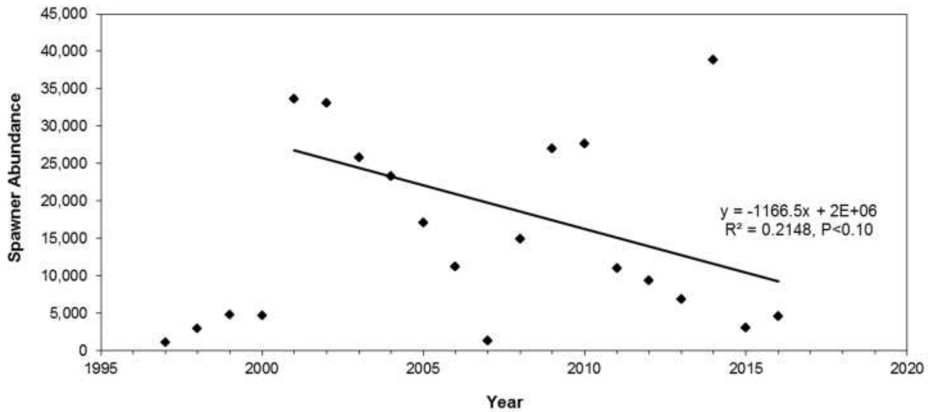
a/ NMFS 2008d
b/ ODFW 2017f
c/ Assumed presence based on connectivity to occupied stream reaches.
d/ Elk Creek Watershed would be crossed but no waterbodies would be affected within the watershed.

Population Status

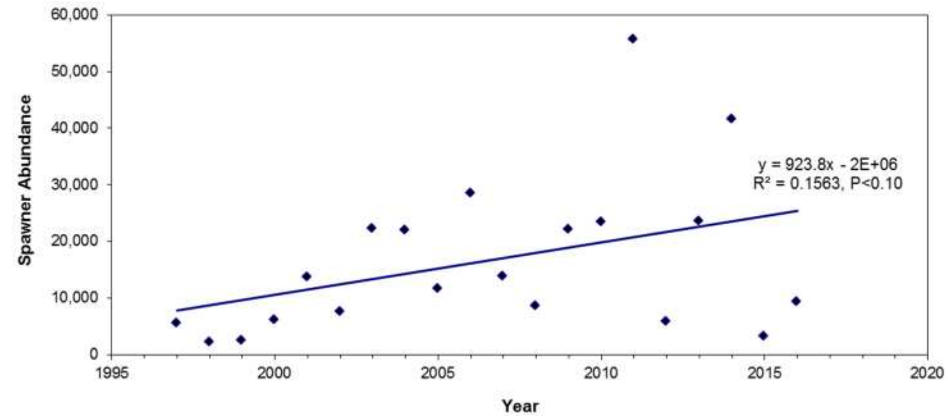
Abundance of naturally producing coho within the Coos Subbasin peaked at 33,595 spawners in 2001 but has generally diminished since then to 11,000 spawners in 2011 and to 9,400 in 2012; the declining trend in spawner abundance since 2001 is significant (see figure 3.5.4-2A).

Coho spawner abundance in the Coquille Subbasin (see figure 3.5.4-2B) and South Umpqua Subbasin (see figure 3.5.4-2C) had both been increasing at significant rates between 1997 and 2011 but declined dramatically in 2012, through 2016, the fewest wild spawners since 2008 in the South Umpqua during 2016 and fewest since 1999 in the Coquille Subbasin during 2015. The overall trend in total number of spawners in all three subbasins, combined (see figure 3.5.4-2D) had likewise been increasing through 2011 but numbers of spawners in 2012 were the fewest since 2000 in the riverine analysis area for Oregon Coast coho salmon. Although the increasing trend through 2011 and decline in 2012 was apparent in all populations of the Oregon Coast ESU (ODFW 2013b), the low spawner abundance since 2012 indicates there has been considerable variation but no overall trend, from 1997 through 2016 in the Oregon Coast ESU, similar to that shown in figure 3.5.4-2D.

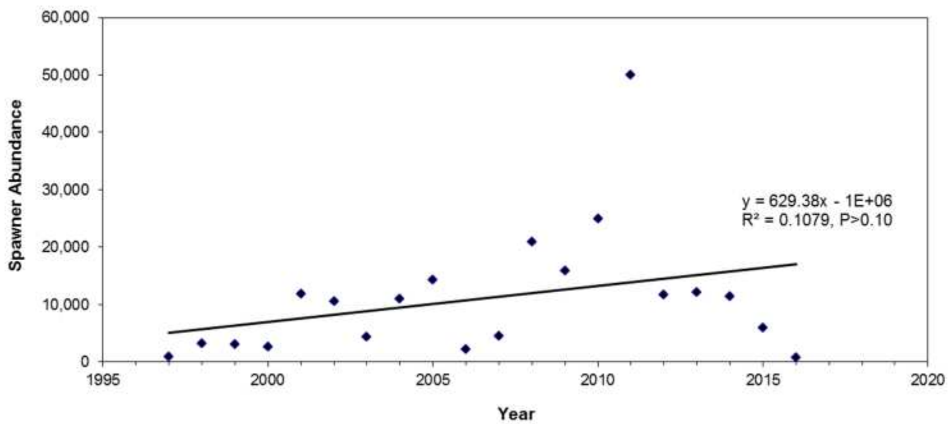
During the 20th century, there had been a prolonged decline in numbers of recruits per spawner (Weikamp et al. 1995; Good et al. 2005) wherein recruits from the return years 1997–1999 failed to replace parental spawners. Since 2000, increased marine survival rates and higher rainfall have likely contributed to a recent upswing in recruits (NMFS 2011d; Stout et al. 2012). But that trend was interrupted during return years 2005, 2006, and 2007 as recruits again failed to replace parental spawners. Possible explanations for recent recruitment failures include the possibility that higher spawning abundance levels in recent years had reached the current carrying capacity of the degraded freshwater environment.



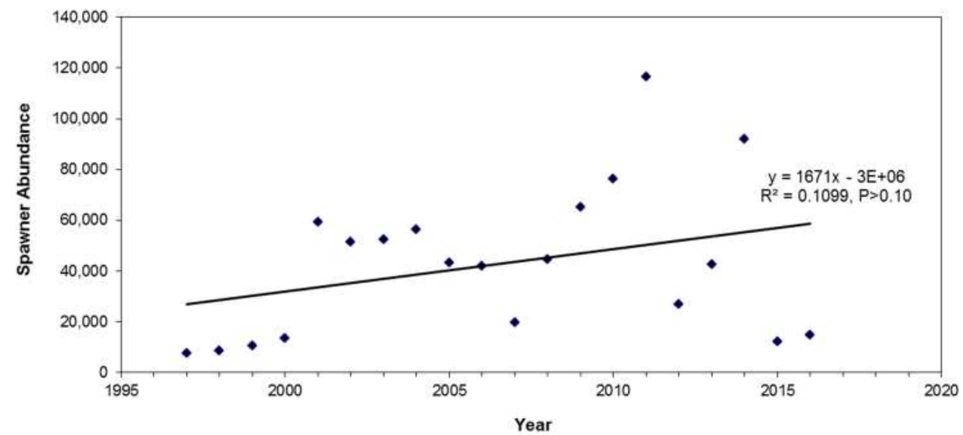
A. Coos Subbasin



B. Coquille Subbasin



C. South Umpqua Subbasin



D. All Subbasins in Analysis Area

Figure 3.5.4-2 Estimated Abundance of Wild Adult Coho Spawners in the Oregon Coast Coho ESU 1997 to 2016, within Three Subbasins Crossed by the Pipeline Project (Source: ODFW 2017d)

As total spawning abundance has been at highest levels since the 1950s, the total numbers of recruits remain lower than in the 1950s–1970s (NMFS 2011d; Stout et al. 2012). These possibilities indicate that degraded freshwater habitat conditions may limit the Oregon Coast coho ESU from rebounding from another prolonged period of poor marine survival of recruits, should that occur in the future. The possibility that either of these factors, individually or together, contributed to the extreme population declines observed in 2012 has not been reported.

Critical Habitat

Critical habitat for the Oregon Coast coho salmon ESU was first proposed in May 1999 (NMFS 1999c). Proposed critical habitat included all river reaches accessible to Oregon Coast coho salmon ESU which were listed as threatened at the time (see discussion above). Proposed critical habitat consisted of water, substrate, and adjacent riparian zones of estuaries and rivers including those in the Umpqua (HUC 17100302), Coos (HUC 17100304) and Coquille (HUC 17100305) hydrologic units (NMFS 1999c). Though not specifically identified, the Coos Bay estuary would have been included. The 1999 proposal was terminated when the District Court set aside the 1998 final rule determining threatened status for the Oregon Coast ESU (see discussion above).

Following re-proposing Oregon Coast coho salmon ESU for listing as threatened in June 2004, critical habitat for the ESU was likewise re-proposed in December 2004 (NMFS 2004). More recently critical habitat has been designated (NMFS 2008d) in three critical habitat units that coincide with the Project components: Unit 9 – South Umpqua Subbasin (HUC 17100302) affected by the Pipeline; Unit 11 – Coos Subbasin (HUC 17100304 - includes the Coos Bay estuary) affected by the LNG Terminal and the Pipeline; and Unit 12 – Coquille Subbasin (HUC 17100305) affected by the Pipeline.

Similar to critical habitat designated for coho salmon in the SONCC ESU, critical habitat for Oregon Coast coho includes stream channels to an extent laterally to the ordinary high water mark (OHWM) (or bankfull elevation or bankfull width). NMFS also defined critical habitat in estuarine and nearshore marine zones as areas contiguous with the shoreline from the extreme high water mark out to a depth no greater than 30 meters (98 feet) below the mean low water mark (NMFS 2004).

Within these areas, NMFS (2004) identified PCEs of critical habitat that include sites essential to support one or more coho life stages (spawning, rearing, migration, and foraging). Those sites each are associated with physical and biological features essential coho conservations (e.g., spawning gravels, water quality, water quantity, side channels, and food base). The following are PCEs for designated critical habitat for the Oregon Coast coho (NMFS 2008d):

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks a) supporting juvenile and adult mobility and survival, b) supporting juvenile use of various of habitats that allow them to avoid high flows, avoid predators, successfully compete, begin the behavioral and physiological changes needed for life in the ocean, and ability to reach the

ocean, and c) essential for nonfeeding adults to successfully swim upstream, avoid predators, and reach spawning areas on limited energy stores.

4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Designated critical habitat for the Oregon Coast coho does not include unoccupied areas. The lateral extent of critical was defined as the width of the stream channel defined as the ordinary high-water line (NMFS 2008d). Human actions on land outside of the stream channel can modify or degrade physical and biological features of the stream and associated PCE at the site and/or in downstream reaches of designated critical habitat.

3.5.4.2 Environmental Baseline

Analysis Area

There are three action area components that are applicable to coho salmon in the Oregon Coast coho salmon ESU: the marine analysis area, the estuarine analysis area, and the riverine analysis area.

The marine analysis area extends approximately 12 nmi offshore to the continental shelf (see figure 2.1.1-2, under section 2.1.1). Within this analysis area, effects to coho salmon within coastal marine waters would be associated with LNG carriers entering and exiting the Port of Coos Bay from the Pacific Ocean that are assumed to transit the marine analysis area perpendicularly—east and west—as they approach and depart from Coos Bay (see the discussion above under section 3.2.1.2 for blue whales).

The estuarine analysis area was described above for marbled murrelet (see figure 2.1.1-2). The estuarine analysis area includes: 1) the existing Federal Navigation Channel which forms part of the waterway for LNG carrier traffic to and from the LNG Terminal, 2) the proposed access channel to the terminal slip, 3) the Navigation Reliability Improvements, 4) the area of North Slough adjacent to the Trans Pacific Parkway/U.S. Highway 101 (US-101) Intersection Widening, 5) the Eelgrass Mitigation site, 6) the Kentuck Project site and sites temporarily occupied during construction activities (see figure 2.1.1-2), and 7) the HDDs of Coos Bay estuary and Coos River.

The riverine analysis area is similar to that described above for coho salmon in the SONCC ESU. The riverine analysis area includes two components: 1) the water column and substrate of all waterbodies crossed by the Pipeline from the point of crossing to the extent downstream where water quality is affected by turbidity generated during construction and sediment generated by runoff from the construction right-of-way, and 2) waterbodies' associated riparian zones affected in the short-term during construction and in the long-term by operation. For coho salmon in the Oregon Coast ESU, the riverine analysis area is limited to fresh waterbodies within Coos Subbasin (HUC 17100304 – figure 3.5.4-3A), Coquille Subbasin (HUC 17100305 – figure 3.5.4-3B) and South Umpqua Subbasin (HUC 17100302 – figure 3.5.4-3C); see table 3.5.4-3.

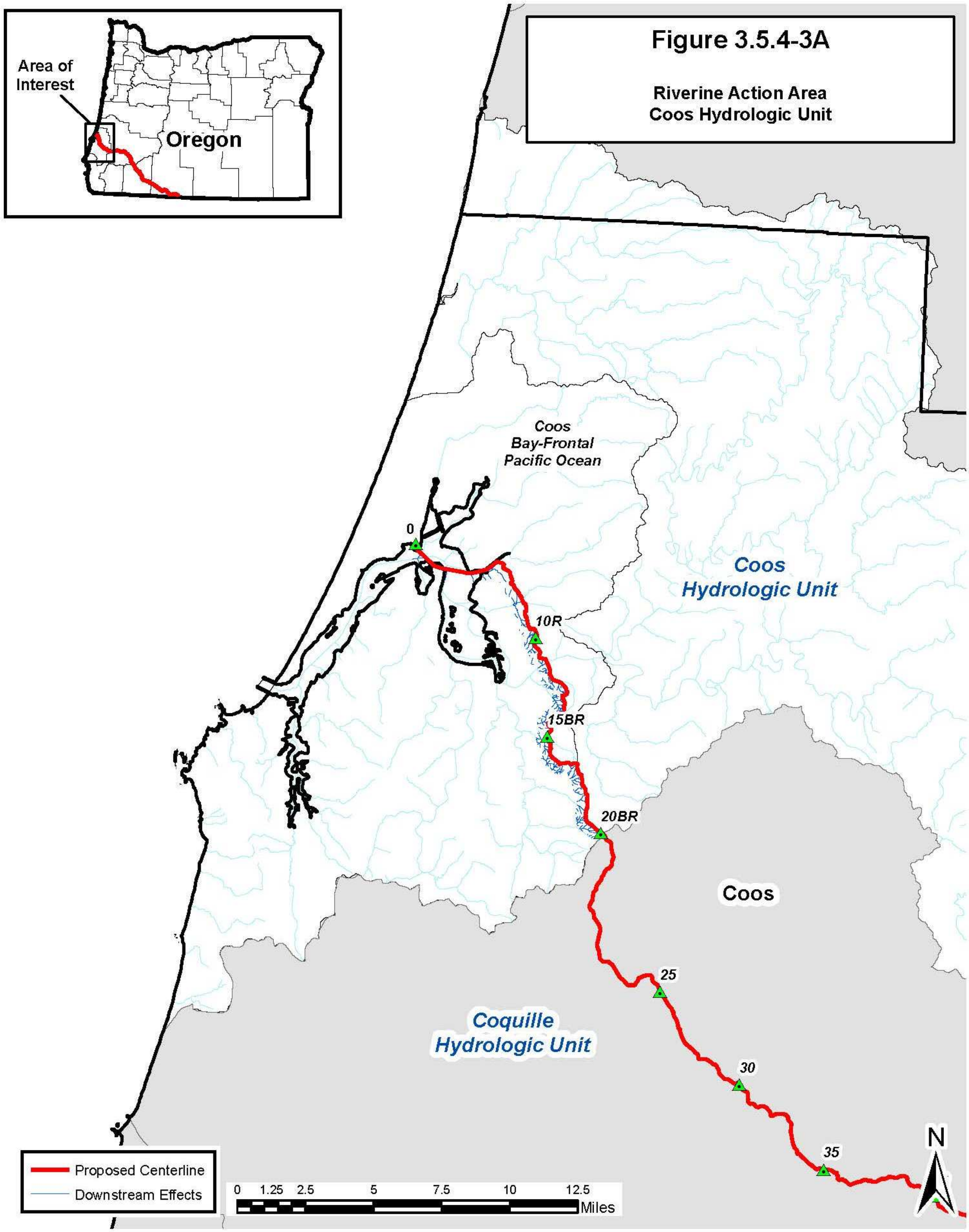


Figure 3.5.4-3A
Riverine Action Area
Coos Hydrologic Unit
Area of Interest
Oregon
Coos Bay-Frontal Pacific Ocean
Coos Hydrologic Unit
Coos
Coquille Hydrologic Unit
0
10R
15BR
20BR
25
30
35
Proposed Centerline
Downstream Effects
0 1.25 2.5 5 7.5 10 12.5
Miles
N

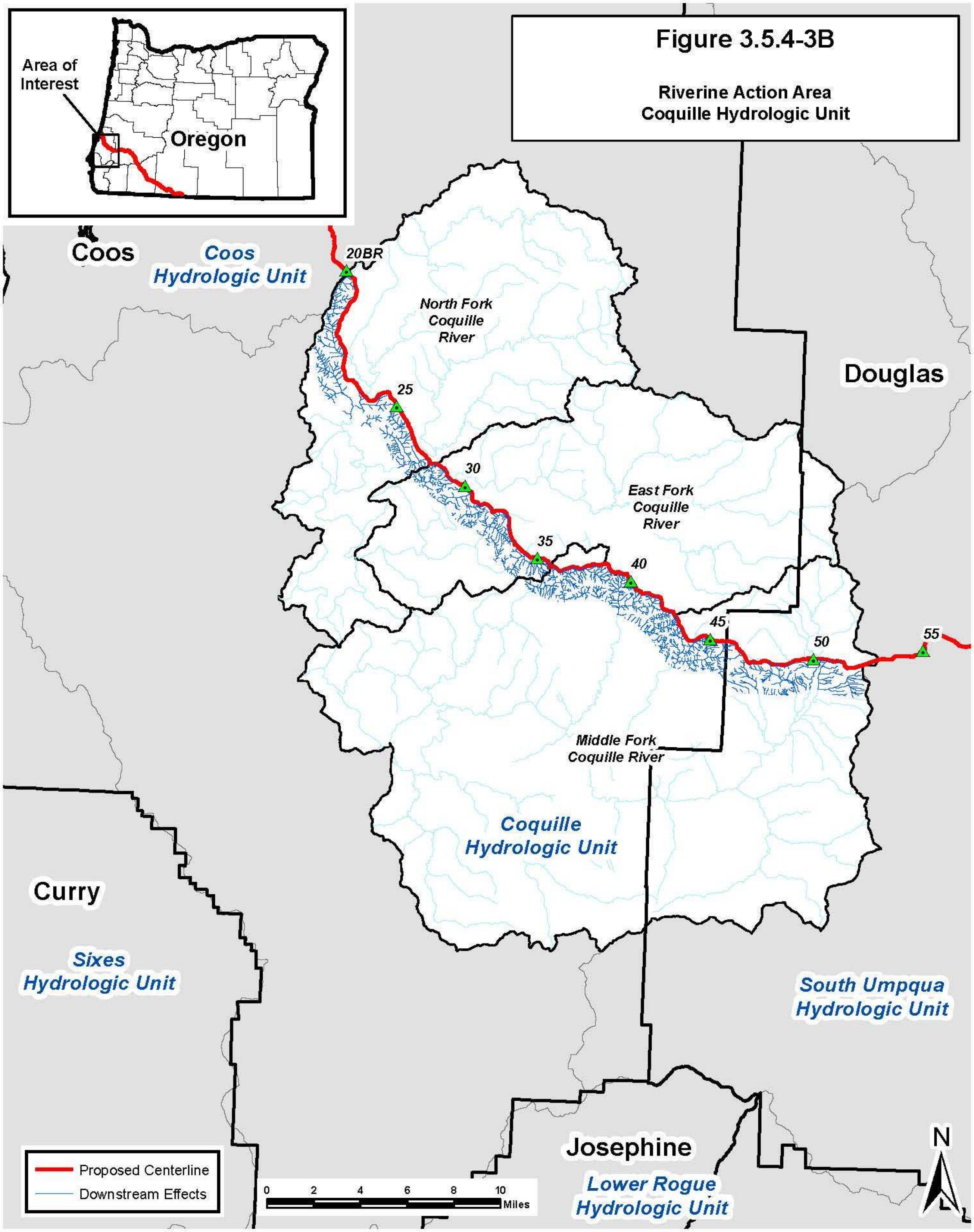


Figure 3.5.4-3B
Riverine Action Area
Coquille Hydrologic Unit
Area of Interest
Oregon
Coos
Coos Hydrologic Unit
20BR
North Fork Coquille River
25
30
35
40
45
50
55
East Fork Coquille River
Douglas
Middle Fork Coquille River
Coquille Hydrologic Unit
Curry
Sixes Hydrologic Unit
South Umpqua Hydrologic Unit
Josephine
Lower Rogue Hydrologic Unit
Proposed Centerline
Downstream Effects
0 2 4 6 8 10 Miles
N

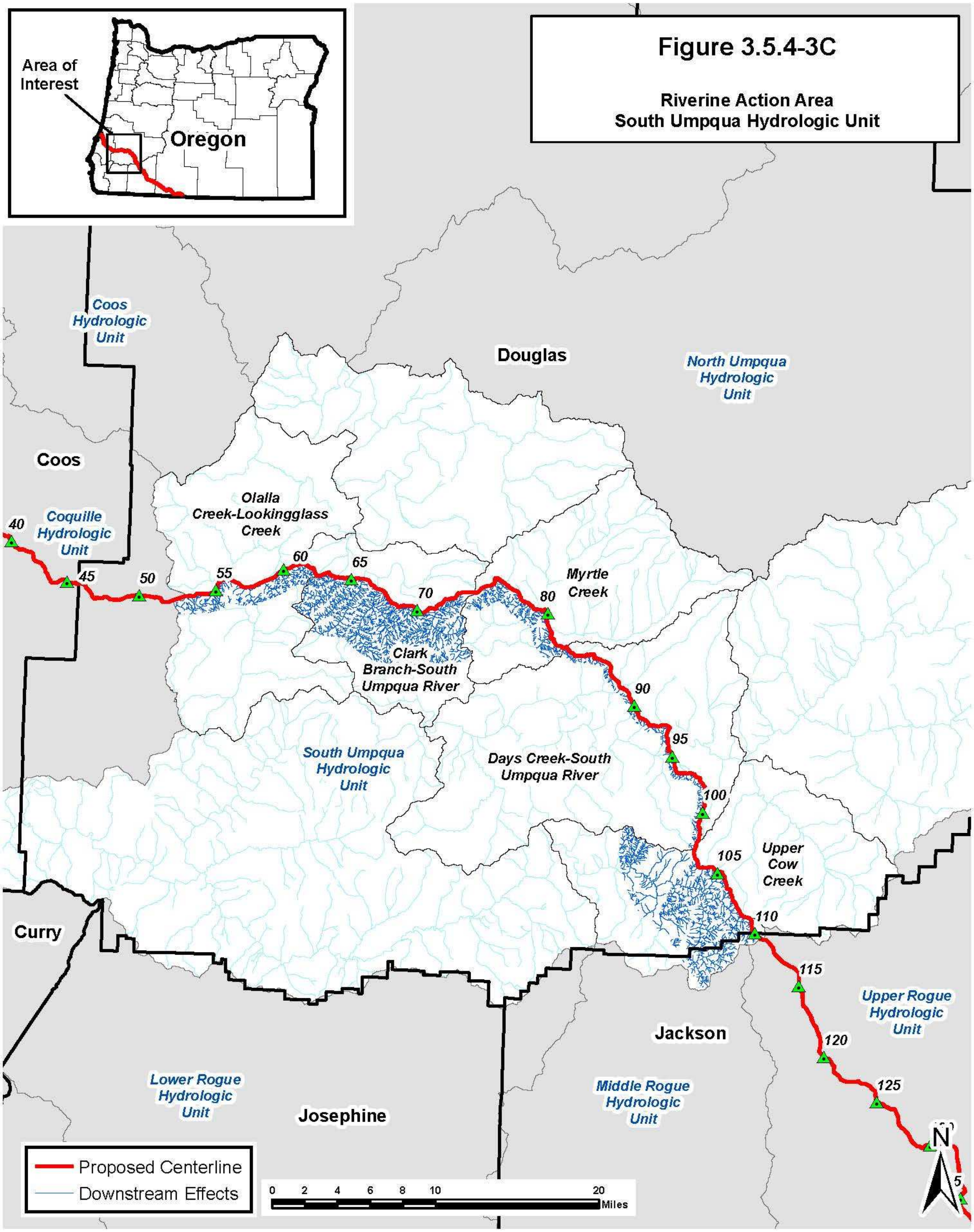


Figure 3.5.4-3C
Riverine Action Area
South Umpqua Hydrologic Unit
Area of Interest
Oregon
Coos Hydrologic Unit
Douglas
North Umpqua Hydrologic Unit
Coos
Coquille Hydrologic Unit
Olalla Creek-Lookingglass Creek
Myrtle Creek
Clark Branch-South Umpqua River
South Umpqua Hydrologic Unit
Days Creek-South Umpqua River
Upper Cow Creek
Curry
Jackson
Upper Rogue Hydrologic Unit
Lower Rogue Hydrologic Unit
Josephine
Middle Rogue Hydrologic Unit
40
45
50
55
60
65
70
80
90
95
100
105
110
115
120
125
Proposed Centerline
Downstream Effects
0 2 4 6 8 10 20 Miles
N

TABLE 3.5.4-3

Summary of River Subbasins and Fifth Field Watersheds Coinciding with the Proposed Pipeline Route, within Range of Oregon Coast Salmon ESU Encountered from West to East

Subbasins and fifth Field Watersheds	Hydrologic Unit Code	Number of Waterbodies a/				
		Estuary	Perennial	Intermittent	Pond b/	Total
Coos Subbasin	**17100304**					
Coos Bay-Frontal Pacific Ocean c/	1710030403	3	6	10	0	19
Coquille Subbasin	**17100305**					
North Fork Coquille River	1710030504		4	4		8
East Fork Coquille River	1710030503		9	15		14
Middle Fork Coquille River	1710030501		7	12		19
South Umpqua Subbasin	**17100302**					
Olalla Creek-Lookingglass Creek	1710030212		4	14		18
Clark Branch-South Umpqua River	1710030211		7	15		22
Myrtle Creek	1710030210		7	7		14
Days Creek-South Umpqua River	1710030205		6	10	3	19
Elk Creek d/	1710030204					0
Upper Cow Creek	1710030206		5	6		11
	TOTAL	**3**	**55**	**83**	**3**	**144**

a/ includes waterbodies crossed and waterbodies not crossed but immediately adjacent to the pipeline and within the right-of-way.
b/ includes stock ponds, industrial ponds.
c/ The Coos River is influenced by tides but it is included as a perennial waterbody in this watershed.
d/ Elk Creek Watershed would be crossed but no waterbodies would be affected within the watershed.

The downstream extent of the riverine analysis area was determined by estimating the likely distance downstream that suspended sediment concentrations generated during stream crossings could attenuate to ambient background levels within the Pipeline project area. The methods used to estimate this distance are explained below.

Pipeline project TSS concentrations generated during wet open-cut pipeline construction have been estimated from models developed by Reid et al. (2004). Amounts of TSS produced during dry open-cut construction (fluming, dam-and-pump) adjustments are fractions of the concentrations produced during wet-open cuts (Reid et al. 2004). Estimates of TSS produced during dry open-cut construction across waterbodies in fifth-field watersheds are presented below in section 3.5.4.3. Average sediment percentages (grain sizes including gravel, sand, silt, and organics) for streams within each fifth-field watershed (see table 3.5.4-10a and table 3.5.4-10b below in this section and table 3.5.4-17 in section 3.5.4.3) were assumed as fractions of the TSS generated during construction and concentrations of each grain class at various distances downstream were estimated using a simple sediment transport model (Ritter 1984). Downstream settling distances would be much greater for deeper waterbodies with high flow velocities than for shallow, slow flowing streams.

Using models noted above and data on the average sediment composition, stream depth, and average summer low flows for streams within range of Oregon Coast coho that would be crossed by the Pipeline, the average downstream distance expected to near a concentration of 2 mg/l for silt (0.0016 cm diameter, 0.023 cm/sec settling velocity) ranges from 34 meters (112 feet) in the Coos Bay Watershed to 482 meters (1,581 feet) in the Upper Cow Creek Watershed; the average downstream distance expected to near a concentration of 2 mg/l for clay (0.0004 cm diameter, 0.0014 cm/sec settling velocity) ranges from 595 meters (1,952 feet) in the Coos Bay Watershed to 7,315 meters (23,993 feet) in the Upper Cow Creek Watershed. These estimates are for average summer low flows likely to occur during construction within the ODFW (2008) allowed in-stream construction period.

While distances for fine clay settling to 2 mg/l would vary among sites, meaningful changes in suspended sediment concentrations at all sites should be much less than average distances of the estimated fine clay particle sizes downstream distance at average low summer flows. The estimated average downstream distance traveled of these very fine particles is a reasonable conservative limit to consider for the analysis area. The riverine analysis area used in this BA for Oregon Coast coho salmon has been limited to downstream distances ranging from 1,952 feet to 23,993 feet (0.4 mile to 4.5 miles) within the affected fifth-field watersheds in the range of Oregon Coast coho salmon (see figure 3.5.4-3).

Species Presence

Based on genetic data and recoveries of tagged fish, the Oregon Coast coho ESU extends to Pacific Ocean tributaries from Cape Blanco north to the Columbia River. Coho in the ESU inhabit waterbodies in 10 fifth-field watersheds that would be crossed by the Pipeline. An eleventh, the Elk Creek Watershed (HUC1710030204), would be crossed but no waterbodies would be affected within the watershed. The Pipeline would cross the following that are inhabited by Oregon Coast coho: Coos Bay-Frontal Pacific Ocean (HUC 1710030403), North Fork Coquille River (1710030504), East Fork Coquille River (HUC 1710030503), Middle Fork Coquille River (HUC 1710030501), Olalla Creek-Lookingglass Creek (HUC 1710030212), Clark Branch-South Umpqua River (HUC 1710030211), Myrtle Creek (HUC 1710030210), Days Creek-South Umpqua River (HUC 1710030205), and Upper Cow Creek (HUC 1710030206). Upstream migrations by coho in the Middle Fork Coquille River are blocked (Bradford Falls) at River Mile 27.3, about 5.3 miles southwest of Camas Valley, Oregon.

The Pipeline would actually cross 116 of the waterbodies in table 3.5.4-4, 111 of them by dry open cutting (flume or dam-and-pump), while the South Umpqua River would be crossed twice, once by a DP crossing at MP 71.27 and again by a diverted open cut at MP 94.73. Coos Bay would be crossed by two HDDs, one from MP 0.28 to MP 1.00, the other from MP 1.46 to MP 3.02. The Coos River (a reach of the estuary but categorized as a perennial waterbody) would be crossed using HDD at MP 11.13. Twenty-eight of the waterbodies listed in table 3.5.4-4 would not be crossed by the Pipeline but are adjacent to the centerline. Blasting may be necessary to construct across 22 streams that would be crossed by dry open cut methods (see Project Description) because the streambed of each is bedrock (see table 3.5.4-4).

All affected waterbodies within the three subbasins and nine fifth-field watersheds (Elk Creek HUC 1710030204, is crossed but no waterbodies are affected) that are within the range of Oregon Coast coho salmon ESU proximate to the Pipeline are included in table 3.5.4-4. There are 144 waterbodies included in the table, of which 55 are perennial, 83 are intermittent, one is an estuary (crossed twice), and three others are ponds. Coho salmon are known to occur in 31 of the waterbodies and are assumed to be present in 12 others based on connectivity to perennial streams known to support coho salmon, the presence of steelhead and/or resident salmonids, and/or information provided by fisheries biologists. Data in table 3.5.4-4 were revised based on ODFW (2017f) fish habitat distribution shapefiles and Oregon Department of Forestry (ODF 2018) Forest Practices statewide hydrography shapefiles that provide field evaluations for fish presence/absence in stream segments.

TABLE 3.5.4-4

Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Coos Subbasin (HUC 17100304), Coos Bay-Frontal Pacific Ocean (HUC 1710030403) Fifth-Field Watershed, Coos County, Oregon							
Estuary Drain (Alt Wet NH (West))	17100304006491 State	0.00	Estuary	Pullback TEWA Adjacent to Pipeline	Coho	Coho, migration, rearing	Oct 1 to Feb 15
Coos Bay (NE-26)	17100304006491 State	0.28 to 1.00	Estuary	HDD	Coho	Coho, migration, rearing	Oct 1 to Feb 15
Coos Bay (NE-26)	171003040064961 State	1.46 to 3.02	Estuary	HDD	Coho	Coho, migration, rearing	Oct 1 to Feb 15
Kentuck Slough EE-SS-9004 (EE-6)		3.02 to 6.39R	Perennial	Adjacent riparian zone	Coho	Coho, spawning, rearing	Jul 1 to Sep 15
Trib to Coos Bay (NW-117/EE-6)	17100304000767 Private	6.39R	Perennial	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Willanch Slough (EE-7)	17100304001393 Private	8.27R	Perennial	Dry Open-Cut	Coho	Coho, migration, rearing	Jul 1 to Sep 15
Johnston Creek S1-05 (GDX-29 / EE-8 (MOD))		8.35R	Perennial	Adjacent riparian zone	Coho	Coho, spawning, rearing	Jul 1 to Sep 15
Trip to Willanch Slough (GDX030)	Private	8.48R	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Cooston Channel (Echo Creek) (SS-100-002)	17100304005045 Private	10.21R	Intermittent	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Coos River (BSP-119)	17100304005030 Private	11.13R	Perennial	HDD	Coho	Coho, migration, rearing	Oct 1 to Feb 15
Vogel Creek (SS-100-005)	17100304005031 Private	11.55BR	Perennial	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Ditch Trib. to Vogel Creek (BR-S-04)	17100304000790 Private	11.88BR	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Ditch Trib. to Vogel Creek (BR-S-06)	17100304000798 Private	12.11BR	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib to Lillian Creek (EE-SS-9021)	17100304014424 Private	13.41BR	Intermittent	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15
Trib. to Stock Slough (EE-SS-9026)	17100304015021 Private	13.92BR	Intermittent	Adjacent to centerline within TEWA	None	None	Jul 1 to Sep 15
Trib. to Stock Slough (BR-S-31)	17100304002068 Private	14.72BR	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Stock Slough (Laxstrom Gulch) (BR-S-30)		14.82BR	Intermittent	Adjacent riparian zone	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Stock Slough (BR-S-36)	17100304000507 Private	15.11BR	Intermittent	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Stock Slough (EE-SS-9068)	17100304000507 Private	15.32BR	Intermittent	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Coquille Subbasin (HUC 17100305), North Fork Coquille River (HUC 1710030504) Fifth-Field Watershed, Coos County, Oregon							

TABLE 3.5.4-4

Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Steinnon Creek (SS-500-003; BR-S-63)	17100305000361 BLM	20.20BR	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Steinnon Creek (BR-S-63)	17100305000361 BLM	24.32BR	Perennial	Dry Open-Cut	Coho	Coho, spawning, rearing	Jul 1 to Sep 15
Ditch	17100305012102 Private	22.72	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
North Fork Coquille River (BSP-207)	17100305000339 Private	23.06	Perennial	Dry Open-Cut	Coho	Coho, spawning, rearing	Jul 1 to Sep 15
Trib. to Middle Creek (BR-S-63)	17100305012832 Private	25.18	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Middle Creek (BSI-137)	BLM- Coos Bay District	27.01	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Middle Creek (BSI-135)	BLM- Coos Bay District	27.03	Intermittent	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15
Middle Creek (BSP-133)	17100305000323 BLM- Coos Bay District	27.04	Perennial	Dry Open-Cut	Coho	Coho, migration, rearing	Jul 1 to Sep 15
Coquille Subbasin (HUC 17100305), East Fork Coquille River (HUC 1710030503) Fifth-Field Watershed, Coos County, Oregon							
Trib. To E. Fork Coquille (BSP-77)	7100305002504 Private	28.86	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. To E. Fork Coquille (BSP-74)	17100305002598 Private	29.30	Intermittent	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. To E. Fork Coquille (BSI-76)	17100305002647 Private	29.47	Intermittent	Dry Open-Cut (Streambed-bedrock)	Coho Assumed	Unknown	Jul 1 to Sep 15
East Fork Coquille River (BSP-71)	17100305000286 Private	29.85	Perennial	Dry Open-Cut	Coho	Coho, spawning, rearing	Jul 1 to Sep 15
Trib. to E. Fork Coquille (SS-003-007A)	17100305002813 Private	30.22	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to E. Fork Coquille (SS-003-007B)	17100305002813 Private	30.29	Perennial	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. To E. Fork Coquille (BSI-70)	17100305018097 BLM- Coos Bay District	31.64	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Elk Creek (BSP-57)	1240218431116 Private	32.40	Perennial	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. To Elk Creek (BSP-55)	1239513431370 Private	32.44	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. To Elk Creek (SS-100-030)	7100305021871 Private	32.56	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Elk Creek (SS-100-031)	17100305021865 Private	32.63	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Elk Creek (BSP-49)	17100305003372 Private	33.00	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Elk Creek (BSP-50)	17100305003372 Private	33.02	Perennial	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15

TABLE 3.5.4-4

Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
South Fork Elk Creek (CSP-5)	17100305000591 Private	34.46	Perennial	Dry Open-Cut	Coho	Coho, spawning, rearing	Jul 1 to Sep 15
Trib. To S. Fork Elk Creek (BSI-251)	17100305021783 BLM-Coos Bay District	35.51	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Coquille Subbasin (HUC 17100305), Middle Fork Coquille River (HUC 1710030501) Fifth-Field Watershed, Coos County, Oregon							
Trib. to Big Creek (BLM 35.87)	17100305025781 BLM-Coos Bay District	35.87	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Big Creek (BLM 36.48)	17100305026477 BLM-Coos Bay District	36.48	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Big Creek (GSI-25/BSI-253)	17100305004068 BLM-Coos Bay District	36.54	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Big Creek (BLM 36.85)	17100305025748 BLM-Coos Bay District	36.85	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Big Creek (BSI-252)	17100305004061 BLM-Coos Bay District	36.92	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Big Creek (ESI-19)	17100305026126 BLM-Coos Bay District	37.32	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. To Big Creek (ESP-20)	17100305000606 BLM-Coos Bay District	37.35	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Big Creek		37.41	Perennial	Adjacent riparian zone	Coho Assumed	Unknown	Jul 1 to Sep 15
Upper Rock Creek (BSP-41)	17100305000252 Private	44.21	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Coquille Subbasin (HUC 17100305), Middle Fork Coquille River (HUC 1710030501) Fifth-Field Watershed, Douglas County, Oregon							
Trib. to Upper Rock Creek (S3-07 /BW-38)	17100305005585 Private	46.56	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Ditch (S3-06)	Private	48.21	Intermittent	Dry Open-Cut	None	None	N/A
Deep Creek (BSP-257)	17100305005863 BLM-Roseburg District	48.27	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Ditch (BDX-32)	Private	49.94	Intermittent	Adjacent to ROW	None	None	Jul 1 to Sep 15
Ditch (BDX-31)	Private	50.02	Intermittent	Dry Open-Cut	None	None	N/A
Middle Fork Coquille River (BSP-30)	17100305000232 Private	50.28	Perennial	Dry Open-Cut (Streambed-bedrock)	None	None	Jul 1 to Sep 15
Trib. to Middle Fork Coquille (GDX-36/BSI-66)	17100305005874 Private	50.45	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Belieu Creek (BSP-61/GSI-37)	17100305000706 Private	50.71	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Middle Fork Coquille (GSI-38)	17100305022784 Private	51.02	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Unnamed Stream (SS-222-006)	Private	51.71	Intermittent	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15

TABLE 3.5.4-4

Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
South Umpqua (HUC 17100302) Subbasin, Olalla Creek-Lookingglass Creek (HUC 1710030212) Fifth-Field Watershed, Douglas County, Oregon							
Trib. to Shields Creek (BSI-202)	17100302001821 Private	55.90	Intermittent	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. to Shields Creek (BSI-203)	17100302001894 Private	55.94	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Shields Creek (Denied Access 13)	17100302044091 Private	56.28	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Shields Creek (Denied Access 14)	17100302044013 Private	56.34	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Olalla Creek (BSI-140)	17100302048489 Private	57.11	Intermittent	Dry Open-Cut (Streambed – bedrock)	None	None	Jul 1 to Sep 15
Trib. to Olalla Creek (BSI-140)	17100302048489 Private	57.14	Intermittent	Dry Open-Cut (Streambed – bedrock)	None	None	Jul 1 to Sep 15
Trib. to Olalla Creek (BSI-138)	17100302002187 Private	57.31	Intermittent	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. to Olalla Creek (BSI-147/EE-12)	17100302002221 Private	57.84	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Irrigation Canal (BDX148)	Private	57.97	Intermittent	Dry Open-Cut	None	None	N/A
Trib. to Olalla Creek (BSI-151)	17100302002311 Private	58.20	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Ditch (BDX-157)	Private	58.30 58.51	Intermittent	Adjacent to centerline within ROW and TEWA	None	None	N/A
Trib. to Olalla Creek (BSP-159)	17100302002420 Private	58.55	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Olalla Creek (BSP-155)	17100302000047 Private	58.78	Perennial	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Ditch - Trib. to Olalla Creek (BDX-153)	17100302002576 Private	59.02	Intermittent	Dry Open-Cut	None	None	N/A
Trib. to Olalla Creek (BSI-132)	17100302002635 Private	59.29	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Olalla Creek (BSI-129)	17100302000705 Private	59.65	Intermittent	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. to McNabb Creek (NSP-14)	17100302002838 Private	60.13	Perennial	Dry Open-Cut (Streambed-bedrock)	None	None	Jul 1 to Sep 15
McNabb Creek (NSP-13)	17100302002924 Private	60.48	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
South Umpqua (HUC 17100302) Subbasin, Clark Branch-South Umpqua River (HUC 1710030211) Fifth-Field Watershed, Douglas County, Oregon							
Kent Creek (BSP-240)	17100302000075 Private	63.97	Perennial	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Trib. to Kent Creek (BS-I241)	17100302003968 Private	63.97	Intermittent	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15

TABLE 3.5.4-4

Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Rice Creek (S2-04; BSP-227)	17100302000079 Private	65.76	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Trib to Rice Creek BSI-228		65.83	Intermittent	Adjacent riparian zone	None	None	Jul 1 to Sep 15
Trib. to Willis Creek (BSI-230)	17100302004832 Private	66.87	Intermittent	Adjacent to centerline within ROW (Streambed-bedrock)	None	None	Jul 1 to Sep 15
Willis Creek (BSP-168)	17100302000083 Private	66.95	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Trib. to Willis Creek (BSI-169)	17100302048422 Private	67.00	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-005-001 (SS-100-011)	17100302049984 Private	69.10	Intermittent	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River SS-004-004 SS-100-012)	17100302005610 Private	69.29	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-004-005 SS-100-013)	17100302000727 Private	69.35	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-004-006 SS-100-014)	17100302005693 Private	69.57	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-999-001)		70.79	Intermittent	Adjacent riparian zone	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-100-015)	17100302006216 Private	71.08	Intermittent	Adjacent In TEWA 71.01-N	None	None	Jul 1 to Sep 15
South Umpqua River (BSP-26)	17100302000086 Private	71.27	Perennial	Direct Pipe	Coho	Coho Migration	Jul 1 to Aug 31
Trib. to South Umpqua River (SS-005-007)	17100302035572 Private	71.34	Intermittent	Adjacent to potential Roth Pipe Yard	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-005-008 SS-100-016)	17100302006366 Private	71.35 71.57	Intermittent	Direct Pipe	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-100-017)	17100302047304 Private	71.69	Intermittent	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-005-009 SS-100-019)	17100302006590 Private	73.04	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (SS-005-013 SS-100-020)	17100302050160 Private	73.51	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15

TABLE 3.5.4-4

Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Trib. to South Umpqua River (SS-005-011 & -12 SS-100-021)	17100302049674 Private	73.56	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Unnamed Stream (SS-005-010)	Private	73.73	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
South Umpqua (HUC 17100302) Subbasin, Myrtle Creek (HUC 1710030210) Fifth-Field Watershed, Douglas County, Oregon							
Rock Creek (EE-SS-9032)	17100302007335 Private	75.33	Perennial	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Trib. to Rock Creek (EE-SS-9033)	17100302001061 Private	75.34	Perennial	Dry Open-Cut	Coho Assumed	Unknown	Jul 1 to Sep 15
Bilger Creek (BSP-1)	17100302000605 Private	76.38	Perennial	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Little Lick (BSP-6)	17100302001073 Private	77.71	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Little Lick Creek (BSI-8)	17100302008039 Private	77.93	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Little Lick Creek (BSI-10)	17100302008047 Private	78.02	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
North Myrtle Creek (NSP-37)	17100302000541 Private	79.12	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Trib. to North Myrtle Creek (NSP-38)	17100302008397 Private	79.15	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to N. Myrtle Creek (EE-SS-9038)	17100302045565 Private	79.17	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to N. Myrtle Creek (EE-SS-9039)	17100302045117 Private	79.19	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
South Myrtle Creek (BSP-172)	7100302000521 Private	81.19	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Trib. to S. Myrtle Creek (BSP-259)	17100302008796 Private	81.38	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to S. Myrtle Creek (SS-100-023)	17100302008772 Private	81.45	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to S. Myrtle Creek (EE-SS-9074)	17100302008917 Private	81.93	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
South Umpqua (HUC 17100302) Subbasin, Days Creek-South Umpqua River (HUC 1710030205) Fifth-Field Watershed, Douglas County, Oregon							
Wood Creek (BSP-226)	17100302001104 Private	84.17	Perennial	Dry Open-Cut (Streambed-bedrock)	None	None	Jul 1 to Sep 15
Trib. to Wood Creek (EE-SS-9040)	17100302009813 Private	85.38	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Wood Creek (EE-SS-9041)	17100302009881 Private	85.69	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Wood Creek (EE-SS-9042)	17100302001103 Private	85.71	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Wood Creek (EE-SS-9043)	17100302036325 Private	85.88	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15

TABLE 3.5.4-4

Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Habitat Component Present b/	Fishery Construction Window c/
Trib. to Wood Creek (EE-SS-9044)	17100302036276 Private	86.07	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to Wood Creek (EE-SS-9045)	17100302036276 Private	86.10	Intermittent	Adjacent to centerline within ROW	None	None	Jul 1 to Sep 15
Trib. to Fate Creek (BSI-236)	17100302036007 Private	88.20	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jul 1 to Sep 15
Trib. to Fate Creek (BSI-238 (MOD))	17100302036007 Private	88.23	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Fate Creek (BSP-232)	17100302001124 Private	88.48	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Days Creek (BSP-233)	17100302000511 Private	88.60	Perennial	Dry Open-Cut (Streambed-bedrock)	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
Saint John Creek (ASP-303)	17100302011280 Private	92.62	Perennial	Dry Open-Cut	Coho	Coho Spawning, Rearing	Jul 1 to Sep 15
H3-01	Private	94.60	Pond	Not Crossed Pond adjacent to Milo Yard	None	None	None
H3-02	Private	94.60	Pond	Not Crossed Pond adjacent to Milo Yard	None	None	None
H3-03	Private	94.60	Pond	Not Crossed Pond in Milo Yard	None	None	None
South Umpqua River (ASP-196)	17100302011516 Private	94.73	Perennial	Diverted Open-Cut	Coho	Coho Spawning, Rearing, Migration	Jul 1 to Aug 31
Trib. to South Umpqua River (ASI-193)	17100302011517 Private	94.85	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to South Umpqua River (ASI-193)	17100302011517 Private	95.03	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to South Umpqua (ASI-190)	17100302038007 BLM-Roseburg District	98.46	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	None	Jul 1 to Sep 15
South Umpqua (HUC 17100302) Subbasin, Upper Cow Creek (HUC 1710030206) Fifth-Field Watershed, Douglas County, Oregon							
Ditch (Beaver Creek) (CDX-50)	Forest Service – Umpqua NF	105.41	Intermittent	Dry Open-Cut	None	None	N/A
Ditch (CDX-49)	Forest Service – Umpqua NF	106.77	Intermittent	Adjacent to centerline within ROW	None	None	N/A
Roadside Ditch (CDX-47)	Forest Service – Umpqua NF	108.08	Intermittent	Dry Open-Cut	None	None	N/A
Roadside Ditch (CDX-48)	Forest Service – Umpqua NF	108.40	Intermittent	Dry Open-Cut	None	None	N/A
Trib. to East Fork Cow Creek (GDX-15)	17100302034497 Forest Service – Umpqua NF	109.13	Intermittent	Adjacent to centerline within TEWA	None	None	Jul 1 to Sep 15
Trib. to East Fork Cow Creek (GSI-16/FS-HF-F)	17100302013838 Forest Service – Umpqua NF	109.33	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15
East Fork Cow Creek (GSP-19/FS-HF-G)	17100302013839 Forest Service – Umpqua NF	109.47	Perennial	Dry Open-Cut (Streambed-bedrock)	None	None	Jul 1 to Sep 15

TABLE 3.5.4-4 Waterbodies Crossed or Adjacent to the Pipeline within the Coos Subbasin (HUC 17100304), Coquille Subbasin (HUC 17100305), and South Umpqua Subbasin (HUC 17100302) and in the Range of the Oregon Coast Coho Salmon ESU (updated May 2018)							
Waterbodies Crossed and Waterbody ID	**NHD Waterbody Reach Code and/or Jurisdiction**	**Pipeline Milepost (MP)**	**Waterbody Type**	**Proposed Crossing Method a/ (potential for blasting) d/**	**Species Present b/**	**Habitat Component Present b/**	**Fishery Construction Window c/**
East Fork Cow Creek (GSP-22/FS-HF-G ASP297)	17100302013839F orest Service – Umpqua NF	109.69	Perennial	Adjacent to centerline within TEWA	None	None	Jul 1 to Sep 15
Trib. to East Fork Cow Creek (FS-HF-J/AW298)	17100302013839F orest Service – Umpqua NF	109.69	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
Trib. to East Fork Cow Creek (FS-HF-K/AW-299)	17100302012765 Forest Service – Umpqua NF	109.78	Perennial	Dry Open-Cut	None	None	Jul 1 to Sep 15
South Umpqua (HUC 17100302) Subbasin, Upper Cow Creek (HUC 1710030206) Fifth-Field Watershed, Jackson County, Oregon							
Trib. to W. Fork Trail Creek (FS-HF-N /ESI-68)	17100302034587 Forest Service – Umpqua NF	110.96	Intermittent	Dry Open-Cut	None	None	Jul 1 to Sep 15

a/ Dry open cut crossing methods include flume or dam-and-pump procedures. Dam-and-pump methods would be utilized where streambed blasting is anticipated to eliminate blasting around the flume. The dam-and-pump crossing method is the preferred crossing procedure in steep incised drainage valleys where worker safety may be compromised when placing ("threading") the pipe string under the flume pipe and where there is a risk of upsetting the flume during this operation. The dam-and-pump crossing method is also the preferred crossing method on small streams under low flow conditions during the recommended ODFW-recommended in-water work period. PCGP proposes temporary/short-term fish passage restriction when completing dam-and-pump crossings within the ODFW-recommended in-water work period. Appendix M provides details of stream crossings.

b/ ODFW 2017f; ODF 2018

c/ Assumes fisheries construction windows only apply to those waterbodies flowing at the time of construction and windows do not apply to HDD crossings.

d/ Steambed bedrock based on PCGP's Wetland and Waterbody delineation surveys. Streambed bedrock may require special construction techniques to ensure pipeline design depth. Special construction techniques may include rock hammering, drilling and hammering, or blasting. The need for blasting would be determined by the construction contractor and would only be initiated after ODFW blasting permits are obtained.

In-stream construction of the Pipeline will occur before most Oregon Coast coho begin upstream migration and spawning by adults (see figure 3.5.4-1). However, juvenile coho are expected to be rearing in many of those streams. Although there are no data on numbers of juveniles expected to be present in streams crossed by the Pipeline, the following estimation procedure was developed after an estimate for numbers of juveniles present in streams crossed was requested by NMFS (2015e).

Total stream miles occupied by coho salmon within the 4th Field HUCs in table 3.5.4-5 and each of the 5th Field HUCs crossed by the Pipeline were derived with GIS by combining shapefiles of ODFW Fish Distribution data (ODFW 2017f) with watershed shapefiles from National Hydrography Dataset (USGS 2016). Stream miles with coho spawning habitats and coho rearing habitat in the range of Oregon Coast coho were similarly derived; stream miles in those habitats were added to provide Stream Miles for Juveniles' Presence in table 3.5.4-5.

Numbers of redds and spawning adult coho salmon counted in fourth field watersheds over time are available on the StreamNet (2012) Database accessed through the ODFW Natural Resources Information Management Program. The database provided only 15 records of redd surveys for Oregon Coast coho in the South Coast 4th Field HUC, all limited to streams within the South Umpqua River (HUC 17100302). The surveys were conducted during 1991 and 1992. With so few records available, numbers of adult coho salmon (not including jacks or subadults) reported as peak live or dead fish were used to estimate numbers of juvenile fry present in streams that would be crossed by the Pipeline. Data for numbers of adults counted per mile from StreamNet Database are summarized in table 3.5.4-6.

TABLE 3.5.4-5

Total Stream Miles of Oregon Coast Coho Habitats in 4th Field and 5th Field Watersheds and Estimates of Streams with Juvenil Fry Coho

Subbasin and Fifth-Field Watersheds	Total Stream Miles with Coho in HUC a/	Stream Miles with Spawning Habitat	Stream Miles with Rearing Habitat	Stream Miles for Juvenile Fry Presence b/
Coos Subbasin	**581.99**	**311.90**	**258.27**	**570.17**
Coos Bay-Frontal Pacific Ocean	206.88	70.02	132.34	202.36
Coquille Subbasin	**597.64**	**385.80**	**207.13**	**592.93**
North Fork Coquille River	147.92	106.77	39.30	146.07
East Fork Coquille River	54.31	42.84	11.47	54.31
Middle Fork Coquille River	91.67	75.06	16.61	91.67
South Umpqua Subbasin	**812.28**	**551.70**	**130.28**	**681.97**
Olalla Creek-Lookingglass Creek	88.36	66.12	14.90	81.02
Clark Branch-South Umpqua River	66.52	36.91	0.67	37.58
Myrtle Creek	92.91	88.50	1.93	90.43
Days Creek-South Umpqua River	102.93	70.84	28.62	99.46
Upper Cow Creek	29.24	0	0	0

a/ Total Stream Miles with Coho in HUC includes miles of Historical, Migration, Rearing, Spawning, and Unknown habitats.
b/ Stream Miles for Juvenile Fry Presence is the sum of Stream Miles for Spawning and Rearing Habitats in HUC
Source: StreamNet 2012; ODFW 2017f

TABLE 3.5.4-6

Summary of Records a/ for Spawning Adult Coho Within the Oregon Coast ESU in 4th Field Watersheds (HUCs) Crossed by the Pipeline Project

Subbasin	Number of Surveys	Year(s)	Average Adults (Live and Dead) per Mile Surveyed	90% Confidence Interval
Coos	706	1950 to 2010	87.58	± 8.01
Coquille	474	1950 to 2010	24.51	± 2.64
South Umpqua	153	1981 to 2004	3.47	± 0.85

Source: StreamNet 2012.

The following assumptions have been applied to the adult spawning data in each of the three watersheds coinciding with Oregon Coast coho and proposed for crossing by the Pipeline:

- The male:female ratio of live or dead spawners is 1:1 (Knudsen et al. 2003),
- At low to moderate densities of spawners, there is 1 redd for each female (Lestelle and Weller 2002);
- Redds are only present in stream reaches classified as spawning habitat by ODFW (2014);
- The average number of eggs per redd is between 300 and 1,200 with 800-900 eggs being most frequent (Sandercock 1991)
- Under average conditions, 15-27 percent of all eggs will survive during incubation (mean

of 27.1 percent survival was observed in Oregon coastal streams Sandercock 1991);

- Juveniles utilize spawning habitats during rearing as well as rearing habitats as classified by ODFW (2014c). Juveniles distribute themselves in uniformly spaced territories regardless of presence of pools, riffles or runs in the natal stream.

With these assumptions, the following are estimates of coho redd abundances in subbasins:

- Average 43.79 redds per mile (± 4.01 redds per mile) within all spawning habitats in the Coos River 4th Field HUC;
- Average 12.26 redds per mile (± 1.32 redds per mile) within all spawning habitats in the Coquille River 4th Field HUC;
- Average 1.74 redds per mile (± 0.43 redds per mile) within all spawning habitats in the South Umpqua River 4th Field HUC;

Average values for redds per mile in 4th Field HUCs, stream miles of spawning and rearing habitats in HUCs, and the assumptions above for eggs per redd and egg survival rates were used to estimate Juveniles per Mile of Habitat in table 3.5.4-5 for each of the 5th Field HUCs crossed within range of the Oregon Coast ESU. Values for redds per mile within 90% confidence intervals were not carried through the analyses in table 3.5.4-7. In reality, estimates of Juvenile Fry per Mile of Habitat would vary from year to year showing at least as much variability as the estimated abundance of wild adult coho spawners reported within the three subbasins of the analysis area from 1997 to 2016, shown in figure 3.5.4-2 above.

There would be some natural mortality between juvenile fry and juvenile smolt stages and during the period from fry emergence (through the end of May) before pipeline construction (beginning July 1). Therefore, estimates are very conservative. Waterbodies within the Coos, Coquille, and South Umpqua subbasins would be crossed between July 1 and September 15. Based on figure 3.5.4-1, instream construction would likely avoid the juvenile coho out-migration periods during June; there would be few or no post-winter pre-smolt juvenile coho present during construction. Very few are expected because reported over-winter survival rates of juvenile coho are <40 percent, at least in waterbodies studied within the Coos Bay Frontal-Pacific Ocean 5th field watershed (Weybright and Giannico 2017).

TABLE 3.5.4-7

Estimates of Juvenil Fry Coho in the Oregon Coast ESU Present in 4th Field and 5th Field Watersheds Crossed by the Pipeline Project

Subbasin and Fifth-Field Watersheds	Total Redds in HUC a/	Total Eggs in HUC b/	Total Juvenile Fry Surviving in HUC c/	Juvenile Fry per Mile of Habitat d/
Coos Subbasin	**13,658**	**11,609,268**	**3,146,112**	**5,518**
Coos Bay-Frontal Pacific Ocean	3,066	26,06,216	706,285	3,490
Coquille Subbasin	**4,730**	**4,020,409**	**1,089,531**	**1,838**
North Fork Coquille River	1,309	1,112,612	301,518	2,064
East Fork Coquille River	525	446,469	120,993	2,228
Middle Fork Coquille River	920	782,225	211,983	2,312
South Umpqua Subbasin	**960**	**815,958**	**221,125**	**324**
Olalla Creek-Lookingglass Creek	115	97,793	26,502	327
Clark Branch-South Umpqua River	64	54,587	14,793	394
Myrtle Creek	154	130,889	35,471	392
Days Creek-South Umpqua River	123	104,776	28,394	285
Upper Cow Creek	0	0	0	0

a/ Total Redds in HUC = the Average Redds per Mile in 4th Field HUC multiplied by Stream Miles of Spawning Habitat in table 3.5.4-5.
b/ Total Eggs in HUC = average of 850 eggs per red (see assumptions) multiplied by Total Redds in HUC.
c/ Total Juvenile Fry Surviving in HUC = 27.1 percent average survival rate of eggs (see assumptions in text) multiplied by Total Eggs in HUC.
d/ Juvenile Fry per Mile of Habitat = Total Juvenile Fry Surviving in HUC divided by Stream Miles of Juvenile's Presence in table 3.5.4-5.

Habitat

Estuarine Habitats

The estuarine habitat along the pipeline route is located in mostly shallow regions of Coos Bay and in the Coos River. Tidally influenced waters extend over seven miles upstream in Catching Slough and Coos River. Tidal gates at the mouths of Kentuck Slough and Willanch Slough have changed salt water inundation and flow regimes in the lower reaches of those waterbodies.

Substrates within the estuary include sub-tidal (continuously submerged) and intertidal (periodically submerged by tidal action) zones. Both zones support various habitats that have been classified by type of bottom material (including rock, sand, mud, and wood/organic debris) and relative position within the estuary (aquatic bed, shore, flat, beach/bar, and tidal marsh) by the ODLCD (1987). Sub-tidal and intertidal habitats within the Coos Bay estuary were mapped in 1987 as a pilot project for the ODLCD Coastal Management Program Dynamic Estuary Management Information System, or DEMIS (ODLCD 1998). The Pipeline route coincides with shallow intertidal and sub-tidal fine bottom and unconsolidated bottom habitat, with a few regions of mixed seabeds of eelgrass, attached algae, and tidal marsh.

Tidal mud flats and eelgrass beds are found on the west shore of Coos Bay; both habitats are utilized by most fish species within the bay at some time during the year (Cummings and Schwartz 1971). Eelgrass densities in Coos Bay are greatest at relatively shallow depths, slightly above and below the mean low water level (Thom et al. 2001). Distribution of eelgrass within the estuary has apparently changed slightly since 1987 (ODLCD 1998). Preliminary distribution of eelgrass (interpreted from infrared imagery, with some field verification) was evaluated in the vicinity of the project area during 2005 (Clinton 2007). Eelgrass on intertidal mud flats between Glasgow Point (Kentuck Inlet) and Russell Point (Haynes Inlet) decreased since 1987 while eelgrass beds on intertidal mud and mud/sand flats extending outward from Kentuck Inlet had apparently increased.

Natural turbidity in the estuary was judged to be higher at upper bay locations, away from water influx from the ocean (Moffatt & Nichol 2006). Turbidity (measured in NTUs) was evaluated at the Charleston Bridge, near the entrance to Coos Bay, and estimated as TSS (measured in mg/l) for modeling dredge-generated turbidity during construction of the proposed LNG Terminal (Moffatt & Nichol 2006). At that location, turbidity varied from 3.7 to 18.1 NTUs (5.7 to 45.7 mg/l) but sometimes exceeded 200 NTU.

Summaries of watershed health indicators have been reported by the Coos Watershed Association for tideland habitats accessible by Oregon Coast coho salmon (Oregon Watershed Enhancement Board 2007). Table 3.5.4-8 provides conditions in the following three estuarine zones:

Tidal wetlands: Marshes and swamps; a vegetated wetland that is periodically inundated by tidal waters. Tidal wetlands include emergent, scrub-shrub, and forested wetland types.

Tidal flat: An area inundated by all high tides and exposed only at low tide. Some tidal flats have extensive growth of algae or seagrass; others are bare mud.

Sub-tidal zone: Sub-tidal estuarine habitats include channel bottoms, slope bottoms, and the open water above them.

Wetland functions within the estuary have been affected by dikes, tide gates, roads and railroads, ditches, and dams that restrict tidal flows and/or have changed tidal flow patterns. Agricultural land uses have contributed to erosion of channels and, along with channel armoring, has affected vegetation diversity in wetlands, channel shading, and salmonid habitat function; tidal wetlands have also been affected excavations and disposal of dredged materials (Oregon Watershed Enhancement Board 2007).

TABLE 3.5.4-8

Watershed Health Indicators for Three Tidal Habitat Zones in the Coos Bay Estuary

Tideland Habitat Zone	Hydro-Modification	Sediment Regime	Water Quality	Vegetation Modification	Invasive Species	Habitat Loss
Tidal Wetlands	Limiting >40% historic wetlands modified	Limiting >40% wetlands affected by major change in sediment regime	Moderate DEQ water quality criteria met <90% of samples	Limiting 40% wetland vegetation altered by land use	Moderate Limited Invasive species impact on tidal wetland function	Limiting >40% zone with complete fill or conversion
Tidal Flat Zone	Limiting >40% historic tidal flats modified	Moderate 20-40% tidal flats affected by major change in sediment regime	Moderate DEQ water quality criteria met <90% of samples	N/A	Moderate Limited Invasive species impact on tidal flat function	Moderate 20-40% zone with complete fill or conversion
Sub-Tidal Zone	Moderate 20-40% historic zone modified	Moderate 20-40% sub-tidal zone affected by major change in sediment regime	Moderate DEQ water quality criteria met <90% of samples	N/A	Moderate Limited Invasive species impact on sub-tidal zone function	Moderate 20-40% zone with complete fill or conversion

Source: Oregon Watershed Enhancement Board 2007.

NMFS performed a preliminary survey of benthic invertebrates in the vicinity of the Federal Navigation Channel in 1989 (Miller et al. 1990). The study characterized the macroinvertebrate community at 20 sites in and adjacent to the navigation channel in support of channel deepening in Coos Bay. There were 121 different invertebrate taxa identified with a mean density of 2,617 individuals/square meter (m^2). The highest invertebrate densities were observed in the lower bay, downstream from the LNG Terminal site (CM 2 to CM 5). One of the sites (Station 11) was located in the navigation channel, immediately adjacent to the LNG Terminal where 16 different taxa were identified and the mean density was 552 individuals/m^2. The polychaete worm, *Glycera tenuis*, dominated the taxa at this location (n=23). Nearby sampling stations also were found to support high numbers of polychaetes, including *Glycera tenuis* and *Heteropodarke heteromorpha*. *Corophium salmonis*, an amphipod important as juvenile salmonid prey, was rarely found in the study area. Total benthic invertebrate densities in Coos Bay ranged from 375 to 13,546/m^2 and were found to be lower than densities observed in the Umpqua River estuary (range from <200 to >50,000/m^2) and the Columbia River estuary (range from <1,000 to >60,000/m^2) (Bottom et al. 1985; Miller et al. 1989; Durkin and Emmett 1980).

Previous studies by ODFW have shown that benthic macroinvertebrates in Coos Bay may not comprise a major portion of the diet for juvenile salmonids. Stomach contents of wild Chinook salmon and hatchery coho salmon juveniles were analyzed from July to September 1980 (Nicholas and Lorz 1984). The survey was performed during the outmigration period for juvenile salmonids, when juveniles are expected to be abundant within the estuary. The major prey species consumed by juvenile Chinook salmon (in order of abundance) were Pacific sand lance (n=89), terrestrial insects (n=59), and decapods (e.g., crab zoea and shrimp larvae) (n=27) (Nicholas and Lorz 1984). Only five amphipods (likely *Corophium* spp.) were identified in 143 Chinook salmon stomach samples. However, amphipods were the major prey species identified in juvenile coho salmon stomach samples (n=105). Other prey species found included terrestrial insects (n=27) and Pacific sand lance (n=25). Previous studies in Coos Bay have found that *Corophium* spp. are abundant in intertidal areas and constitute an important diet element for juvenile Chinook salmon and striped bass (BLM 1971). Shallow water habitats near the LNG Terminal have been mapped as habitat for *Corophium* spp (Coos County Planning Department 1979).

Based on the presence of juvenile salmonids at nearby ODFW sampling sites, it is likely that juvenile coho and other fish species utilize the shallow water areas near the LNG Terminal for foraging during periods of the year. The shoreline has been mapped as potential habitat for the amphipod *Corophium* spp., which is considered an important prey species (Coos County Planning Department 1979) and was shown to be consumed in large numbers by coho salmon (Nicholas and Lorz 1984). Shanks et al. (2011) sampled zooplankton in Coos Bay near the LNG Terminal site. A variety of zooplankton were found to be present within the bay, with potential salmonid forage items such as copepod adults, lavaceans, harpacticoid copepods, and Daphnia noted in abundance.

However, benthic studies conducted by NMFS within and in the vicinity of the Federal Navigation Channel found that *Corophium salmonis* occurred in much lower densities than other Oregon estuaries (Miller et al. 1990; Bottom et al. 1985; Miller et al. 1989; Durkin and Emmett 1980). Based on site observations made in November 2006, it appears that shallower habitats at the LNG Terminal site contain a higher percentage of fine substrates, and thus could support a greater abundance of benthic macroinvertebrates than had been observed within the navigation channel, which is dominated by coarser sand.

Freshwater Habitats

Conditions of aquatic habitats within the fifth-field watersheds in the Coos, Coquille, and South Umpqua subbasins that would be crossed by the Pipeline were evaluated with data collected by

ODFW in their Aquatic Inventories Project (ODFW 2014c). In cooperation with other agencies, ODFW has conducted stream surveys throughout the state including streams within watersheds crossed by the Pipeline. .Four types of habitat information provide quantitative evaluations of the fish habitat condition within the various watersheds: 1) pool habitat condition, 2) riffle habitat condition, 3) shade conditions, 4) woody debris habitat condition, and 4) riparian habitat condition. ODFW (Foster et al. 2001) has developed benchmark criteria for each of these habitat conditions that would represent undesirable and desirable habitat conditions. The benchmarks are provided in table 3.5.4-9 along with the various aquatic habitat conditions to which they apply.

TABLE 3.5.4-9

Oregon Department of Fish and Wildlife Aquatic Inventory and Analysis Project Criteria for Aquatic Habitat Conditions and Benchmarks

Aquatic Habitat Condition	Benchmark Level for Condition	
	Undesirable	Desirable
Pools		
Pool Area (% total stream area)	<10	>35
Pool Frequency (channel widths between pools)	>20	5-8
Residual Pool Depth (meters [m])		
Small Streams (<7 m wide)	<0.2	>0.5
Medium Streams (≥7 m and <15 m width)		
Low Gradient (slope <3%)	<0.3	>0.6
High Gradient (slope >3%)	<0.5	>1.0
Large Streams (≥15 m width)	<0.8	>1.5
Complex Pools (pools with ≥3 LWD pieces / km of reach length)	<1	>2.5
Riffles		
Width/Depth Ratio (active channel based)		
East Side	>30	<10
West Side	>30	<15
Gravel (% area)	<15	≥35
Silt-Sand-Organics (% area)	>20	<10
Volcanic Parent Material	>15	<8
Sedimentary Parent Material	>20	<10
Channel Gradient <1.5%	>25	<12
Shade (Reach Average, Percent)		
Stream Width <12 m		
West Side	<60	>70
Northeast	<50	>60
Central-Southeast	<40	>50
Stream Width >12 m		
West Side	<50	>60
Northeast	<40	>50
Central-Southeast	<30	>40
Large Woody Debris		
Pieces/100m Stream Length	<10	>20
Volume (m^3)/100 m Stream Length	<20	>30
"Key" Pieces (>60 cm and 10 m long)/100 m	<1	>3
Riparian Conifers (30 m From Both Sides of Channel)		
Number >20 inches dbh/1,000 feet Stream Length	<150	>300
Number >35 inches dbh/1,000 feet Stream Length	<75	>200

Source: Foster et al. 2001

Benchmark conditions are not absolute but they provide a method for comparing values of key aquatic habitat components (Foster et al. 2001) that are used to establish baseline conditions within watersheds to be crossed by the Pipeline. Pools provide refuges for fish during high and low stream flows. Pools provide slow water habitats for adults and juveniles, provide over-wintering habitat for some fish species, provide habitat during periods of low summer flows, and pools associated with large wood provide habitat complexity.

Riffles provide spawning habitats for various salmonid species that construct nests or redds in gravels of various sizes, specific to salmonid species. Sand, silt, and organic debris can reduce suitability of spawning habitats by filling pores between gravel particles that are necessary for intergravel stream flows, availability of oxygen, and for development of embryos; high percentages of sand, silt, and organic material in riffles indicate poor conditions as spawning habitat.

Riparian trees provide shade over stream channels which reduce deleterious effects of high summer water temperatures. Roots of riparian vegetation stabilize stream banks, contribute to development of bank undercutting (thermal and hiding cover), limit erosion and sedimentation from stream banks, and provide LWD as an important component of the aquatic habitat. LWD, especially contributed by riparian conifers, provides cover for fish, physical habitat complexity that influences stream flows and channel diversity, and biological complexity as substrate for macroinvertebrate communities that provide food for salmonids during different life stages (Foster et al. 2001).

Data used to evaluate aquatic habitat conditions, reported by ODFW (2014c), are provided in appendix X for each stream reach included in the inventories and evaluations of benchmark conditions are summarized in tables 3.5.4-10a and 3.5.4-10b, below.

Coos Subbasin - HUC 17100304. Data available from the ODFW (2014c) Aquatic Inventories Project provided aquatic habitat conditions for 33 stream reaches within the Coos Bay-Frontal Pacific Ocean Fifth-Field Watershed (HUC 710030403) surveyed between 1992 and 1999. The sampled reaches were of first, second or third order (Strahler numbers 1, 2, 3) streams with active channel widths (bankfull widths) averaging 5.8 meters and active channel heights averaging 0.5 meter.

Desirable conditions for pool habitat in surveyed reaches ranged from only 11 percent for pool frequency to 35 percent for residual pool depth (see table 3.5.4-10a). In general, pool habitat conditions were undesirable or less than desirable (moderate) for most streams within the watershed. Riffle habitats were relatively abundant (68 percent of stream reach areas) but degraded by high levels of silt, sand and organic materials and width to depth ratios of sampled reaches tended to be high, indicative of relatively shallow wide stream channels that provide less suitable habitat than deep, narrow channels (see benchmarks in table 3.5.4-9).

Riparian conditions in streams surveyed within the Coos Bay Frontal-Pacific Ocean watershed are mostly undesirable. Trees in less than half of the reaches provide adequate shade of stream channels and the numbers of large conifer trees within surveyed riparian zones were undesirable; large conifers were absent in many of the surveyed reaches. It is not surprising that the amount of LWD, including key pieces (pieces of large wood ≥0.6 meter diameter and ≥12 meters long), is undesirable, less than benchmark. Low estimates of riparian shade is indicative of lower gradient streams and floodplains that have been altered by past land uses in the watershed. As one consequence, summer stream temperatures in lower reaches exceed levels suitable as juvenile salmonid summer rearing habitats (Coos Watershed Association 2006). The ODFW (2008) in-stream construction window for coastal tributaries is July 1 to September 15 although work in the Coos Bay estuary and Coos River mainstem is allowed from October 1 to February 15.

TABLE 3.5.4-10a

Aquatic Habitat Conditions from Samples Taken by ODFW in Stream Reaches within
Fifth-Field Watersheds of the Coos and Coquille Subbasins Crossed by the Pipeline Project

	Mean Values (with Standard Errors) in Relation to Benchmark Conditions in Surveyed Reaches (by %) of Watersheds a/							
	Coos Bay-Frontal HUC 1710030403		North Fork Coquille HUC 1710030504		East Fork Coquille HUC 1710030503		Middle Fork Coquille HUC 1710030501	
Aquatic Habitat Condition	**Mean (Standard Error)**	**Undesirable Desirable Conditions**	**Mean (Standard Error)**	**Undesirable Desirable Conditions**	**Mean (Standard Error)**	**Undesirable Desirable Conditions**	**Mean (Standard Error)**	**Undesirable Desirable Conditions**
Pools								
Pool Area (% total stream area)	36.6 (6.5)	35.7% 39.3%	43.4 (3.5)	13.8% 55.4%	37.8 (2.2)	8.1% 54.1%	34.4 (2.1)	13.1% 50.5%
Pool Frequency (channel widths between pools)	72.6 (18.3)	60.7% 10.7%	22.3 (4.5)	26.2% 18.5%	12.8 (1.6)	17.6% 27.0%	30.6 (8.2)	25.3% 28.3%
Residual Pool Depth (m) by stream size and gradient	0.5 (0.1)	10.7% 35.7%	0.5 (0.03)	1.5% 35.4%	0.6 (0.03)	0.0% 52.7%	0.6 (0.02)	1.0% 43.4%
Complex Pools (pools with ≥3 LWD pieces ≥3 per km of reach length	0.3 (0.2)	92.9% 7.1%	4.7 (0.7)	43.1% 44.6%	4.6 (0.6)	36.5% 52.7%	3.3 (0.5)	53.5% 37.4%
Riffles								
Width/Depth Ratio (active channel based)	22.2 (3.1)	30.4% 34.8%	17.2 (1.3)	8.6% 47.1%	16.0 (0.9)	5.4% 50.0%	22.9 (1.8)	18.2% 39.4%
Gravel (% of area)	28.4 (5.4)	40.9% 45.5%	36.1 (2.0)	9.0% 59.7%	42.0 (2.6)	9.5% 54.1%	50.0 (2.2)	5.1% 72.7%
Silt-Sand-Organics (% of area) by parent material and gradient b/	48.5 (8.6)	59.1% 27.3%	29.2 (3.4)	43.3% 19.4%	21.9 (2.2)	39.2% 21.6%	15.1 (1.3)	26.3% 41.4%
Shade								
Reach Average, % by stream width	67.1 (4.5)	30.3% 48.5%	87.5 (1.9)	4.1% 95.9%	91.1 (1.0)	1.4% 97.3%	81.4 (2.3)	11.1% 80.6%
Large Woody Debris								
LWD Pieces/100m of Stream Length	14.8 (3.2)	57.6% 21.2%	15.9 (1.3)	35.1% 23.0%	22.0 (1.6)	16.2% 41.9%	13.0 (1.2)	48.1% 22.2%
LWD Volume (m^3)/100m of Stream Length	23.8 (6.3)	72.7% 24.2%	25.7 (3.4)	59.5% 24.3%	61.9 (9.2)	31.1% 51.4%	21.2 (2.6)	67.6% 24.1%
Key Pieces (≥60cm D by ≥12m L)/100m of Stream Length c/	0.9 (0.3)	75.8% 9.1%	1.2 (0.3)	70.3% 8.1%	1.9 (0.3)	47.3% 17.6%	0.7 (0.1)	76.9% 5.6%
Riparian Conifers								
Number >20in DBH/1000ft of Stream Length	21.4 (11.0)	97.0% 3.0%	23.4 (6.1)	98.6% 1.4%	47.3 (13.3)	90.5% 1.4%	25.6 (4.5)	94.4% 0.0%
Number >35in DBH/1000ft of Stream Length	1.3 (0.9)	100.0% 0.0%	7.2 (2.8)	98.6% 0.0%	11.6 (3.1)	95.9% 0.0%	7.3 (2.3)	98.1% 0.0%

a/ Values unweighted by surveyed reach length.
b/ Assumes sedimentary parent material in all surveyed reaches.
c/ D= diameter, L = length

TABLE 3.5.4-10b

Aquatic Habitat Conditions from Samples Taken by ODFW in Stream Reaches within Fifth-Field Watersheds of the South Umpqua Subbasin Crossed by the Pipeline Project

	Mean Values (with Standard Errors) in Relation to Benchmark Conditions in Surveyed Reaches (by %) of Watersheds a/									
	Olalla Creek-Lookingglass Creek HUC 1710030212		Clark Branch-South Umpqua River HUC 1710030211		Myrtle Creek HUC 1710030210		Days Creek-South Umpqua River HUC 1710030205		Upper Cow Creek HUC 1710030206	
Aquatic Habitat Condition	Mean (Standard Error)	Undesirable Desirable Conditions	Mean (Standard Error)	Undesirable Desirable Conditions	Mean (Standard Error)	Undesirable Desirable Conditions	Mean (Standard Error)	Undesirable Desirable Conditions	Mean (Standard Error)	Undesirable Desirable Conditions
Pools										
Pool Area (% total stream area)	49.5 (3.1)	5.6% 75.9%	22.9 (4.0)	46.9% 28.1%	35.6 3.3	19.0% 44.8%	27.5 (2.3)	24.2% 28.6%	25.3 (3.1)	21.4% 17.9%
Pool Frequency (channel widths between pools)	15.7 (6.1)	11.1% 33.3%	85.1 (33.8)	50.0% 12.5%	51.3 19.6	24.1% 24.1%	34.6 (7.5)	37.4% 15.4%	47.3 (18.1)	46.4% 14.3%
Residual Pool Depth (m) by stream size and gradient	0.4 (0.02)	0.0% 13.0%	0.4 (0.02)	6.3% 3.1%	0.4 0.03	0.0% 22.4%	0.4 (0.02)	3.3% 12.1%	0.4 (0.03)	0.0% 21.4%
Complex Pools (pools with ≥3 LWD pieces ≥3 per km of reach length	2.6 (0.6)	63.0% 31.5%	0.03 (0.03)	96.9% 0.0%	1.1 0.3	75.9% 17.2%	2.3 (0.5)	64.8% 24.2%	0.1 (0.0)	96.4% 0.0%
Riffles										
Width/Depth Ratio (active channel based)	16.5 (1.2)	11.1% 50.0%	22.2 (2.5)	20.0% 23.3%	24.2 1.8	27.6% 29.3%	15.4 (0.9)	4.2% 53.7%	15.5 (2.5)	7.1% 39.3%
Gravel (% of area)	40.7 (2.0)	2.1% 70.2%	55.1 (3.2)	0.0% 86.7%	42.4 2.2	3.5% 66.7%	46.5 (1.9)	0.0% 69.2%	46.5 (3.5)	3.6% 75.0%
Silt-Sand-Organics (% of area) by parent material and gradient b/	15.8 (1.9)	31.9% 44.7%	9.2 (1.2)	6.7% 43.3%	30.8 2.3	66.7% 8.8%	17.7 (1.8)	29.7% 31.9%	29.9 (3.0)	71.4% 0.0%
Shade										
Reach Average, % by stream width	78.2 (1.6)	7.4% 77.8%	91.7 (6.2)	11.4% 80.0%	66.3 5.8	31.8% 60.6%	82.4 (1.8)	7.8% 85.3%	79.8 (4.4)	7.1% 85.7%
Large Woody Debris										
LWD Pieces/100m of Stream Length	13.6 (1.3)	46.3% 24.1%	4.2 (0.9)	85.7% 2.9%	11.3 4.8	80.3% 6.1%	10.8 (1.0)	54.9% 13.7%	10.1 (1.1)	57.1% 3.6%
LWD Volume (m^3)/100m of Stream Length	21.0 (2.5)	57.4% 24.1%	6.3 (2.0)	91.4% 2.9%	14.1 3.2	77.3% 10.6%	14.8 (1.7)	74.5% 14.7%	17.4 (2.1)	60.7% 17.9%
Key Pieces (≥60cm D by ≥12m L)/100m of Stream Length c/	0.6 (0.1)	74.1% 0.0%	0.2 (0.1)	94.3% 0.0%	0.4 0.1	84.8% 1.5%	0.4 (0.1)	85.3% 2.0%	0.7 (0.1)	82.1% 3.6%
Riparian Conifers										
Number >20in DBH/1000ft of Stream Length	60.8 (11.3)	83.3% 3.7%	13.4 (5.9)	100.0% 0.0%	29.8 7.6	93.9% 1.5%	30.1 (6.4)	95.1% 1.0%	74.9 (16.2)	82.1% 3.6%
Number >35in DBH/1000ft of Stream Length	3.3 (1.6)	100.0% 0.0%	2.4 (1.3)	100.0% 0.0%	4.9 1.5	100.0% 0.0%	10.3 (4.2)	97.1% 1.0%	16.7 (4.8)	92.9% 0.0%

a/ Values unweighted by surveyed reach length.
b/ Assumes sedimentary parent material in all surveyed reaches.
c/ D= diameter, L = length

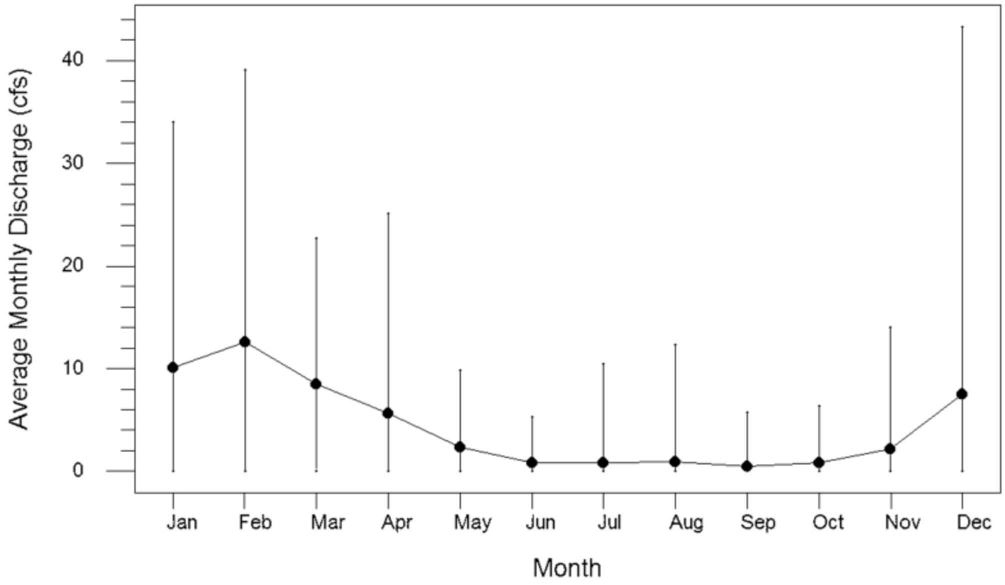
The Pipeline would be adjacent to Kentuck Slough and would cross Willanch Slough upstream from tide gates, in low gradient reaches with associated low gradient floodplains. Echo Creek would be crossed upstream from the confluence with the Coos Bay estuary, a reach that is not tidally influenced. Specific aquatic habitat conditions in those streams (Coos Watershed Association 2006) are consistent with conditions reported for stream reaches surveyed in by ODFW Aquatic Inventories Project and summarized in table 3.5.4-10a.

Stream discharges over the annual cycle are provided in figure 3.5.4-4 for two streams within the Coos Subbasin: Pony Creek—a small, tidally influenced stream and tributary to Coos Bay draining a watershed 3.88 square miles—and West Fork Millacoma River—a large tributary to the Coos River, draining a 46.90-square-mile watershed. Seasonal discharges in West Fork Millacoma River are representative of large and small waterbodies crossed by the Pipeline within the Coos Subbasin. However, flows in Pony Creek have been influenced by releases from Upper Pony Creek Reservoir since construction of the new dam, completed in 2001 (Sol Coast Consulting & Design, LLC and Parsons Brinckerhoff 2009).

Highest monthly discharges occur between December and April in both waterbodies along with the largest range in variability (maximum and minimum discharge for a given month). Lowest discharges occur between June and October. In all months, minimum discharges in Pony Creek were zero (see figure 3.5.4-4A) and minimum discharges in West Fork Millicoma River were less than 10 cubic feet per second (cfs) during July, August, September and October in some years (see figure 3.5.4-4B). The ODFW (2008) in-stream construction window for coastal tributaries is July 1 to September 15.

Coquille Subbasin - HUC 17100305. ODFW, BLM, and Oregon Forest Industry Council surveyed 336 stream reaches in the four fifth-field watersheds within the Coquille Subbasin that would be crossed by the Pipeline: 18 in the Coquille HUC 1710030505, 76 in the North Fork Coquille River HUC 1710030504, 95 in the East Fork Coquille River HUC 1710030503, and 147 in the Middle Fork Coquille River HUC 1710030501. Surveys were conducted during summers in different watersheds between 1992 and 2005. Conditions for aquatic habitats in the four watersheds are included in table 3.5.4-10a. Sampled reaches of first through fifth order (Strahler numbers 1 through 5) streams had active channel widths averaging less than 3 meters and active channel heights averaging less than 0.6 meter.

Conditions associated with riparian vegetation are generally undesirable in each of the watersheds: there are too few large conifers along most stream reaches and LWD numbers, volume, and presence of key pieces tend to be below benchmark levels, especially for reaches in the Middle Fork Coquille River watershed. Pool conditions tend to more desirable than in the Coos Bay-Frontal Pacific Ocean watershed except for pool complexity formed by LWD, not surprising given the overall undesirable condition for LWD in surveyed streams. Overall, amounts of shade for reaches in the North Fork, East Fork, and Middle Fork Coquille watersheds are at desirable levels (see table 3.5.4-10a), covering more than 80 percent of stream channels.



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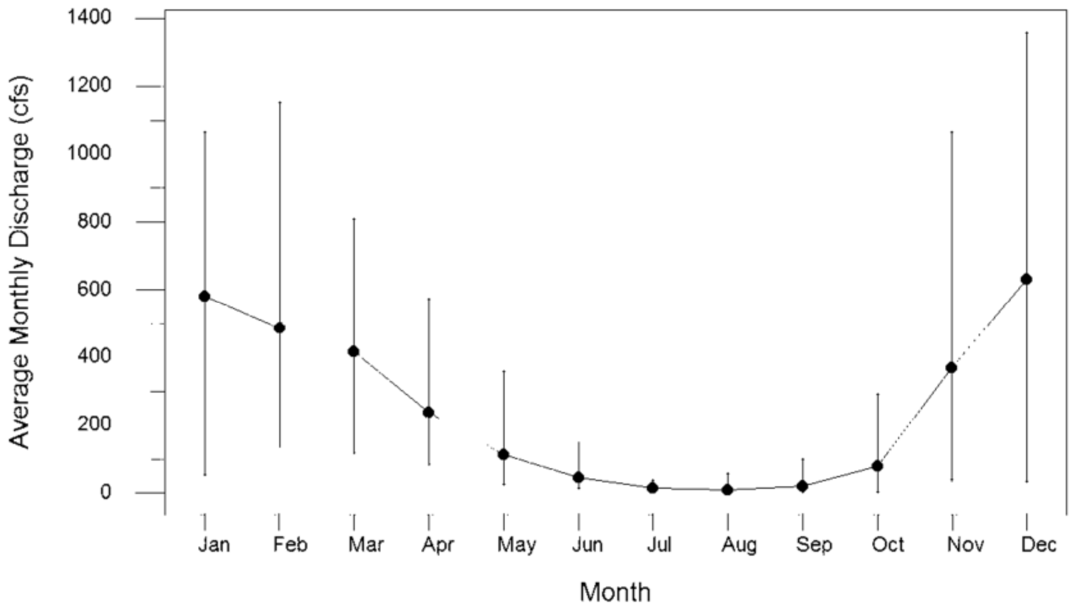


B

Figure 3.5.4-4 Average Monthly Discharge (cfs) in (A) Pony Creek (USGS Gage 14324580) from 1975 to 2008, and (B) West Fork Millicoma River (USGS Gage 14324500) from 1954 to 1981. Vertical lines show maximum and minimum discharges during the periods of record.

Streams in the four watersheds are mostly deeper and narrower (low width/depth ratios) than in the Coos Bay Frontal watershed. Gravel substrates appear to be less limited in reaches within the three watersheds compared to the Coos Bay Frontal. Fine sediments (silt, sand, and organic materials) are present at undesirable levels within many riffle habitat units. These conditions are consistent with summaries of watershed health indicators reported by the Coquille Watershed Association for aquatic/in-stream habitats accessible by Oregon Coast coho salmon (Oregon Watershed Enhancement Board 2007) in lower Coquille River, North Fork Coquille River, East Fork Coquille River, and Middle Fork Coquille River. Conditions for aquatic habitats in the watersheds are included in table 3.5.4-10a. Likewise, BLM (1999a) evaluated habitat conditions in the Upper Middle Fork Coquille Watershed (appendix B.3, table B.3-1b to PCGP's Resource Report 3), noting major problems with erosion and sedimentation due to proliferation of roads during the previous 40 years. Access to upstream habitats was limited by various types of barriers, principally culverts associated with forest roads.

The Coquille Sub-basin was included in NMFS' (2016b) recent evaluation of habitat conditions within Oregon's Mid-south Coast Stratum. Although not specifically addressing the three 5th field watersheds in the sub-basin that would be crossed by the Pipeline, many of the same habitat limiting factors that were described by BLM (1999a) and OregonWatershed Enhancement Board (2007) persist as habitat concerns. The same issues that were discussed above for the Coos Subbasin apply: habitat complexity, fine sediments, stream flows, suitable rearing habitats, refugia, and limited fish passage.

Juvenile salmonid habitat complexity in low gradient streams requires some form(s) of shelter as large wood, pools, connected off-channel alcoves, beaver ponds, lakes, interconnected floodplains and wetlands that provide refugia and shelter from extreme water temperatures and hiding cover from predators (Oregon Watershed Enhancement Board 2007). Spawning gravel quantities, measured by percent of riffle areas covered with gravel and gravel quality depends on embeddedness (percent of riffle areas in silt, sand, and organic fines). Waterbodies in the three watersheds within the Coquille Subbasin that would be crossed by the Pipeline are primarily limited in these and most other aquatic habitat health indicators (see table 3.5.4-11).

Stream discharges over the annual cycle are provided in figure 3.5.4-5 and tributary to Coquille River draining a watershed 73.90 square miles, and Middle Fork Coquille River – a larger tributary to the Coquille River, draining a 305-square-mile watershed.

Highest monthly discharges occur between November and April in both waterbodies along with the largest range in variability (maximum and minimum discharge for a given month). Lowest discharges occur between June and October. Minimum discharges in North Fork Coquille River were less than 10 cfs during August, September, and October in some years (see figure 3.5.4-5A) and were less than 20 cfs during August, September, October, and November in some years in the Middle Fork (see figure 3.5.4-5B). The ODFW (2008) in-stream construction window for the Coquille River and tributaries is July 1 to September 15.

TABLE 3.5.4-11

Comparisons of Aquatic Habitat Watershed Indicators in Fifth-Field Watersheds within the Coquille Sub-Basin that Would Be Crossed by the Pipeline Project from West to East

5th Field Watershed (HUC)	Winter Rearing Habitat Complexity	Summer Rearing Habitat Complexity	Spawning Gravel Quantity	Spawning Gravel Quality	Channel Modification	Large Wood	Water Quality	Water Temperature
North Fork Coquille River (1710030504)	Limiting	Limiting	Moderate	Limiting	Limiting	Limiting	Moderate	Limiting
East Fork Coquille River (1710030503)	Limiting	Limiting	Limiting	Limiting	Limiting	Limiting	Limiting	Limiting
Middle Fork Coquille River (1710030501)	Limiting	Limiting	Moderate	Limiting	Limiting	Limiting	Limiting	Limiting

Source: Oregon Watershed Enhancement Board 2007.

Aquatic habitat categories:

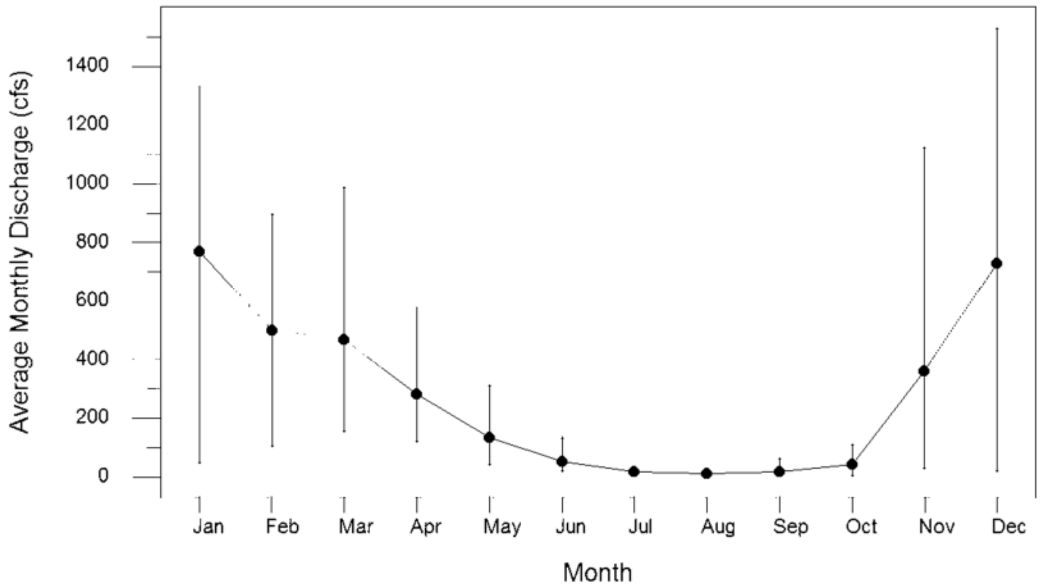
Limiting: indication of degraded watershed health and a significant amount of restoration action is needed to improve watershed conditions.

Moderate: indication of less than desirable watershed health and moderate to significant levels of restoration action is needed to improve watershed conditions.

Adequate: indication of functional watershed health and minimal restoration activities are needed to maintain exiting watershed conditions.

South Umpqua Subbasin – HUC 17100302. The Pipeline would cross five fifth-field watersheds in the South Umpqua subbasin. Between 1992 and 2010, the BLM and Umpqua Basin Fisheries Restoration Initiative surveyed 57 stream reaches in the Olalla-Lookingglass Creek watershed (HUC 1710030212), 97 reaches within the Clark Branch-South Umpqua River watershed (HUC 1710030211), 52 reaches within the Myrtle Creek watershed (HUC 1710030210), 34 reaches within the Days Creek-South Umpqua River watershed (HUC 1710030205), and 28 reaches within the Upper Cow Creek watershed (HUC 1710030206). Conditions for aquatic habitats in the five watersheds are included in table 3.5.4-10b.

Stream reaches sampled in the Olalla-Lookingglass Creek watershed had significantly ($P<0.05$) more area of pool habitats than reaches in the other watersheds of the South Umpqua Subbasin (see table 3.5.4-10b). However, complex pools associated with LWD were undesirably limited (too few pieces per reach length) in most stream reaches for all six watersheds. Conditions for residual pool depths and pool frequencies were mostly intermediate (moderate), neither undesirable nor desirable for most of the sampled reaches in watersheds to be crossed by the Pipeline. Ratios of stream widths to depths in most stream reaches in the six watersheds were generally low, more narrow and deep than wide and shallow. Areas of gravel in riffle habitats were mostly desirable or moderate conditions. Areas of fine sediments in riffles would be undesirable for the majority of stream reaches in the Upper Cow Creek watershed but at moderate or desirable conditions in reaches sampled in the other five watersheds (see table 3.5.4-10b).



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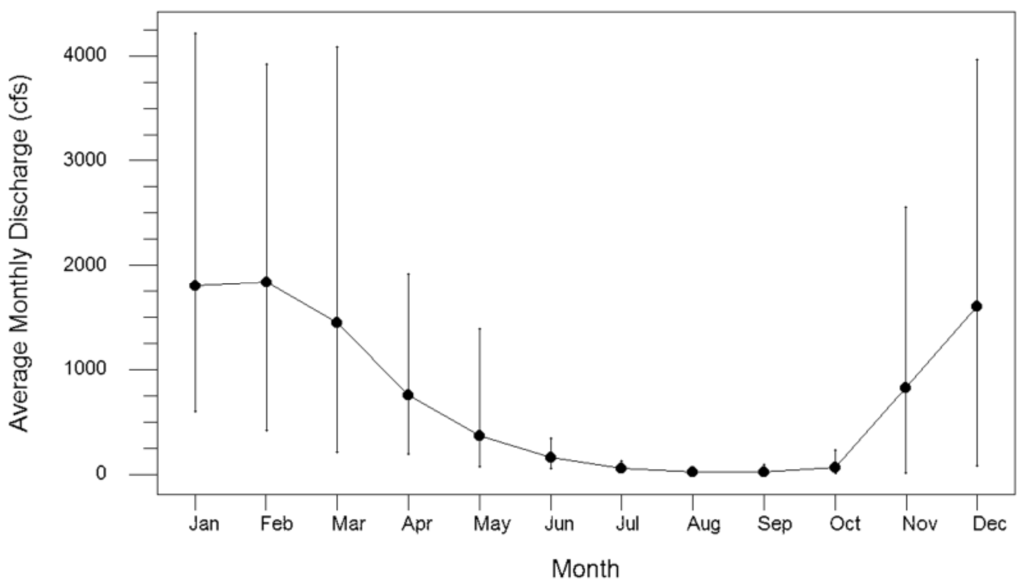


B

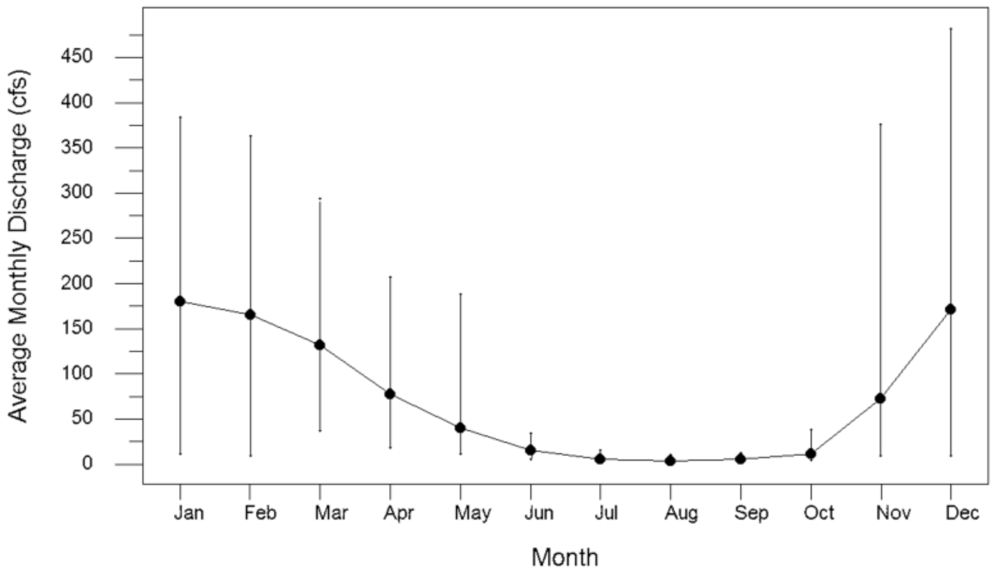
Figure 3.5.4-5 Average Monthly Discharge (cfs) in (A) North Fork Coquille Fiver (USGS Gage 14326800) from 1963 to 1981, and (B) Middle Fork Coquille River (USGS Gage 14326500) from 1930 to 1946. Vertical lines show maximum and minimum discharges during the periods of record

Shade conditions would be considered desirable for the majority of stream reaches in all six watersheds but numbers of large conifers in riparian zones were below desirable benchmark levels. LWD conditions in most stream reaches were also below desirable benchmark conditions (see table 3.5.4-10) for all of the watersheds to be crossed by the Pipeline. Likewise, BLM evaluated habitat conditions in the five 5th field watersheds crossed by the Pipeline (see table 3.5.4-1). Summaries of the watershed analyses are provided in appendix B.3 to PCGP's Resource Report 3 (table B.3-1c, table B.3-1d, table B.3-1e, table B.3-1f, and table B.3-1g). As a rule, streams lacked in-stream LWD, fish access was limited, sedimentation was excessive, and habitats had been affected by high flows that degraded in-stream habitats.

The South Umpqua Sub-basin was included in NMFS' (2016b) recent evaluation of habitat conditions within Oregon's Umpqua Stratum. Although not specifically addressing the five 5th field watersheds in the sub-basin that would be crossed by the Pipeline, many of the same habitat limiting factors that were described by BLM nearly 30 years ago persist as habitat concerns. The same issues that were present in the past persist in the South Umpqua Sub-basin: water quantity and quality and stream complexity are the main limiting factors.

Stream discharges over the annual cycle are provided in figure 3.5.4-6 for two waterbodies within the South Umpqua Subbasin, North Myrtle Creek – a small tributary to Myrtle Creek and the South Umpqua River with a 54.2-square-mile watershed, and the mainstem South Umpqua River with a watershed area of 1,670 square miles.

Highest monthly discharges occur between November and April in both waterbodies along with the largest range in variability (maximum and minimum discharge for a given month). Lowest discharges occur between June and October. Minimum discharges in North Myrtle Creek were less than 5 cfs during July, August, September, and October in some years (see figure 3.5.4-6A) and were less than 100 cfs during July, August, and September in some years in the South Umpqua River mainstem (see figure 3.5.4-6B). The ODFW (2008) in-stream construction window for tributaries to the South Umpqua River is July 1 to September 15 and from July 1 to August 31 for the South Umpqua River.



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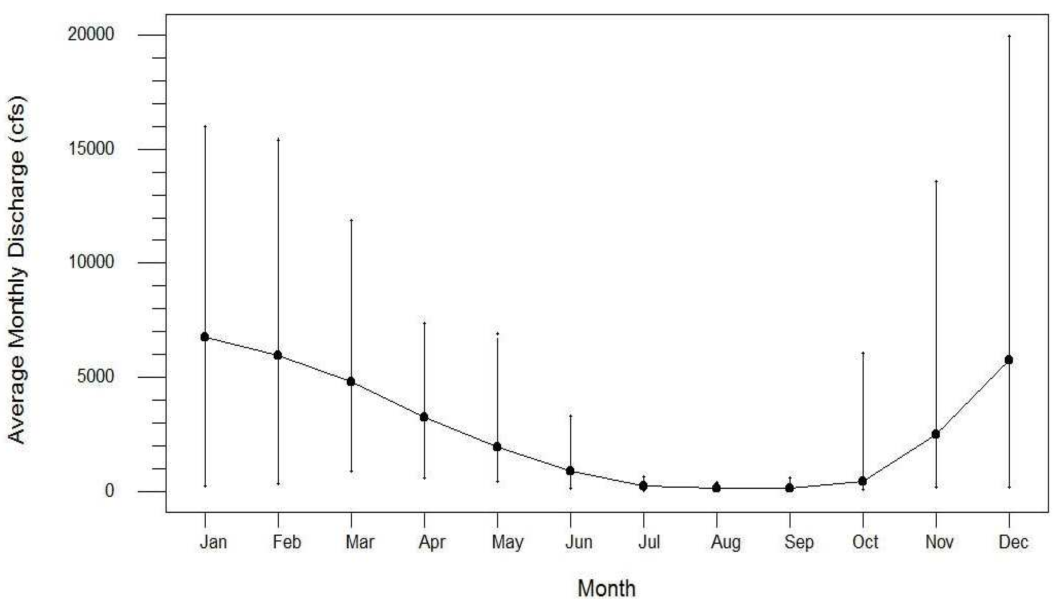

B

Figure 3.5.4-6 Average Monthly Discharge (cfs) in (A) North Myrtle Creek (USGS Gage 14311000) from 1955 to 1986, and (B) South Umpqua River (USGS Gage 14312000) from 1906 to 2016. Vertical lines show maximum and minimum discharges during the periods of record

The only watershed known to be affected by recent wildfire - the Stouts Creek Fire - is the Days Creek–South Umpqua Watershed. No information comparable to data collected by ODFW Aquatic Inventory and Analysis and reviews prepared by BLM, Forest Service, and/or Oregon Watershed Enhancement Board has been available for the Days Creek–South Umpqua Watershed since the Stouts Creek fire and no documented update of watershed conditions is available.

The Stouts Creek Fire started on June 26 and was contained on July 30, 2015 and burned 12,719 acres in the Days Creek–South Umpqua Watershed (approximately 9.0 percent of the total watershed area), 13,494 acres in the Elk Creek Watershed (approximately 24.8 percent of the total watershed area), and 239 acres in two sub-watersheds within the Upper Cow Creek 5th level Watershed (HUC 1710030206), amounting to 0.5 percent of the total watershed area. The three watersheds are within the South Umpqua Sub-basin (HUC 17100302).

The fire burned 26,452 acres (41.3 square miles), of which 14,251 acres were on National Forest Service land (Umpqua National Forest); 5,544 acres were on BLM Medford District land; and 6,658 acres were on private land. The fire affected from 84 percent to 99 percent of two sub-watersheds in the Elk Creek 5th level watershed (HUC 1710030204): 4,509 acres in Callahan Creek (Lower Elk Creek HUC 171003020404) and 8,024 acres in Drew Creek (Drew Creek HUC 171003020403). The fire also burned 4,008 acres within Hatchet Creek sub-watershed (Corn Creek-South Umpqua HUC 171003020502) and portions of the Stouts Creek sub–watershed (HUC 171003020503) within the Days Creek – South Umpqua 5th level watershed.

The Days Creek–South Umpqua and Elk Creek watersheds were assessed most recently in 2003 by the Umpqua Basin Watershed Council (Geyer 2003c). The 2003 assessment utilizes ODFW habitat benchmarks and measurements to interpret conditions of fish habitat, showing habitat conditions for streams in different 5th field watersheds within the South Umpqua Sub-basin. Specific values for those habitat conditions for streams in the Days Creek–South Umpqua Watershed were provided below in table 3.5.4-10b, and generally coincide with the summary provided in Map 3-3 through Map 3-6 in Geyer (pages 65-68, 2003), especially in categories for conditions of pools and large woody debris (LWD):

> "Of the 84 surveyed stream reaches, only five rate as fair or good in all four categories (6.0%). Sixty-four stream reaches (76.2%) have at least two categories rate as poor. Looking at Map 3-3, it is striking that three-fourths of all reaches rate as poor for large woody material. Over 90% of pools rate as poor or fair (see Map 3-4), and almost half of riffles rate as poor (see Map 3-5). Finally, approximately one third of riparian areas rate as poor (see Map 3-6)."

Key findings for stream functions within the Subbasin focus on stream morphology (most streams have low gradients with few stream miles in source areas where most LWD is recruited; lack of LWD, poor riffle and pool conditions limit fish habitat), stream connectivity (dams and culverts are barriers or impede connectivity and fish access to stream habitats), and channel modifications (many channels have been modified without permits) (Geyer 2003c). Likewise, key findings for riparian zone conditions include riparian tree components (predominant hardwoods and brush/blackberry), riparian vegetation widths or buffers (almost half of potential anadromous salmonid streams have riparian zones that are two trees wide or greater), and riparian shade (potential salmonid streams are predominantly shaded by vegetation or infrastructure, but over a third are less than half covered). Further, water temperatures in reaches of multiple streams in the Sub-basin were found to be limited by ODEQ (in years 1998 and 2002) water quality standards based on salmonid tolerance levels. Alternatively, no streams in the sub-basin were on the ODEQ 303(d) list for sedimentation (total suspended solids, TSS) or for turbidity (as nephelometric turbidity units, NTU) at the time the watershed assessment was prepared (Geyer 2003c).

Data provided by the Umpqua National Forest (Forest Service 2015) on modeled effects of the Stouts Creek fire (eg. Cannon et al. 2010) and reviews of scientific studies related to post-fire stream discharge, surface erosion, and effects to water quality (Hallema et al. 2017) and salvage logging effects on sediment transport (Silens et al. 2009) were combined with the most recent Oregon Watershed Enhancement Board 2003 watershed assessment for the South Umpqua Subbasin (Geyer, 2003c), which includes the Days Creek-South Umpqua Watershed. That investigation estimated that debris-flow volumes would increase with basin size and distance along the drainage network, but some smaller drainages were also predicted to produce substantial volumes of material. The predicted probabilities and some of the volumes predicted for the modeled storms indicate a potential for substantial debris-flow delivery to coho salmon-bearing streams and designated critical habitats downstream in Stouts Creek, lower East Fork Stouts Creek, Hatchet Creek, Callahan Creek, and Drew Creek. All are tributaries to the South Umpqua River for which water quality is likely to decline due to increased delivery of sediment because of the Stouts Creek Fire.

According to geographic data developed by the Umpqua National Forest and GIS shapefiles provided to Edge Environmental, Inc., 9.14 mi^2 in the Stouts Creek Fire perimeter were unburned or burned with very low intensity (22.1 percent), 11.55 mi^2 (28.0 percent) burned with low intensity, 13.70 mi^2 (33.2 percent) were moderate, and 6.90 mi^2 (16.7 percent) burned with high intensity. Areas of high severity burn were extensive in headwaters of Hatchet and Callahan creeks and smaller drainage areas in Drew Creek. Those drainages support Oregon Coast coho and designated critical habitat (0.7 mile in Hatchet Creek, 3.6 miles in Callahan Creek, and 2.6 miles in Drew Creek). According to the Umpqua National Forest (Forest Service 2015), post-fire runoff, erosion, and debris flows risks would increase in Hatchet and Callahan creeks along with increasing risks of spawning and rearing habitat degradation. Roads are also likely to be impacted from higher runoff and debris flows, scouring roadbeds and increasing sedimentation to coho habitat (Forest Service 2015).

Forest fires can lead to increased peak instream discharge and surface erosion; effects to water quality and aquatic habitats are exacerbated by increased wildfire severity over larger areas of slopes that lead to increased overland flow of eroded materials (Hallema et al. 2017). In addition, soil texture, litter cover, soil moisture and organic matter are affected by wildfire duration and fire temperature which can lead to soil water repellency and decreased water infiltration (Hallema et al. 2017). Further, research has shown that post-fire salvage logging increases mass wasting by creating more effective terrestrial sediment transport networks to stream channels, thus delivering more sediment than burned watersheds without salvage logging (Silins et al. 2009). Wildfire has also been found to increase concentrations of phosphorous in burned and post-fire, log-salvaged streams which elevated algal production and increased stream primary productivity, levels of secondary invertebrate consumers, and increased size and growth rates of fish as tertiary consumers (Silins et al. 2014).

USGS has developed empirical models to estimate probabilities for the occurrence and volume of post wildfire debris flows (Cannon et al. 2010). The models describe debris-flow probability as a function of readily obtained measures of areal burned extent, soil properties, basin morphology, and rainfall from short-duration and low recurrence-interval rainstorms and describe debris-flow volume as a function of drainage basin gradient, extent of area burned, and storm rainfall. The models have been applied to burned watersheds in the Intermountain West and the Pacific Coast by USGS Landslide Hazards Program and include modeling predicted debris flows after the Stouts Creek Fire. USGS conducted a post-fire debris-flow hazard assessment for the Stouts Creek Fire using geospatial data related to basin morphometry, burn severity, soil properties, and rainfall characteristics to estimate the probability and volume of debris flows that may occur in response to a design storm (the model results are available online at https://landslides.usgs.gov/hazards/postfire_debrisflow/).

For model applications, the Stouts Creek Fire area was divided into 324 discrete drainage mini-basins with areas averaging 0.57 km^2 (ranging from 0.02 km^2 to 7.43 km^2). Estimated debris-flow probabilities in the drainage mini-basins ranged from 0 to >80 percent in response to the rainfall intensity for a 2-year recurrence interval rainstorm measured for 1-hour duration along with rainstorm interval recurrences of 5-years, 10-years, 25-years, 50-years and 100-years.

Basins and drainage networks with the highest volumes of debris flows following 2-year, 5-year, and 10-year recurrence interval rainstorms tended to be in the center of the fire area, centered on Hatchet Creek in the Corn Creek sub-watershed (HUC 171003020502), in the eastern portion of the Stouts Creek sub-watershed (HUC 171003020503), and the headwaters of Callahan Creek (Lower Elk Creek sub-watershed, HUC 171003020404) and Drew Creek (Drew Creek sub-watershed, HUC 171003020403). Highest volumes for predicted debris flows averaged 180,303 m^3 (ranging from 82,574 m^3 up to 445,238 m^3 in 12 mini-watersheds where probabilities were 0 to 20 percent for 9 of the 12 watersheds following a 2-year recurrence interval rainstorm). Probabilities and predicted debris flow volumes following different rainfall recurrence intervals are provided in appendix M, table M-8.

Estimated debris-flow volumes increase with basin size and distance along the drainage network, but some smaller drainages were also predicted to produce substantial volumes of material. The predicted probabilities and some of the volumes predicted for the modeled storms indicate a potential for substantial debris-flow delivery to coho salmon-bearing streams and designated critical habitats downstream in Stouts Creek, lower East Fork Stouts Creek, Hatchet Creek, Callahan Creek, and Drew Creek. All are tributaries to the South Umpqua River for which water quality is likely to decline due to increased delivery of sediment because of the Stouts Creek Fire. Consequently, post-fire effects to water quality and streambed substrates in this portion of the South Umpqua Subbasin are expected.

Critical Habitat

Using available spatial data from ODFW on specific occupied stream reaches (ODFW 2014c), NMFS developed critical habit information based on fifth-field watersheds to designate specific streams as critical habitat within watersheds, including the 10 watersheds that would be crossed by the Pipeline. Included in the designation of critical habitat for the Oregon Coast coho are estuaries associated with the watersheds, beginning at the estuary mouth, including the entrance to the Coos Bay estuary at the land end of North Jetty and South Jetty. Critical habitats for Oregon Coast coho in specific waterbodies crossed by the Pipeline are compiled in appendix M and are summarized in table 3.5.4-12. Critical habitat includes the Coos Bay estuary and 25 freshwater streams in which critical habitat for Oregon Coast coho salmon has been designated (NMFS 2008d). Critical habitat is designated within 6,568 stream miles in 81 fifth field watersheds covering a total of 10,751 square miles with 7,342 stream miles of current and/or historically occupied habitat. Approximately 27 percent of critical habitat for the Oregon Coast coho ESU is within the three subbasins in table 3.5.4-12: 2.9 percent is in the Coos Bay Frontal-Pacific Ocean; 4.0 percent is within the three fifth field watersheds crossed in the Coquille Subbasin; and 4.9 percent is within the five fifth field watersheds crossed in the South Umpqua Subbasin.

TABLE 3.5.4-12

Critical Habitat – Stream Miles and Riparian Zones - Designated for Oregon Coast Coho within Watersheds Crossed by the Pipeline Project

Subbasins and Fifth-Field Watersheds	Waterbodies with Coho Presence a/			Riparian Zone Width (feet) (1 SPTH) c/	Areas (acres) of Riparian Vegetation within Riparian Zone (1 SPTH)	
	Number of Waterbodies with Critical Habitat b/	Total Stream Miles with Critical Habitat	Proportion of Total Critical Habitat Stream Miles in ESU b/		Within Subbasin or Watershed	Within 1 SPTH of waterbodies with Critical Habitat b/
Coos Subbasin	**157**	**540.9**	**0.082**	**216**	**471,867**	**29,611**
Coos Bay-Frontal Pacific Ocean	62	191.7	0.029	225	151,585	10,925
Coquille Subbasin	**164**	**544.5**	**0.083**	**196**	**676,291**	**26,575**
North Fork Coquille River	33	136.9	0.021	224	98,407	7,656
East Fork Coquille River	11	43.9	0.007	204	85,963	2,231
Middle Fork Coquille River	24	81.7	0.012	189	197,314	3,839
South Umpqua Subbasin	**214**	**688.1**	**0.105**	**165**	**1,152,662**	**27,901**
Olalla Creek-Lookingglass Creek	20	76.8	0.012	169	103,212	3,186
Clark Branch-South Umpqua River	17	64.3	0.010	149	59,577	2,347
Myrtle Creek	23	89.3	0.014	168	76,250	3,684
Days Creek-South Umpqua River	32	92.9	0.014	164	141,569	3,752
Upper Cow Creek	0	0.0	0.000	187	47,499	0
TOTAL	**535**	**1,773.5**	**0.270**		**2,300,820**	**84,087**

a/ data from ODFW GIS database (ODFW 2017f)
b/ NMFS 2008d
c/ 1 SPTH, one site-potential tree height

3.5.4.3 Effects of the Proposed Action

Analyses of effects for coho salmon in the Oregon Coast ESU are addressed separately for the marine analysis area, estuarine analysis area, and riverine analysis area.

Direct and Indirect Effects – Marine Analysis Area

Potential project-related effects to Oregon Coast coho within the marine analysis area include 1) acoustic effects to coho from LNG carriers transiting the marine analysis area, and 2) the inadvertent release of oil, gas and fuel from LNG carriers at sea.

<u>Acoustic Effects</u>

Underwater noise may affect coho salmon in the Oregon Coast ESU. LNG carriers transiting the marine analysis area would produce underwater noise. Underwater noise levels are expected to vary by ship type and also by carrier length, gross tonnage, carrier speed, and, to some extent, carrier age—older carriers tended to be louder than newer carriers. Based on the general trend for higher underwater noise generated by larger carriers (McKenna et al. 2012), it is possible for some of the LNG carriers that would utilize the LNG Terminal to generate more noise than the

LNG tanker built in 2003 with 138,028 m^3 capacity reported by Hatch et al. (2008) that produced sound levels (with 1 standard error) of 182 ± 2 dB re: 1 μPa @ 1 meter.

State agencies in Washington, Oregon, and California, along with federal agencies have developed interim noise exposure threshold criteria for pile driving effects on fish (WSDOT 2011a; Fisheries Hydroacoustic Working Group 2008, Popper et al. 2006). These threshold criteria are considered levels below which injury effects would not occur to fish, including salmonids, from in-water noise. As a result, these thresholds should be suitable for all forms of in-water noise. Interim noise exposure threshold criteria for pile driving effects on fish (WSDOT 2011a) include 1) a SEL_{cum} of 187 dB re 1 μPa^2 s for fishes more than two grams, 2) a SEL_{cum} of 183 dB re 1 μPa^2 s for fishes less than two grams, and 3) an SPL_{peak} of 206 dB re 1 μPa for all sizes of fishes (WSDOT 2011a).

The LNG tanker in the Hatch et al. (2008) study produced sound levels (with 1 standard error) of 182 ± 2 dB re: 1 μPa @ 1 meter that attenuated to 160 dB at 35 ± 11 meters and to 120 dB at 16,185 ± 5,359 meters. All values are less than those noted above as causing direct harm to fish, with the possible exception of very small fish within one meter (three feet) of the hull for an extended period. Additionally, since carriers are in transit and fish can easily move away from carriers, fish exposure would be very brief, further reducing the chance for noise exposure that would result in adverse effects.

It is likely that any LNG carrier noise generated in the marine analysis area would be below thresholds for adverse effects to fish with the possible exception of those fish very near the hull for extended periods, which would be an unlikely event. Noise from LNG carriers would likely increase the background noise within the marine analysis area, which is occurring globally (Slabbekoorn et al. 2010). While background levels are not specifically known in the marine analysis area, analyses of more recent vessel-traffic related noise shows that such levels along the US west coast are holding steady or increasing slightly offshore from Southern California but decreasing in the area off Oregon and Washington (Andrew et al. 2011). Oregon Coast coho in the marine analysis area might detect noise from LNG carriers but are not expected to be adversely affected. Ship noises from LNG carriers transiting the marine analysis area are not expected to adversely affect Oregon Coast coho salmon.

Fuel or Oil Spills at Sea

The LNG carriers use either a steam or duel fuel diesel electric propulsion system that is primarily fueled by natural boil-off gas. Fuel (e.g., diesel) used for back-up generation for LNG carrier propulsion and oil or hydraulic fluids used for mechanical equipment could possibly leak or be inadvertently spilled while the carriers are in transit. The low volume of petroleum oils and fuel on LNG carriers greatly reduces chance of impacts in the marine environment from petroleum spills. The Federal Water Pollution Control Act, as amended by the CWA (33 U.S.C. 1251–1387), prohibits the discharge of oil upon the navigable waters of the U.S. LNG carriers calling on the LNG Terminal would also be required by the Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills. Therefore, neither fuel nor oil leaks from LNG vessels transiting in the waterway to and from the LNG Terminal are likely to have adverse effects on aquatic resources including coho salmon.

Direct and Indirect Effects – Estuarine Analysis Area

Potential project-related effects to coho salmon in the Oregon Coast ESU within the estuarine analysis area include 1) turbidity effects from dredging the slip and access channel, 2) turbidity effects from LNG carrier propeller wash and ship wake, 3) suspended sediment released during HDD construction across Coos Bay Estuary and Coos River, 4) stranding Oregon Coast coho by LNG carrier ship wake, 5) introduction of exotic, invasive species from ballast water, 6) entrainment and impingement of Oregon Coast coho in LNG carriers' intake port, 7) estuary water cooling during LNG carrier cargo loading, 8) effects from operational lighting, 9) acoustic effects to coho during LNG Terminal construction, 10) habitat modifications related to the slip, access channel, NRI areas, and pile dike rock apron, 11) restoration activities at the Kentuck Mitigation Site, 12) shading, 13) nuisance species introduction, and 14) food organism entrainment.

Timing to Life History Functions

In-water construction of the JCEP Project within the Coos Bay estuary is planned from October 1 through February 15 following ODFW's recommendation (ODFW 2008). This work window applies to Coos Bay estuary and estuarine portion of the Coos River (upstream to Millicoma-South Coos River confluence), which coincides with adult upstream migrations of coho (see figure 3.5.4-1, above).

Approximately one-half of each brood of coastal coho salmon in Winchester Creek/South Slough (tributaries to Coos Bay) moved to the estuary as sub-yearlings (Miller and Sadro 2003). The estuary provides feeding and migratory habitat for adult and maturation habitat for juvenile coho that inhabit the ecotones between freshwater and saline portions of the estuary for up to 8 months and then move back upstream to overwinter. By October, adult coho salmon would likely have migrated from critical habitat in the estuary to upstream spawning habitats but the timing and progress of upstream migration could be influenced by drought and autumn precipitation. For example in fall 2011, significant rainfall did not occur until late December and adult coho held in mainstem pools for an extended period, waiting for rainfall, followed by increased discharge (ODFW 2012a). Adult coho could be present in designated critical habitat within the estuary, coincidental with in-water construction for the Project. Principal direct impact during in-water construction would most likely be related to acoustic effects and turbidity generated by dredging and construction of the slip and access channel andthe Navigation Reliability Improvements. In the unlikely event of an inadvertent release of drilling mud into the estuary during HDD construction, this may also cause a direct affect

Turbidity Effects from Dredging in Coos Bay

Construction of the LNG Terminal slip would require the excavation and dredging of the shoreline of Coos Bay near Jordan Cove, including removal of about 5.7 mcy of sediment as part of the development of a slip and access channel. The 5.7 mcy of materials would be used to raise the elevation of the LNG Terminal and the South Dunes site to elevations above the tsunami inundation zone.

At least 3.6 mcy would be removed behind a berm in upland habitat away from the bay, with little potential for sediments to affect the marine environment. The remaining 2.1 mcy would be removed by dredging of the berm (0.7 mcy) and the new access channel (1.4 mcy) in the bay (see discussion in section 3.5.1.3, green sturgeon).

Turbidity was modeled for new construction was based on the anticipated geotechnical and environmental conditions for this project using the COE's DREDGE model and two dimensional numerical model Mike21 (see discussion in section 3.5.1.3, green sturgeon). Increases in suspended sediment and turbidity levels in the bay due to construction-related dredging would persist for a short period of time (4-6 months) affecting a relatively limited area. Modelling at the access channel has demonstrated the maximum turbidity plume extent, defined by the simulated 10 NTU above background contour, to be approximately 780 and 750 feet when using cutter suction and clamshell dredges respectively. (Moffatt & Nichol 2017c). Therefore, short-term increases in turbidity above background levels would occur in the vicinity of dredging activity. Due to the limited extent of increased suspended sediment during periods when rearing coho salmon are not abundant and the likely ability of juvenile and adult fish to avoid active construction areas, substantial adverse effects to coho salmon would not occur from slip and access channel construction.

During capital dredging, a total of approximately 590,000 cy of dredge material will be removed from four locations (referred to as Dredge Areas 1 through 4) adjacent to the existing Federal Navigation Channel between RM 2 and 7. These areas will be dredged to a controlled depth to match the adjacent Federal Navigation Channel, which is currently -37 feet MLLW.

Dredging methods will be similar to what is described above for the slip and access channel, and could include mechanical methods from a barge or hydraulic cutter section dredging. Material from the four dredge areas will be moved to the APCO Sites. The potential turbidity plume extents, defined by the simulated 10 NTU above background contour, from the Navigation Reliability Improvements varies by location and dredge equipment but could extend from 2,820 feet to 4,600 feet from the activity depending on the ebb and flow of the tidal current and extent of additional sediment generated. However, this increased turbidity would be expected to be short-term (Moffatt & Nichol 2017c). See the green sturgeon section for more information on dredging in the NRI.

The ambient suspended sediment levels in the water (generated by flows, waves and ship traffic) create a background level of suspended sediment. Within Coos Bay, suspended sediment measurements taken at the Charleston Bridge over a 2-year period show an average summer turbidity level of 10 mg/l and an average winter level of 27.3 mg/l.[8] Some individual events (e.g., winter storms) measured at the Charleston Bridge were recorded between 100 and 500 mg/l. Aquatic organisms in Coos Bay are adapted to and exposed to periods of high to moderate turbidity during the winter months. Dredge operations are expected to result in similar effects, with higher concentrations of suspended sediments in the immediate area of dredging.

At the Eelgrass Mitigation site, a total of 40,000 cy of dredge material will be removed most likely with a small hydraulic dredge. Modeled turbidity values were determined to range from 270 to 290 NTUs. The potential turbidity plume extents, defined by the simulated 10 NTU above background contour, from the excavator dredge area would be generally limited to between 340 and 360 feet in all directions (Moffatt & Nichol 2017c). Since the site is a more confined and shallow area with somewhat limited circulation, the turbidity plume would be

[8] Jordan Cove included in its application to the FERC a study by Moffatt & Nichol entitled "Report on Turbidity Due to Dredging," attached as appendix F.2 of Environmental Resource Report 2 submitted May 2013.

maintained within the local area of excavation. The duration of suspended sediment settling, therefore, is expected to be very short with turbidity dissipating to background levels within an hour after dredge operations cease, depending on the tidal cycle. Turbidity controls utilized during construction are anticipated to minimize risk of turbidity associated with the eelgrass mitigation area. See the green sturgeon section for a discussion of these controls.

If coho salmon are exposed to moderate to high levels of suspended sediment for prolonged periods, a number of adverse effects could occur including behavioral changes, sub-lethal effects, and increased mortality from predators. The exposure of listed fish to increased suspended sediment may result in a behavioral response to move to locations with lower concentrations of sediment. If fish failed to avoid increased suspended sediment, such exposure could result in gill irritation or abrasion, which can reduce respiratory efficiency or lead to infection and a reduction in feeding efficiency due to reduced visibility. However, suspended sediment concentrations resulting from in-water construction are unlikely to reach levels that would cause these results except in the immediate vicinity of dredge operations. Dredging is expected to create localized, short-term spikes of high to moderate TSS and turbidity. Effects to salmonids are expected to be slight due to the limited area affected in the bay and limitations on construction periods. Rearing and migrating coho, which should be uncommon in Coos Bay during the in-water work window, would likely avoid active work areas.

Although localized, short-term, elevated levels of TSS concentrations and turbidity are anticipated from access channel and slip formation, and the NRIs such conditions may result in behavioral changes that could affect Oregon Coast coho salmon.

Contamination Effects from Dredging

NMFS (2009c) has noted that subadults and adults feeding in bays and estuaries may be exposed to contaminants that may affect growth and reproduction. Such effects due to bioaccumulation of pesticides and other contaminants have been documented in white sturgeons that also inhabit West Coast estuaries (NMFS 2009c). Sediments within the proposed dredge prism for the access channel were sampled to determine whether they meet Dredged Material Evaluation Framework (DMEF) guidelines, as identified for the Lower Columbia River Management Area, for in-water disposal (SHN 2006). An analysis of grain size distribution and total volatile solids composition was initially performed to determine if the sediments require further testing for chemical analysis. All of the samples were primarily composed of medium to fine grained sand and had a very low percentage of total volatile solids. Since none of the samples exceeded 20 percent fines or 5 percent total volatile solids, no further chemical testing was required and the sediments were deemed suitable for in-water disposal, according to DMEF guidelines. These findings indicate that resuspension of sediments associated with the dredging for the access channel should not result in significant increases the bioavailability of contaminants to fish and fish food organisms within the Project analysis areas.

This conclusion is further supported by previous sediment evaluations conducted for Coos Bay channel maintenance and improvement dredging. Most recently in 2004, the COE performed sediment sampling and characterization at various stations along the Federal Navigation Channel (COE 2005). Throughout the entire sampling area, only low levels of sediment contaminants were identified, with all levels well below their respective DMEF screening levels. One of the sampling stations (0915CB-BC-10) was located approximately 0.4 mile downstream of the LNG

Terminal. The 2004 sediment sampling effort found only low levels of chemical contaminants, with all levels below their respective DMEF screening levels. None of the samples contained DDT or its derivative by-products (DDE, DDD, see section 3.5.1.3, green sturgeon) at levels that could cause adverse effects to fish resources.

In 2011 and 2016, JCEP conducted geotechnical investigations at the NRI sites to support the JCEP's DMMP. Analysis of the physical characteristics of sediments at the NRI sites determined that sediment composition consisted of sand, silty sand, sandstone, and siltstone. This is similar to the character of sediments collected from the adjacent FNC and from within the footprint of the proposed LNG Terminal access channel. These sediments were generally described as coarse-grained with high sand content, which the Portland Sediment Evaluation Team (PSET) previously determined suitable for unconfined aquatic disposal. Due to their proximity to previous sampling locations in the FNC and access channel, sediments to be dredged from the NRI areas are expected to have a chemical character similar to the FNC and access channel sites with low likelihood of potential contaminants. Therefore, it is expected they also would be suitable for unconfined aquatic disposal.

Turbidity Effects from Temporary In-water Construction

In-water construction activities are likely to temporarily increase TSS concentrations and turbidity. Such increases would result from in-water construction related to the:

- Temporary Material Barge Berth (TMBB),
- Material Offloading Facility (MOF),
- Pile Dike Rock Apron,
- Trans Pacific Parkway/US-101 Intersection Widening,
- APCO Site access bridge construction,
- replacement of anchoring systems for existing meteorological ocean data collection buoys as well as addition of anchoring systems for two new buoys,
- establishment of hydraulic connections to the Kentuck Project for estuarine habitat mitigation, and
- creation of the Eelgrass Mitigation site.

Turbidity increases would be localized and limited to the time required to complete each of the respective JCEP Project components. Minor, localized increases in suspended sediments (resuspension lasting a few hours to a few days) may continue to occur until all disturbed materials in the construction area have been flushed out. Implementation of erosion and sediment control measures and in-water work conservation measures will greatly reduce the duration and intensity of sediment and turbidity in the waterways (see appendix N). The exposure of listed fish to increased suspended sediment may result in a behavioral response to move to locations with lower concentrations of sediment. If fish failed to avoid increased suspended sediment, such exposure could result in gill irritation or abrasion, which can reduce respiratory efficiency or lead to infection and a reduction in feeding efficiency due to reduced visibility. However, suspended sediment concentrations resulting from in-water construction are unlikely to reach the levels that would cause these results. Increased turbidity may affect OC coho that occur in the immediate vicinity of construction.

Turbidity Effects – LNG Carriers in the Waterway

Propeller wash from LNG carriers and tug boat propellers associated with the Project, as well as ship wakes breaking on shore, could cause increased erosion along the shoreline and re-suspend the eroded material within the water column and displacing bottom organisms due to bottom scour. This may affect the diversity and health of the benthic community regarding food availability and feeding conditions for foraging and migrating fish species (see discussion in section 3.5.1.3, green sturgeon). Waves from vessels breaking on the shoreline can also cause fish stranding (see discussion below). The possible magnitude and effects of the proposed Project including approximately 120 LNG carrier round trips per year on shoreline erosion were approximated by JCEP through model studies, the results of which are discussed below. The possible magnitude and effects of the proposed Project on shoreline erosion were approximated by JCEP through model studies, the results of which are discussed in detail in section 3.5.1.3 and are summarized below. Overall effects on bank and bottom erosion and elevated suspended sediment effects are expected to be unsubstantial.

Models were developed to assess the likely size of waves hitting the shore relative to existing conditions. Additional models assessed likely magnitude of propwash effects on the channel and docking area (see section 3.5.1.3, green sturgeon). The results of the wave model indicated that waves resulting from 120 round trips per year were not greatly different in most areas than natural conditions. The Moffatt & Nichol (2008a) model found that the maximum wave height generated would be about 1.1 feet. Although waves of this size occur throughout much of the bay, they only occur about 2 percent or less of the time annually based on the locations modeled. Among the seven locations chosen by Moffatt & Nichol, the model predicted that the waves generated would equal from 0.0 to 3.1 percent of the annual wave energy at these locations above the current wave energy level. A separate wave model estimate estimated that additional waves generated by the new LNG traffic could increase shoreline sediment transport at the modeled point by 5 to 8 percent over existing conditions (wind-generated waves plus existing large vessel–generated waves). The effect on turbidity relative current conditions would likely be slight and not directly affect coho salmon.

The models addressing propwash effects had similar likely low effects on turbidity. The model by Moffatt & Nichol (2008a) generally found along most of the route no marked bottom disturbance or sediment suspension would occur, as the increased velocity would be similar to maximum tidal currents. Within about the last half- to quarter-mile before reaching the slip (based on the point selected for modeling) is where bottom velocity is increased. Some increased bottom scour and locally elevated turbidity may occur in this area but the effects would be limited in dimension. Disturbance would be limited, partly due to the coarse (mostly sand) bottom substrate that is relatively resistant to resuspension and rapidly settles. A separate model by CHE (2011) found bottom velocity greater than about 4 ft/sec would occur only in an approximate 80-foot-wide band. Therefore, velocity generated by the propeller in excess of tidal flow velocity would be limited to a narrow band in the mid-channel, limiting the area where sediment may be suspended from propeller actions of the LNG vessel. However, this region is generally of coarser sediment that is less prone to suspension. Turbidity would likely be slight due to the coarse characteristics of the navigation channel sediment that is resistant to current-induced suspension. Some increased velocity would occur in the docking area. Sediment analysis suggests that over 95 percent of the bottom material (mostly silt/clay size) in the access channel would be susceptible to suspension at this velocity. The report also estimated that bottom scour would be limited to about two inches over a limited bottom area (approximately 100 by 50 feet) in the access channel. Some bottom disturbance would likely occur during docking but over a very small area.

A more recent vessel wake analysis was recently completed (Moffatt & Nichol 2017d). This study compared two modeling scenarios – “without project” and “with project.” The “with project” scenario included the latest anticipated dredged depths for the federal navigation channel, access channel, and marine slip. This study also incorporated the latest anticipated vessel characteristics for the new facility, which included 240 vessel transits, bulk carriers and tugs. For the “with project” scenario, all LNG carriers were assumed to travel no faster than 5 knots, with tugs traveling up to 10 knots outbound. Results of the 2017 wake analysis are summarized below.

The results of the more recent vessel wake analysis indicates the drawdown generated by LNG carriers’ departure and arrival under the proposed project would be lower than existing conditions (0.4 - 0.5 feet for bulk carriers compared to 0.1-0.2 feet for LNG carriers at the shoreline). The predicted wave heights at the shoreline are higher with the tugs (0.6 – 0.8 feet) than with the bulk carriers under the proposed Project. However, even the magnitude of tug wakes would be at the low end of the locally generated wind-wave heights ranging from about 0.5 to 3 feet (CHE 2011, Moffatt &Nichol 2017e). . The wave effect on the shoreline from increased vessel transits with the JCEP can be managed by reducing vessel speed (Moffatt & Nichol 2017e).

An updated 2017 prop wash memo (Moffatt & Nichol 2017e) included modeling the use of ship engines and tug assist for berthing and unberthing in the marine slip area. Results indicated high propeller wash velocities along the east side of the slip during unberthing. The largest bottom velocities (13.6 feet/sec) were estimated to occur on the eastern side of the Access Channel and the Slip near the MOF. During berthing, the largest bottom velocities (5.4 feet/sec) are expected to be near the western slope within the Slip and the Access Channel.

Scour depths were estimated to be nearly 0.5 feet due to propeller wash in the Access Channel and the Slip near the eastern side of the Access Channel and the Slip if there is no slope protection installed. However, slope protection is planned for each side of the slip, and for the east and west sides of the access channel. These results do not change the earlier conclusion that suspended sediment levels during carrier docking are expected to only have short-term localized effects to Oregon Coast coho that may occur in the docking area.

Overall, models indicated some additional shore sediment movement could occur from the waves generated by the passage of LNG vessels through Coos Bay, particularly the tug vessels, the effects would be small because increased waves would occur infrequently, contribute a very small portion of total annual wave energy and sediment transport, and be within the normal magnitude of waves that naturally occur within the bay. Additionally bottom disturbance would likely occur during LNG vessel transit in the main channel where sediment is coarse and also during docking. In most cases, this disturbance is likely to be much less than estimated because of the conservative assumptions used for this model. Therefore, the total effect of suspended sediment is likely to be within the range of natural annual variability of wave conditions. Elevated suspended sediment levels from transit and docking are consequently expected to be brief and localized, having only short-term local effects to any Oregon Coast coho salmon along the route or in the access channel and marine slip area.

Erosion and Runoff from Coos Bay Upland Facilities

Impacts on marine resources could occur from the clearing of vegetation at the terminal, erosion and sediment runoff, and potential hazardous substance spills during construction. While no streams are present in the upland portion of the terminal, the removal of current vegetation could modify the character and amount of water runoff into the bay.

Nearshore vegetation clearing could indirectly affect aquatic resources in the bay. However, the amount of nearshore vegetation that would be removed for this Project is small. Other than an existing disturbed shoreline near the South Dunes site that would be used as a temporary laydown area, no planned nearshore disturbance would occur outside of the upland and shoreline excavated and dredged to create the marine slip for the terminal.

During construction, uncontrolled increases in sediment runoff to Coos Bay could impact local aquatic resources. JCEP would prevent uncontrolled releases of sediment runoff during construction by implementing erosion control and revegetation measures from its Plan and Procedures. Additionally, accidental spills of hazardous materials (e.g., equipment fuel, oils, and paints) during construction could have effects on aquatic resources in the bay. JCEP prepared a draft site-specific SPCCP to minimize the potential for accidental releases of hazardous materials.

Stormwater Discharge

LNG Terminal

Stormwater discharge has the potential to contain chemicals toxic to coho salmon. However the NPDES permit that the applicant would be obtained requires discharges to not modify state water quality standards of the receiving water (see discussion in section 3.5.1.3, green sturgeon). The proposed oil and grease treatment system is designed to limit discharges of oil and grease. This system design would ultimately need approval from the State to obtain the NPDES permit (see discussion in section 3.5.1.3, green sturgeon).

Trans Pacific Parkway/US-101 Intersection Widening

Stormwater generated as a result of new impervious area at the Trans Pacific Parkway/US-101 Intersection Widening will be collected and conveyed to treatment facilities to provide treatment for 100% of the 2-year storm event. Drainage curbs will be installed near the edge of pavement along the northwest side of the roadway. These drainage curbs will collect and convey flow from the road crown to water quality treatment facilities. The water quality facilities will provide treatment for the design flow volume and bypass higher flows before discharging the runoff into Coos Bay.

APCO Sites

APCO Site 1 (East) will be surfaced with dense-graded gravel and will have existing drainage patterns will be preserved to the maximum extent practical. Stormwater will be treated primarily by vegetated swales and filter strips. Fill placed on APCO Site 2 (West) will be surfaced with native vegetation. Additional storm water controls will be added if necessary. The bridge connecting APCO Site 1 and 2 is in preliminary design. The stormwater run-off from the bridge will be treated prior to discharge to Coos Bay.

PCGP Contractor Yards

PCGP has proposed contractor yards that border Coos Bay at the shore and another that borders Isthmus Slough at the shoreline, all designated critical habitat for coho. Several other proposed yards border or are close (<100 feet) to waterbodies inhabited by Oregon Coast coho. Although the yards are previously disturbed industrial sites, stored materials and surface runoff could enter Oregon Coast critical habitat. Any potential risks due to surface runoff will be mitigated through implementation of an approved stormwater management plan.

Kentuck Project Site

Roadway improvements associated with the Kentuck Project, which include elevating and re-paving of East Bay Drive and Golf Course Lane, will result in the addition of new impervious area. The stormwater facilities at the Kentuck Project site will be designed to provide treatment for 100% of the 2-year storm event wherever feasible.

East Bay Drive will sheet flow stormwater runoff to roadside drainage curbs. Once along the curb, water will flow toward cartridge filters, which will treat water before discharging the runoff onto rip-rap road base adjacent to the receiving waters in Kentuck Inlet.

Along most of Golf Course Lane, surface water ditches and flow-through bio-infiltration conveyance systems are proposed. In these areas, collected flow that does not fully infiltrate into the underlying well-draining soils will be conveyed to an outfall into the Kentuck Slough. At the north end of Golf Course Road, runoff will be collected in drainage curbs and conveyed to cartridge filters before discharging to Kentuck Slough.

Temporary Construction Facilities

Construction laydown areas will be surfaced to a large extent with larger, open-graded aggregate that will allow infiltration; therefore, stormwater from these areas will be self-contained and will infiltrate without the need for outfalls. Impervious surface will not be added at the Pony Village and Myrtlewood Offsite Park & Rides for the JCEP Project Area. Stormwater treatment for temporary facilities is described further in JCEP's Resource Report 2 (Storm Water Management Plan appendix), and the ESCP in an appendix to JCEP's Resource Report 7.

<u>Stranding from Ship Wake</u>

Fish stranding can occur when fish become caught in a vessel's wake and are deposited on shore by the wave generated by the vessel wake. Stranding typically results in mortality unless another wave carries the fish back into the water. Pearson et al. (2006) in a study of fish stranding noted that a series of interlinked factors act together to produce stranding during vessel traffic and may include water surface elevations, with low tides more likely to result in strandings than high tide; beach slope, with strandings more likely on low gradients than high; wake characteristics influenced by vessel size, hull form, depth underwater (draught), and speed with faster speed producing larger wakes; and biological factors, such as numbers of small fish present near the shoreline and whether or not fish are strong swimmers (see discussion in section 3.5.1.3, green sturgeon). All of these factors can vary simultaneously, making it difficult to predict the location and to what degree strandings may occur. A few areas may have the potential to strand fish in Coos Bay. One is the mud flats on the west side of the navigation channel along the Coos Bay and Empire Range that have beach morphology that has been shown to have potential for stranding, especially at low tide. The sizes of juvenile coho in the estuary are expected to be comparable to sizes of juvenile Chinook salmon (less than 9 cm) that became stranded by ship wakes in the Columbia River (Pearson et al. 2006); juvenile coho may be susceptible to stranding by ship wake.

Ship wakes produced by deep-draft vessels traveling at speeds greater than the estimates for LNG vessel speeds along most of the route within the Coos Bay estuary have been observed to cause occasional stranding of juvenile salmon with no observed strandings as a result of vessels traveling at speeds under 9 knots (10.4 mph) (Pearson et al. 2006). The hull geometry of the LNG vessels is such that bow wakes are minimized, especially at the slower speeds of 4 to 6 knots (4.6 to 6.9 mph) that would occur during most of the transit route through Coos Bay. The one exception is near the Coos Bay entrance (first mile), when vessels may be traveling 8 to 10 knots (9.2 to 11.5 mph). While waves generated in this region may be larger than farther in the bay, this is an area likely already receiving larger ocean-generated waves, so the vessel-generated waves would be little different than current conditions in this region.

Therefore, the LNG carriers would be traveling along most of the route at speeds less than that observed (Pearson et al. 2006) to cause stranding. In models and research conducted by JCEP, wave heights produced by LNG vessel traffic would not exceed that of normal conditions in Coos Bay and overall waves would contribute to a small portion of the total waves that occur in the bay. In addition, the LNG carriers would be arriving and leaving at high tide, which is a period when gently sloping beaches are mostly covered and less likely dewatered from waves. Considering that LNG marine traffic (about 120 inbound and 120 outbound trips per year) would enter and leave at high slack tide, have mostly low vessel speeds, and wave height would be in normal range, it appears unlikely that LNG carrier traffic in the waterway would substantially contribute to stranding of Oregon Coast coho within Coos Bay.

Exotic, Invasive Species by LNG Carriers

Invasive species have the potential to modify the food base and induce other ecological modifications in the estuarine area of Coos Bay. NAS are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Within the Coos Bay estuary, over 67 NAS have been identified (ANSTF 2006).

There are no current studies that evaluate the impact of introduced fishes on coho salmon (ODFW 2005). The introduced species, striped bass and shad, presents the highest risk of impact to coho salmon in the Coos Bay estuary (ODFW 2005). However, navigational dredging within Coos Bay has altered salinity levels, which may have impacted striped bass egg and larval survival, reducing numbers and threat of striped bass predation on coho (Moore et al. 2000).

Loaded with water from the surrounding ports and coastal waters throughout the world, ships can carry a diverse assemblage of marine organisms in ballast water that may be foreign and exotic to the ship's port of destination. If water were to be directly transported from port to port, which is not proposed, this transfer could result in aquatic biological invasions. Invasive species threaten to outcompete and exclude native species and the overall health of an ecosystem, causing algal blooms and hypoxic conditions and affecting all trophic levels resulting in a decline in biodiversity.

Potential new invasions of zebra mussel (*Dreissena polymorpha*), Chinese mitten crab (*Eriocheir sinensis*), and hydrilla (*Hydrilla verticillata*) can potentially affect Oregon Coast coho salmon. Other invasive organisms including varied plants, invertebrates, and other fish are also known to be detrimental to native Oregon Coast coho salmon (Stout et al. 2012). For example, Oregon Coast coho smolts during out-migration consume a mudshrimp (*Upogebia pugettensis*), the major food sources in Yaquina Bay (Stout et al. 2012). These intertidal benthic invertebrates have been dramatically affected by the recently introduced isopod parasite (*Orthione griffenis*), likely introduced from Asia in the 1980s (Dumbauld et al. 2011).

EPA developed specific requirements for ballast water treatment under the Vessel General Permit requirement under the CWA NPDES program to reduce the chance of releasing invasive organisms in U.S. waters in 2013 (78[7] Federal Register 121938 [April 12, 2013]). This regulation requires that beginning December 19, 2013, all newly built large vessels would be required to treat ballast water to kill potential invasive organisms, with older vessels of the size that would be used for the Project having some delay in implementation of this requirement (first scheduled dry dock date after January 1, 2016). Prior to implementing treatment of ballast water, the current BWE process is mandatory under the National Ballast Water Management Program all large vessels that would discharge ballast water within 200 miles of the U.S. coast would be required to exchange ballast water outside of this 200-mile area. This was originally established by Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 and further amended by National Invasive Species Act of 1996 and National Aquatic Invasive Species Act of 2003, amended in 2005 and again in 2007 (NEMW 2007).

The required treatment of water would ultimately be an improvement over the requirement to just exchange ballast water to “flush” potential invasive organisms outside of the 200-mile territorial waters of the U.S., which was reported to reduce organisms by 88 to 99 percent (NRC 2011). The new requirement for treatment level is to reduce most organism types to less than 10 living organisms per cubic meter of ballast water. While this requirement may not eliminate all risk of invasive species entering waters, it is a substantial measure that would reduce the risk of project actions introducing invasive organisms into waters of the project area. Several other regulations apply to ballast water management and discharge that would be followed by all LNG vessels; these regulations would also aid in both ensuring reduction of discharge of potentially invasive species and, through vessel inspections, that procedures are followed, as noted in section 3.1.1.3.

All ships utilizing the Port of Coos Bay are subject to the 2012 USCG Final Rule on Ballast Water Discharges. Pursuant to this Final Rule, in order to discharge ballast water into the slip area while concurrently loading LNG cargo, all LNG carriers are required to carry out an exchange of ballast water in waters beyond the EEZ, from an area more than 200 nautical miles from any shore, and in waters more than 2,000 meters deep, or utilize one of several USCG-approved Ballast Water Management (BWM) methods. It is expected that LNG carriers calling at the LNG Terminal will be required to exchange ballast water at sea, more than 200 miles offshore; therefore, the discharge of ballast water will comply with the 2012 Ballast Water

Discharge Standards and the potential impact for ballast water to introduce invasive species of interest in Coos Bay will be negligible.

ODEQ recently revised the Oregon ballast water regulations to make the Oregon regulations more stringent for vessels arriving from “low salinity ports” by requiring ballast exchange in addition to the current Federal ballast water treatment requirements. This applies to vessels that represents a ”high-risk” for the transport and release of aquatic invasive species arriving from “low salinity ports” (like those in Oregon). A “low salinity port” is defined as a port where ballast water salinity is less than or equal to 18 parts per thousand (or when the vessel operator is unable to verify ballast salinity). A “High Risk Voyage” is defined as voyages originating in the “low salinity ports” that represents a “high-risk” for the transport and release of aquatic invasive species arriving from such “low salinity ports.”

The new rules retain ballast water exchange requirements, in addition to meeting federal ballast water treatment requirements, for what is termed as “high-risk voyages,” i.e., those that have taken ballast from low-salinity environments. This is a measure to protect Oregon’s low-salinity ports during a period when the reliability of new “first generation” ballast water technologies are proven to be effective for low salinity ballast.

The ballast water discharged at the terminal would be that from 200 miles out in the open sea. Therefore, it is expected that current and future provisions apply both to the import and export of nuisance species, and by compliance with this Act and other regulations, the LNG carriers would not likely cause exotic nuisance species to be introduced into Coos Bay, U.S. waters, or the ports of destination of the LNG cargos. As a result, adverse effects on Oregon Coast coho salmon are expected to be unsubstantial.

Another potential source of invasive species, other than LNG carrier ballast water, is transfer between waterbodies by construction equipment used in water, or other water transfer actions. USGS (2017) identified two NAS that may occur within the Coos Bay estuary: New Zealand mud snails (*Potamopyrgus antipodarum)* and brackish water snail *(Assiminea parasitologica)*. PCGP would not obtain hydrostatic test water from either Coos Bay or the Coos River, to prevent the spread of NAS from the estuary to inland watersheds. PCGP currently has procedures in the *Hydrostatic Testing Plan* (see appendix U), which includes measures such as inspection and cleaning of all dredge and similar equipment prior to use intended to reduce or eliminate the chance of spreading invasive species.

Entrainment of Coho Salmon from Dredging

After a review of dredging studies done through 1998, Reine et al. (1998) concluded that “much of the available evidence suggests that entrainment is not a significant problem for many species of fish and shellfish in many bodies of water that require periodic dredging.” Dredge entrainment studies over a four-year period in the Columbia River found no juvenile or adult salmonids entrained during dredging, although some other pelagic fish were entrained (Larson and Moehl 1990). Juvenile salmonids also generally remain in shallower depths likely away from the typically deeper bottom dredge areas (Carlson et al. 2001) and dredging would occur when few or no rearing or migrating juvenile coho salmon would be present.

Entrainment and Impingement through Vessel Cooling Water Intake at the LNG Terminal

During operation of the LNG Terminal, vessels at LNG slip may entrain marine organisms including juvenile coho salmon through cooling water intake needed for vessel power plant operations. The quantity of cooling water used depends primarily on size and type of vessel, time at the terminal, and power source used while at the terminal, and amount of recirculation. LNG vessels would re-circulate water while loading LNG at the berth and the amount of cooling water to be re-circulated is a function of the propulsion system for the vessels. The details of the cooling water intake and flow amount are discussed in section 3.5.1.3 but based on assumptions estimated cooling water used for each LNG vessel, depending on vessel type while at the LNG Terminal is between 22 to 69.7 million gallons of cooling water recirculated to the Slip over a 24 to 26-hour loading cycle of LNG cargo.

LNG vessel sea chests are typically 3.5 to 4.2 square meters covered by a screen with 4.5 mm bars, spaced every 25 mm and approximately 15 to 20 feet above the channel bottom. Additional finer mesh screens are located internally on the vessels to prevent larger items from entering the system. These screens would not meet NMFS (1997c) screening criteria for juvenile salmonids. Smaller marine and estuarine fish, juvenile stages of crab and shrimp and other zooplankton, eggs, and larvae fish could also be entrained. Some estuarine organisms, potentially including juvenile salmonids, would be removed from Coos Bay with this process during every loading cycle. It is expected that a high portion of juvenile larval stages of fish and invertebrates entrained or impinged would suffer mortality. Nevertheless, natural mortality of these early life stages is extremely high. The result would be less than 1% of earliest life stages reaching adult size, with natural mortality more than 20 to 30% per day during the earliest growth periods (Comyns pers. comm. 2003). For example, data from an estuarine cooling water intake site determined that intake water larval stage entrainment had very low natural survival (Marine Research Inc. 2004). On a typical LNG carrier, the location of the water intake is near the inner portion of the slip at a depth of about 30 feet, and as a result, it is unlikely there would be an abundance of aquatic organisms in the intake area. Salmonids migrating in Coos Bay would more likely be swimming in the main channel, away from the shoreline and the inset slip, thus reducing their chance of encountering the LNG carrier intakes. Therefore, the off-channel, artificially-created marine slip at the LNG Terminal would probably have a lower presence of fish than the rest of Coos Bay, and the risk of juvenile salmonids becoming impinged or entrained in the LNG carriers' water intakes is expected to be low.

The estimated velocity at the opening of the cooling water intake for a steam propulsion system ranges from 2.2 to 4.4 feet per second (ft/sec) (0.66 to 1.3 meters/second), depending on the intake rate of cooling water used. The estimated velocity at the opening of the cooling water intake for a dual propulsion system is approximately 1.3 ft/sec (0.39 meters/second), depending on the intake rate of cooling water used. NMFS recommends an approach velocity for screening systems for salmonids of less than 60 mm is 0.33 ft/ sec, and 0.8 ft/sec for larger juvenile salmonids (NMFS 1997c). These guidelines also include other requirements such as sweeping velocity and type and size of openings that are not present on these screens. The result is likely to be that fish at least up to fry and possibly larger juvenile size salmonids including coho salmon near the intakes may be entrained or impinged during cooling water intake.

Loss of juvenile coho salmon could reduce adult coho salmon returns. NMFS (2008d) in their assessment of effects of loss of juvenile coastal coho salmon from local airport expansion assumed a 4 percent Coos Bay coho salmon smolts survived to return as adults. Even so, due to the extremely small portion of total water intake relative to the volume of Coos Bay, the relative portion of juvenile salmonids that would suffer direct mortality would be small. In the case of coho salmon, few would be as small as 60mm, as most would be outmigrating as age 1+ likely greater than 120mm. So, many of the juvenile coho salmon would actively be able to avoid being entrained or impinged at the unscreened intake. Also, the slip would be excavated from the current upland, located away from the main channel of Coos Bay, which may, depending on coho salmon distribution, reduce overall chance of coho salmon being in the vicinity of the LNG vessel intakes while at the terminal. This would reduce the chance of juvenile migrating coho salmon in the Coos Bay being in the vicinity of the intake. Actual distribution of juvenile coho salmon within the project area is unknown. However, juvenile salmonid studies in the lower Columbia River observed that juvenile coho salmon were in greater abundance away from shoreline areas often in deep water during their outmigration (Johnson and Sims 1973; Dawley et al. 1986; Ledgerwood et al. 1991). Carlson et al. (2001) found that in the lower Columbia River that less than 20 percent of all fish were found along the shore, with about evenly split between the channel and channel margins.

Based on the Columbia River studies coho salmon migrating to the ocean would likely be more closely associated with the main channels than the nearshore area and the inset slip, reducing their chance of encountering the intakes. While actual Coos Bay distribution is unknown available literature suggest relative abundance near the LNG carrier intake would be relatively low. Considering likely distribution of coho salmon relative to the vessel intake, size of juvenile coho salmon that would allow avoidance, and limited frequency and magnitude of cooling water intake, loss of coho salmon from entrainment would be slight.

Entrainment of Food Organisms

As noted above, entrainment of organisms, including plankton that are a source of food for juvenile coho salmon, would occur from water intake for LNG vessels. Food organisms used by juvenile estuarine coho salmon and other salmonids include a variety of taxa. Many forms of invertebrates including epibenthic and pelagic zooplankton (e.g., harpacticoid copepods, calanoid copepods, amphipods, and mysids), larval stages of other groups, and larval fish are known sources of food used by estuarine rearing stages of coho salmon.

Shanks et al. (2010, 2011) sampled zooplankton and icthyoplankton in Coos Bay near the LNG Terminal. The primary intent of these studies was to help characterize what food sources are present in the region of the water intake and the relative effect entrainment may have on these food sources. The sampling was intended to determine seasonal, tidal, and daily changes in abundance of zooplankton including larval fish, shellfish, potential salmonid prey organisms, and other miscellaneous zooplankton that may occur in the project area. A variety of zooplankton were found to be present within the bay (see table 3.5.4-13). Among the potential salmonid forage items, copepod adults, lavaceans, harpacticoid copepods, and Daphnia had the highest peak abundance. Overall, larval fish abundance was generally low, with those that spawn primarily in or near estuaries common (surf smelt, sand lance, and staghorn sculpins). At times, other larval or juvenile fish were relatively abundant including English sole, buffalo sculpin, anchovy, and pipefish. A total of nine fish species were captured (Shanks et al. 2011). Over 12 taxa of crab and shrimp larvae were also collected, including some recreational and commercially important crab and shrimp species, such as Dungeness crab and ghost shrimp larvae (Shanks et al. 2011).

TABLE 3.5.4-13

Taxa Groups Collected in Coos Bay Near the LNG Terminal during 2009–2011

Categories	Specific Taxa
Fish larvae/juvenile	Surf smelt, sand lance, staghorn sculpin, buffalo sculpin, anchovy, pipefish, English sole, gunnel, pricklefish
Crab/Shrimp larvae	Porcelain crabs, pea crabs, green crab (invasive), xanthid crabs, majid crabs, cancer crabs (e.g., Dungeness, rock crab), Lithodidae, Hippidae, Pagurid (hermit crabs), Callinassa (ghost shrimp), Sergestid shrimp, Pachygrapus crassipes (striped shore crab)
Gastropod and Bivalves larvae	Mytilus (mussels), Clinocardium (cockles), Bivalve juveniles, Gastropod juveniles
Larval Invertebrates	Barnacle nauplii and cyprids, Mytilus larvae, bivalve larvae
Cnidaria/ctenophore	Sea anemone, Hydroids, sea goose berry
Polychaete Worm Larvae	Marine worms
Salmonid Food Prey	Mysids, Amphipods, Isopods, Cumaceans, Copepod adults, Harpacticoid copepods, Calanoid copepods, Daphnia, Larvaceans, larval fish

Source: Shanks et al. 2010, 2011

To make a reasonable estimate of potential loss from cooling water intake, we compared the relative amount of water used while at terminal to the amount of water in the Coos Bay project area. There are several assumptions with this method; the three major ones are: 1) organism distribution would be similar in water used to that in the bay as a whole, 2) all organisms entrained would be lost to the system, and 3) no avoidance to entrainment would occur. In addition, the estimate of entrainment loss was compared to what typical natural mortality loss would be for invertebrate and vertebrate life stages that are common in zooplankton as potential salmonid food sources. This information provides a perspective of how entrainment loss may influence food supply relative to natural conditions. This approach was developed in the Shanks et al. (2010, 2011) documents.

The amount of water that would be used during one LNG vessel loading event, assuming no recirculation, is estimated to range from 82.5 to 263.8 thousand m^3 (22 to 69.7 million gallons) over the course of about 24 to 26 hours while the LNG vessel would be at terminal. The period at the terminal would span approximately two tidal cycles (each tidal cycle takes approximately 12 hours). An approximation of spring high tide water exchange in the Project vicinity over one complete high and low tide cycle is 122.5 million m^3 based on data from the SHN Consulting Engineers and Geologist, Inc., technical memo (see Shanks et al. 2010, 2011). Neap tides (tides that occur when the difference between high and low tide is least) are less; however, these were not directly measured. In their analysis of ballast water intake, Shanks et al. (2010, 2011) estimated the volume passing the Project during lower tidal levels to be 106 million m^3. Assuming tidal values would mostly vary between two ranges the average volume passing the LNG Terminal would be about 2 times 114.25 million m^3. Using the figure of 114.25 million m^3 for water in Coos Bay, it was estimated that from 0.07 to 0.23 percent of the water near the marine slip would be taken in for engine cooling while an LNG vessel is at terminal at the terminal based on average tidal exchange. Theoretically, organisms in this entrained water would be lost to the Coos Bay system and therefore not available as a food source.

The loss of these organisms from entrainment can also be compared to loss from natural mortality in the bay environment. Instantaneous natural mortality rate (per day) can be defined by the function: M = ln (N_0/N_t)/-t, where M is instantaneous mortality rate, and N_0 and N_t are the initial and final abundance of larval after time t (Rumrill 1990). The comparison between entrainment and natural mortality loss of potential larval food organisms was made assuming 100 percent mortality of all organisms entrained during water intake and all mortality occurred during a single day. Additionally, it was assumed that all pelagic zooplankton in the project area during water exchange on an average day (i.e., 114.25 million m^3) suffered one day's natural mortality at the rate determined in the literature.

Rumrill (1990) provides estimates of mortality rates for a variety of marine invertebrate larval and in some cases through juvenile stages. McGurk (1986) supplies similar information for a variety of larval stages of marine fish. These values provide the bases for comparison of potential Project entrainment loss to that from natural mortality. Rumrill (1990) supplied estimates of morality rate using two methods with different data sets. One set is based on the contrast between larval production and subsequent recruitment, and the other is based on the monitoring of larval cohort in the plankton. The lowest and average mortality rates from Rumrill (1990) and McGurk (1986) are shown in table 3.5.4-14 for invertebrates and fish larvae. Invertebrate 1 and 2 in this table refer to the two respective rate groups from Rumrill (1990). Average and lowest mortality rates data for larval invertebrates and larval fish from these two sources were similar. Average loss of organisms from entrainment during one LNG vessel loading cycle would range from 0.4 to 0.7 percent of what would occur from natural morality in one day. For the lowest literature mortality rate of larval taxa among those reported, daily entrainment loss would be much higher ranging from 0.7 to 1.8 percent depending on what water volume was used during one vessel loading cycle and which taxa group data are used. These values are conservative estimates when compared to natural mortality that would occur in the Coos Bay system overall because entrainment would not occur daily whereas natural mortality would.

Because about 120 round LNG carrier trips a year would occur, LNG loading and water intake use would occur on average every three days. Therefore, relative fish food organism loss from entrainment annually would be considerably less than that estimated. Overall reduction in food sources for marine predators from entrainment of planktonic organisms appears to be slight, considering various factors. On average, water intake would be less than 0.23 percent of the water passing the project on a daily tidal cycle, so relatively few organisms would be subject to entrainment assuming similar planktonic organism distribution at the intake. Typical "loss" on average would be about 0.7 percent or less of loss from natural mortality of invertebrate and fish larvae during the day of LNG cargo loading. Considering that LNG carriers would only be at the site and take on cargo every three days, the relative loss would be even less than this estimate. Overall, the loss of marine fish and their prey resources that may be utilized by coho salmon from entrainment, relative to numbers in Coos Bay, would be small and have unsubstantial effects on supply of coho salmon food resources.

TABLE 3.5.4-14

Comparison of Relative Loss of Larval Invertebrates and Larval Fish from Entrainment to Natural Mortality during Water Intake (Cooling) during One LNG Vessel Loading Event in Coos Bay, Oregon

Mortality Category in Literature Source	Taxa Group b/	Natural Mortality Rate M (daily)(M=ln(S)/-t) c/	Estimated Percent Loss from Entrainment Relative to Daily Loss from Natural Mortality a/	
			Low Intake	High Intake

Lowest	Larval Invertebrate 1	0.0305	2.5%	7.4%
Lowest	Larval Invertebrate 2	0.0161	3.6%	14.9%
Lowest	Larval Fish	0.0200	3.6%	11.6%
Average	Larval Invertebrate 1	0.1450	0.7%	1.7%
Average	Larval Invertebrate 2	0.2470	0.4%	0.8%
Average	Larval Fish	0.1969	0.4%	1.7%

a/ Values based on average daily Coos Bay tidal water exchange rate of 114,250,000 m^3, and one LNG vessel water intake of 82,500 m^3 (low) and 263,800 m^3 (high). Assumes 100% mortality of entrained organisms.
b/ Sources: Invertebrates from Rumrill (1990), and fish from McGurk (1986).
c/ S= Survival, t=days, ln=natural log base e

Temperature Effects in the Marine Slip from LNG Vessels at LNG Terminal

As previously discussed above for green sturgeon (section 3.5.1.3), the release of engine cooling water from LNG carriers at the terminal would result in warming the nearby water in the slip. Results of the modeling showed that for typical ambient flow conditions at a distance of 50 feet from the discharge point (LNG carrier sea chest), temperatures from dual fuel diesel electric LNG carriers would not exceed 0.3°C (0.54°F) above the ambient temperature. This difference would decrease with further distance. Based on estimated slip volume this total heat could result in an average water increase for the total slip volume during one day when the vessel is loading would range from 0.03 to 0.06°F. Additionally, no temperature effects would extend beyond the slip due to the much larger water volume of Coos Bay.

However, the slight increase in water temperature in the slip due to the release of engine cooling water while the vessel is at terminal would be ameliorated by cooling of the slip water during cargo load, due to the fact that LNG is at a temperature of -260°F. There would be a heat exchange between the cold hull of the vessel and the surrounding slip water, as discussed for green sturgeon above.

The results of the 2011 modeling described above were supplemented in 2017 with additional thermal plume modeling to investigate the extent of the regulatory mixing zone (RMZ) where cooling water discharge will be greater than 0.3 degrees Celsius above ambient (Moffatt & Nichol 2017g). The RMZ used in the temperature plume modeling is defined as the three-dimensional extent where water quality standards may be exceeded as long as acutely toxic conditions are prevented and fish habitat and other uses are protected. This modeling analyzed LNG carriers with capacity of 148,000 m^3 and 170,000 m^3. It also modeled cooling water discharges of 10 degrees to nearly 21 degrees Celsius into various ambient temperatures ranging from 8 degrees to 18 degrees Celsius and under constant and stratified salinity conditions. In summary, this latest modeling showed that the largest RMZ was associated with steam-driven carriers and extended up to 79.2 feet and 22.1 feet in longitudinal and transverse directions respectively, with a vertical rise of 12.1 feet under peak summer temperature conditions. Dual fuel diesel-electric driven carriers had a substantially smaller RMZ that extended up to 36.5 feet and less than 7 feet in longitudinal and transverse directions, respectively, with a vertical rise of up to 1.3 feet. In the future, LNG vessels will trend more to dual fuel diesel electric propulsion systems thereby reducing the total cooling water intake per vessel call (Moffatt & Nichol 2017g). It is unlikely that the water temperature of the slip would be greatly increased from the release of engine cooling water, therefore, no significant adverse impacts on aquatic species in the bay are anticipated.

Fish and invertebrates are adapted to function over the normal range of conditions encountered in their environment. Moderate to large temperature increases have the potential to reduce fish and invertebrate growth, reproductive success, and if high enough cause direct mortality. Fish of the north Pacific, including those found in Coos Bay, are adapted to cool water conditions and could be adversely affected by sharp large increases in water temperature. Temperatures over about 24 to 26°C (75.2 to 78.8°F) would be considered lethal in the short-term (a few days) for salmonids (WDOE 2002). The temperature of the water in Coos Bay undergoes both seasonal and diurnal fluctuations. In December and March, the ocean and fresh water entering the estuary had similar temperatures, around 50°F (10°C). In summer, low stream flows results in a rise of temperatures in the bay, to above 60°F (15.6°C) in September at CM 8 (Roye 1979).

It is expected that water temperature in the terminal slip influenced by engine water releases from an LNG carrier at the terminal is not likely to cause adverse impacts to coho salmon. First, engine cooling water released into the slip would only slightly increase water temperature for a limited distance away from the vessel. Second, the slight increase in water temperatures from engine cooling water releases would be offset by cooling from contact with the hull of a vessel loading LNG. Third, the volume of water in the slip and exchanges during tidal cycles would further minimize temperature variations.

Effects of Operational Lighting

Localized changes in light regime have been shown to affect fish species behavior in a variety of ways (Simenstad et al. 1999; Valdimarsson et al. 1997; Tabor et al. 2004, Nightingale and Simenstad 2001). Disorientation may cause delays in migration, while avoidance responses may cause diversion of migratory routes into deeper, less protected waters. In some cases, increased light may attract both predators and potential prey species (Simenstad et al. 1999; Valdimarsson et al. 1997; Tabor et al. 2004). Juvenile coho salmon show no response to moderately high light intensity, but become inactive in very low light (Hoar et al. 1957). Depending on their reaction, fish may have migration delayed, be moved into less protected deepwater habitat, or they may become more susceptible to predation, as light increases predators' ability to see fish and also may be attracted to the area.

Nighttime construction is likely to occur in the estuarine analysis area for in-water work activities such as dredging or placing revetment, as well as on-water activities such as receiving deliveries at the TMBB or MOF. Construction lighting will be designed, installed, and operated at a level that allows construction work to be completed safely and effectively while minimizing glare to surrounding areas. Construction lighting will be directed only to the surface waters of Coos Bay when necessary, in order to minimize impacts to aquatic organisms. Lighting for in-water work will be limited to the area around each vessel and the area of the in-water work. For example, during dredging, the area under the crane boom for clamshell dredging or derrick arm for cutter suction dredging will be lit. Lighting is anticipated to be a mix of fluorescent and sodium fixtures around the vessels (dredge, barges, tugs, and support vessels) with larger sodium or halogen lights shining on the work area (i.e., the water) under the crane boom or derrick of the suction dredge. Lighting for on-water work, such as barge or ship unloading, will be limited to the vessels and adjacent landing areas. Final marine construction lighting requirements will be subject to review and approval by the USCG as part of the Construction Security Plan.

Lighting at the LNG Terminal would likely include a mixture of low-power fluorescent lighting and higher intensity security lighting that would primarily be located on shore, in and adjacent to the slip. When an LNG vessel is not in the berth, the lighting would be reduced to that required for security. It would be focused upon the structures and not be in proximity to the water so as to serve as an attractant or deterrent to fish species. No high intensity lighting would be present near the water except possibly during vessel docking. When an LNG vessel is at the berth, it would physically block the lighting on the berth from the slip waters and, due to its proximity to the slip wall, would block the fish from getting too close to the lighting on the berth.

Lighting on the tug dock would be low intensity lighting for safety, providing sufficient light for personnel movements on the trestle out to the tug berth and for movement on the berth itself. There is no intention to provide lighting near the water line or high intensity lighting that would be associated with activities other than the simple berthing of the tugs at this location. The reduced lighting levels near the water would reduce or eliminate any behavioral effects to fish in the Project vicinity. The final details of the lighting arrangement would be determined through consultation with resource agencies including NMFS and ODFW to reduce potential adverse effects. Considering the limited distribution of the affected area, mitigation measures in place to reduce the light intensity, ample deep water adjacent to the affected area where fish could avoid lights at the LNG slip, and that final plans would be in place to further minimize light on water areas, adverse effects to Oregon Coast ESU coho salmon are not anticipated.

Acoustic Effects from Construction and Operation

Underwater noise may affect coho salmon. Noise from construction of the LNG Terminal and related effects on aquatic species in Coos Bay were previously discussed for green sturgeon. During construction and operation, noise would be generated by:

- excavation and dredging of the slip and access channel,
- installation of the open cell sheet pile bulkhead at the LNG berth,
- installation of the piles to support the LNG berth and tugboat dock,
- installation of land-based mooring bollard piles at the MOF face,
- installation of temporary mooring piles at the TMBB,
- installation of temporary dredge transport pipelines to the APCO Site, Kentuck Project, and Eelgrass Mitigation Site,
- installation of temporary mooring piles for booster pump and off loader barges used for Navigation Reliability Improvement dredging, APCO temporary work bridge piles, MOF fender piles,
- LNG vessel transit in Coos Bay, and
- general operations at the terminal.

These activities would generate underwater sounds pressure levels that could elicit some behavioral responses in aquatic organisms including fish.

The Fisheries Hydroacoustic Working Group (2008), a group including the FWS, NMFS, and the states of Washington, Oregon and California, has established recommended interim criteria for protecting fish from noise generated by pile driving of a peak level of 206 dB and cumulative level of 187 dB (fish greater than two grams) and 183 dB (fish less than two grams).

Construction air noise levels for the LNG Terminal are expected to be similar to typical commercial structure construction programs, which average from 47 to 57 dBA at 2,000 feet in the air (H&K 1994). Noise levels 50 feet air distance from typical construction equipment (not including pile driving, or sheet wall installation) to be used at the site would typically range from about 70 to 90 dB (see table 3.3.2-1 in section 3.3.2, Western Snowy Plover). Typical noise generated from operation would be less. Considering that noise levels would be attenuated from this equipment into water, based on the interim NMFS criteria, levels of noise that could cause direct adverse effects to fish would be unlikely from typical equipment and future operations.

Underwater noise may also be generated by driving sheet piles on land (dry piles) since some noise propagates through ground and sediments (especially through harder substrates such as rock and clay), and may transfer to the water column somewhere else (known as sound flanking). Sound in the water column would be at a lower level than at the source (WSDOT 2011a) because most sound energy does not travel through water but rather through the sediment. The potential effects of pile driving on land and in the water are discussed in detail in the green sturgeon section.

To summarize, injury to fish from peak sound pressure levels (206 dB in current guidelines) would occur up to 37 meters from the face of the MOF. Also, this study predicted that injury to both small (less than 2 grams) and large (greater than or equal to 2 grams) fish from cumulative sound exposure levels (183 and 187 dB respectively under current guidelines) would occur up to 1,723 meters from the shoreline. This distance was the same for both 10,000 and 20,000 total impact strikes because, in both cases, this was the distance when the noise attenuated to the sound level considered effectively quiet (150 dB). Under proposed guidelines (Popper et al. 2014), modeled distances to injury were considerably less, although the distance to temporary threshold shift (TTS) was the same – 1,723 meters. Based on the results of Wladichuk et al. 2018, installation of land-based piles at the MOF face would increase potential exposure of individual coho to underwater noise in an area encompassing the navigation channel from the MOF across the bay to the airport and southwest to the vicinity of Southport Lumber yard (Figure 3.5.1-2). These noise thresholds could be reached during pile driving of the 8 mooring bollards at the MOF that would take approximately 14 days to install. Individual fish occurring in this area during pile driving could experience physiological effects sufficient to cause injury.

Land-based pile driving at the MOF shown to generate injury-level in-water noise would be limited to the approved in-water work window, which is October 1 through February 15. This window would minimize risk of physical injury or disturbance to individual Oregon Coast coho that may occur in the Project vicinity during construction.

In addition to the large number of piles that would be driven on land, a smaller number of piles would be driven in the water column at various locations (e.g., TMMB, APCO site, etc.) that could create temporary noise levels sufficient to cause physical injury within approximately 300 feet of pile driving activities. These distances assume no sound attenuation (e.g., bubble curtain, cushion blocks, etc.). In-water pile driving would be limited to the approved in-water work window for the Project, which is October 1 through February 15. This window will minimize potential interaction with Oregon Coast coho juvenile rearing and outmigration through the estuary.

For vessel traffic and dredging activities, the intensity of the sound pressure levels can vary considerably. However, sound pressure levels are generally in the range of 112 to 160 dB, intensities that may influence organism behaviors or perceptions but are not great enough to cause physiological damage (Richardson 1995; Hastings and Popper 2005; Fisheries Hydroacoustic Working Group 2008).

It is expected that LNG carrier noise in Coos Bay would be less than in the marine analysis area as vessel speed would be greatly reduced, which affects the magnitude of sound levels. In the Hatch et al. (2008) study, an LNG carrier during travel produced sound levels (with one standard error) of 182 ± 2 dB re: 1 µPa at 1 meter that attenuated to 160 dB at 35 ± 11 meters and to 120 dB at 16,185 ± 5,359. Other than possibly values within one meter (3.3 feet) of the vessel hull, these are all values less than the current interim noise levels for fish noted above. Some dredging activities may generate noise levels that may be harmful to very small fish close to the activity. Fischer (2004) noted dredging source dB levels of 172 and 185 at one meter (3.3 feet) from the dredge. The upper range of these values exceeds the interim noise criteria for small fish (those less than two grams). Small fish very near the dredging (within about a meter) may be harmed if they remained in the area for a period of time. Initial slip dredging will involve some sediment removal from shallow water. Since dredging would occur during a period of low fish abundance, with few rearing juvenile coho present, it is expected coho salmon would rarely if ever be in a zone considered directly hazardous from noise levels.

Generally, response to noise impacts would be behavioral and perceptual, and not physiological in nature, as fish would tend to avoid the area during periods of high noise output. Underwater noise generated during on land construction and operation, ship noises from LNG carriers within the estuarine analysis area, and dredging in Coos Bay are all not expected to adversely affect coho salmon. It is expected that construction and operations noise would not have substantial adverse effects on aquatic resources including Oregon Coast coho salmon.

Habitat Effects – Slip and Access Channel

The construction of the LNG Terminal marine slip and access channel would impact local aquatic resources by removal or conversion of some habitats. About 36.7 acres of current upland habitat would be converted to open water, primarily deep subtidal habitat, during construction of the marine slip. Development of the LNG Terminal access channel and MOF would affect about 39.8 acres of estuarine habitat. About 14.76 acres of intertidal to shallow subtidal habitat, including 1.9 acres of eelgrass habitat and 0.06 acre of salt marsh, would be permanently modified to primarily deep subtidal habitat during the dredging process of the deepened channel.

Eelgrass habitat supplies a diverse habitat for fish (Murphy et al. 2000) and is thought to supply salmon fry with food and cover from predators (Simenstad 1987 and 1994). Generally, increases in eelgrass are considered to result in increases in juvenile salmon, including coho salmon (Plummer et al. 2012). Eelgrass is an important ecological component in Coos Bay affecting many species. For example, submerged aquatic grasses are important habitat for small prey species of adult lingcod (in Appendix B-2 of PFMC 2008). Submerged grass meadows provide cover and food for a large number of organisms including burrowing, bottom-dwelling invertebrates; diatoms and algae; herring that deposit eggs clusters on leaves; tiny crustaceans and fish that hide and feed among the blades; and, larger fish, crabs and wading birds that forage in the meadows at various tides. Eelgrass provides shelter for a variety of fish and may lower predation, allowing more opportunity for foraging. The protective structure attribute of eelgrass is primarily for smaller organisms and juvenile life history stages of fishes. Previous studies (Akins and Jefferson 1973) have reported that Coos Bay has 1,400 acres of lower intertidal and shallow subtidal flats covered by eelgrass meadows.

The dredging operation would change physical conditions of the bottom, locally altering the bathymetry and potentially altering the morphology and water currents. Benthic and epibenthic invertebrates that presently inhabit shallow intertidal and subtidal regions within the boundaries of the access channel would be removed with the dredged material. Ghost shrimp and sand shrimp (adults, juveniles and larvae), amphipods, clams, Dungeness crab, and various fish species are important prey for Oregon Coast coho. Therefore, the loss of invertebrates and vertebrates at the access channel would result in a reduction in fish food available to coho salmon in those areas affected by the Project in the short-term. However, the resulting deeper, less diverse habitat would likely be less productive for benthic food sources, and juvenile coho salmon are less likely to forage on benthic resources at these deeper depths.

As noted above the CHE (2011) modeling indicated during LNG transit, bottom disturbance from high bottom velocities would occur. This could result in some benthic organisms (potential coho salmon prey) being disrupted and some sediment would be moved during arrival and departure. Mobile organisms (e.g. crabs, shrimp) would be able to return to the region, while some benthic organisms may be permanently displaced. Turbidity would likely be slight due to the coarse characteristics of the navigation channel sediment that is resistant to current induced suspension. Overall, some loss of benthic organisms may occur from LNG vessel propeller wash during each transport trip near the slip approach, but the magnitude would be small and likely less than currently occurs under each existing large vessel trip.

The CHE (2011) report also modeled velocities and likely effects on sediment scour at the docking facility from the tugboat pushing of vessels to the terminal. Assuming very high power use by the tug to dock the LNG vessel, the model estimated maximum velocity on the far bank (about 275 feet from the propeller) would be mostly less than 2.0 ft/sec, which would be unlikely to erode the bank. Furthermore, this area would be armored so no erosion would occur. Near the bottom, maximum velocity in the docking channel would be about 2.16 ft/sec. Sediment analysis suggests that over 95 percent of the bottom material (mostly silt/clay size) in the docking channel would be susceptible to suspension at this velocity. The report also estimated that bottom scour would be limited to about two inches over a limited bottom area (approximately 100 by 50 feet) in the docking channel. Some bottom disturbance would likely occur during docking. In most cases, this disturbance is likely to be much less than estimated because of the conservative assumptions used for this model.

Overall while some sessile benthic and fewer mobile organisms may be displaced during boat transit in the main channel and landing within the docking channel, the limited occurrence and magnitude of bottom disturbance and sediment suspension would result in unsubstantial area organism effects and therefore no marked reduction in potential food sources for Oregon Coast coho.

As noted above, benthic communities in Coos Bay inhabiting mud substrates recovered to pre-dredging conditions in four weeks following typical channel dredging (McCauley et al. 1977). However, recovery in estuarine channel mud has been reported to be typically six to eight months (Newell et al. 1998). In the lower Columbia River, McCabe et al. (1997, 1998) noted benthic organism recovery in three months. Complete recovery may take longer than four weeks but would likely still be short-term. Since most juvenile coho are not present in Coos Bay until the spring outmigration period, and dredging would occur in fall to winter, many benthic food organism would be recovered in the dredged area prior to their arrival, limiting effects of organism loss to coho salmon. However, because of the large quantity being dredged and increased depth, it may take a longer period relative to typical dredging. This likely would result in short-term adverse effects to the benthic community and potential food resources for Oregon Coast coho salmon. Potential long-term effects of habitat modification would be offset by replacement of shallow water habitat, including eelgrass beds, in other portions of the Coos Bay (see section 3.5.4.4, Conservation Measures).

Shading Effects

Shading from over-water structures reduces the amount of light available to phytoplankton and aquatic macrophytes. However, the area where shading LNG Terminal facilities would occur is intended for industrial uses and not the creation of new habitat. The general habitat in the slip's region would not be conducive for many marine resources because of depth and steep rip/raped armored banks, so relatively few resources would likely utilize this newly created area. The water areas within the slip are being created from upland areas and therefore shading of currently un-shaded habitat would occur, and no net loss in productivity due to shading would occur. Project components that potentially could shade the new open water created by the construction of the slip include:

- The tug dock would be built over an open water portion of the newly developed slip and it would generally be about 470 feet long by 18 feet wide. In addition, there would be 360 feet of 8-foot-wide floats for mooring and accessing the security vessels.
- The tug dock would be connected from shore by a pile-founded trestle.

Most fish, including coho salmon, have developed countershading as an adaptation to avoid predation (Moyle and Cech 2000) from above (dark dorsal surface blends with bottom substrate) and from below (light ventral surface blends with light from the surface). Fish within a shaded area would be more easily detected by a predator, especially from below because light colored ventral surfaces would stand out against a shaded water surface. Predation potential, based on some observed fish behavior, is a concern (Nightingale and Simenstad 2001). However actual increased occurrence in predator numbers from even substantial overwater structures has rarely been documented. Additionally review of many marina and pier studies have not documented actual increased predation at these facilities (Nightingale and Simenstad 2001). For example, marine marina studies have found no documentation of increased concentrations of juvenile salmonid predators and some predators such as birds may be of lower abundance than under natural shoreline conditions (Cardwell et al. 1980, and Heiser and Finn 1970, as cited in NMFS 2005c). The extent to which any of these predators affect juvenile or adult coho salmon in shaded areas created by the proposed action is unknown, however, the probability of this occurring is low since it shades less than one percent of the slip surface area and the dock is located at the north side of the slip.

Kentuck and Eelgrass Mitigation Sites

There would be short-term localized impacts to aquatic resources to construct the Kentuck Project and Eelgrass Mitigation. Kentuck Project construction activities would include transporting dredge material into the site and earthwork and civil infrastructure improvements to re-establish a connection with Kentuck Inlet and Coos Bay. Dredge material is currently proposed to be unloaded and hydraulically transported into the site through a Temporary Dredge Transfer Line from a Temporary Dredge Off-Loading Area located as close as possible to the site in a minimum 20 feet of water depth. The Off-Loading Area could include a hydraulic unloader on a deck barge, mooring/fleeting barges, and booster pump(s). The number of temporary piles and/or spuds required to moor barges would vary depending on actual equipment and configuration. Intake water for offloading operations may be drawn through self-cleaning fish screens sized to minimize fish entrapment. Infrastructure improvements would include: constructing a new bridge in East Bay Drive to allow tidal exchange between Kentuck Inlet and the Kentuck Project; improving the existing dike separating the site from Kentuck Slough; constructing a new muted tidal regulator (i.e., a "fish-friendly" tide gate) in the upper portion of the Kentuck Project to redirect a portion of Kentuck Slough flows into the Kentuck Project; and raising the profile of East Bay Drive and approximately 1,900 lineal feet of Golf Course Lane to be above the zone of tidal influence. A fish-friendly culvert or other structure would be constructed within Golf Course Lane to allow passage into the drainage above the former golf course irrigation sump pond. The earthwork and the majority of the infrastructure construction activities would be isolated from Kentuck Slough, Kentuck Inlet, and Coos Bay. Construction of the East Bay Drive bridge and muted tidal regulator would require in-water work and isolation measures. The new bridge and tide gate would be designed to meet ODFW and NMFS fish passage requirements. JCEP would continue to work with both agencies, as the designs progress, to address fish passage without impacting the current influx of salt water on adjacent properties. There would be a short-term increase in turbidity into Kentuck Inlet and Coos Bay when the connection is reestablished to the bay and while the site equilibrates (see section 3.1.4.3, Sedimentation and Turbidity Levels).

As part of the Eelgrass Mitigation, a shallow-water hydraulic dredge is proposed to be used to lower areas that are currently too shallow to support eelgrass. A Temporary Dredge Line would connect the dredge and Temporary Loading Area, which would be located as close to the site as possible in a minimum 20-foot water depth. The Loading Area is proposed to include deck barge, transport barges/scows and tug boats. As noted above, the number of temporary mooring pile and/or spuds would depend on equipment and configuration. Construction would occur during the ODFW in-water work window. Construction of the mitigation site would likely result in direct mortality of marine organisms and would temporarily elevate turbidity levels from dredging, as discussed in section 3.1.4.1, Direct Mortality of Marine Organisms, and section 3.1.4.3, Sedimentation and Turbidity Levels. The resulting habitat increase from the Eelgrass Mitigation site would provide benefits to the fish and marine organisms that utilize this habitat overall by increasing the natural cover and forage production in Coos Bay. It is likely that the increased habitat would offset the losses from the LNG Terminal site.

Suspended Sediment – HDD across Coos Bay Estuary and Coos River

Coos Bay would be crossed by two HDDs, one from MP 0.28 to MP 1.00 (West HDD), the other from MP 1.46 to MP 3.02 (East HDD). The Coos River (a tributary to the estuary) would also be crossed using HDD at MP 11.13. At that location, the Coos River is under tidal influence and is addressed here in the estuarine analysis area rather than in the riverine analysis area. An HDD involves drilling a pilot hole, then enlarging that hole through successive reaming. High pressure drilling fluids, usually consisting of a slurry made of bentonite clay mixed with water, would be jetted at the drill head to advance the hole. Pipe sections long enough to span the entire crossing would be staged and welded along the construction work area on the opposite side of the waterbody, hydrostatically tested, and then pulled through the drilled hole. The right-of-way between the entry and exit hole of an HDD would generally not need to be cleared or graded, except for the area of the guide wires. Additionally, direct impacts on the waterbody, adjacent riparian vegetation, and associated aquatic resources would be avoided through an HDD. An HDD should not result in an increase of suspended sediments into the stream crossed, unless there is an "inadvertent return" or release of drilling mud, as discussed below.

The horizontal crossing length of the West HDD would span 5,192 feet, extending from the North Spit to the southeast, crossing the Coos Bay navigation channel and terminating at North Point in North Bend, Oregon. The HDD profile would pass approximately 158 feet below the railroad trestle bridge and approximately 138 feet below the deepest part of the navigation channel. The depth and the locations of the railroad trestle foundations are unknown at this time (GeoEngineers 2017a). The feasibility analysis for the West HDD anticipates a relatively low risk of hydraulic fracture and drilling fluid surface releases occurring along most of the HDD alignment during construction. However, there would be a high risk of hydraulic fracture and drilling fluid surface release within about 150 feet of either end of the HDD due to the anticipated loose sand and decreased depth of cover. Installation of an oversized casing may be needed at both ends of the HDD path to assist in efficiently transferring axial loads to the drill bit, and to mitigate against hydraulic fracture and drilling fluid surface releases within the loose sand anticipated in the upper 30 feet (GeoEngineers 2017a).

The horizontal crossing length of the East HDD would span 8,972 feet extending from North Point in North Bend, Oregon eastward across Coos Bay and ending at the mouth of Kentuck Slough. Surface conditions at North Point at the west end of the HDD consists of a relatively flat ground surface covered with fill stockpiles. The east end of the HDD is located within a flat grass vegetated area in Kentuck Slough Valley. The proposed depth of the pipeline would be 210 feet below ground surface.

For this HDD design, GeoEngineers (2017a) anticipates that it would be completed using pilot hole intersect methods, due to the substantial length. Because this crossing would be completed using pilot hole intersect methods, both ends are identified as entry points. For this design, the carrier pipe would be strung and fabricated along the Kentuck Slough valley floor on the east end of the crossing. The proposed carrier pipe stringing area would be located northeast of the east entry point along the Kentuck Slough valley floor. Kentuck Slough and Kentuck Way limit the available pipe string length to 5,293 feet so a tie-in weld will be required during pullback operations. The orientation of the HDD alignment would require two horizontal curves in the pull section, making fabricating and handling the pipe more difficult.

Drilling fluid containment would be achieved via relatively small fluid containment pits excavated adjacent to the entry points of the drill. These pits typically measure approximately 6 to 10 feet square and 4 to 6 feet deep. During drilling operations, drilling fluid returns and cuttings from downhole flow into the pits where the fluid is then pumped to a recycling system where most of the cuttings are removed and the drilling fluid can be recirculated downhole (GeoEngineers 2017a).

Because of the length of the HDD, there would be an increased risk of drilling fluid surface release during reaming operations. This risk can be reduced by reaming the hole from both ends of the crossing. This methodology helps reduce downhole annular drilling fluid pressures by shortening the flow path of the drilling fluid through the hole. Although this increased risk does not necessarily affect the technical feasibility of the proposed HDD, reaming from both sides of the crossing could potentially have cost impacts that may require consideration. In general, GeoEngineers (2017a) expects the risk of drill hole instability along the HDD drill paths to be relatively low. Minor hole instabilities may be encountered within the very loose to loose soils expected along the upper portions of the HDD profile at the east end near Kentuck Slough, but that condition would not jeopardize the successful installation of the product pipe. If hole instabilities are anticipated within the shallow portions of the drill profiles, large-diameter casing can be installed through the tangent sections of the drill profiles to stabilize those areas.

According to GeoEngineers' design (2017b) for construction using HDD across the Coos River (see appendix E), the design length of the Coos River HDD crossing would be approximately 1,602 feet. The proposed entry point would be located approximately 500 feet from the north bank of the Coos River and the exit point would be approximately 630 feet from the south bank. The entry and exit points would allow for adequate depth beneath the Coos River. The preliminary design would provide a minimum of 50.3 feet of cover below the Coos River. GeoEngineers' evaluation determined that the construction of the Coos River HDD crossing is likely feasible. GeoEngineers opined that there is a relatively high risk of hydraulic fracture and drilling fluid surface releases on upland sites along the first 500 feet and last 300 feet of the HDD, respectively. However, the risk of drilling fluid surface release to the Coos River would be relatively low. As is typical with all HDDs, the risk of drilling fluid surface release becomes high within approximately 150 feet of the exit. Drilling fluid surface releases may occur within these high risk zones even if the contractor maintains drilling fluid returns during construction and also maintains drilling fluid properties that are conducive to cuttings removal and formation of a "wall cake" to help stabilize the borehole and limit fluid interaction between the borehole and surrounding soils (GeoEngineers 2017b).

Inadvertent Release of Drilling Muds (Inadvertent Return)

The HDD installation method is considered an effective technique for avoiding in-stream impacts by eliminating the need for in-stream excavation (Reid and Anderson 1998; Reid et al. 2004). Even with this technique, there is a potential for impact as a result of the HDD process. Drilling requires use of a drilling mud for lubrication of the bit and removal of cuttings. A non-toxic, biodegradable bentonite clay mixture makes up drilling mud. Because the drilling mud is under pressure during drilling, if the bit encounters substrate fractures or channels, it is possible for bentonite to escape from the hole (termed an "inadvertent return"). Bentonite can escape to the surface through fractures in the drilled substrate.

While bentonite by itself is generally considered a non-toxic drilling mud (Breteler et al. 1985; Hartman and Martin 1984; Sprague and Logan 1979), Reid and Anderson (1998) indicate the toxicity of bentonite (sodium montmorillonite) in fresh water ranges from 5,000 to 19,000 ppm (mg/liter) based on 96-hour tests for LC50 (the concentration at which 50 percent of the test population dies after 95 hours of exposure) on rainbow trout. The toxicity classifications based on LC50 values ranged from "slightly toxic" (5,000 ppm) to "practically non-toxic" (19,000 ppm) (Reid and Anderson 1998). In other tests, toxicities to lake whitefish and rainbow trout demonstrated threshold concentrations of 16,613 and 49,838 ppm (mg/l), respectively (Reid and Anderson 1998). More recently, toxicity to rainbow trout (LC50, 96-hour) was reported to be 19,000 mg/l (ClearTech 2015). LCD50 concentrations >10,000 ppm would be considered "practically non-toxic". In marine water, a 96-hour LC50 bioassay for toxicity of bentonite on a mysid shrimp (*Mysidopsis bahia*) was >1,000,000 ppm (Reid and Anderson 1998).

Bentonite, as with any fine particulate material, can interfere with oxygen exchange by the gills of aquatic organisms (EPA 1986). The degree of interference generally increases with water temperature (Horkel and Pearson 1976). Impacts would be localized and would normally be limited to individual fish in the immediate vicinity of the inadvertent return. The majority of highly mobile aquatic organisms, such as fish, would be able to avoid or move away from turbidity spots and plumes (Reid and Anderson 1999). Short-term pulses of suspended sediments (sharp increases within an hour) disrupt the feeding behavior and dominance hierarchies of juvenile coho salmon and elicit alarm reactions that may cause fish to relocate downstream to undisturbed areas (Wilber and Clarke 2001; Berg and Northcote 1985). Other less mobile or immobile organisms, such as clams, mussels and other macroinvertebrates, would incur direct mortality (Wilber and Clarke 2001). Bentonite can smother macroinvertebrates and adversely affect filter-feeders (Falk and Lawrence 1973, Hair et al. 2002, and Land 1974 in Cameron et al. 2002). Bentonite can also exacerbate or enhance the effects of toxic compounds to fish and aquatic invertebrates if those compounds are present in aquatic habitats (Hartman and Martin 1984). Similar to other fine-grained particulates, bentonite in flowing water is more likely to remain in suspension longer than in standing water. Consequently, effects to coho salmon by a release of bentonite into a waterbody would ultimately depend on volume of the release, volume of water present, and current.

Dispersion of drilling fluids from a release site (inadvertent return) is a function of the energy, salinity, and sediment transportation characeristics of the watercourse and the amount of fluid released. In low-flow areas such as tidal mudflats, releases will exhibit limited horizontal transport. If drilling fluid is released into Coos Bay, the drilling fluid will not likely mobilize as it would in a rapidly moving river (Reid and Anderson 1998). Coos Bay is relatively shallow throughout much of the HDD alignment. The mudline becomes exposed during low tides across much of the alignment except within the dredged shipping channel. In the event of a drilling fluid release into Coos Bay, the drilling fluid would likely settle onto the bay floor, where it could be contained and removed (Pacific Connector Gas Pipeline 2017). Since marine bioassays suggest bentonite to be non-toxic (Reid and Anderson 1998), a coating of bentonite on mudflats would most likely create a physical barrier to benthos burrows and interfere with species' feeding mechanisms, similar to existing depositional phenomena in the estuary. If drilling fluid is released into Coos Bay it would be addressed in accordance with the provisions of the containment plan (Pacific Connector Gas Pipeline 2017). It is expected that most drilling fluid released could be captured and cleaned up.

Reid and Anderson (1998), the Canadian Pipeline Water Crossing Committee (1999), and Reid et al. (2008) reported that 13 of 30 HDD stream crossings had drilling mud releases (citing Harder Associates 1996). The statistic is based on drilling mud releases during the early days of HDD technology (first conducted in 1971). The summary by Reid and Anderson (1998) that follows provides a substantive description of the causes of inadvertent returns and subsequent effects to streams and habitat in the cases drilling mud releases.

Drilling mud releases during HDD construction can result from:

1. Circulation losses through highly permeable gravels;
2. Mud migration along rock joints or fractures that intersect with the river bottom;
3. Loss of pilot hole directional control resulting in the intersection with the river bottom or approach slope;
4. Drilling mud pressures exceeding ground stress, widening existing or creating new fractures (hydraulic fracturing), allowing for mud migration;
5. Substantially different elevations of entry and exit drill locations. Resulting pressure head differences can cause substantial upland leakages of drilling muds once the drill bit nears the ground surface or when it breaks the surface.

Drilling mud releases may surface through river and streambeds, wetland bottoms, or at upland locations. The volume of mud released to the surface would depend on:

1. Porosity of the substrate transporting the mud;
2. Extent and size of the porous material;
3. Pressure exerted on the mud by the hydraulic system;
4. Viscosity of the mud at the time of exposure;
5. Whether mud circulation can be maintained.

Magnitude of effects by mud releases to fish, streams and habitat would depend on the following (page numbers referenced from Reid and Anderson, 1998):

1. Toxicity of the drilling mud components and additives (pages 57-59; also Table 1);
2. Increased sediment loads (page 59);
3. Effects to hydrological conditions that would cause poor conditions for wetland plant establishment and growth (pages 59-60);
4. Release into streams and rivers could cause increases in the downstream drift of stream macroinvertebrates (page 60);
5. Level of exposure to fish (e.g., concentration), duration of exposure , lifestage of fish present, timing of release, and ability of the watercourse to remove or incorporate the released muds without degrading existing habitats (page 61).

The report by Reid and Anderson (1998) summarizes the general effects, known or hypothesized, associated with drilling mud releases but does not provide specific effects associated with each of the 13 instances cited.

In the event an inadvertent return occurs into the river, drilling fluid would enter the waterway causing short-term, temporary water quality impacts downstream of the project area including sedimentation and turbidity. In the event drilling fluid is inadvertently released into the river, the behavioral avoidance response of Oregon Coast coho is presumed to be triggered within the immediate vicinity of the release and the fish are expected to return and utilize the affected area shortly after the inadvertent release has been halted. PCGP's *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations* (see appendix D) describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The HDD Contingency Plan also includes procedures for cleanup of drilling mud releases. If significant concentrations are found during monitoring as a result of a release, the following possible corrective measures would be taken:

1. Deployment of containment structures, if feasible, and removal of drilling mud from substrate and streambanks if possible.
2. Increase the drilling fluid viscosity in an attempt at sealing the point at which fluid is leaving the drilled hole. The drilling operation may be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the higher viscosity drilling fluid.
3. If increasing the drilling fluid viscosity is ineffective, lost circulation materials (LCM) may be introduced into the hole by incorporating them in the drilling fluid and pumping the material down-hole. The drilling operation may again be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the LCMs.
4. Depending on the location of the fractured zone, a steel casing may be installed that is of sufficient size to receive the largest expected down-hole tools for the crossing. This casing installation provides a temporary conduit for drilling fluids to flow while opening the remaining section of the hole to a diameter acceptable for receiving the proposed pipe sections. To alleviate future concerns with the steel casing after the HDD installation is completed, the casing is generally extracted from the hole prior to or just after completing the HDD installation. However, there have been instances when attempts at extracting the steel casing were unsuccessful.
5. In the event drilling fluid flow is not regained through the annulus of the drilled hole and a steel casing installation is not utilized, the HDD contractor may elect to install a grout mixture into the drilled hole in an attempt to seal the fractured zone. The down-hole drilling assembly is generally extracted, and the existing hole is re-drilled to the point at which it had previously been drilled prior to having encountered the loss of drilling fluid.
6. In addition, a grouting program may be implemented from the surface in the event that the installation of grout into the drilled hole is unsuccessful. This approach is only practical in areas where drilling rigs with vertical drilling capabilities can access the HDD alignment. If a surface grouting program is utilized, the HDD drilling assembly is extracted from down-hole. Multiple holes are then drilled vertically on either side and along the HDD alignment to allow for grout slurry to be pumped into the fracture zone where the drilling fluid had previously been lost from the drilled hole. This process can take several days to complete in order to insert the grout in a grid pattern that covers the full fractured zone, during which time the HDD operation is suspended. Upon completion of the surface grouting program, the HDD operation would resume and the pilot hole would be reestablished through the grouted formation.

In some instances, it may be determined that the existing hole encountered a zone of unsatisfactory soil material, and the hole may have to be abandoned. If the hole is abandoned, it would be filled with cuttings and drilling fluid.

Overall at the site of any inadvertent return, the amount of drilling mud released into a waterbody would be low. The HDD locations on the Coos Estuary and on the Coos River have a large volumes of water and swift flows, where the drilling mud would be diluted. If an inadvertent release of drilling mud from an HDD occurred on the Coos River, it would be expected to have minor short-term adverse effects to aquatic resources including coho salmon.

Direct and Indirect Effects – Riverine Analysis Area

Outside of Coos Bay, the Pipeline would cross 116 of the waterbodies in table 3.5.4-4 (summarized below in table 3.5.4-13). Dry open cuts would be utilized at 89 crossings, while the South Umpqua River would be crossed twice, once by a Direct Pipe (DP) technology at MP 71.3 and again by a diverted open cut at MP 94.7. Twenty-eight of the waterbodies summarized in table 3.5.4-13 would not be crossed by the Pipeline but are adjacent to the centerline and within the construction right-of-way. Blasting may be necessary to construct across 22 streams that would be crossed by dry open-cut methods (see Project Description) because the streambed of each is bedrock (see tables 3.5.4-4 and 3.5.4-15).

All affected waterbodies within the three subbasins and nine fifth-field watersheds that are within the range of Oregon Coast coho salmon ESU proximate to the Pipeline are included in table 3.5.4-15. There are 137 waterbodies included in the table, of which 51 are perennial, 80 are intermittent, three are estuarine (Coos Bay crossed twice and the Coos River), and three others are ponds, not crossed (see table 3.5.4-4, above).

TABLE 3.5.4-15

Proposed Pipeline Construction Methods for Crossing Waterbodies within Subbasins and Fifth-Field Watersheds Coinciding with the Proposed Pipeline Route and Coho in the Oregon Coast ESU

	Number of Waterbodies with Construction Method							
Subbasins and Fifth-Field Watersheds	**HDD or Direct Pipe**	**Bore**	**Wet Open-Cut**	**Diverted Open-Cut**	**Dry Open-Cut: Fluming**	**Dry Open-Cut: Bedrock a/**	**Total Crossed**	**Adjacent Not Crossed b/**
Coos Subbasin								
Coos Bay-Frontal Pacific Ocean	3				10	0	**13**	6
Coquille Subbasin								
North Fork Coquille River					7	0	**7**	1
East Fork Coquille River					9	4	**13**	1
Middle Fork Coquille River					15	1	**16**	3
South Umpqua Subbasin								
Olalla Creek-Lookingglass Creek					12	5	**17**	1
Clark Branch-South Umpqua River	1				9	3	**13**	9
Myrtle Creek					11	3	**14**	0
Days Creek-South Umpqua River				1	9	5	**15**	4
Upper Cow Creek					7	1	**8**	3
TOTAL	**4**	**0**	**0**	**1**	**89**	**22**	**116**	**28**

a/ Bedrock streambeds would be crossed by dry open-cuts but may require special construction techniques to ensure pipeline design depth including rock hammering, drilling and hammering, or blasting. The need for blasting would be determined by the contractor and would only be initiated after ODFW blasting permits are obtained.
b/ Waterbodies within the construction right-of-way that would not be crossed.

The Pipeline would cross 43 waterbodies that are known or presumed to be inhabited by coho salmon in the Oregon Coast ESU (see table 3.5.4-2, above). Effects by the Project could occur to freshwater, in-water construction activities, terrestrial/riparian habitat modification, accidental spills or leaks of hazardous materials, and periodic maintenance of the Pipeline. Construction of the Project could directly and/or indirectly affect Oregon Coast coho salmon and critical habitat through one or more of the following pathways:

- interference with key life history functions for native species;
- acoustic shock from blasting pipe trench through bedrock streambeds ;
- underwater noise produced during use of a track hoe or impact hammer if fish are proximate to the construction site;
- suspended sediment (turbidity) generated during pipeline construction across waterbodies can adversely affect coho and aquatic habitats;
- inadvertent release of drilling mud during HDD construction;
- movement blockage during in-stream construction;
- inadvertent release of drilling mud during HDD construction;
- movement blockage during in-stream construction;
- salvaging fish that are entrained and/or entrapped;
- removal of riparian vegetation that can reduce shade (which could increase water temperatures), limit streambank stability, and affect recruitment of LWD;
- effects to aquatic habitats including freshwater stream invertebrates;
- hydrostatic testing and risk of test water entering streams;
- introduction and/or redistribution of aquatic nuisance species;
- mobilization of contaminated substances;
- accidental release of fuels and entry of other petroleum products into surface waters;
- risk of channel migration, avulsion, widening, and/or streambed scour;
- effects to hyporehic exchange and hyporehic zones;
- run-off from new permanent access roads, new temporary access roads, existing access roads and temporary extra work areas;
- run-off from contractor yards, rock source and disposal sites, and aboveground facilities; and
- application of herbicides to control noxious weeds near waterbodies may adversely affect coho.

Timing to Life History Functions

Within the range of Oregon Coast coho ESU, PCGP would avoid constructing across fish-bearing streams during periods of sensitive fish use. This construction window would typically occur in periods of lower flow rates in streams. The ODFW (2008) in-stream construction window for coastal tributaries, the Coquille River and tributaries, and tributaries to the South Umpqua River is July 1 to September 15. In-stream work within the South Umpqua River mainstem is permitted from July 1 to August 31.

In general, construction of the Pipeline would be timed to miss periods of major juvenile or adult migrations in freshwater based on allowed fishery construction windows, typically July 1 to mid-September for most streams, and some other dates for specific waterbodies. Timing of in-water work in aquatic habitats within the Coquille and South Umpqua subbasins would generally coincide with low flows and high water temperatures during summer and early autumn, discussed above in section 3.5.4.2 (see figure 3.5.4-4, Coos subbasin; figure 3.5.4-5, Coquille subbasin; and figure 3.5.4-6, South Umpqua subbasin). The in-stream construction windows could coincide with upstream adult migration by coho. Construction across waterbodies within the Coquille and South Umpqua subbasins would be completed before spawning (see figure 3.5.4-1). However, juvenile coho would be present and migrating adults might be present within waterbodies flowing at the time of construction. Juveniles rear for about 15 months in freshwater before migrating in spring to the ocean. Consequently, juveniles present would likely be limited to juvenile fry that are several months old from the current year's emergence.

Acoustic Shock

There are 22 waterbodies within the Oregon Coast coho ESU where shallow bedrock may occur where potentially necessitating blasting and/or mounted impact hammers be used to construct a trench through bedrock substrates (see table 3.5.4-4, summarized above in table 3.5.4-15). Explosives detonated near water produce shock waves that can be lethal to fish, eggs, and larvae by rupturing swim bladders and addling egg sacs (British Columbia Ministry of Transportation 2000). Explosives detonated underground produce two modes of seismic wave:, 1) body waves that are propagated as compressional primary (P) waves and shear secondary (S) waves; and 2) surface waves produced when a body wave travels to the earth surface and is reflected back (Alaska Department of Fish and Game - ADFG 1991). Shock waves propagated from ground to water are less lethal to fish than those from in-water explosions because some energy is reflected or lost at ground-water interface (ADFG 1991). Peak overpressures as low as 7.2 psi produced by blasting on a gravel/boulder beach caused 40 percent mortality in coho salmon smolts. Other studies revealed 50 percent mortality in smolts with peak overpressures ranging from 19.3 to 21.0 psi (ADFG 1991).

In 1991, the ADFG established a standard for blasting effects to anadromous fish that limited blast-induced overpressures in the water column. ADFG (1991) reported that a pressure change of 2.7 psi is the level for which no fish mortality occurs. ADFG (1991) calculated the straight line distances for a single shot explosive charge of given weight through rock and other materials to dissipate to an overpressure standard of 2.7 psi (non-lethal pressure for anadromous fish). Typical trench blasting scenarios use multiple 1- to 2-pound charges separated by an 8-milisecond delay to excavate the trench. With use of 1- to 2-pound charges in rock, the setback distance (at which 2.7 psi would occur) from the blast trench to the fish habitat is between 34 and 49 feet (see Table 3, in ADFG, 1991).

New research (Dunlap, 2009) and an in-depth review (Kolden and Aimone-Martin, 2013) of empirical studies of the physiological effects of blasting on adult salmonids and embryos prompted ADFG to revise the blasting standard (Timothy, 2013):

> *"The instantaneous pressure rise in the water column in rearing habitat and migration corridors is limited to no more the 7.3 psi where fish are present. Peak particle velocities in spawning gravels are limited to no more the 2.0 in/s during the early stages of embryo incubation before epiboly is complete."*

Application of the new standard for 7.3 psi in equations in ADFG (1991) was used to derive setback distances from water for 2-pound charges in rock. Based on these calculations, a distance of about 26 feet would result in the avoidance of adverse effects to salmonids in water. The setback distance used in PCGP's Fish Salvage Plan (appendix T) added 25 feet to each side of the construction right-of-way, totaling at least 50 feet from the blasting location at the trench. Application of the new ADFG blasting standard for a 2-pound charge in bedrock would indicate that the current setback distance is more than adequate to ensure that any blasting that does occur will not adversely affect ESA-listed coho salmon and other salmonid species.

Several approaches have been suggested to reduce risk of injury or mortality to fish in closest proximity to blasting locations (Wright and Hopky 1998):

- deployment of bubble curtains/air curtains to disrupt the shock wave;
- deployment of noise generating devices, such as an air compressor discharge line, to scare fish away from the site; or
- removal or exclusion of fish from the work area before the blast occurs.

To reduce impacts on resources, PCGP developed a *Blasting Plan* (see appendix C to the POD) with measures that incorporate many of these recommendations. The plan stated that PCGP does not anticipate conduction any in-water blasting in any streams crossed by the Pipeline. However, blasting may occur in uplands adjacent to streams, or within dry streambeds. In those situations, PCGP would attempt to minimize shock waves from blasting that may affect aquatic resources by the types of explosives selected, the size of charges, and the sequences of firing. In addition, bubble curtains may be used. The details of specific site blasting actions would be determined in coordination with managing resource agencies. Lastly, fish may be removed from the crossing area, in accordance with PCGP's *Fish Salvage Plan* (see appendix T and section 3.5.4.4, Conservation Measures below).

The *Fish Salvage Plan* includes measures to exclude fish and prevent them from re-entering isolated portions within waterbodies crossed for distances sufficient to avoid or minimize adverse effects by blasting bedrock in streambeds. The specific plans would be approved by the managing resource agencies. Prior to any blasting, proper permits would be obtained and agencies notified as required by permits.

Of the 22 waterbodies where shallow bedrock may occur potentially necessitating blasting and/or mounted impact hammers used to construct a trench, only 15 are known or assumed to support Oregon Coast coho: three in the East Fork Coquille watershed (tributary to East Fork Coquille River at MP 28.9, tributary to Elk Creek at MP 32.4, South Fork Elk Creek at MP 34.5); five in the Olalla Creek-Lookingglass Creek watershed (tributary to Shields Creek at MP 56.3, tributary to Olalla Creek at MP 57.1, tributary to Olalla Creek at MP 58.6, tributary to McNabb Creek at MP 60.1, McNabb Creek at MP 60.5); two in the Clark Branch-South Umpqua River watershed (Rice Creek at MP 65.8, Willis Creek at MP 66.9); three in the Myrtle Creek watershed (North Myrtle Creek at MP 79.1, tributary to North Myrtle Creek at MP 79.2, South Myrtle Creek at MP 81.2); and two in the Days Creek-South Umpqua River watershed (Fate Creek at MP 88.5, Days Creek at MP 89.6).

Dry open-cut construction, most likely by dam-and-pump procedures, would be used to cross 15 streams. At some waterbody crossing sites the right-of-way will be "necked down" to 75 feet; in others the construction right-of way would be the full 95-foot width. Fish would be salvaged from within the 75-foot or 95-foot wide right-of-way crossing of each stream by dry open-cut. The fish salvage area would be isolated by sand bag dams installed upstream and downstream from the centerline. As described in the *Fish Salvage Plan* (see appendix T), fish would be excluded from an area larger than the limits of the construction right-of-way width, isolated by sand bags. If basting is required, fish would be excluded from an additional 25 feet on each side of the construction right-of-way, an estimated maximum of 145 feet. Application of the new ADFG blasting standard for a 2-pound charge in bedrock would indicate that the current setback distance is more than adequate to ensure that any blasting that does occur will not adversely affect ESA-listed coho salmon and other salmonid species. The plan includes measures to exclude fish and prevent them from re-entering isolated portions within waterbodies crossed for distances sufficient to avoid or minimize adverse effects by blasting bedrock in streambeds.

Estimates of juvenile coho present in at crossing sites in streams were based on the following assumptions: 1) all rights-of-way are 95 feet wide at each stream crossing within which coho would be salvaged, and 2) coho would be excluded from an additional 50 feet (a total of 145 feet of stream length) from the right-of way edges (25 feet from each edge). Numbers of juvenile fry coho potentially present or assumed to be present in the streams with bedrock substrates are provided in table 3.5.4-16. Construction of the Pipeline through bedrock at those streams is likely to require blasting and the estimates in table 3.5.4-16 represent numbers of juvenile fry coho (195 juveniles expected) that could be displaced and or salvaged prior to blasting. The estimates in table 3.5.4-16 are based on no fish being herded out of the work area prior to dewatering (see *Fish Salvage Plan*). The actual number that would be salvaged is expected to be much less.

TABLE 3.5.4-16

Worst Case Estimates of Juvenile Fry Coho Present or Assumed as Present at Streams with Bedrock Substrates and Juveniles Salvaged Prior to Blasting During Construction of the Pipeline Project within the Oregon Coast ESU

Subbasin and Fifth-Field Watersheds	Dry Open-Cut w/ Juvenile Fry Coho Present	JuvenileFry Present at Each Crossing a/	Total Juvenile Fry Present b/	Juvenile Fry Salvaged at Each Crossing c/	Total Juvenile Fry Salvaged d/
Coos					
Coos Bay-Frontal Pacific Ocean	0	N/A	0	N/A	0
Coquille					
North Fork Coquille River	0	N/A	0	N/A	0
East Fork Coquille River	3	61	184	40	120
Middle Fork Coquille River	0	N/A	0	N/A	0
South Umpqua					
Olalla Creek-Lookingglass Creek	5	9	45	6	29
Clark Branch-South Umpqua River	2	11	22	7	14
Myrtle Creek	3	11	32	7	21
Days Creek-South Umpqua River	2	8	16	5	10
Upper Cow Creek	0	N/A	0	N/A	0
TOTAL	**15**		**287**		**195**

a/ Juvenile Fry Present at Each Crossing based on Juveniles per Mile (see table 3.5.3-6) within a stream crossing length of 145 feet (95 feet construction right-of-way plus an additional 25 feet on each side, a worst case, see text).
b/ Total Juvenile Fry Present (worst case) = number of Juvenile Fry Present at Each Crossing multiplied by number of Dry Open-Cut crossings with potential for blasting and with Juveniles Coho Present.
c/ Juvenile Fry Salvaged at Each Crossing based on Juveniles per Mile (table 3.5.4-7) within a stream crossing length of 95 feet (worst case, see text), not salvaged within the additional 25 feet on each side.
d/ Total Juveniles Salvaged (worst case) = number of Juvenile Fry Salvaged at Each Crossing multiplied by number of Dry Open-Cut crossings with blasting and Juvenile Fry Coho Present. The estimate is based on no fish being herded out of the work area prior to dewatering (see Fish Salvage Plan in appendix T). The actual number that would be salvaged is expected to be much less.

Underwater Noise

Dry open-cut construction, more than likely dam-and-pump methodology, would be used at sites where blasting and/or mounted impact hammers would be required to construct a trench through bedrock substrates. Impulsive type sounds, sound generated by pile driving for example, create stress waves in the piling material that radiate sound through the surrounding media of substrate, air, and water and may propagate outward from the source through bottom sediment (Popper and Hastings 2009). Various studies have reported fish mortality, physical injury, auditory tissue damage, decreased viability of eggs, and decreased larval growth due to noise, mostly explosive blasts, seismic survey blasts, and air gun blasts (Hastings and Popper 2005). State agencies in Washington, Oregon, and California along with federal agencies have developed interim noise exposure threshold criteria for pile driving effects on fish (WSDOT 2011a; Fisheries Hydroacoustic Working Group 2008; Popper et al. 2006; and see discussion above in section 3.5.3.3 for coho salmon SONCC ESU). The threshold noise levels are assumed to be applicable to noise from a mounted impact hammer operating on bedrock substrates for 15 waterbodies potentially affected by the Pipeline project in the Coos, Coquille, and South Umpqua subbasins (see table 3.5.4-14, above).

Average maximum noise produced by mounted impact hammers due to impact on substrates (e.g., rock) has been reported at 90 dBA from 50 feet away in the air (see Table 7-4 in WSDOT 2011a). Using a simplified conversion of dB between air and water (see footnotes and discussion above in section 3.5.3.3 for coho salmon SONCC ESU) the noise produced by the impact hammer in air would be equivalent to about 182 dB re: 1 µPa @ 1 meter in water (see section 3.5.3.3 above for source impact hammer dB value). However, there is no information available to determine whether that noise level would be equivalent to peak sound levels or RMS levels, which are the basis for evaluating potential harm to fish, particularly related to cumulative sound exposure levels caused by multiple impact hammer strikes. However using the most conservative criteria (cumulative levels which assume multiple impacts over a short period), impact hammer values of 182 dB are at the limit of the current criteria considered to cause harm (183 dB; see section 3.5.3.3 above).

Further, the estimate of noise produced by in-water use of an impact hammer in any waterbody would be influenced by water currents, water depth, and bottom material and topography, as well as configuration and materials of the river banks. The effects of these factors are unknown (WSDOT 2011a). However, noise propagation in any waterbody, upstream and downstream from the construction site would be limited by the stream channels' sinuosity since the propagation is limited to straight-line distance from the source (WSDOT 2011a). Noise produced by impact hammers would be much reduced if construction does not occur within the water column, similar to reduction set back distances from the blast trench to the fish habitat to reduce blast overpressures to below 2.7 psi, discussed above.

Sounds produced by a mounted impact hammer operating in dry conditions might be conducted through bedrock substrate to approach the hearing threshold of fish, as for example the Atlantic salmon, which is around 90 dB re: 1 µPa (see Figure 3 in Hastings and Popper 2005). It is assumed that salmonids in the Pipeline project area at the time of construction would have hearing thresholds similar to Atlantic salmon. With that assumption, listed and non-listed salmonids present at the time of construction might detect the noise produced by an impact-hammer striking bedrock, but the noise is not expected to be of sufficient intensity to cause them injury as would SELs produced by pile driving.

When using the dam-and-pump stream crossing methodology, the typical right-of-way distribution of an isolated streambed (dry open-cut) would be no less than 25 feet on one side of the pipe trench and 50+ feet on the opposite side of the pipe trench depending on whether it is a 75- or 95-foot-wide crossing. Therefore, an area within the waterbody crossing equivalent to length of the blasting trench and approximately 25 feet wide (in the worst-case scenario) would be exposed to instantaneous hydrostatic pressure changes above 2.7 psi. In reality the distance in water affected outside of the 25 feet on land would be less than an additional 25 feet because water does not transmit energy pressure waves as well as rock (only about 70 percent of the distance away from the charge relative to rock, the most conductive substrate of pressure waves; see calculations in ADFG 1991), which the maximum distance is based upon. As noted above (see Acoustic Shock subsection) a fish salvage plan (see section 3.5.4.4, Conservation Measures below) is in place that would result in any fish present being removed from the area within this 25-foot potential effect area, eliminating potential noise effects from stream crossings.

There would be no in-water blasting; therefore, no in-water noise monitoring has been proposed. Procedures for conducting blasting in-the-dry have been provided in in appendix T, *Fish Salvage Plan*. Monitoring for efficacy of each stream crossing and fish salvage would be conducted throughout the entire process including function of upstream block nets to exclude fish from areas where they might be affected by blasting in the dry thus eliminating potential noise effects to fish during stream crossings. In situations where blasting would occur in uplands adjacent to streams or within dry streambeds, PCGP would attempt to minimize shock waves from blasting that may affect aquatic resources by the types of explosives selected, the size of charges, and the sequences of firing. In-air noise due to blasting would be mitigated in all noise-sensitive areas as described in PCGPs *Blasting Plan* (see appendix C to the POD).

Suspended Sediment by Pipeline Crossing Methods

Pipeline crossings of surface waterbodies would cause some downstream turbidity and sedimentation. The type of crossing and stream sediment characteristics can affect turbidity and suspended sediment in streams. All streams in the range of Oregon Coast coho salmon ESU would be crossed using the dry open-cut method (flume and dam-and-pump) (table 3.5.4-15), except those streams crossed by HDD, Direct Pipe (DP), or diverted open cut. Dry crossing methods including diverted open cut would result in minimal impacts, including temporary increases in suspended sediments in restricted areas. DP and HDDs would be installed without in-water work and would not directly affect the aquatic environment and associated species, except in the case of an inadvertent return during an HDD crossing, which could affect stream suspended sediment levels as discussed below.

Suspended Sediment – Dry Open Cut

Pipeline crossings of surface waterbodies would cause some downstream turbidity and sedimentation. The type of crossing and stream sediment characteristics can affect turbidity and suspended sediment in streams. All streams in the range of Oregon Coast coho salmon ESU, other than those crossed by HDD, DP, or diverted open-cut, would be crossed using the dry open-cut method (flume and dam-and-pump) (see table 3.5.4-15). Turbidity and sedimentation impacts from the dry open-cut methods are associated with: 1) installation and removal of the upstream and downstream dams used to isolate the construction area; 2) water leaking through the upstream dam and collecting sediments as it flows across the work area and continues through the downstream dam; 3) movement of in-stream rocks and boulders to allow proper alignment and installation of the flume and dams; and 4) when streamflow is returned to the construction work area after the crossing is complete and the dams and flume are removed. Both "dry" techniques produce much less sediment in the water than alternative "wet" open cut methods (Reid and Anderson 1999; Reid et al. 2002; Reid et al. 2004, Reid et al. 2008, Harper 2012). Therefore, if properly installed and maintained during construction and restoration, dry open-cut construction across waterbodies would produce minor levels of sediment and turbidity.

PCGP would minimize impacts on surface waters and aquatic resources by implementing the waterbody crossing and erosion and sediment control measures as described in its Pipeline project-specific ECRP. Actions described in GeoEngineers (2017d) would also be used to determine level of stream crossing risk. GeoEngineers, using a combination of field data and GIS data, rated proposed stream crossings based on the matrix along the entire route including 101 streams in the range of Oregon Coast coho. The matrix has two axes rating the crossing based on impact potential at the crossing and the relative stream response potential at the crossing. Each crossing was rated as low, medium, or high for each of the two axes (all stream crossings were placed into one of nine categories, such as Low–Low, Low–Medium, and Medium–High). Crossing 43 of the streams would warrant application of typical construction practices; crossing 33 of the streams would warrant typical construction practices with BMPs for sensitive streambed, banks, or riparian revegetation conditions to be determined by the EI during construction; crossing four streams would warrant typical construction practices with BMPs for sensitive streambed, banks, or riparian revegetation conditions to be selected by a qualified professional prior to construction based on site-specific information from pre-construction evaluation; and crossing one stream would warrant typical construction practices with enhancement BMPs such as rootwad enhancement for bank stabilization.

Construction across waterbodies would be completed as quickly as possible to shorten the duration of sedimentation and turbidity. If channels are dry during construction, small streams (less than 10 feet) are projected to be crossed in less than 24 hours, and intermediate streams (10 to 100 feet) usually in less than 48 hours. Times may be longer when flow diversion is required. Reid et al. (2004) noted that in flowing streams they monitored, in-stream work averaged 38 and 64 hours for dam-and-pump and flumed crossings, respectively. If circumstances required a construction delay, adequate site stabilization measures would be employed in accordance with the ECRP and permit conditions. However, failure of flow sealing and other in-stream structures at upstream diversions structures could occur from a variety of malfunctions such as pump failure, dam and flume failure, poor dam seal and others. Reid et al. (2004) noted seal failures of monitored diverted open cut crossing in one of 23 dam-and-pump projects and five of 12 for flumed projects. Should these occur, suspended sediment would be relatively elevated over those without failure, but immediate repair work could reduce the magnitude and duration of elevated suspended sediment. The effect on suspended sediment from planned dry crossings and unintended wet cuts crossings with repairs are discuss below in this subsection.

Alternatively, Harper (2012) modeled sediment entrained during wet open-cut pipeline crossings of 6 major (width >100 feet), 46 intermediate (widths >10 feet and <100 fee t), and 227 minor waterbodies (widths <10 feet) in New Hampshire. In addition, modeling included suspended sediment generated following dry open-cut crossing of intermediate and minor waterbodies but was restricted to a one hour period of duration associated with a "quick-flush" that occurs after a pipe is installed, the trench is backfilled, and water barriers, upstream and downstream from the workspace, are removed and turbulent, high energy flow across the backfilled trench suspends sediments which are expected to last for one hour (Harper 2012). The effect on suspended sediment from planned dry crossings and unintended wet cuts crossings with repairs are discussed below in this subsection.

Severity of Effects from Suspended Sediment

Salmonids exposed to moderate to high levels of suspended sediment for extended periods could be adversely affected. At high levels, turbidity directly affects survival and growth of salmonids and other species, interferes with gill function, and adversely affects substrate for egg development (reviewed and compiled by Bash et al. 2001). Turbidity can also reduce macrophyte cover (over the long-term) by limiting photosynthesis (Goldsborough and Kemp 1988), as well as adversely affecting fish vision, which is a requisite for social interactions (Berg and Northcote 1985), feeding (Vogel and Beauchamp 1999; Gregory and Northcote 1993), and predator avoidance (Meager et al. 2006; Miner and Stein 1996).

Salmonids may avoid areas of increased turbidity levels at 20 mg/l suspended sediment, and possibly lower concentrations depending on length of exposure (Newcombe and Jensen 1996). The elevated suspended sediment conditions would be short-term during pipeline installation and would not be continuous at any one location. This would reduce the chances of continuous elevated exposure for fish that may move little. Some other studies have found varied effects including lesser effects at these concentrations, with overall effects related to both duration as well as concentration (Newcomb and Jensen 1996).

Sediment stirred into the water column can be redeposited on downstream substrates, which could bury aquatic macroinvertebrates (an important food source for salmonids, and other fish in estuarine areas). Additionally, downstream fine particle sedimentation could affect spawning substrate habitat, spawning activities, eggs, larvae, and juvenile fish survival, as well as benthic community diversity and health (reviewed and compiled by Bash et al. 2001). Because the effects of increased sedimentation and turbidity are often limited to the period of in-stream work, the duration of these effects are usually relatively short. However, specific site characteristics including flow, substrate composition, relative disturbance and other factors could make the duration of construction effects last longer. One long-term study (during construction through three years after construction) of multiple pipeline crossings of coldwater streams found no measurable effect to fish or benthic resources or their habitat within 2 months to 3 years of construction (Blais and Simpson 1997) and Gartman (1984) reported rapid recolonization of benthic organisms on 30 pipeline projects post-construction.

Dry open-cut construction methods have the potential to alter fish abundance over the short-term. Reid et al. (2002) found that fish abundance downstream of dam-and-pump or flumed crossings reduced immediately after construction in two of four sampled sites. Mean sediment concentrations during construction at these four sites were all less than 100 mg/l (range 8 to 86 mg/l). Two sites sampled one month later had downstream reductions in fish abundance including brook trout. However, Reid et al. (2002) concluded, based on limited physical sediment-related stream changes, observed differences in fish abundance for most sampling were likely the result of factors other than project-generated sediment, such as low flow generated from water diversion actions and fish sampling methods. One year after construction, Reid et al. (2002) found no difference in fish abundance below these two sites from preconstruction levels.

Newcombe and Jensen (1996) compiled research from many sources that demonstrate effects to anadromous and resident salmonids by various levels of suspended sediment and exposure over time. This modelling process is used to assess the possible effects to salmonid resources in the project area from in-stream pipeline construction based on estimates of sediment concentration exposure duration. The developed models that approximate the level of effect is based on known levels of suspended sediment concentration and duration of exposure to that concentration in a stream. In order to use these models to estimate effects to salmonids, an estimate of these two parameters is needed.

Output from each model provides SEV scores that are summarized below. Values range from 0 to 14, where an SEV of 0 indicates no effects, an SEV between 1 and 3 indicates behavioral effects, an SEV from 4 to 8 indicates sublethal effects, and an SEV from 9 through 14 indicates lethal and paralethal effects (see Table 1 in Newcombe and Jensen 1996).

Behavioral Effects SEV scores

1 = Alarm reaction
2 = Abandonment of cover
3 = Avoidance response

Sublethal Effects SEV scores

4 = Short-term reduction in feeding rates and/or feeding success
5 = Minor physiological stress (increase coughing rate and/or increased respiration rate)
6 = Moderate physiological stress
7 = Moderate habitat degradation; impact on homing
8 = Major physiological stress; long-term reduction in feeding rate- feeding success; poor condition

Lethal and Paralethal Effects SEV scores

9 = Reduced growth rate and/or delayed hatching and/or reduced fish density
10 = 0 to 20 percent mortality and/or increased predation and/or moderate to severe habitat degradation
11= >20 to 40 percent mortality
12= >40 to 60 percent mortality
13= >60 to 80 percent mortality
14= >80 to 100 percent mortality

SEV scores are complex interactions of TSS concentrations and time of exposure to those concentrations where higher concentrations and longer exposures result in higher SEV scores and greater impact to fish. Effects of high concentrations may be ameliorated by brief exposures and conversely effects of low concentrations may be exasperated by prolonged exposures. In the analyses, downstream effects of TSS are primarily caused by very fine sand, silt and clay particles; coarser sediments settle out of suspension over relatively short distances downstream, closer to the crossing site. Specific information about each waterbody crossing is required to predict amounts of suspended sediment that would be generated, transported, and deposited downstream. That information includes: 1) stream width and depth, 2) water velocity, 3) streambed roughness, 4) grain size of excavated materials, and 5) background (ambient) levels of suspended sediment (Reid et al. 2008). Once total suspended sediment (TSS) concentrations generated by in-stream activities have been determined, they are applied in the dose-response assessments of sediment exposure, the SEV models by Newcombe and Jensen (1996).

Estimates of Likely Effects from Suspended Sediment

Average Channel Characteristics. PCGP incorporated site data, regional data, and available literature based models to provide an estimate of both suspended sediment levels and extent of effects to Oregon Coast coho salmon ESU from construction across streams. Specific channel characteristics for streams crossed by the Pipeline are not available. However, data provided in the ODFW (2014c) stream surveys included bankfull channel widths, bankfull depths, and stream gradients, in addition to substrates (Sand-Silt-Organics) noted in table 3.5.4-10a and table 3.5.4-10b above, for multiple streams within fifth-field watersheds crossed by the Pipeline (table 3.5.4-17). Those data were used to develop stream channel characteristics in each fifth-field watershed crossed that are assumed to apply to the actual streams that would be crossed in each of the watersheds.

TABLE 3.5.4-17

Channel Conditions for Streams Sampled during the Aquatic Habitat Inventory (ODFW 2014c) in Nine Watersheds within the Oregon Coast ESU that would be Crossed by Pipeline Project

Subbasin and Fifth-Field Watersheds	Number of Stream Reaches Surveyed a/	Average Values for Streams Sampled in Watershed a/			
		W = Bankfull Width (meters)	D = Bankfull Channel Depth (meters)	S = Channel Gradient (percent slope)	Percent Sand, Silt, Organics in Substrate
Coos					
Coos Bay-Frontal Pacific Ocean	30	5.8	0.5	2.2	59.2
Coquille					
North Fork Coquille River	73	5.8	0.5	3.6	33.4
East Fork Coquille River	74	6.9	0.5	5.3	24.9
Middle Fork Coquille River	99	7.2	0.6	4.6	22.4
South Umpqua					
Olalla Creek-Lookingglass Creek	54	5.6	0.5	3.4	24.4
Clark Branch-South Umpqua River	33	4.9	0.5	5.0	15.7
Myrtle Creek	60	5.3	0.4	4.6	42.8
Days Creek-South Umpqua River	98	4.6	0.5	4.6	22.3
Upper Cow Creek	28	4.3	0.7	6.2	30.4

a/ Stream-specific values are provided in appendix Y.

Estimates of Bankfull Flows. Sediment transport in streams depends, in part, on stream channel characteristics. Stream-specific values that were averaged in table 3.5.4-17 were used to determine stream discharged rate (Q) and water velocity (V_A). Manning's Formula (Limerinos 1970; Arcement and Schneider 1989) was used to estimate Q, the stream discharge rate (cubic meters per second, meter^3/sec):

$$Q = A\ (k/n)\ (R^{2/3})\ (S^{1/2})$$

with estimates of A, the cross-sectional area of a stream (square meters); R, the hydraulic radius (meters, where R = A/P, and P is the wetted perimeter in meters); S, the slope of channel (channel gradient); the constant *k* equals 1.486 if English units are used or 1 with metric units; and n, Manning's roughness coefficient. Stream-specific Aquatic Habitat Inventory data (see appendix Y) were used to estimate the stream channel cross-section shape and cross-section area. If the predominant depth was greater than half the bankfull width, the cross-section channel shape was assumed to be a V. If the bankfull depth was less than half the bankfull width, the cross-section channel shape was assumed to be a trapezoid with each bank as a 1:1 slope, dependent on predominant depth (bottom = W – (2 D)). If the bankfull depth was equal or greater than half the bankfull width, the cross-section channel shape was assumed to be a V. Manning's n was estimated from various sources (Chow 1959; Limerinos 1970; Arcement and Schneider 1989) and ranged from n = 0.060 for floodplain channels with light brush and trees in summer, to n = 0.050 for channels with pools, shoals and stones to n = 0.045 for mountain streams with bottom gravels, cobbles, and boulders and no vegetation in the channel (Chow 1959).

Estimates of Q derived with Manning's Formula are assumed to be measures of the carrying capacity (bankfull flow) of a particular channel section (Arcement and Schneider 1989). Carrying capacities of a channel section are assumed to occur during periods of high flow, generally during winter months in the Pipeline project area. Stream flow rate or discharge rate, Q, is related to cross-sectional area (A) and average streamflow velocity (V_A):

$$Q = A \cdot V_A, \text{ alternatively } V_A = Q / A$$

Estimates of Q derived with Manning's Formula are assumed to be measures of the carrying capacity (bankfull flow) of a particular channel section (Arcement and Schneider 1989). Carrying capacities of a channel section are assumed to occur during periods of high flow, generally during winter months in the Pipeline project area. Estimates of variables used to derive Q and V_A are provided in table 3.5.4-18, averaged by watershed.

TABLE 3.5.4-18

Estimates Used to Derive Bankfull Flow and Bankfull Velocity in Nine Watersheds within the Oregon Coast ESU that would be Crossed by Pipeline Project

Subbasin and Fifth-Field Watersheds	Average Estimates for Streams Sampled in Watershed a/				
	A = Channel Cross Sectional Area ($meter^2$)	P = Wetted Perimeter (meters)	R = Hydraulic Radius (meters)	Q = Bankfull Flow ($meter^3$/sec)	V_A = Bankfull Velocity (meter/sec)
Coos					
Coos Bay-Frontal Pacific Ocean	2.6	6.2	0.4	2.5	1.0
Coquille					
North Fork Coquille River	3.3	6.2	0.4	6.4	1.9
East Fork Coquille River	3.4	7.3	0.4	7.9	2.3
Middle Fork Coquille River	4.8	7.7	0.5	11.7	2.2
South Umpqua					
Olalla Creek-Lookingglass Creek	2.5	6.0	0.4	4.8	1.8
Clark Branch-South Umpqua River	2.6	5.3	0.4	5.1	2.1
Myrtle Creek	2.5	5.7	0.4	4.2	1.7
Days Creek-South Umpqua River	2.2	4.9	0.4	4.7	1.9
Upper Cow Creek	2.8	4.9	0.4	9.1	2.6

a/ Stream-specific estimates are provided in appendix Y.

Seasonal Discharge. Pipeline construction across waterbodies would occur during ODFW (2008) in-stream construction windows (section Timing to Life History Functions, above). Hydrographs of monthly discharges of waterbodies within the Coos (figure 3.5.4-4), Coquille (figure 3.5.4-5), and South Umpqua (figure 3.5.4-6) subbasins to be crossed by the Pipeline show peak seasonal flows during winter months, December through February. Lowest flows occur during summer months, coinciding with the ODFW construction windows. Assuming that high winter stream flows correspond to the bankfull carrying capacities of channel sections (Arcement and Schneider 1989), in-stream flows during the ODFW construction window would be some fraction of the winter flows. Those fractions are included in table 3.5.4-19 with the mid-point that is used to adjust low flows and velocities for each sampled reach of Aquatic Habitat Inventory data (see appendix Y).

TABLE 3.5.4-19

Recorded High Flows During Winter and Average Low Flows during the ODFW In-stream Construction Window in Hydrographic Data within the Coos, Coquile, and South Umpqua Subbasins Crossed by the Pipeline Project

Subbasin and Hydrograph	High Flow (cfs) (Month)	In-stream Construction Window	Average Flows (cfs) During Window	Percent of High Flow During Window	Percent Mid-Point
Coos					
Pony Creek a/	17 (Feb)	Jul 1-Sep15	0.01	0.03	1.4
W.Fk. Millacoma River	489 (Jan)	Jul 1-Sep15	13.7	2.8	
Coquille					
Mid.Fk. Coquille River	2,220 (Feb)	Jul 1-Sep15	40.5	1.8	2.0
N.Fk. Coqulle River	630 (Dec)	Jul 1-Sep15	14.4	2.3	
South Umpqua					
N. Myrtle Creek	182 (Dec)	Jul 1-Sep15	4.8	2.6	2.8
S. Umpqua River	6,862 (Dec)	Jul 1-Aug 31	196	2.9	

a/ Ten-year flows in Pony Creek were evaluated from 1992 to 2001 rather than from the most recent 10-years, 1999 to 2008, because of releases from Upper Pony Creek Reservoir since completion of the new dam in 2001.

The 10-year average of low water stream flows in the Coos Subbasin during the ODFW in-stream construction window are assumed to be 1.4 percent of high winter flows (see table 3.5.4-19) based on discharge data for Pony Creek and West Fork Millacoma River during December (see figure 3.5.4-4). Average low water flows in the Coquille Subbasin during the construction window are 2.0 percent of high winter flows (see figure 3.5.4-5) and average low flows in the South Umpqua Subbasin are 2.8 percent of high winter flows (see figure 3.5.4-6). Stream depths for all waterbodies within the each subbasin were reduced by the same proportion through iterations that reduced bankfull flows in the Coos, Coquille, and South Umpqua subbasins by 1.4 percent, 2.0 percent, or 2.8 percent, respectively, in all streams in the Aquatic Habitat Inventory samples. Reduced stream depths generate reduced values of A, P, and R in Manning's Formula. Stream-specific estimates of Q and V_A during low water flow conditions were likewise derived and are provided in table 3.5.4-20, averaged by watershed. Reduced stream depths generated reduced values of A, P, and R in Manning's Formula.

<u>Background Turbidity and Suspended Sediment</u>. Turbidity, generally reported in NTUs, is a measure of the lack of transparency (cloudiness) of water caused by suspended or dissolved substances that cause light to be scattered and adsorbed. Turbidity is often measured on-site using a turbidity meter that measures the scattering of light in a water sample relative to a known range turbidity standards. Turbidity is directly related to the concentration of sediments suspended in water but the relationship between turbidity and suspended sediment is complicated by sediment particle size, particle composition, and water color (ODEQ 2010).

GeoEngineers (2017f) evaluated the potential risk of turbidity increasing during construction across waterbodies. The qualitative evaluation was based on each affected waterbody's hydroperiod, presence of erodible clay and loam soils in streambanks, presence of clay in streambed (suspended clay contributes to turbidity disproportionally to its erodibility), long-term stability of stream channels, and level/duration of construction effort and stabilization measures likely added at the time of construction. The turbidity risk was scored from 1 (low) to 5 (high).

TABLE 3.5.4-20

Estimates Used to Derive Low Water Flows and Velocities during In-stream Construction in Nine Watersheds within the Oregon Coast ESU that would be Crossed by Pipeline Project

Subbasin and Fifth-Field Watersheds	Average Estimates for Streams Sampled in Watershed a/				
	A = Channel Cross Sectional Area (meter^2)	P = Wetted Perimeter (meters)	R = Hydraulic Radius (meters)	Q = Low Water Flow (meter^3/sec)	V_A = Low Water Velocity (meter/sec)
Coos					
Coos Bay-Frontal Pacific Ocean	0.18	4.89	0.04	0.04	0.22
Coquille					
North Fork Coquille River	0.29	4.86	0.05	0.13	0.45
East Fork Coquille River	0.30	6.03	0.05	0.16	0.52
Middle Fork Coquille River	0.42	6.21	0.05	0.23	0.51
South Umpqua					
Olalla Creek-Lookingglass Creek	0.27	4.80	0.05	0.13	0.47
Clark Branch-South Umpqua River	0.47	4.13	0.10	0.14	0.81
Myrtle Creek	0.27	4.61	0.05	0.12	0.46
Days Creek-South Umpqua River	0.23	3.79	0.05	0.13	0.52
Upper Cow Creek	0.27	3.23	0.08	0.26	0.81

a/ Stream-specific values are provided in appendix Y.

Of 133 waterbodies evaluated within range of Oregon Coast coho, 23 were scored with a low risk (score of 1 or 2) of turbidity increase over a 24-hour period, and 110 were scored with a moderate risk (score of 3 or 4), generally due to soil erosion potential, presence of clay or mud, and/or the presence of steep slope or an incised channel that would require construction of a deep trench (GeoEngineers 2017f). The evaluation concluded that turbidity generated during construction may exceed Oregon water quality standards for short distances and short durations downstream from each stream crossing, either coinciding with construction across perennial waterbodies or in intermittent streams coincidental with autumn precipitation.

Ambient turbidity was not addressed by GeoEngineers (2017f). Turbidity (NTU) has been evaluated by ODEQ (2013) and retrieved from Laboratory Analytical Storage and Retrieval (LASAR) Web Application in 2013 before ODEQ discontinued support of the site (ODEQ 2017), making the data unavailable. Turbidity within individual streams may be highly variable, but during the period coinciding with ODFW (2008) in-stream construction windows, reported turbidity was minimal and of low variability in streams for which data exists (see table 3.5.4-21).

The majority of ODEQ LASAR data were turbidity (NTU) measurements taken in the field. TSS were occasionally been reported but mostly without measuring corresponding turbidity. Relationships between turbidity and suspended solid concentrations are best if determined on a stream-by-stream basis (Downing 2008). However, since stream-specific data for turbidity and TSS were not available, four available literature generated models were used to supply a reasonable range of the possible relationships. Relationships are reported for streams in Alaska (Lloyd 1987; Lloyd et al. 1987) and streams in the Puget Lowlands (Packman et al. 1999); the models are non-linear. At low turbidity levels (see table 3.5.4-21), conversions of NTUs to TSS are relatively consistent among the models. Based on these conversions, an overall background level of 2 mg/l is assumed for TSS concentrations for all streams crossed by the Pipeline during the ODFW in-stream construction window. Available turbidity data (NTU) from stations included in the table averaged for July, August, and September yielded an average of 0.8 NTU. When converted to TSS using the models in the table, the conversion yields an average of 1.0 mg/l as a background level within range of the Oregon Coast coho. In support of that assumption, ODEQ (2010) reported that during dry seasons, background turbidity levels are relatively low and consistent in small streams throughout Oregon, generally from 1 to 2 NTUs. A background TSS concentration of 2 mg/l during summer is also consistent with measurements reported by USGS in Myrtle Creek, Big Butte Creek, and the Rogue River mainstem during summers 1977, 1978, and 1979 (historical data provided by the Forest Service. Results from the ODEQ data analysis and other sources reported above support using 2 mg/l as ambient TSS levels during the in-stream crossing period including all or portions of July, August, and September.

TABLE 3.5.4-21

Turbidity (NTU) Records Measured by ODEQ during all Seasons in Waterbodies Proximate to the Pipeline Project in the Coos, Coquille, and South Umpqua Subbasins and Conversion to TSS by Available Models

Subbasin and Waterbody	Number of Records	Period of Record	Mean Turbidity (NTU) (Maximum) (Minimum)	Model Conversion to TSS (mg/l) a/			
				Model 1 Mean TSS (Maximum) (Minimum)	Model 2 Mean TSS (Maximum) (Minimum)	Model 3 Mean TSS (Maximum) (Minimum)	Model 4 Mean TSS (Maximum) (Minimum)
Coos							
Kentuck Slough	10	2005-2007	27.6 (89) (4)	136.5 (487.1) (13.1)	34.9 (115.0) (4.7)	49.2 (189.6) (3.2)	112.9 (434.8) (7.2)
Willanch Creek	1	1982	29	131.8	36.1	43.2	99.0
Catching Slough	13	2005-2007	11.1 (39) (1)	47.2 (186.2) (2.6)	13.6 (49.0) (1.1)	14.8 (63.8) (0.5)	34.0 (146.3) (1.2)
Coquille							
Cunningham Creek	11	2001-2010	26.2 (82.8) (9.3)	127.5 (447.8) (3.5)	33.0 (106.7) (1.5)	45.0 (172.4) (0.7)	103.2 (395.3) (1.6)
N.Fk. Coquille River	12	2004-2010	6.9 (26.8) (2)	26.5 (120.3) (5.8)	8.2 (33.3) (2.3)	7.6 (38.9) (1.3)	17.4 (89.2) (2.9)
Mid.Fk Coquille River	13	2001-2010	12.5 (48.1) (1.2)	53.8 (237.8) (3.3)	15.4 (60.9) (1.4)	17.0 (84.2) (0.7)	38.9 (193.0) (1.5)
South Umpqua							
Bilger Creek	26	2004-2006	7.6 (81) (0.2)	37.7 (436.5) (0.4)	9.6 (104.3) (0.2)	13.7 (167.4) (0.1)	31.5 19384) (0.2)
Clark Creek	2	1994	1.5 (2) (1)	4.2 (5.8) (2.6)	1.7 (2.3) (1.1)	0.9 (1.3) (0.5)	2.0 (2.9) (1.2)
S.Fk. Myrtle Creek	26	2004-2006	4.5 (33) (0.7)	17.3 (153.3) (1.6)	5.4 (41.2) (0.7)	5.0 (51.2) (0.3)	11.4 (117.4) (0.7)
Days Creek	4	2006	4.3 (15) (0.5)	16.6 (61.1) (1.2)	5.1 (18.3 (0.5)	4.8 (18.1) (0.2)	10.9 (41.5) (0.5)
S.Fk. Cow Creek	1	1990	1	2.60	1.11	0.51	1.16

TABLE 3.5.4-21

Turbidity (NTU) Records Measured by ODEQ during all Seasons in Waterbodies
Proximate to the Pipeline Project in the Coos, Coquille, and South Umpqua Subbasins and Conversion to TSS by Available Models

Subbasin and Waterbody	Number of Records	Period of Record	Mean Turbidity (NTU) (Maximum) (Minimum)	Model Conversion to TSS (mg/l) a/			
				Model 1 Mean TSS (Maximum) (Minimum)	Model 2 Mean TSS (Maximum) (Minimum)	Model 3 Mean TSS (Maximum) (Minimum)	Model 4 Mean TSS (Maximum) (Minimum)

a/ Models used to convert Turbidity (T) to Suspended Solids Concentration (SSC) or Total Suspended Solids (TSS) in waterbodies crossed or proximate to the Pipeline project . Turbidity information source: ODEQ (2013) included data collected prior to 2013.
Model 1 (Lloyd 1987; Lloyd et al. 1987) applicable to waters throughout Alaska: $T = 0.44 (SSC)^{0.858}$
Model 2 (Lloyd 1987; Lloyd et al. 1987) applicable to interior Alaskan streams: $T = 1.103 (SSC)^{0.968}$
Model 3 (Packman et al. 1999) Rutherford Creek, King County, Washington: $\ln(TSS) = 1.32 \ln(NTU) – 0.68$
Model 4 (Packman et al. 1999) nine streams sampled in the Puget Lowlands, Washington: $\ln(TSS) = 1.32 \ln(NTU) + 0.15$

NTU – nephelometric turbidity unit

Particle Transport. Sediment particles will be transported distances downstream (L, in meters) based on 1) the particle size and settling velocity (V_S, - centimeters per second – in water at 20°C, see for example the Wentworth Grain Size Chart, USGS 2003), 2) the average streamflow velocity (meters per second), and 3) the average depth of flow (D, meters) downstream, using the following "velocity-distance-time" equation;

$$L = V_A (D / V_S)$$

Estimates of transport distances (L in meters) for various sediment particles ranging in sizes from clay to coarse gravel are provided, as examples, in table 3.5.4-22 for three waterbodies in the Pipeline project vicinity for which data are available. Particle sizes deleterious to salmonids (250 µm or less in the models of Newcombe and Jensen (1996), above) could settle out of suspension less than 1 meter (0.2 feet) downstream (e.g., medium sand in low flows for Tributary to Catching Creek). Alternatively, particles could remain suspended for 4.7 kilometers (2.9 miles) or more (very fine silt in Willis Creek).

TABLE 3.5.4-22

Estimated Downstream Transport Distances for Particles
(ranging from Very Fine Silt to Coarse Gravel) in Three Streams (as examples).

Particle Description	Particle Diameter a/	Settling Velocity (V_S)	Estimated Particle Transport Distance (L) Downstream b/		
			Tributary to Catching Creek	Steele Creek	Willis Creek
Coarse Gravel	1.60 cm	90 cm/s	0 m	0 m	0 m
Very Coarse Sand	0.1 cm	15 cm/s	0 m	0 m	0 m
Coarse Sand	0.05 cm	8 cm/s	0 m	0 m	1 m
Medium Sand	0.025 cm	3 cm/s	0 m	0 m	2 m
Fine Sand	0.0125 cm	1.25 cm/s	0 m	1 m	5 m
Very Fine Sand	0.0062 cm	0.329 cm/s	1 m	4 m	20 m
Coarse Silt	0.0031 cm	0.085 cm/s	3 m	16 m	78 m
Medium Silt	0.0016 cm	0.023 cm/s	9 m	59 m	289 m
Very Fine Silt-Clay	0.0004 cm	0.0014 cm/s	153 m	977 m	4,742 m

a/ note that 0.025 cm = 250 µm

b/ Parameter values used to estimate L:

Trib. Catching Creek: V_A =0.27 m/s; D = 0.01 m.
Steele Creek: V_A = 0.53 m/s; D = 0.03 m.
Willis Creek: V_A = 0.66 m/s; D = 0.1 m.

Sediment Generated During Pipeline Construction. Modeled concentrations of TSS produced in waterbodies during wet open-cut pipeline construction were developed from empirical data collected during construction across 15 to 19 streams in North America (Reid et al. 2004). Models were developed to predict mean TSS concentrations immediately downstream (approximately 50 meters) of pipeline construction sites. Models included TSS generated by all construction activities and by trenching, pipe lowering, and backfilling. The models predicting mean TSS generated by all activities (including trenching, pipe lowering, and backfilling) had the highest correlation coefficients (Reid et al. 2004). The model predicting mean TSS (***C*av**) at about 50 meters downstream by all activities associated with wet open-cut pipeline construction is:

$$C_{av} = 1.5 \times 10^6\ U^{1.09}\ d_{50}^{0.95}\ P_f^{0.35}\ q^{-1}$$

where *U* = mean flow velocity (m per second) at the crossing location during the construction period, equivalent to V_A derived using Manning's Formula (table 3.5.4-17 and appendix Y); d_{50} = the median sediment size (m) of the excavated material by weight, P_f = percentage of fines (silt and clay) in the excavated material (%) and is assumed to equal the percent of silt and organics in surface substrates for all streams within a given fifth-field watershed (estimated as 2/3 of the Percent Sand, Silt, Organics in Substrate tabulated in table 3.5.3-12); *q* = the width adjusted stream flow rate where *q* = *Q/B*, (m^2 per second) with *B* = the watercourse width (m) adjusted for a particular flow rate and *Q* = stream flow rate (m^3 per second) derived using Manning's Formula (values for *Q* are in table 3.5.4-18 and appendix Y). Values for d_{50} in these analyses were derived by regressing values of d_{50} and P_f provided in Table 2 of Reid et al. (2004); the relationship of d_{50} to P_f from that study is $d_{50} = 38.12\ e^{-0.0963\ Pf}$ (r^2 = 0.636, P<0.001).

In these simulations, Q is related to B through Manning's Formula and as B increases numerically, Q also increases but at a faster numerical rate (as a power function). If all other model parameters are held constant in the Reid et al. (2004) model, increased width adjusted stream flow rate, *q* (due high flow, Q, and proportionally smaller watercourse widths, *B*) will decrease the TSS concentration (C_{av}) because *q* is factored as q^{-1} in the equation. Conversely, lower *q* values will generate higher C_{av} with all other parameters in the equation held constant. Stream-specific estimates of *U, d50, P_f*, q^{-1}, and C_{av} during low water flow conditions are provided in appendix Y and averaged by watershed in table 3.5.4-23.

TABLE 3.5.4-23

Estimates Used to Predict TSS Concentrations at 50 meters Downstream from Wet Open-Cut Pipeline Construction in Nine Watersheds within the Oregon Coast ESU that would be Crossed by Pipeline Project

	Average Estimates for Streams Sampled in Watershed a/					
Subbasin and Fifth-Field Watersheds	**U Low Water Velocity (m/sec)**	**D50 Median Sediment Size (m)**	**P_f Percent Fines (Silt, Clay)**	**q Width Adjusted Stream Flow (m^2/sec)**	**B Watercourse Width (m)**	**C_{av} Predicted TSS Concentration at 50 meters (mg/L)**
Coos						
Coos Bay-Frontal Pacific Ocean	0.22	0.117	39.5	0.01	4.86	4,101.7
Coquille						
North Fork Coquille River	0.46	0.219	22.24	0.03	4.82	2,922.9
East Fork Coquille River	0.52	0.297	16.59	0.03	5.99	2,783.5
Middle Fork Coquille River	0.51	0.978	14.96	0.03	6.16	2,576.5

South Umpqua						
Olalla Creek-Lookingglass Creek	0.47	0.234	16.27	0.03	4.76	2,424.6
Clark Branch-South Umpqua River	0.81	0.629	10.48	0.08	4.04	1,195.4
Myrtle Creek	0.46	0.027	28.52	0.03	4.57	3,435.8
Days Creek-South Umpqua River	0.13	1.306	14.84	0.02	3.74	726.5
Upper Cow Creek	0.84	0.038	20.24	0.09	3.15	1,996.4

a/ Stream-specific values are provided in appendix Y.

In addition to developing predictive models of TSS concentrations generated by wet-open cut pipeline construction, Reid et al. (2004) measured TSS downstream from 12 flumed pipeline crossings and 23 dam-and-pump crossings (dry-open cut or isolated pipeline construction crossings) with comparisons to 11 wet open-cut construction crossings. By accounting for flow, background TSS concentrations, sampling distance downstream, and duration of construction, Reid et al. (2004) determined that mean TSS concentrations generated during dry open-cut construction by fluming were 3.7% of the wet open-cut concentrations and were 0.85% of the wet open-cut concentrations for dam-and-pump construction. These relationships were used in table 3.5.4-24 to adjust average TSS concentrations estimated at 50 meters downstream from wet open-cut pipeline crossings to average TSS concentrations at flumed pipeline crossings and dam-and-pump pipeline crossings.

TABLE 3.5.4-24

Estimates of TSS Concentrations Generated During In-stream Construction and Estimated Downstream Distance from Wet Open-Cut Construction to Attenuate to Ambient TSS in Nine Watersheds within the Oregon Coast ESU that would be Crossed by Pipeline Project

	Average Estimates for Streams Sampled in Watershed a/			
Subbasin and Fifth-Field Watersheds	**Wet Open–Cut TSS (mg/l) at 50 m**	**Fluming TSS (mg/l) at 50 m**	**Dam & Pump TSS (mg/l) at 50 m**	**Distance (m) for TSS (Clay Fraction) to Equal Ambient (= 2 mg/l)**
Coos				
Coos Bay-Frontal Pacific Ocean	4,102	153	35	595
Coquille				
North Fork Coquille River	2,923	109	25	1,840
East Fork Coquille River	2,783	104	24	1,744
Middle Fork Coquille River	2,576	96	22	2,072
South Umpqua				
Olalla Creek-Lookingglass Creek	2,425	90	21	1,780
Clark Branch-South Umpqua River	1,195	73	17	2,402
Myrtle Creek	3,436	128	29	1,713
Days Creek-South Umpqua River	727	27	6	638
Upper Cow Creek	1,996	74	17	7,319

a/ Stream-specific values are provided in appendixY.

Estimated Downstream Distance of Suspended Sediment. Ritter (1984) provided a variant of the "velocity-distance-time" equation, above to estimate concentrations of suspended sediments (C_X, as mg/L) some distance (x) downstream from a pipeline trench being constructed across a waterbody. Ritter's model for downstream sediment transport distance during construction across minor streams, with complete mixing of sediment particles, estimates the concentration downstream C_X by:

$$C_X = C_O e^{-(vs/d)(x/u)}$$

where C_O (mg/L) is the initial concentration of suspended solids in the water column at the trenching site, vs = the settling velocity (m/second) of sediment particles, d = stream depth (m), u = stream current velocity (m/second), and x = distance (m) downstream.

The formula for estimating the concentration downstream (Ritter 1984) is used to estimate the distance downstream for TSS concentrations at 50 m (C_O) to equal assumed ambient concentrations (C_X = 2 mg/l). The estimate is calculated by solving for x (distance) in the equation with appropriate transformations and inclusion of only the estimated clay fraction as TSS concentration since the silt fraction would settled out of suspension upstream:

$$x = (\ln(C_X) - \ln(C_O)) + (d / vs)\, u$$

where x = distance (m) downstream, C_O = the initial concentration (mg/l) of suspended solids in the water column at the trenching site, vs = the settling velocity (m/second) of the clay fraction, d = stream depth (m), u = stream current velocity (m/second), and x = distance (m) downstream. The distances x for TSS generated by wet open-cut construction techniques to attenuate to ambient TSS (C_X) is provided in table 3.5.4-24.

Inverse relationships between TSS concentrations produced at 50 meters from in-stream construction and TSS concentrations at variable distances downstream were evaluated for each of the three pipeline crossing techniques by nonlinear regressions of distance downstream (from 1 to 1000 m) and total TSS concentrations at distance x, solving for x in the above equation [$x = (\ln(C_X) - \ln(C_O)) + (d / vs)\, u$]. Best fit regression models were selected (exponential vs. logarithmic) to model the inverse relationships between distance and TSS concentration for data averaged in each watershed. Those regression equations are provided in table 3.5.4-25 and define the nonlinear relationships between y = concentration (mg/l) and x = downstream distance (m).

TABLE 3.5.4-25

Nonlinear Regression Equations (with Coefficients of Determination, r^2)
for Estimating TSS Concentrations (y, mg/l) at Distances Downstream (x, m) during
In-stream Construction in Nine Watersheds within the Oregon Coast ESU to be Crossed by Pipeline Project

Subbasin and Fifth-Field Watersheds	**Wet Open–Cut Regression TSS = y Distance (m) = x**	**Fluming Regression TSS = y Distance (m) = x**	**Dam & Pump Regression TSS = y Distance (m) = x**
Coos			
Coos Bay-Frontal Pacific Ocean	y= -397.1 ln(x) + 2,860.9 r^2 = 0.986	y= -14.78 ln(x) + 106.46 r^2 = 0.986	y= -3.38 ln(x) + 24.39 r^2 = 0.986
Coquille			
North Fork Coquille River	y= -262.0 ln(x) + 2,215.8 r^2 = 0.954	y= -9.75 ln(x) + 82.46 r^2 = 0.954	y= -2.23 ln(x) + 18.89 r^2 = 0.954
East Fork Coquille River	y= -238.3 ln(x) + 2,172.7 r^2 = 0.925	y= -8.87 ln(x) + 80.85 r^2 = 0.925	y= -2.03 ln(x) + 18.52 r^2 = 0.925
Middle Fork Coquille River	y= -223.0 ln(x) + 2,000.7 r^2 = 0.933	y= -8.30 ln(x) + 74.45 r^2 = 0.933	y= -1.90 ln(x) + 17.05 r^2 = 0.933
South Umpqua			
Olalla Creek-Lookingglass Creek	y= -207.5 ln(x) + 1,882.9 r^2 = 0.930	y= -7.72 ln(x) + 70.07 r^2 = 0.930	y= -1.77 ln(x) + 16.05 r^2 = 0.930
Clark Branch-South Umpqua River	y = 1,098.9 $e^{-0.0013x}$ r^2 = 0.903	y = 40.89 $e^{-0.0013x}$ r^2 = 0.903	y = 9.37 $e^{-0.0013x}$ r^2 = 0.903
Myrtle Creek	y= -310.1 ln(x) + 2,637.8 r^2 = 0.948	y= -11.54 ln(x) + 98.16 r^2 = 0.948	y= -2.64 ln(x) + 22.48 r^2 = 0.948
Days Creek-South Umpqua River	y= -59.76 ln(x) + 526.87	y= -2.22 ln(x) + 19.61	y= -0.51 ln(x) + 4.49

TABLE 3.5.4-25 Nonlinear Regression Equations (with Coefficients of Determination, r^2) for Estimating TSS Concentrations (y, mg/l) at Distances Downstream (x, m) during In-stream Construction in Nine Watersheds within the Oregon Coast ESU to be Crossed by Pipeline Project			
Subbasin and Fifth-Field Watersheds	**Wet Open–Cut Regression TSS = y Distance (m) = x**	**Fluming Regression TSS = y Distance (m) = x**	**Dam & Pump Regression TSS = y Distance (m) = x**
	$r^2 = 0.963$	$r^2 = 0.963$	$r^2 = 0.963$
Upper Cow Creek	$y = 1{,}193.8\ e^{-0.0011x}$ $r^2 = 0.918$	$y = 44.43\ e^{-0.0011x}$ $r^2 = 0.918$	$y = 19.18\ e^{-0.0011x}$ $r^2 = 0.918$

Suspended Sediment Downstream Effects. Newcombe and Jensen (1996) developed six different models assessing effects of TSS on various fish and habitat groupings. As noted above the model addressing effects on both adult and juvenile stages of salmonids (Model 1) provides the best overall assessment of general level of severity of effects for juvenile and adult coho salmon in project area streams at the time of instream construction. Input for the model includes TSS concentration (mg/l) and duration (hours) of exposure to the suspended sediments and has the form:

$$z = a + b\,(\log_e x) + c\,(\log_e y)$$

where z = SEV score, x = duration of exposure in hours, and y = concentration of suspended sediment in mg/l. Constants a, b, and c were empirically derived for Model 1, used here, and other models (see Table 3, in Newcombe and Jensen 1996). If duration of exposure is known, and z (SEV) is set as a defined value, TSS concentration for that defined SEV score can be computed as:

$$y = e^{((z - a) - b\,(\log e\ x))\,/\,c} \text{ or } y = \exp\,(((z - a) - (b\,(\log_e x)))\,/\,c$$

In any of the Newcombe and Jensen models, there is a nearly consistent range for the whole number z, varying from z – 0.5 to z + 0.49. For example, if SEV = 3, the range for that score in the exponential equation, above would be between 2.50 and 3.49; for SEV = 5, the range is 4.50 to 5.49, and so on. For any given duration of exposure (x), the TSS concentration (y) is minimized using (z – 0.5) in the solution. Using the minimum TSS concentration for any given SEV score maximizes the predicted downstream distances for that concentration when solving the regression equations in table 3.5.4-25 for each of the three waterbody crossing methods in each of the nine watersheds.

contractor EnSite USA were asked to provide typical durations, based on their experience, for in-stream time requirements for placing and removing isolation structures for streams in different width categories. High pulses of sediment suspended during dry open-cut procedures are generated during installation and removal of isolation structures prior to and after fluming or dam-and-pump installation, trenching, pipe installation, and trench backfilling. EnSite provided the following durations of typical sediment pulses for four stream width classes during installation of stream-crossing structures: for widths ≤10 feet - 2 hours; widths >10 feet to ≤25 feet - 4 hours; >25 feet to ≤50 feet - 5 hours; and > 50 feet to ≤100 feet, 6 hours. EnSite also provided the following durations of sediment pulses for the same four width classes during removal of dry open-cut crossing structures: for widths ≤10 feet - 2 hours; widths >10 feet to ≤25 feet - 3 hours; >25 feet to ≤50 feet - 4 hours; and > 50 feet to ≤100 feet, 5 hours. Numbers of streams in range of Oregon Coast coho and streams with coho and streams with assumed coho presence within those four width categories that would be crossed by the Pipeline in each watershed are provided in table 3.5.4-26 using the worst case of structure installation. In general, there are very few streams with widths >25 feet.

TABLE 3.5.4-26

Numbers of Streams in Range of Oregon Coast Coho within Four Width Classes that Would Be Crossed by Dry Open-Cuts and Estimated Durations (Worst Case) for In-stream Sediment Generating Actions

Subbasin and Fifth-Field Watersheds	Total Number of Streams Crossed	Total Streams Crossed with Coho a/	Number by Width Class and Duration b/			
			≤10 ft 2 hours	>10 to ≤25ft 4 hours	>25 to ≤50 ft 5 hours	>50 ft 6 hours
Coos						
Coos Bay-Frontal Pacific Ocean	10	7	7	3	0	0
Coquille						
North Fork Coquille River	7	3	3	2	2	0
East Fork Coquille River	14	8	8	5	0	1
Middle Fork Coquille River	22	0	13	1	2	0
South Umpqua						
Olalla Creek-Lookingglass Creek	17	5	13	2	1	1
Clark Branch-South Umpqua River	13	4	6	4	1	1
Myrtle Creek	14	5	9	3	2	0
Days Creek-South Umpqua River	15	4	5	8	1	1
Upper Cow Creek	8	0	4	2	2	0

a/ Includes assumed presence from table 3.5.4-4 but not coho in the Coos Bay Estuary
b/ Durations for structure installation by width class provided by personnel with pipeline contractor EnSite USA

SEV Scores Downstream. Durations for in-stream sediment generating actions provided by EnSite USA from table 3.5.4-26 are used in table 3.5.4-27 with minimun TSS concentrations for specific SEV scores ranging from minor behavioral effects (SEV = 1, alarm reaction) to extreme sublethal effects (SEV = 8, major physiological stress) to estimate the maximum downstream distances at which those severity of ill effects would occur to Oregon Coast coho by in-stream construction across streams in the four watersheds.

Failures of isolation structures to exclude streamflow during fluming or dam-and-pump would result in suspended sediment entrained downstream, assumed to be equal to TSS levels generated during wet open-cut in table 3.5.4-27. Scenarios of exposures as long as six hours could occur while work crews repair the failed isolation structures. Six-hour exposure would cause SEV = 7 (moderate habitat degradation, impaired homing) for all stream widths and could cause major physiological stress (SEV = 8) to Oregon Coast coho for relatively short distances downstream (<55 meters) in six of the nine watersheds in table 3.5.4-27. Longer exposures could be required if dry open-cut construction (flume or dam- and-pump) is abandoned and the waterbody crossing is completed using wet open-cut construction.

Values of 0, in columns associated with specific SEV scores and TSS concentrations in table 3.5.4-27, indicate that there are no distances downstream from construction by wet open-cut or dry open-cut (flume or damp-and-pump) that the specified TSS concentration and exposure duration during a particular crossing method would generate the SEV score for that column in that watershed. For example, there is no distance downstream for construction during fluming in the Days Creek-South Umpqua River watershed at which a SEV score = 5 if the TSS value of 59.4 mg/l and the exposure duration is 2 hours.

The modeling results provided in table 3.5.4-27 provide the maximum downstream distances that TSS generated by each of the crossing methods would attenuate to the concentrations shown (rows labeled TSS (mg/L) with specific durations based on stream width (groupings labeled with width category followed by hours) that would yield a specific SEV score (columns SEV=1 to SEV=8) for fluming or dam-and-pump crossing methods. Using estimates for fluming in streams ≤10 feet wide within Coos Bay Frontal-Pacific Ocean watershed as an example, for the range of distance = 0 (actually 50 meters downstream from the pipe trench as applied in the Reid et al. 2004 model for average TSS generated by all activities) to distance = 24 m, SEV =5 with TSS concentration = 59.4 mg/l and duration = 2 hours. Other estimates include:

- From downstream distance = 24 m to distance = 478 m, SEV = 4 with TSS concentration = 15.3 mg/l and duration = 2 hours.
- From downstream distance = 478 m to distance = 1,031 m, SEV = 3 with TSS concentration = 3.95 mg/l and duration = 2 hours
- From downstream distance = 1,031 m to distance = 1,257 m, SEV = 2 with TSS concentration = 1.02 mg/l and duration = 2 hours.
- From downstream distance = 1,257 m to distance = 1,323 m, SEV = 1 with TSS concentration = 0.26 mg/l and duration = 2 hours.
- Past distance = 1,323 m downstream, SEV = 0.

TABLE 3.5.4-27

Maximum Distances Downstream to Attain SEV Scores 1 to 8 with TSS Concentrations and Durations due to Wet Open-Cut, Flume, and Dam-and-Pump Crossing Procedures in Each Watershed within the Oregon Coast Coho ESU to be Crossed by the Pipeline Project

Construction Method Stream Widths	Duration a/	Concentration	SEV=1	SEV=2	SEV=3	SEV=4	SEV=5	SEV=6	SEV=7	SEV=8
Wet Open Cut										
All Stream Widths	**6 hours**	**TSS (mg/L) =**	**0.11**	**0.41**	**1.60**	**6.21**	**24.1**	**93.2**	**361**	**1,399**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,346	1,345	1,341	1,326	1,268	1,065	542	40
North Fork Coquille River			4,701	4,695	4,674	4,593	4,290	3,295	1,185	23
East Fork Coquille River			9,092	9,081	9,035	8,862	8,223	6,152	1,999	26
Middle Fork Coquille River			7,867	7,856	7,814	7,655	7,066	5,182	1,559	15
Olalla Creek-Lookingglass Creek			8,743	8,731	8,681	8,490	7,790	5,582	1,534	10
Clark Branch-South Umpqua River			7,107	6,065	5,023	3,981	2,940	1,898	856	0
Myrtle Creek			4,946	4,941	4,923	4,850	4,579	3,663	1,544	54
Days Creek-South Umpqua River			6,731	6,697	6,565	6,078	4,508	1,417	16	0
Upper Cow Creek			8,474	7,243	6,012	4,781	3,549	2,318	1,087	0
Fluming										
Widths ≤10 ft =	**2 hours**	**TSS (mg/L) =**	**0.26**	**1.02**	**3.95**	**15.3**	**59.4**	**230**	**9,520**	**12,906**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,323	1,257	1,031	478	24	0	0	0
North Fork Coquille River			4,578	4,236	3,135	977	11	0	0	0
East Fork Coquille River			8,830	8,107	5,824	1,617	11	0	0	0
Middle Fork Coquille River			7,625	6,960	4,887	1,243	6	0	0	0
Olalla Creek-Lookingglass Creek			8,454	7,664	5,241	1,202	4	0	0	0
Clark Branch-South Umpqua River			3,881	2,839	1,787	755	0	0	0	0
Myrtle Creek			4,836	4,529	3,512	1,312	29	0	0	0
Days Creek-South Umpqua River			5,991	4,262	1,139	7	0	0	0	0
Upper Cow Creek			4,661	3,430	2,199	968	0	0	0	0
Widths >10 ft to ≤25 ft =	**4 hours**	**TSS (mg/L) =**	**0.15**	**0.58**	**2.24**	**8.67**	**33.6**	**130**	**504**	**1,952**

TABLE 3.5.4-27

Maximum Distances Downstream to Attain SEV Scores 1 to 8 with TSS Concentrations and Durations due to Wet Open-Cut, Flume, and Dam-and-Pump Crossing Procedures in Each Watershed within the Oregon Coast Coho ESU to be Crossed by the Pipeline Project

Construction Method Stream Widths	Duration a/	Concentration	SEV=1	SEV=2	SEV=3	SEV=4	SEV=5	SEV=6	SEV=7	SEV=8
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,333	1,295	1,158	749	139	0	0	0
North Fork Coquille River			4,632	4,433	3,739	1,934	150	0	0	0
East Fork Coquille River			8,945	8,523	7,068	3,424	206	0	0	0
Middle Fork Coquille River			7,731	7,342	6,011	2,770	138	0	0	0
Olalla Creek-Lookingglass Creek			8,581	8,117	6,547	2,847	113	0	0	0
Clark Branch-South Umpqua River			4,319	3,277	2,235	1,193	152	0	0	0
Myrtle Creek			4,885	4,707	4,076	2,335	270	0	0	0
Days Creek-South Umpqua River			6,307	5,202	2,466	137	0	0	0	0
Upper Cow Creek			5,179	3,948	2,717	1,486	255	0	0	0
Widths >25 ft to ≤50 ft =	**5 hours**	**TSS (mg/L) =**	**0.12**	**0.48**	**1.86**	**7.21**	**28**	**108**	**419**	**1,625**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,335	1,304	1,187	826	203	1	0	0
North Fork Coquille River			4,644	4,477	3,885	2,244	268	0	0	0
East Fork Coquille River			8,970	8,616	7,374	4,033	389	0	0	0
Middle Fork Coquille River			7,754	7,428	6,289	3,299	271	0	0	0
Olalla Creek-Lookingglass Creek			8,608	8,220	6,873	3,436	234	0	0	0
Clark Branch-South Umpqua River			4,460	3,418	2,376	1,334	293	0	0	0
Myrtle Creek			4,895	4,746	4,211	2,648	439	0	0	0
Days Creek-South Umpqua River			6,378	5,433	2,919	263	0	0	0	0
Upper Cow Creek			5,346	4,115	2,884	1,652	421	0	0	0
Widths >50 ft =	**6 hours**	**TSS (mg/L) =**	**0.11**	**0.41**	**1.60**	**6.21**	**24.1**	**93.2**	**361**	**1,399**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,337	1,310	1,208	885	264	2	0	0
North Fork Coquille River			4,652	4,508	3,990	2,487	399	0	0	0
East Fork Coquille River			8,987	8,682	7,592	4,516	604	0	0	0
Middle Fork Coquille River			7,770	7,488	6,488	3,724	433	0	0	0
Olalla Creek-Lookingglass Creek			8,628	8,291	7,107	3,913	387	0	0	0
Clark Branch-South Umpqua River			4,574	3,533	2,491	1,450	408	0	0	0
Myrtle Creek			4,903	4,774	4,306	2,889	615	2	0	0
Days Creek-South Umpqua River			6,428	5,599	3,280	413	0	0	0	0
Upper Cow Creek			5,482	4,251	3,020	1,789	557	0	0	0
Dam-and-Pump										
Widths ≤10 ft =	**2 hours**	**TSS (mg/L) =**	**0.26**	**1.02**	**3.95**	**15.3**	**59.4**	**230**	**9520**	**12,906**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,246	996	419	15	0	0	0	0
North Fork Coquille River			4,180	2,978	801	5	0	0	0	0
East Fork Coquille River			7,989	5,503	1,299	5	0	0	0	0
Middle Fork Coquille River			6,851	4,600	983	2	0	0	0	0
Olalla Creek-Lookingglass Creek			7,536	4,911	935	2	0	0	0	0
Clark Branch-South Umpqua River			2,747	1,705	663	0	0	0	0	0
Myrtle Creek			4,478	3,363	1,108	15	0	0	0	0
Days Creek-South Umpqua River			4,020	909	3	0	0	0	0	0
Upper Cow Creek			3,322	2,090	859	0	0	0	0	0
Widths >10 ft to ≤25 ft =	**4 hours**	**TSS (mg/L) =**	**0.15**	**0.58**	**2.24**	**8.67**	**33.6**	**130**	**504**	**1,952**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,289	1,136	695	104	0	0	0	0

Construction Method Stream Widths	Duration a/	Concentration	SEV=1	SEV=2	SEV=3	SEV=4	SEV=5	SEV=6	SEV=7	SEV=8
North Fork Coquille River			4,400	3,632	1,727	97	0	0	0	0
East Fork Coquille River			8,451	6,845	3,024	128	0	0	0	0
Middle Fork Coquille River			7,276	5,808	2,426	82	0	0	0	0
Olalla Creek-Lookingglass Creek			8,040	6,310	2,468	65	0	0	0	0
Clark Branch-South Umpqua River			3,185	2,143	1,101	60	0	0	0	0
Myrtle Creek			4,676	3,977	2,122	186	0	0	0	0
Days Creek-South Umpqua River			5,032	2,170	83	0	0	0	0	0
Upper Cow Creek			3,839	2,608	1,377	146	0	0	0	0
Widths >25 ft to ≤50 ft =	**5 hours**	**TSS (mg/L) =**	**0.12**	**0.48**	**1.86**	**7.21**	**28**	**108**	**419**	**1,625**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,298	1,168	777	160	0	0	0	0
North Fork Coquille River			4,449	3,793	2,043	186	0	0	0	0
East Fork Coquille River			8,556	7,178	3,637	261	0	0	0	0
Middle Fork Coquille River			7,373	6,111	2,955	177	0	0	0	0
Olalla Creek-Lookingglass Creek			8,155	6,665	3,051	148	0	0	0	0
Clark Branch-South Umpqua River			3,326	2,284	1,243	201	0	0	0	0
Myrtle Creek			4,721	4,125	2,446	323	0	0	0	0
Days Creek-South Umpqua River			5,285	2,624	174	0	0	0	0	0
Upper Cow Creek			4,006	2,775	1,544	313	0	0	0	0
Widths >50 ft =	**6 hours**	**TSS (mg/L) =**	**0.11**	**0.41**	**1.60**	**6.21**	**24.1**	**93.2**	**361**	**1,399**
Watersheds:			**Maximum Distance (m) to Equal SEV Level with Duration and Concentration b/**							
Coos Bay-Frontal Pacific Ocean			1,305	1,192	839	215	1	0	0	0
North Fork Coquille River			4,484	3,908	2,294	292	0	0	0	0
East Fork Coquille River			8,629	7,419	4,131	428	0	0	0	0
Middle Fork Coquille River			7,440	6,330	3,386	300	0	0	0	0
Olalla Creek-Lookingglass Creek			8,235	6,922	3,533	261	0	0	0	0
Clark Branch-South Umpqua River			3,441	2,400	1,358	316	0	0	0	0
Myrtle Creek			4,752	4,231	2,698	472	1	0	0	0
Days Creek-South Umpqua River			5,467	2,992	290	0	0	0	0	0
Upper Cow Creek			4,142	2,911	1,680	449	0	0	0	0

a/ Durations for wet open-cut indicate time to repair isolation structures after failure. Durations for dry open-cut from table 3.5.4-26.

b/ Maximum downstream distances derived by solving SEV equation ($Y = e^{((z - a) - b (\log_e x)) / c}$) for concentration (Y) by minimizing SEV scores (Z -0.5) and using durations (hours) from table 3.5.4-26. Concentrations derived from appropriate equations, table 3.5.4-25.

Evident from examining table 3.5.4-27, no flumed crossings in any of the four watersheds would cause SEV scores greater than 5 (sublethal effects including minor physiological; increase in rate of coughing; increased respiration rate) except for distances 2 meters or less downstream when fluming waterbodies >25 feet wide in the Coos Bay Frontal-Pacific Ocean and Myrtle Creek watersheds. Likewise, no crossings with dam-and-pump procedures applied would cause SEV scores greater than 4 (sublethal effects, including short-term reduction in feeding rates; short-term reduction in feeding success) except for distances of 1 meter downstream when fluming waterbodies >50 feet wide in the Coos Bay Frontal-Pacific Ocean and Myrtle Creek watersheds. Except for possible failures of isolation structures that would cause TSS concentrations similar to wet open-cut procedures with exposures as long as 6 hours (discussed above), no in-stream construction would cause moderate or major physiological stress (SEV scores 6 to 8, respectively; see Newcombe and Jensen 1996) or cause lethal conditions for salmon (SEV > 8).

A failure of crossing isolation structures lasting up to 6 hours could cause a SEV score of 8 (major physiological stress; long-term reduction in feeding rate/feeding success; poor condition) up to 40 meters downstream and a SEV score of 7 (moderate habitat degradation, impact on homing) for at least 542 meters downstream from dry open cut crossings within five streams with critical habitat in the Coos Bay Frontal-Pacific Ocean watershed; SEV score of 8 up to 23 meters and SEV score of 7 up to 1,185 meters of three streams crossed by dry open-cut with critical habitat within the North Fork Coquille River watershed; SEV score of 8 up to 26 meters and SEV score of 7 up to 1,999 meters of two streams crossed by dry open-cut with critical habitat within the East Fork Coquille River watershed; SEV score of 8 up to 10 meters and SEV score of 7 up to 1,534 meters of two streams crossed by dry open-cut with critical habitat within the Olalla Creek-Lookingglass Creek watershed; SEV score of 7 up to 856 meters of four streams crossed by dry open-cut with critical habitat within the Clark Branch-South Umpqua River watershed; SEV score of 8 up to 54 meters and SEV score of 7 up to 1,544 meters of three streams crossed by dry open-cut with critical habitat within the Myrtle Creek watershed; and SEV score of 7 up to 16 meters of four streams crossed by dry open-cut with critical habitat within the Days Creek-South Umpqua River watershed. To ensure a SEV score less than 7 (moderate habitat degradation, impact on homing), in-stream work to repair a failed containment structure would likely have to be restricted to less than 4 hours.

Similar analyses were conducted for individual streams to be crossed in each watershed that provide critical habitat and fresh water EFH for Oregon Coast coho salmon. Based on the width-specific durations of exposure (table 3.5.4-26) and the minimum TSS concentrations and concomitant miximum distances downstream produced by fluming or dam-and-pump construction methods to equate to specific SEV scores (table 3.5.4-27), the greatest risk to Oregon Coast coho would be 1 to 2 meters downstream during fluming in streams greater than 25 feet wide within the Coos Bay Frontal and Myrtle Creek watersheds (table 3.5.4-27). At those distances, SEV = 6 causing moderate physiological stress for juvenile or adult coho.

The possibility for known or assumed salmon-bearing streams to be affected by TSS generated during dry open-cutting neighboring streams was explored at the request of NMFS (NMFS 2017i). Distances of nearest neighboring streams from each salmon-bearing stream are included in table 3.5.4-28. Nearest-neighbor streams are only considered for effects if they are within the same fifth field watershed as the targeted stream. Distance for the confluence of a nearest neighbor stream with a coho-bearing stream is assumed to be the same as the distance between the two stream crossing sites, forming an equilateral triangle. For each neighboring stream, maximum downstream distances for minimum TSS concentrations that produced the highest SEV score were computed with the same procedure described and available in table 3.5.4-27. If a stream had bedrock substrate, dam-and-pump crossing was assumed, otherwise a flumed crossing was assumed.

TABLE 3.5.4-28

Waterbodies with Critical Habitat and Known or Assumed to Support Oregon Coast Coho with Risks of TSS Effects Downstream Generated during Crossing and Risks of TSS Effects Generated by Crossing Nearest Neighbor Waterbodies.

Waterbodies Supporting Oregon Coast Coho, Critical Habitat, and EFH								Nearest Neighbor with Risk of Downstream Effects to Coho				
Waterbodies Crossed and Waterbody ID	**Pipeline Milepost (MP)**	**Critical Habitat**	**EFH**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS Downstream During Crossing (rationale) a/**	**Maximum Distance (m) Downstream from Crossing with Highest SEV Score b/**	**Crossing Distance (m) from Coho Stream c/**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS at Confluence by Crossing Nearest Neighbor (rationale) a/**	**Maximum Distance (m) Downstream from Nearest Neighbor with Highest SEV Score b/**
Coos Subbasin (HUC 17100304), Coos Bay-Frontal Pacific Ocean (HUC 1710030403) Fifth-Field Watershed, Coos County												
Coos Bay (NE-26)	0.28 to 1.00	Yes	Migration, Rearing	HDD	N/A	None (HDD)	N/A	N/A	N/A	N/A	None (distance)	N/A
Coos Bay (NE-26)	1.46 to 3.02	Yes	Migration, Rearing	HDD	N/A	None (HDD)	N/A	N/A	N/A	N/A	None (distance)	N/A
Trib to Coos Bay (NW-117/EE-6)	6.39R	No	Unknown	Fluming	11	Moderate-High (perennial)	139 SEV=5	3,026	Fluming	24	None-Low (distance)	>1,333 SEV=0
Willanch Slough (EE-7)	8.27R	Yes	Migration, Rearing	Fluming	24	Moderate-High (perennial)	139 SEV=5	338	Fluming	13	None-Low (intermittent)	749 SEV=4
Trib. to Cooston Channel (Echo Creek) (SS-100-002)	10.21R	No	Spawning, Rearing	Fluming	9	None-Low (intermittent)	24 SEV=5	1,481	HDD	650	None (HDD)	N/A
Coos River (BSP-119)	11.13R	Yes	Migration, Rearing	HDD	650	None (HDD)	N/A	676	Fluming	6	Moderate-High (perennial)	1,031 SEV=3
Vogel Creek (SS-100-005)	11.55BR	Yes	Spawning, Rearing	Fluming	6	Moderate-High (perennial)	24 SEV=5	531	Fluming	10	None-Low (intermittent)	1,031 SEV=3
Stock Slough (BR-S-36)	15.11BR	Yes	Spawning, Rearing	Fluming	8	None-Low (intermittent)	24 SEV=5	338	Fluming	9	None-Low (intermittent	478 SEV=4
Stock Slough (EE-SS-9068)	15.32BR	Yes	Spawning, Rearing	Fluming	9	None-Low (intermittent)	24 SEV=5	338	Fluming	8	None-Low (intermittent	478 SEV=4
Coquille Subbasin (HUC 17100305), North Fork Coquille River (HUC 1710030504) Fifth-Field Watershed, Coos County,												
Steinnon Creek (BR-S-63)	24.32BR	Yes	Migration, Rearing	Fluming	17	Moderate-High (perennial)	150 SEV=5	2,576	Fluming	3	None-Low (intermittent	3,135 SEV=3
North Fork Coquille River (BSP-207)	23.06	Yes	Migration, Rearing	Fluming	47	Moderate-High (perennial)	268 SEV=5	547	Fluming	2	None-Low (intermittent	977 SEV=4
Middle Creek (BSP-133)	27.04	Yes	Migration, Rearing	Fluming	48	Moderate-High (perennial)	268 SEV=5	48	Fluming	7	None-Low (intermittent	977 SEV=4
Coquille Subbasin (HUC 17100305), East Fork Coquille River (HUC 1710030503) Fifth-Field Watershed, Coos County												
Trib. To E. Fork Coquille (BSP-77)	28.86	No	Assumed	Dam-and-Pump	8	None-Low (bedrock)	5 SEV=4	708	Fluming	6	None-Low (intermittent	1,617 SEV=4
Trib. To E. Fork Coquille (BSP-74)	29.30	No	Assumed	Fluming	6	None-Low (intermittent)	11 SEV=5	274	Dam-and-Pump	4	None-Low (bedrock)	1,299 SEV=3
Trib. To E. Fork Coquille (BSI-76)	29.47	No	Assumed	Dam-and-Pump	4	None-Low (intermittent)	5 SEV=4	274	Fluming	6	None-Low (intermittent)	1,617 SEV=4

TABLE 3.5.4-28

Waterbodies with Critical Habitat and Known or Assumed to Support Oregon Coast Coho with Risks of
TSS Effects Downstream Generated during Crossing and Risks of TSS Effects Generated by Crossing Nearest Neighbor Waterbodies.

Waterbodies Supporting Oregon Coast Coho, Critical Habitat, and EFH								Nearest Neighbor with Risk of Downstream Effects to Coho				
Waterbodies Crossed and Waterbody ID	**Pipeline Milepost (MP)**	**Critical Habitat**	**EFH**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS Downstream During Crossing (rationale) a/**	**Maximum Distance (m) Downstream from Crossing with Highest SEV Score b/**	**Crossing Distance (m) from Coho Stream c/**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS at Confluence by Crossing Nearest Neighbor (rationale) a/**	**Maximum Distance (m) Downstream from Nearest Neighbor with Highest SEV Score b/**
East Fork Coquille River (BSP-71)	29.85	Yes	Migration, Rearing	Fluming	75	Moderate-High (perennial)	604 SEV=5	596	Fluming	10	Moderate-High (perennial)	1,617 SEV=4
Trib. To E. Fork Coquille (AA-003-007B)	30.29	No	Assumed	Fluming	10	Moderate-High (perennial)	11 SEV=5	113	Fluming	10	Moderate-High (perennial)	1,617 SEV=4
Elk Creek (BSP-57)	32.40	No	Assumed	Fluming	10	Moderate-High (perennial)	11 SEV=5	64	Dam-and-Pump	5	None-Low (bedrock)	1,299 SEV=3
Trib. To Elk Creek (BSP-55)	32.44	No	Assumed	Dam-and-Pump	5	None-Low (bedrock)	5 SEV=4	64	Dam-and-Pump	10	None-Low (bedrock)	1,299 SEV=3
South Fork Elk Creek (CSP-5)	34.46	Yes	Migration, Rearing	Dam-and-Pump	15	None-Low (bedrock))	128 SEV=4	1,690	Fluming	4	None-Low (intermittent	1,617 SEV=4
Coquille Subbasin (HUC 17100305), Middle Fork Coquille River (HUC 1710030501) Fifth-Field Watershed, Coos County												
None												
South Umpqua (HUC 17100302) Subbasin, Olalla Creek-Lookingglass Creek (HUC 1710030212) Fifth-Field Watershed, Douglas County												
Trib. to Shields Creek (BSI-202)	55.90	No	Assumed	Fluming	20	None-Low (intermittent)	113 SEV=5	64	Fluming	8	None-Low (intermittent)	1,202 SEV=4
Trib. to Olalla Creek (BSI-138)	57.31	No	Assumed	Fluming	8	None-Low (intermittent)	4 SEV=5	274	Dam-and-Pump	5	None-Low (bedrock)	935 SEV=3
Olalla Creek (BSP-155)	58.78	Yes	Spawning, Rearing	Fluming	87	Moderate-High (perennial)	387 SEV=5	370	Dam-and-Pump	11	None-Low (bedrock)	2,468 SEV=3
Trib. to Olalla Creek (BSI-129)	59.65	No	Assumed	Fluming	16	None-Low (intermittent)	113 SEV=5	579	Fluming	8	None-Low (intermittent)	1,202 SEV=4
McNabb Creek (NSP-13)	60.48	Yes	Spawning, Rearing	Dam-and-Pump	12	None-Low (bedrock)	65 SEV=4	563	Dam-and-Pump	6	None-Low (bedrock)	935 SEV=3
South Umpqua (HUC 17100302) Subbasin, Clark Branch-South Umpqua River (HUC 1710030211) Fifth-Field Watershed, Douglas County												
Kent Creek (BSP-240)	63.97	Yes	Spawning, Rearing	Fluming	17	Moderate-High (perennial)	152 SEV=5	2,881	Dam-and-Pump	25	None-Low (bedrock)	2.143 SEV=2
Rice Creek (S2-04; BSP-227)	65.76	Yes	Spawning, Rearing	Dam-and-Pump	25	None-Low (bedrock)	60 SEV=4	1,916	Dam-and-Pump	30	None-Low (bedrock)	2,284 SEV=2
Willis Creek (BSP-168)	66.95	Yes	Spawning, Rearing	Dam-and-Pump	30	None-Low (bedrock)	201 SEV=4	80	Dam-and-Pump	3	None-Low (bedrock)	663 SEV=3
South Umpqua River (BSP-26)	71.27	Yes	Migration	Direct Pipe	35	None (Direct Pipe	N/A	129	Fluming	3	None-Low (intermittent)	663 SEV=3
South Umpqua (HUC 17100302) Subbasin, Myrtle Creek (HUC 1710030210) Fifth-Field Watershed, Douglas County												
Rock Creek (EE-SS-9032)	75.33	No	Assumed	Fluming	17	Moderate-High (perennial)	270 SEV=5	11	Fluming	16	Moderate-High (perennial)	270 SEV=5

TABLE 3.5.4-28

Waterbodies with Critical Habitat and Known or Assumed to Support Oregon Coast Coho with Risks of TSS Effects Downstream Generated during Crossing and Risks of TSS Effects Generated by Crossing Nearest Neighbor Waterbodies.

Waterbodies Supporting Oregon Coast Coho, Critical Habitat, and EFH								Nearest Neighbor with Risk of Downstream Effects to Coho				
Waterbodies Crossed and Waterbody ID	**Pipeline Milepost (MP)**	**Critical Habitat**	**EFH**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS Downstream During Crossing (rationale) a/**	**Maximum Distance (m) Downstream from Crossing with Highest SEV Score b/**	**Crossing Distance (m) from Coho Stream c/**	**Proposed Crossing Method**	**OHM Width (feet)**	**Risk of TSS at Confluence by Crossing Nearest Neighbor (rationale) a/**	**Maximum Distance (m) Downstream from Nearest Neighbor with Highest SEV Score b/**
Trib. to Rock Creek (EE-SS-9033)	75.34	No	Assumed	Fluming	16	Moderate-High (perennial)	270 SEV=5	11	Fluming	17	Moderate-High (perennial)	270 SEV=5
Bilger Creek (BSP-1)	76.38	Yes	Spawning, Rearing	Fluming	6	Moderate-High (perennial)	29 SEV=5	1,674	Fluming	21	Moderate-High (perennial)	2,335 SEV=4
North Myrtle Creek (NSP-37)	79.12	Yes	Spawning, Rearing	Dam-and-Pump	31	None-Low (bedrock)	323 SEV=4	48	Dam-and-Pump	8	None-Low (bedrock)	1,108 SEV=3
South Myrtle Creek (BSP-172)	81.19	Yes	Spawning, Rearing	Dam-and-Pump	41	None-Low (bedrock)	323 SEV=4	306	Fluming	2	None-Low (intermittent)	1,312 SEV=4
South Umpqua (HUC 17100302) Subbasin, Days Creek-South Umpqua River (HUC 1710030205) Fifth-Field Watershed, Douglas County												
Fate Creek (BSP-232)	88.48	Yes	Spawning, Rearing	Dam-and-Pump	20	None-Low (bedrock)	83 SEV=3	193	Dam-and-Pump	23	None-Low (bedrock)	2,170 SEV=2
Days Creek (BSP-233)	88.60	Yes	Spawning, Rearing	Dam-and-Pump	23	None-Low (bedrock)	83 SEV=3	193	Dam-and-Pump	20	None-Low (bedrock)	2,170 SEV=2
Saint John Creek (ASP-303)	92.62	Yes	Spawning, Rearing	Fluming	15	Moderate-High (perennial)	137 SEV=4	3,880	Diverted Open-Cut	160	Moderate-High (perennial)	N/A
South Umpqua River (ASP-196)	94.73	Yes	Rearing, Migration	Diverted Open-Cut	160	Moderate-High (perennial)	N/A	193	Fluming	10	None-Low (intermittent)	1,139 SEV=3
South Umpqua (HUC 17100302) Sub-basin, Upper Cow Creek (HUC 1710030206) Fifth field Watershed, Douglas County												
None												

a/ Risks from downstream TSS by crossing all streams with bedrock substrate are considered None to Low; risks of downstream TSS crossing intermittent streams are considered None to Low; risks from downstream TSS by crossing perennial streams are considered Moderate to High.
b/ Highest SEV scores for each given crossing method and stream width category in specific watershed provided in table 3.5.4-27
c/ Distance for confluence of nearest neighbor with coho stream is assumed to be the same as the distance between the two stream crossing sites, forming an equilateral triangle.

If the nearest neighbor distance to a salmon-bearing stream exceeded the maximum distance with highest SEV score downstream from the neighbor stream, then "None-Low" risk of TSS to the salmon-bearing stream produced during construction of the neighboring stream is assumed. Construction across nearest neighbors could generate some level of risk for elevated TSS concentrations in the known or assumed salmon-bearing streams crossed in the range of Oregon Coast coho. In table 3.5.4-28, risks from downstream TSS by crossing any stream with a bedrock substrate are considered "None-Low" because fine sediment (silt and clay) would not be mobilized in the water column; risks of downstream TSS crossing intermittent streams are considered "None-Low" because those streams would likely be dry during the in-stream construction period (ODFW 2008); risks from downstream TSS by crossing perennial streams are considered "Moderate-High" because flowing water would be present at the time of construction. The highest risk for SEV = 5 (causing minor physiological stress) would occur at the confluence of the nearest neighbor to Rock Creek (Myrtle Creek watershed). All other SEV values at a nearest neighbor's confluence to coho-occupied and streams with critical habitat are SEV ≤ 4. However, the estimated TSS concentration at any nearest neighbor tributary confluence would be diluted by greater flow rates and water volumes in larger streams occupied by coho and therefore the estimated SEV in the coho stream would be considerably less than at the confluence.

A similar analysis of sediment effects on EFH streams known to support Oregon Coast coho that are not directly crossed by the Pipeline but have a tributary that would be crossed and which could have an effect on the EFH fish-bearing stream is provided in Section 4.2.3.2. However, conducting the analysis required a different methodology than used in the nearest neighbor analysis provided for Oregon Coast coho, above.

Downstream effects and maximum SEV levels that could occur during diverted open-cut to cross the South Umpqua River at MP 94.73 are unknown. As discussed below, sediment generated by diverted open cut of the South Umpqua River would not severely impact juvenile or adult salmonids or salmon eggs or larvae downstream due, in part, to the short downstream transport distance of very coarse pebbles, but also because the grain size would not be within the range of particulates that cause adverse effects to fish under any duration of exposure. There would be short-term turbidity increases for short distances lasting for several hours during portions of the installation and removal of the diversion structures for the proposed diverted open-cut crossing of the South Umpqua River. However, suspended sediment generated during construction at this crossing would likely be less than levels that cause minor physiological stress for fish (SEV=5).

Suspended Sediment – HDD

The Coos River at MP 11.13 is the only site within the riverine analysis area proposed to be crossed using HDD. At that location, Coos River is tidally influenced and the analysis of suspended sediment associated with HDD was discussed above with effects to HDD across the Coos Bay Estuary, estuarine analysis area.

Suspended Sediment – DP Crossing

DP technology would be used to cross the South Umpqua River at MP 71.3. Like HDD, DP crossings use a bentonite lubricant that theoretically could have an inadvertent return to the surface where it could enter the water contributing to suspended sediment levels. DPs are completed using an articulated, steerable MTBM mounted on the leading end of the product pipe or casing which is jacked into position using a pipe thrusting machine mounted at or near the ground surface. Soil and rock are excavated by the cutting head and removed through pressurized slurry pipes to the launching pit at a rate that is balanced with the advance rate of the machine, as the MTBM and pipe are jacked through the formation. A pipe-thrusting machine located in or near the launching pit provides the necessary force to advance the product pipe and provide the face pressure required for excavation. Small sections of pipe are welded to the back of subsequent sections after each section is advanced. Friction between the pipe and surrounding soil can create significant resistance during DP installation. To reduce the frictional resistance, over cutting is employed to create a small annular space between the pipe and external soil. The over cut is typically on the order of one to two inches.

The use of bentonite slurry helps reduce the frictional resistance between the pipe and soil as well as reducing the risk of collapse of the annulus around the pipe. Bentonite lubrication is typically added from the launch seal and from a specialized lubrication ring located behind the MTBM and in front of the jacking pipe. According to GeoEngineers' Technology Overview for Direct Pipe (see appendix E), the bentonite lubrication system used to lubricate the annulus between the product pipe and the excavation is introduced at a relatively low pressure reducing the potential for hydraulic fracture and inadvertent drilling fluid returns. Because the excavated hole is continuously supported and the risk of hydraulic fracture is low, the Direct Pipe alignment can be designed much shallower than is typical for HDD. Because of the limited amount of lubricant used and relatively low pressure of this construction, the chance of any inadvertent return occurring is remote. Therefore, the chance of accidental contribution of increased suspended sediment to this crossing is unlikely and adverse effects to Oregon Coast coho salmon in this area would be unsubstantial.

Suspended Sediment – Diverted Open Cut

The diverted open-cut crossing method would require an in-stream tie-in, but it would be made in the dry behind the diversion structure. During the crossing, initial trenching would first occur on the dry side of the river; however, depending on the water levels during the season, it may be necessary to install a diversion to push or divert the flow to at least the middle of the river. PCGP is proposing a diverted open-cut at the eastern crossing of the South Umpqua River at MP 94.7 because the river is too wide to utilize other dry crossing methods (flume or dam-and-pump).

The South Umpqua River channel is sufficiently flat, wide, and shallow to divert all of the river flow to one side or bank of the river while work is proceeding in the dry on the opposite bank. The eastern crossing of the South Umpqua River would require TEWAs to be located in the river and would require equipment to work in the river to place the diversion structures or dams to divert the river flow from one side of the river and then to the other. The diversion could be constructed using portadams, aqua dams, steel plates, plastic sheeting, and/or sand bags to divert the river's flow temporarily away from the work area in order to minimize contact between streamflow and the excavation and backfill activities. This would require PCGP to place equipment within the stream to install, maintain, and ultimately remove the diversion structures. PCGP estimates the crossing would take a minimum of 14 days to complete, including three to four days of in-stream work to install, rearrange, and remove the diversion structures.

Once the construction right-of-way has been isolated by the diversions and/or sediment control devices, trenching would proceed to approximately the middle of the river. Trench spoil would be stored within the stream channel below the diversion or sediment control structures to ensure that sedimentation from saturated materials does not flow back into the river. After the trench has been completed, a section of pipe would be placed in the trench. Trench boxes or another marker form would be placed at the end of the pipe section in the middle of the riverbed for the tie-in. The trench would be backfilled and the streambed restored to the original contour configuration, except for the immediate area around the tie-in.

The diversion structure would then be removed and rearranged to divert the flow temporarily to the other side or dry side of the river in order to minimize contact between streamflow and the excavation and backfill activities. This would again require PCGP to place equipment within the stream to rearrange the diversion structures. Once the diversion structures have been properly reconfigured and extended beyond the tie-in location and the river flow diverted to the opposite side of the river, excavation for the other section of pipe would begin. Trenching would proceed across the river bed to the tie-in point in the middle of the river where it would be uncovered. Once the excavation is complete, the second pipe section would be carried in and tied into the first section. After the tie-in has been made, the streambed would be restored to its original contours and configuration and the diversions structures would be removed. Streambanks would be re-established and stabilized.

During the diverted open-cut at the eastern crossing of the South Umpqua River, multiple discharge pumps would be required to keep the tie-in area dry while the welds are being made and to control any flow seepage in the work areas. The discharge from this activity would occur to a straw bale discharge structure located in an upland area as far away from the river as possible to prevent any silt-laden water from flowing into the river.

GeoEngineers (see appendix E.2 to PCGP's Resource Report 2) provided results of sampled grain-size diameters of pebbles counted at the proposed diverted open-cut crossing site in the South Umpqua River (see table 1 in appendix E.2). The smallest grain reported is 1.6 inches diameter which is classified as a "coarse" to "very coarse pebble" (see Wentworth Grain Size Chart, USGS 2003) with an approximate settling velocity (in water at 20°C) of about 73 cm/sec or 0.24 feet/second. GeoEngineers also estimated discharge (cfs) in the South Umpqua River during the construction period (see table 2 in appendix E.2) and estimated maximum water depths and velocities under diverted flow conditions (see table 3 in appendix E.2). Those estimates ranged from a 4.9 feet depth with water velocity of 1.9 feet/second at discharge of 110 cfs to a 6.3 feet depth with velocity of 4.7 feet/second during discharge rate of 340 cfs. Based on the grain settling velocity (V_S), the stream flow velocity (V_A), and stream depth (D), the downstream distance (L) of grain transport is estimated by

$$L = (D \cdot V_A) / V_S$$

The composition of stream bed subsurface in the South Umpqua River channel was not sampled. However, GeoEngineers (2015) previously completed four geotechnical borings in the vicinity of the proposed crossing for the purpose of evaluating HDD feasibility. The boring logs are included in Appendix B within GeoEngineers' report. The borings were completed within the floodplain adjacent to the channel upstream of the proposed crossing location. Extrapolation of the information suggests bedrock is present at shallow depths throughout the streambed and adjacent floodplain. The depth to bedrock varied between approximately 3 feet at boring B-3 to 21.5 feet at boring B-2. Boring B-2 also included sandy gravel with cobbles between the surface and the bedrock. The pebble count conducted near the proposed crossing yielded a grain-size distribution of the existing alluvial material (GeoEngineers 2015), which is consistent with the reported grain-size distribution with the materials identified in boring B-2.

For the smallest grain sampled in the substrate - very coarse pebble - the transport distance downstream from the diverted open-cut would range from 39 feet with 110 cfs to 123 feet with 340 cfs. The sediment generated by diverted open cut of the South Umpqua River would not severely impact juvenile or adult salmonids or salmon eggs or larvae downstream due, in part, to the short downstream transport distance of very coarse pebbles, but also because the grain size would not be within the range of particulates that cause adverse effects to fish under any duration of exposure (see Newcombe and Jensen 1996). Suspended sediment generated during construction at this crossing would likely be less than levels that cause physiological stress for fish (and may exceed the Oregon water quality standard for short distances and short durations downstream, either coinciding with construction across this perennial waterbody or coincidental with autumn precipitation. There would be short-term turbidity increases for short distances lasting for several hours during portions of the installation and removal of the diversion structures for the proposed diverted open-cut crossing of the South Umpqua River.

Movement Blockage

Of the 48 waterbodies with confirmed or assumed presence of Oregon Coast coho salmon, all but five will be crossed by dry open-cut. Dry open-cut construction is expected to block upstream movement by adult salmonids, as well as within stream movements of juvenile coho. Restrictions on migration could occur from short-term elevation of sediment and method of water diversion around the stream crossing area. As discussed above, fish are expected to abandon cover and/or avoid turbidity plumes generated by in-stream construction. In-stream construction would be completed prior to most upstream migrations by Oregon Coast coho.

In addition, block nets would be employed at all waterbody crossings in which water is present at the time of construction. Procedures to exclude fish from the construction right-of-way, maneuvering fish downstream of the crossing site, isolating and dewatering the construction site, removing fish from within the isolated construction site during dewatering, fish handling, holding and release, and monitoring with documentation are described in appendix T, *Fish Salvage Plan*. The *Fish Salvage Plan* was reviewed by BLM, Forest Service, and Bureau of Reclamation and each agency submitted documentation to PCGP stating that the plan was complete.

Flumes would maintain streamflow and fish might move upstream or downstream through the flume. With the dam and pump method, coho salmon would not be able to move upstream or downstream through the work area until the dams have been removed. Flumes and isolation structures (e.g., dams) would be removed as soon as possible following backfilling of the trench. Overall, the presence of temporary physical structures would not cause meaningful delays to adult upstream migrating coho salmon resulting in unsubstantial effects to coho salmon individuals.

The diverted open-cut of the South Umpqua River could take about 14 days to complete. Because one channel would be open during the entire crossing, no passage of fish would be impeded and no fish removal would be required. Overall, the levels of suspended sediment and physical structures would not cause meaningful delays to adult upstream migrating coho salmon resulting in unsubstantial effects to coho salmon individuals.

Newcombe and Jensen's (1996) Severity of ill Effect (SEV) scale includes avoidance behavior (SEV = 3), a behavioral effect that changes the activity patterns or alters the kinds of activity usually associated with an undisturbed environment (Muck 2010) and may indicate juvenile and/or adult coho instream movements would be affected. Likewise, an SEV score of 3 indicates a "measured change in habitat preference" in models developed by Anderson et al. 1996. SEV scores of 3 and higher due to elevated TSS concentrations are assumed to block or interfere with fish movements during durations of exposure to the suspended sediment downstream (provided in table 3.5.4-26). Downstream distances at which SEV ≥ 3 during fluming or dam-and-pump construction in each 5^{th} field watershed were provided in table 3.5.4-27.

Entrapment

Waterbody crossings using the "dry" crossing methods, flume or dam-and-pump, may result in some fish being entrapped in streams. Flumes and dams would be completely installed and functioning before any in-stream trenching disturbance occurs. Construction across a waterbody would take up to four days using dry open cut methods, but less for small and intermediate streams.

For a typical crossing, once streamflow is diverted through the flume pipe but before pipeline trenching begins, fish trapped in any water remaining in the work area between the dams would be removed and released using the *Fish Salvage Plan* (see appendix T). Salvage methods could include, seines, and/or dip nets and electrofishing (see section 3.5.4.4, Conservation Measures). Seining would be the primary method used to salvage fish but electrofishing methods may be used if all fish cannot be removed from the area potentially dewatered (see appendix T). All methods of capture and holding have risks of stress, injury, or mortality of fish. Fish inadvertently left within the dammed-off construction zone could be killed by impingement on pump intakes used to dewater the construction zone or would likely die once all water was removed. To eliminate or greatly reduce these effects, PCGP would contract with either ODFW or a qualified consultant to capture the fish. Fish removal personnel will be approved by ODFW and NMFS for this listed species. Personnel who would handle and/or remove fish on federal lands would be approved by the Forest Service or the BLM or be done directly by agency personnel if approved by ODFW. Overall, some listed juvenile fry coho salmon are likely to suffer injury or mortality but, with the implementation of project conservation measures, the numbers would be slight.

There are 89 waterbodies that would be crossed by flumed dry open-cut procedures, with an additional 22 waterbodies with bedrock streambeds that may necessitate blasting and/or use of mounted impact hammers (discussed above under Acoustic Shock) and require crossing with dam-and-pump construction. However, only eight of the streams with bedrock streambeds are known to support Oregon Coast coho and three others are assumed to be occupied by coho.

There are 43 streams (see table 3.5.4-2) known or assumed to support Oregon Coast coho that would be crossed by the Pipeline. There are thirteen known a streams that would be crossed in the Coos Bay Frontal-Pacific Ocean watershed; three known in the North Fork Coquille River; two known and six assumed streams in the East Fork Coquille River; no streams with coho presence (known or assumed) would be crossed in the Middle Fork Coquille River; two streams known to have coho and three assumed in the Olalla Creek-Lookingglass Creek watershed; four streams known (not including the South Umpqua River) with coho in the Clark Branch-South Umpqua River watershed; three known and two assumed coho streams crossed in the Myrtle Creek watershed; four known in the Days Creek-South Umpqua River; and (not counting the South Umpqua River). There are no streams, known or assumed to be occupied that would be crossed in the Upper Cow Creek watershed.

The width of the construction right-of-way across waterbodies would either be 75 or 95 feet. Fish would be salvaged from within the 75-foot or 95-foot wide right-of-way crossing of each dry open-cut stream where blasting is not expected. The fish salvage area would be isolated by sand bag dams installed upstream and downstream from the centerline.

Estimates of juvenile coho present in at crossing sites in streams were based on all rights-of-way are 95 feet wide at each stream crossing within which coho would be salvaged. Numbers of juvenile coho potentially present or assumed to be present in the streams with crossed by dry open-cut (no blasting) are provided in table 3.5.4-29 and do not include numbers within streams with bedrock substrates that were provided in table 3.5.4-16. In the 23 waterbodies known or assumed to be inhabited by Oregon Coast coho that would be crossed by fluming, 768 juvenile fry coho could be displaced and or salvaged prior to construction which does not include the 195 juvenile fry coho that could be salvaged from streams with bedrock prior to blasting (see table 3.5.4-16). The estimates in table 3.5.4-29 are based on no fish being herded out of the work area prior to dewatering (see *Fish Salvage Plan* in appendix T) so the actual number that would be salvaged is expected to be much less.

TABLE 3.5.4-29

Worst Case Estimates of Juvenile Coho Present or Assumed as Present at Streams Crossed by Dry Open-Cut (Fluming only, No Blasting Assumed) and Juveniles Salvaged Prior to Construction of the Pipeline Project within the Oregon Coast ESU

Subbasin and Fifth-Field Watersheds	Dry Open-Cut w/ Juvenile Fry Coho Present, Assumed	Juvenile Fry Present at Each Crossing a/	Total Juvenile Fry Present b/	Juvenile Fry Salvaged at Each Crossing c/	Total Juvenile Fry Salvaged d/
Coos					
Coos Bay-Frontal Pacific Ocean	7	63	440	63	440
Coquille					
North Fork Coquille River	3	37	111	37	111
East Fork Coquille River	4	40	160	40	160
Middle Fork Coquille River	0	N/A	0	N/A	0
South Umpqua					
Olalla Creek-Lookingglass Creek	4	6	24	6	24
Clark Branch-South Umpqua River	1	7	7	7	7
Myrtle Creek	3	7	21	7	21
Days Creek-South Umpqua River	1	5	5	5	5
Upper Cow Creek	0	N/A	0	N/A	0
TOTAL	**23**		**768**		**768**

a/ Juvenile Fry Present at Each Crossing based on Juveniles per Mile (see table 3.5.4-7) within a stream crossing length of 95 feet (worst case, see text).
b/ Total Juvenile Fry Present (worst case) = number of Juvenile Fry Present at Each Crossing multiplied by number of Dry Open-Cut

TABLE 3.5.4-29

Worst Case Estimates of Juvenile Coho Present or Assumed as Present at Streams Crossed by Dry Open-Cut (Fluming only, No Blasting Assumed) and Juveniles Salvaged Prior to Construction of the Pipeline Project within the Oregon Coast ESU

Subbasin and Fifth-Field Watersheds	Dry Open-Cut w/ Juvenile Fry Coho Present, Assumed	Juvenile Fry Present at Each Crossing a/	Total Juvenile Fry Present b/	Juvenile Fry Salvaged at Each Crossing c/	Total Juvenile Fry Salvaged d/

crossings with with Juvenile Fry Coho Present or Assumed.
c/ Juvenile Fry Salvaged at Each Crossing based on Juveniles per Mile (table 3.5.4-7) within a stream crossing length of 95 feet (worst case, see text).
d/ Total Juvenile Fry Salvaged (worst case) = number of Juvenile Fry Salvaged at Each Crossing multiplied by number of Dry Open-Cut crossings with Juvenile Fry Coho Present. The estimate is based on no fish being herded out of the work area prior to dewatering (see *Fish Salvage Plan*). The actual number that would be salvaged is expected to be much less.

Riparian Vegetation Removal and Modification

Vegetated areas adjacent to waterbodies have been classified/defined in different ways depending on the resource and/or management objective being analyzed. Analyses conducted for Oregon Coast coho have considered effects to riparian vegetation present within a one site-potential tree height (1SPTH) buffer on either side of a waterbody on both federal and non-federal lands. This analysis area was determined in discussions with NMFS, USFWS, and other federal agencies during Interagency Task Force meetings.

Riparian Reserves are areas that are managed to protect habitat for fish species, as well as other riparian-dependent plants and animals on federal lands (BLM and Forest Service lands). Riparian Reserves include areas that range in size from 1SPTH to 2SPTH buffers on either side of a waterbody, depending on the waterbody type. Analyses to coho salmon here do not consider effects to Riparian Reserves because those effects would be limited to certain federal lands and analyses provided below consider effects on all lands, hence the analysis of effects to Riparian Zones rather than to Riparian Reserves. This analysis considered all intermittent and perennial waterbodies crossed and adjacent to the Pipeline in the range of Oregon Coast coho and also included waterbodies that are not assumed to have coho present.

Aquatic resources could be affected as a result of removal of vegetation and habitat at the waterbody crossing sites as required for construction. Short-term, physical habitat disruption would occur during trenching activities. Long-term degradation of habitats could occur if the stream contours are modified in the area of the crossing; the flow patterns are changed; and if erosion of the bed, banks, or adjacent upland areas introduces sediment into the waterbody. Loss of riparian vegetation along the banks would reduce shade, potentially increasing water temperatures, remove an important source of terrestrial food for aquatic organisms, and decrease LWD and the associated reduction in habitats, and potentially increase mass slope failures adjacent to waterbodies.

Much of the impact to coldwater anadromous and resident fisheries by past land uses have been alterations of riparian habitats by logging, road building, agriculture, or other developments such as residences and utility corridors. A total of 201.29 acres of vegetation within riparian zones one site-potential tree height wide (ranging from 164 feet wide for Days Creek-South Umpqua River watershed to 225 feet wide in Coos Bay Frontal-Pacific Ocean watershed) associated with waterbodies within range of the Oregon Coast coho ESU would be directly affected by all construction related activities. More than half of the affected vegetation (112.96 acres) would be within forested vegetation types with 16.86 acres of late successional-old growth forest and

45.82 acres of mid-seral forest would be removed within riparian zones (see table 3.5.4-30a). As discussed in section 3.5.4.2, Habitat, and data presented in table 3.5.4-10a and table 3.5.4-10b, the LWD components of most aquatic habitats in watersheds occupied by Oregon Coast coho and crossed by the Pipeline are LWD deficient and below benchmark conditions established by ODFW.

In forested habitats, conifer trees would be replanted within the construction right-of-way and TEWA outside of the 30-foot-wide maintenance corridor, which would revert to their pre-construction state over time. The 30-foot-wide maintenance corridor centered over the Pipeline would be maintained in an herbaceous/shrub state during the life of the project, assumed to be 50 years (see table 3.5.4-30b). Over the long-term, 4.55 acres through riparian LSOG forest and 11.44 acres through mid-seral forest would be maintained in an herbaceous/shrub state within riparian zones associated with Oregon Coast coho (see table 3.5.4-30b).

In areas of riparian vegetation, PCGP would neck down to a 75-foot-wide construction right-of-way at most waterbody crossings, and maintain a setback between waterbody banks and TEWAs in forested areas. Following construction, PCGP would implement measures to replant native trees and scrubs where they had been before in riparian areas, and would minimize vegetation maintenance by allowing the development of a riparian strip at least 25 feet wide to be permanently revegetated on private lands and 100 feet wide on federally-managed lands as measured from the edge of the waterbody. In forested areas, replanting of native trees would occur beyond the 25- and 100-foot-wide areas, respectively. Following planting, vegetation monitoring would occur for two to three years to ensure successful revegetation. If vegetation does not meet designated goals, additional planting would occur and monitoring would continue until the desired revegetation is achieved. Within the 30-foot-wide corridor, the plants would be maintained by periodic vegetation maintenance. As required by FERC's Plan, PCGP consulted with the NRCS, BLM, and Forest Service regarding specific seeding dates and recommended seed mixtures for the project area (see PCGP's Resource Report 7). The recommendations have been incorporated into the Pipeline project-specific ECRP (see appendix F). The ECRP describes the procedures that would be implemented to minimize erosion and enhance revegetation success for the entire Pipeline project.

Overall, restricting the low-growth vegetation area to a small portion of the total riparian right-of-way clearing would allow much of ecological function of the riparian conditions relative to coho salmon needs (e.g., shade, future LWD and organic input) to return more quickly. This would limit the overall long-term impacts of loss of riparian habitat to a small portion of each stream crossed, reducing future negative effects to coho salmon resources. Some limited intermediate term adverse effects to coho salmon habitat function would occur, primarily as a result of LWD reduction. The effect of riparian vegetation removal on water temperature and LWD are presented in the following subsections (after tables 3.5.4-30a and 3.5.4-30b).

A series of tables (M-2 through M-5, provided in appendix M) identify the areas (acres) of vegetation within riparian zones (1SPTH) affected by construction and operation of the Pipeline project across or adjacent to waterbodies with expected Oregon Coast and SONCC coho presence, by 5th field watershed. The tables identify general vegetation (forested by ageclass/ non-forested) within riparian zones that would be affected from the Pipeline crossing the waterbodies or from waterbodies adjacent to the Pipeline, as well as identify the acres of vegetation affected within the riparian zone that is federally designated critical habitat. Tables M-2 and M-4 identify areas (acres) of vegetation affected within Riparian Zones of waterbodies known or suspected to have Oregon Coast coho salmon presence, and tables M-3 and M-5 identify acres of vegetated affected within Riparian Zones of waterbodies known or suspected to have SONCC coho salmon presence.

Effects to waterbodies and Oregon Coast and SONCC coho due to removal of riparian vegetation and maintenance within the construction and operation corridor adjacent to but not crossed by the Pipeline project would be similar to effects to riparian vegetation for streams crossed by the Pipeline:

- Loss of riparian vegetation along the banks would reduce shade potentially increasing water temperatures.
- Decreased LWD recruitment in streams and on adjacent uplands, although current conditions of LWD in 5th field watersheds crossed by the Pipeline are generally undesirable.
- Removal of an important source of terrestrial food for aquatic organisms.
- Potentially increase mass slope failures and/or erosion due to surface runoff adjacent to waterbodies that could increase sediment in the waterbody.

Where vegetation is cleared from the riparian zone of a waterbody not crossed but adjacent to the Pipeline, a vegetation buffer (of some width but less than 1SPTH) adjacent to the waterbody is expected to remain. Consequently, effects from the Pipeline would be less than those described for riparian zones and associated waterbodies that would be crossed. Riparian vegetation within 1SPTH that would be maintained in a herbaceous state within the 30-foot maintenance corridor during the life of the Pipeline is included in tables M-4 and M-5. The majority of riparian vegetation affected by the Pipeline is associated with waterbodies crossed by the right-of-way (61 percent with potential Oregon Coast coho presence and 81 percent with potential SONCC coho presence), not riparian vegetation associated with waterbodies adjacent to the right-of-way.

TABLE 3.5.4-30a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide) Adjacent to Perennial and Intermittent Waterbodies within Range of Oregon Coast Coho Crossed by the Pipeline Project

	Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Landowner	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Coos Bay Frontal Pacific Ocean (HUC 1710030403)												
BLM-Coos Bay District	2.57	0.29	3.9	0	**6.76**	0	0	0	0	1.91	**1.91**	**8.66**
Non-Federal	0.84	5.57	10.29	2.36	**19.06**	0	30.82	0	0	5.18	**36.01**	**55.07**
Watershed Total	**3.41**	**5.85**	**14.19**	**2.36**	**25.82**	**0**	**30.82**	**0**	**0**	**7.09**	**37.91**	**63.74**
North Fork Coquille River (HUC 1710030504)												
BLM-Coos Bay District	1.22	2.86	0.26	0	**4.34**	0	0.03	0	0	0.15	**0.19**	**4.53**
Non-Federal	0	1.91	1.1	0	**3**	0	0	0	0.25	0.28	**0.53**	**3.53**
Watershed Total	**1.22**	**4.76**	**1.36**	**0**	**7.34**	**0**	**0.03**	**0**	**0.25**	**0.44**	**0.72**	**8.06**
East Fork Coquille River(HUC 1710030503)												
BLM-Coos Bay District	0.25	0	1.16	0	**1.4**	0	0	0	0	0.4	**0.4**	**1.8**
Non-Federal	0	2.90	11.43	3.30	**17.63**	0	0.02	0	2.00	0.82	**2.84**	**20.47**
Watershed Total	**0.25**	**2.90**	**12.59**	**3.30**	**19.03**	**0**	**0.02**	**0**	**2.00**	**1.22**	**3.24**	**22.27**
Middle Fork Coquille River (HUC 1710030501)												
BLM-Coos Bay District	2.47	0.67	5.08	0	8.21	0	0	0	0	1.4	**1.4**	**9.62**
BLM-Roseburg District	0.96	2.25	0.1	0	3.31	0	0.01	0	0	0	**0.01**	**3.32**
Non-Federal	0.4	3.05	2.1	0.25	5.79	0.07	0	1.18	1.81	0.22	**3.27**	**9.06**
Watershed Total	**3.82**	**5.96**	**7.28**	**0.25**	**17.31**	**0.07**	**0.01**	**1.18**	**1.81**	**1.62**	**4.69**	**22.00**
Olalla Creek-Lookingglass Creek (HUC 1710030212)												
Non-Federal	1.40	2.50	1.24	0.18	**5.32**	0	0.60	0.73	0	0.29	**1.63**	**6.95**
Watershed Total	**1.40**	**2.50**	**1.24**	**0.18**	**5.32**	**0**	**0.60**	**0.73**	**0**	**0.29**	**1.63**	**6.95**
Clark Branch-South Umpqua River (HUC 1710030211)												
Non-Federal	0	5.49	1.27	0	**6.76**	0	0.28	20.61	0	0.51	**21.41**	**28.17**
Watershed Total	**0**	**5.49**	**1.27**	**0**	**6.76**	**0**	**0.28**	**20.61**	**0**	**0.51**	**21.41**	**28.17**
Myrtle Creek (HUC 1710030210)												
Non-Federal	3.78	7.03	0.44	0.08	**11.33**	0	0.20	6.88	3.41	0.70	**11.2**	**22.53**
Watershed Total	**3.78**	**7.03**	**0.44**	**0.08**	**11.33**	**0**	**0.20**	**6.88**	**3.41**	**0.70**	**11.2**	**22.53**
Days Creek-South Umpqua River (HUC 1710030205)												

TABLE 3.5.4-30a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide) Adjacent to Perennial and Intermittent Waterbodies within Range of Oregon Coast Coho Crossed by the Pipeline Project

	Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Landowner	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
BLM-Roseburg District	0.36	0	0.24	0.09	**0.69**	0	0	0	0	0.11	**0.11**	**0.80**
Non-Federal	0.54	8.43	1.34	2.08	**12.39**	0	0.43	4.41	0	1.8	**6.64**	**19.03**
Watershed Total	**0.90**	**8.43**	**1.58**	**2.17**	**13.08**	**0**	**0.43**	**4.41**	**0**	**1.91**	**6.75**	**19.82**
Upper Cow Creek (HUC 1710030206)												
Forest Service-Umpqua National Forest	2.08	2.90	2.00	0	6.97	0	0.16	0	0	0.62	**0.78**	**7.75**
Watershed Total	**2.08**	**2.90**	**2.00**	**0**	**6.97**	**0**	**0.16**	**0**	**0**	**0.62**	**0.78**	**7.75**
All Fifth-Field Watersheds and Jurisdictions												
BLM-Coos Bay District	6.51	3.82	10.4	0	20.71	0	0.03	0	0	3.86	3.9	24.61
BLM-Roseburg District	1.32	2.25	0.34	0.09	4	0	0.01	0	0	0.11	0.12	4.12
Forest Service-Umpqua National Forest	2.08	2.90	2.00	0	6.97	0	0.16	0	0	0.62	0.78	7.75
Federal Subtotal	**9.91**	**8.97**	**12.74**	**0.09**	**31.68**	**0**	**0.20**	**0**	**0**	**4.59**	**4.8.0**	**36.48**
Non-Federal Subtotal	**6.96**	**36.88**	**29.21**	**8.25**	**81.28**	**0.07**	**32.35**	**33.81**	**7.47**	**9.80**	**83.53**	**164.81**
Overall Total	**16.86**	**45.82**	**41.95**	**8.34**	**112.96**	**0.07**	**32.55**	**33.81**	**7.47**	**14.40**	**88.33**	**201.29**

a/ Project components considered in calculation of habitat "Removed:" Pipeline project construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

TABLE 3.5.4-30b

Total Terrestrial Habitat (acres) within the 30-foot-wide Corridor Maintained within Riparian Zones (One Site-Potential Tree Height Wide) on Federal and Non-Federal Lands within Range of Oregon Coast Coho Crossed by the Pipeline Project

Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Landowner	Forest Habitat b/					Other Habitat b/						Total Riparian Zone Impact (acres)
	Late Successional Old Growth Forest	Mid-Seral Forest	Regenerating Forest	Clearcut, Forest	Forest Total	Forested Wetland	Nonforested Wetland	Unaltered Nonforested Habitat	Agriculture	Altered Habitat	Other Total	
Coos Bay Frontal Pacific Ocean (HUC 1710030403)												
BLM-Coos Bay District	0.48	0.07	1.23	0	**1.78**	0	0	0	0	0.42	**0.42**	**2.20**
Non-Federal	0.28	1.09	2.22	0.69	**4.29**	0	5.47	0	0	0.73	**6.2**	**10.49**
Watershed Total	**0.75**	**1.17**	**3.46**	**0.69**	**6.07**	**0**	**5.47**	**0**	**0**	**1.15**	**6.62**	**12.68**
North Fork Coquille River (HUC 1710030504)												
BLM-Coos Bay District	0.30	0.91	0.02	0	**1.23**	0	0.01	0	0	0.02	**0.03**	**1.26**
Non-Federal	0	0.49	0.48	0	**0.97**	0	0	0	0.03	0.08	**0.11**	**1.09**
Watershed Total	**0.30**	**1.40**	**0.50**	**0**	**2.20**	**0**	**0.01**	**0**	**0.03**	**0.10**	**0.14**	**2.34**
East Fork Coquille River (HUC 1710030503)												
BLM-Coos Bay District	0.11	0	0.31	0	**0.42**	0	0	0	0	0	**0**	**0.42**
Non-Federal	0	0.73	2.78	0.93	**4.44**	0	0.01	0	0.23	0.22	**0.45**	**4.89**
Watershed Total	**0.11**	**0.73**	**3.09**	**0.93**	**4.86**	**0**	**0.01**	**0**	**0.23**	**0.22**	**0.45**	**5.31**
Middle Fork Coquille River (HUC 1710030501)												
BLM-Coos Bay District	0.80	0.17	0.81	0	**1.78**	0	0	0	0	0.75	**0.75**	**2.53**
BLM-Roseburg District	0.27	0.57	0.05	0	**0.89**	0	0	0	0	0	**0**	**0.89**
Non-Federal	0.14	0.97	0.46	0.06	**1.64**	0.03	0	0.27	0.57	0.04	**0.91**	**2.55**
Watershed Total	**1.22**	**1.71**	**1.32**	**0.06**	**4.31**	**0.03**	**0**	**0.27**	**0.57**	**0.79**	**1.66**	**5.97**
Olalla Creek-Lookingglass Creek (HUC 1710030212)												
Non-Federal	0.24	0.69	0.15	0.07	**1.15**	0	0.2	0.16	0	0.07	**0.44**	**1.59**
Watershed Total	**0.24**	**0.69**	**0.15**	**0.07**	**1.15**	**0**	**0.2**	**0.16**	**0**	**0.07**	**0.44**	**1.59**
Clark Branch-South Umpqua River (HUC 1710030211)												
Non-Federal	0	1.11	0.26	0	**1.37**	0	0.08	4.08	0	0.10	**4.26**	**5.62**
Watershed Total	**0**	**1.11**	**0.26**	**0**	**1.37**	**0**	**0.08**	**4.08**	**0**	**0.10**	**4.26**	**5.62**
Myrtle Creek (HUC 1710030210)												
Non-Federal	1.20	2.10	0.24	0	**3.53**	0	0.09	0.8	0.78	0.06	**1.73**	**5.26**
Watershed Total	**1.20**	**2.10**	**0.24**	**0**	**3.53**	**0**	**0.09**	**0.8**	**0.78**	**0.06**	**1.73**	**5.26**

TABLE 3.5.4-30b

Total Terrestrial Habitat (acres) within the 30-foot-wide Corridor Maintained within Riparian Zones (One Site-Potential Tree Height Wide) on Federal and Non-Federal Lands within Range of Oregon Coast Coho Crossed by the Pipeline Project

	Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Landowner	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Days Creek-South Umpqua River (HUC 1710030205)												
BLM-Roseburg District	0.06	0	0.08	0.02	**0.16**	0	0	0	0	0.09	**0.09**	**0.25**
Non-Federal	0	1.84	0.29	0.54	**2.67**	0	0.10	0.60	0	0.17	**0.88**	**3.54**
Watershed Total	**0.06**	**1.84**	**0.37**	**0.56**	**2.82**	**0**	**0.10**	**0.60**	**0**	**0.26**	**0.97**	**3.79**
Upper Cow Creek (HUC 1710030206)												
Forest Service-Umpqua National Forest	0.67	0.69	0.6	0	1.96	0	0.03	0	0	0.08	**0.11**	**2.07**
Watershed Total	**0.67**	**0.69**	**0.6**	**0**	**1.96**	**0**	**0.03**	**0**	**0**	**0.08**	**0.11**	**2.07**
All Fifth-Field Watersheds and Jurisdictions												
BLM-Coos Bay District	1.69	1.15	2.37	0	5.21	0	0.01	0	0	1.19	1.2	6.41
BLM-Roseburg District	0.33	0.57	0.13	0.02	1.05	0	0	0	0	0.09	0.09	1.14
Forest Service-Umpqua National Forest	0.67	0.69	0.60	0	1.96	0	0.03	0	0	0.08	0.11	2.07
Federal Subtotal	**2.69**	**2.41**	**3.10**	**0**	**8.22**	**0**	**0.04**	**0**	**0**	**1.36**	**1.40**	**9.62**
Non-Federal Subtotal	**1.86**	**9.02**	**6.88**	**2.29**	**20.06**	**0.03**	**5.95**	**5.91**	**1.61**	**1.47**	**14.98**	**35.03**
Overall Total	**4.55**	**11.44**	**9.99**	**2.31**	**28.27**	**0.03**	**5.99**	**5.91**	**1.61**	**2.83**	**16.38**	**44.63**

a/ Project components considered in calculation of habitat "Removed:" Pipeline project construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

Water Temperature

Clearing the right-of-way would remove shading vegetation from uplands and riparian areas, exposing the land and water to increased sunlight, potentially resulting in direct increases in water temperatures. Additionally, indirect increases in stream water temperatures may occur as water flows over the warmer land surface and eventually reaches the waterbody (Beschta and Taylor 1988).

The effects of water temperature on salmonid life stages have been extensively reviewed by McCullough (1999), Richter and Kolmes (2005), and others. Maximum water temperatures ranging from 22 to 24°C (71.6 to 75.2°F) limit distribution of many salmonid species. No salmonids can survive water temperatures exceeding 25°C (77°F) for extended periods (Ice 2008). High water temperatures can cause migratory species (including anadromous salmonids) to delay upstream migration (Bjornn and Reiser 1991), can decrease survival of spawners by increasing metabolic rates (Ice 2008), can positively influence rates of embryo development and emergence, but can negatively influence DO concentrations, which limit rates of embryo development (Bjornn and Reiser 1991). High temperatures inversely influence solubility of oxygen in water (Ice 2008) so that introduction of organic matter with decomposition by microorganisms reduces dissolved oxygen exacerbated by high temperatures. Along with increased fines (suspended silt and clay) and decreased relative rate of oxygen input to water (reaeration) through reduction in stream flows (Ice 2008), can adversely affect various salmonid life stages. Coho upstream migration water temperature requirements are from 7.2 to 15.6°C (46.0 to 62.1°F), spawning requirements range from 4.4 to 9.4°C (42.9 to 52.9°F), and for incubation 4.4 to 13.3°C (42.9 to 61.9°F); preferred temperature is 12.1°C (60.8°F) and upper lethal temperatures range from 26.0 to 28.8°C (86.8 to 92.8°F), depending on previous acclimation temperatures (Bjornn and Reiser 1991).

Vegetative cover that provides shade, especially during summer, is one factor that regulates water temperature. Construction across waterbodies would necessitate removal of trees and riparian shrubs at the crossing locations. Available information on the effects of pipeline construction in other regions on water temperature has found no or immeasurable change. The total width of riparian area affected by shade tree removal would be small (less than 100 feet) relative to the length of any stream crossed. In one study, construction across two coldwater, fish-bearing streams in Alberta required removing forested riparian vegetation; water temperatures at construction sites and downstream did not increase above temperatures at control sites upstream from construction (Brown et al. 2002). In the Alberta study, the highest water temperature recorded was 66°F (19°C in August). In the New York study, the highest temperature was 79°F (26°C) sometime between August and October. Similarly, water temperatures measured at four coldwater streams in New York before and during pipeline construction and for three years following construction showed no short- or long-term effects on water quality parameters, including water temperature, even though such effects were expected because streambank vegetation had to be cleared, which reduced shading (Blais and Simpson 1997).

Another recent right-of-way clearing study in Oregon found little to no effect from existing and proposed right of clearing on coldwater Cascade mountain streams (Tetra Tech 2013). Monitoring of 22 existing cleared right-of-ways for transmission lines in the Cascade region along the upper North Santiam River averaging 244 feet wide found no significant temperature (peak daily average, and daily maximum) change across the clearings compared to existing uncleared areas on each of these streams. While temperature changes did occur across the clearing (average of peak daily maximum change 0.19°F/100 feet of stream), these increases were no different from the temperature changes in the uncleared wooded areas just upstream of these clearing. While these streams did retain some vegetation in the right-of-way, they were kept relatively low to ensure no issues with the power lines. Modeling of these streams using the SSTEMP (Bartholow 2002) estimated some relatively small increases, which were generally greatest for smallest streams. The model assumed all or most vegetation would be removed from banks over a 150-foot-wide projected clearing. The results for both existing (summer 2012) and projected worst-case (likely maximum summer air temperature) environmental conditions with very conservative shade assumptions (0 and 25 percent for entire 150-foot clearings) showed an average increase of about 1.1°F (median of about 0.4°F) in the modeled maximum and maximum daily mean temperature across the assumed future clearing of these 22 streams. The small size of the streams in this study affected the model results. All but 3 of the streams had flow less than one cfs and width less than 10 feet. The three larger streams had modeled maximum temperature changes ranging from 0.0 to 0.2°F. Most of these streams had relatively low to moderate temperatures (mean maximum about 55°F); therefore, these low temperature increases were generally not expected to affect fish resources (Tetra Tech 2013).

Following requests by the Forest Service, PCGP had temperature models run by North State Resources (NSR) on six different stream segments on NFS lands in the Umpqua River basin on tributaries to East Fork Cow Creek (five crossings) and on the upper Rogue River basin on Little Butte Creek (NSR 2009). While not all of these streams are in the range of Oregon Coast ESU coho salmon, they are suitably representative of likely temperature changes that could be expected of streams of similar characteristics (i.e., width, flow, slope, vegetation, etc.) in regions where the ESU is located using these model parameters. Of the three smallest streams (with base flows <0.1 cfs, widths ≤3 feet), modeled average temperature increases ranged from 1.0 to 8.6°C (1.8 to 15.4°F) right after construction. Because these streams were so small, they likely also would have temperatures reduced rapidly downstream of the clearing from ground water inflow and likely would have no measurable effects on streams they flow into downstream. The two five- and six-foot-wide streams would have estimated maximum increases ranging from 0.4 to 0.5°C (0.7 to 0.9°F), with maximum temperatures remaining at or below 15.6°C (60.1°F) in these two streams just downstream of the crossing. These temperatures would remain well within suitable range for salmonids. The largest stream (22 feet wide) estimated increase was estimated to be 0.02 to 0.1°C (0.04 to 0.2°F) depending on the temperature model. The modeled results, based on assumptions used about rate of vegetation regrowth, found that most temperature increases remained within the first five years, but were approaching pre-project temperatures within 10 years. Conditions at other streams along the pipeline route may vary from these due to site-specific differences, but these results may be fairly representative of changes that may occur at forested streams along the route. Overall results suggest that, other than the very smallest streams where fish resources would be limited, changes in temperature from vegetation removal are likely to remain small and immeasurable having unsubstantial effects on fish resources.

Similarly, GeoEngineers (2017c) modeled thermal impacts within Fourth Field Watersheds where streams would be crossed by the Pipeline where riparian shading vegetation would be removed within the 75-foot wide construction corridor and would be affected within the 30-foot maintenance corridor for the long-term (see table 3.5.4-30b, above). Model results show a maximum predicted increase of 0.16°C at one 75 foot clearing. The analysis showed that elevated water temperatures would return to ambient levels within a maximum distance of 25 feet downstream of the pipeline corridor, based on removal of existing riparian vegetation over a cleared corridor width of 75 feet (GeoEngineers 2017c). The results are similar to the more geographically-limited results obtained by North States Resources (NSR 2009) which suggested more thermal impact. The conclusion drawn by GeoEngineers (2017c) was that the magnitude of thermal impact caused by construction would not be expected to cause a thermal barrier to fish migration.

GeoEngineers (2017c) also used the SSTEMP model by Bartholow (2002) to estimate potential temperature effects at 15 proposed pipeline crossing locations (each a 75-foot-wide clearing) along the whole route. A total of 12 of these were in the watershed range of the Oregon Coast coho salmon ESU and two are within the range of the SONCC coho salmon ESU. These sites are generally representative of watershed habitat conditions where project area coho salmon may be present along the project route although not necessarily where coho salmon are directly present. The streams selected varied in size from 2 to 85 feet wide (average 29 feet), moderately large streams, with only eight of these having a less than 10-foot flowing width. Conditions modeled were based on conditions measured during late August 2010 and did not consider maximum potential air temperatures though they were likely representative of summer conditions. The average modeled increase for these 15 streams was 0.03°F, and the maximum increase among the streams was 0.03°F. Overall, these estimated changes are relatively low. They are lower than the NSR (2009) estimates for one comparable stream, but model conditions were slightly different. The GeoEngineers model assumed a 75-foot-wide clearing, whereas the NSR model assumed a 95-foot-wide clearing and other parameter differences that would contribute to the different results.

As a rule, the effect of water temperature of a non-fish-bearing tributary on water temperature of a fish-bearing receiving stream is determined as the weighted mean of the two water temperatures, weighted by respective volumes or in-stream flows. If T_1 = temperature of tributary with F_1 = flow rate, and T_2 = temperature of receiving stream with F_2 = flow rate, then the resulting water temperature T_R at the confluence of the two waterbodies would be:

$$T_R = (T_1\ F_1 + T_2\ F_2) / (F_1 + F_2).$$

For example, Hydrofeature N is an unnamed tributary to East Fork Cow Creek crossed at MP 111.01. Pipeline construction would increase the water temperature by 8.6ºC (47.5ºF) from its base temperature of 11ºC (51.8ºF) (see NSR 2009). The water temperature would be increased to 19.6ºC (67.3ºF) but its reported summer base flow is 0.002 cfs. ODEQ measured water temperature within East Fork Cow Creek during September 1998, reported at 13.5ºC (56.3ºF). No in-stream flow data are available for East Fork Cow Creek but USGS (Gage 14309500) has measured flows in West Fork Cow Creek, reporting an average flow of 11.4 cfs during September. Using those data as to illustrate how water temperatures would be combined by the weighted average, the resulting water temperature of Hydrofeature N and the receiving stream would be T_R = (19.6ºC x 0.002 cfs + 13.5ºC x 11.4 cfs) / (0.002 cfs + 11.4 cfs) = 13.501ºC (56.302ºF). The increase of water temperature in the receiving stream by the tributary water temperature would be immeasurable [in this illustration the increase would be 0.001ºC (0.002ºF)].

PCGP has proposed supplemental riparian plantings as outlined in the ECRP (see appendix F) to help ensure that the core coldwater habitat temperature criteria are not exceeded at the maximum point of impact. These measures are designed to speed up the rate of riparian area recovery and provide more effective shade immediately following construction. Much of the riparian area would be allowed to regrow from plantings with herbaceous plants (only 10 feet wide would be maintained without some growth) and conifer and other trees (all but 30-foot width). On small streams and to a lesser extent on larger streams, even 10- to 15-foot-high trees would supply shade, reducing solar heating effects on streams. Thus plantings and vegetation regrowth in riparian areas would help moderate potential temperature increases in the short-term (a few years). PCGP would install supplemental transplanted trees on the Umpqua National Forest within the riparian areas of East Fork Cow Creek (i.e., 15 to 20 feet tall with full crowns) to increase riparian area canopy closure and placing LWD and boulders to create micro-topography within the wetted stream channel (see the ECRP). Shading from transplanted vegetation and micro-topographic features incorporated into the final grading plan are likely to reduce the heat load enough to reduce the likelihood of measurable water temperature increases. PCGP modeled the potential benefit of post project effective shade created by these mitigation measures on the Umpqua National Forest. The results of the 10-year post-project modeling time step were used to predict the benefits of the mitigation measures because the trees that would be transplanted provide at least the same shade values as predicted for this time step. The predicted water temperature changes are small, with less than a 0.3°C (0.5°F) change at the point of maximum impact, with no increase at the stream network scale (NSR 2009). Thus, based on the model, the slight effects of solar heating from clearing would gradually be reduced or completely eliminated over time, at most between 5 and 10 years. Inclusion of the measures improves the certainty that riparian area clearance and stream channel disturbance activities within the construction right-of-way would not cause measurable water temperature increases at the maximum point of impact or at the stream network scale.

Based on available information, it is anticipated that any changes in water temperature, related to 75-foot-wide right-of-way vegetation clearing at waterbody crossings, are likely to be very small and undetectable through measurements, except for possibly the very smallest and often intermittent flowing streams. Any temperature changes that may occur would gradually be reduced or eliminated over time as most riparian vegetation, from plantings and natural vegetation growth, increases in size and thus increases stream shading. Adverse effects on coho salmon resources along the route would be unsubstantial due to limited distribution of any measurable changes to regions within the 48 waterbodies with confirmed or assumed presence of Oregon Coast coho.

Large Woody Debris

A potential effect on fisheries that would result from forest clearing at pipeline crossings of waterbodies is the reduction of LWD in streams and on adjacent uplands (Harmon et al. 1986; Sedell et al. 1988). Large logs provide in-stream hydraulic complexity, which contributes to habitat complexity and the formation and maintenance of pools, riffles and other habitats which are critical to salmonid spawning and juvenile rearing. As the size of individual logs or accumulations of logs increases, the size and stability of pools that are created also increase (Beschta 1983). Riparian forests that undergo harvesting of large trees take on secondary-growth characteristics and contribute lower quantities of woody debris than unmanaged, old-growth forests (Bisson et al. 1987). However, sufficiently wide, carefully managed riparian buffers that retain a full complement of ages, sizes, and species of native trees and vegetation can ensure adequate recruitment of LWD to streams (Bisson et al. 1987; Murphy and Koski 1989).

Existing conditions associated with riparian vegetation within all 10 fifth-field watersheds in the range of the Oregon Coast coho salmon crossed by the Pipeline (see discussion related to table 3.5.4-10a and table 3.5.4-10b) are generally undesirable. Streams in the watersheds are deficient in numbers of LWD pieces per length of stream channel, in volume of LWD, and in numbers of key pieces (60 cm or greater in diameter by 12 meters or greater in length) per unit of stream length. There are too few large conifers along most stream reaches and LWD numbers, volume, and presence of key pieces tend to be below benchmark levels.

The Pipeline project would remove 16.72 acres of LSOG forest and 45.75 acres of mid-seral forest within riparian zones in watersheds occupied by Oregon Coast coho (see table 3.5.4-30a), which would affect recruitment of LWD at those sites. Of the total riparian forest affected (including clear-cut and regenerating forest stands, 28.01 acres would be removed in the Coos Subbasin, 41.01 acres within the Coquille Subbasin, and 43.10 acres within the South Umpqua Subbasin.

PCGP has proposed to use on-site mitigation for impacts to waterbodies by installing LWD at agency- and land owner-approved and appropriate areas within the construction right-of-way across certain waterbodies (see section 3.5.4.4, Conservation Measures). The use of LWD as a mitigation measure for impacts associated with in-stream construction has been documented as an effective means of creating in-stream habitat heterogeneity, reducing streambank erosion, reducing sediment mobilization (Bethel and Neal 2003), and enhancing local fish abundance (Scarborough and Robertson 2002). Placement of LWD on the streambanks and in the streams can provide slight shade and increase bank stability, while vegetation is maturing following construction. Additionally, placement of LWD in streams or on streambanks can provide habitat as substrate for benthic invertebrates, an important food source for salmonids, and also increase habitat for forage species with the creation of pools and enhancement of the salmonid rearing potential of an area (Cederholm et al. 1997; Slaney et al. 1997). Long-term losses of LWD input would largely be mitigated through riparian replanting of conifers in the right-of-way as discussed under Riparian Vegetation and Removal, above. While there may be some reduction in total stream LWD between short and long-term, the amount would be relatively small considering the total area that could be affected (most 75 feet of channel) and mitigation and enhancements that would be implemented (see Conservation Measures). LWD changes would result in minor intermediate term adverse effects to Oregon Coast coho salmon.

<u>Streambank Erosion and Streambed Stability</u>

The clearing and grading of the right-of-way during construction could increase erosion along streambanks resulting in higher turbidity levels in the waterbodies crossed. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. Streambank erosion, sedimentation, and higher turbidity levels related to the Project could affect aquatic resources, as discussed above. The degree of impact on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size.

The rootwad network of trees adjacent to stream supplies bank stability. Those within 25 feet of the stream are considered most important at providing the root source aiding in bank stability

(WDNR 1997). To aid in maintaining this bank stability, PCGP would cut most trees near the bank, except those in the trench line, at ground level leaving the root systems in place helping to maintain riparian stability. Roots would be removed over the trench line or from any steam banks that would need to be cut down or graded to accomplish the crossing.

To minimize these impacts, PCGP would use temporary equipment bridges, mats, and pads to support equipment that must cross the waterbody (perennial, intermittent, and ephemeral if water is present) or work in saturated soils adjacent to the waterbody. PCGP would also install sediment barriers, such as silt fence and straw/hay bales, across the right-of-way at the edge of waterbodies throughout construction except for short periods when the removal of these sediment barriers is necessary to dig the trench, install the pipe, and restore the right-of way. Practices to minimize streambank erosion are provided in section 5.0 in the ECRP (see appendix F).

The FWS expressed concerns that more detailed site-specific information on bank material, streambed composition, shoreline vegetation, and other information is needed to adequately ensure that actions occurring at a stream crossing do not substantially increase streambank erosion and streambed instability. PCGP, in response to these requests, has conducted an assessment of crossing conditions of all streams suitable for analysis based on the FWS risk matrix (GeoEngineers 2017d). The analysis results were addressed under *Suspended Sediment – Dry Open-Cut*, above. Briefly, GeoEngineers (2017d) rated 101 streams in the range of Oregon Coast coho based on the project impact potential at the crossing and the relative stream response potential at the crossing. Each crossing was rated as low, medium, or high for each of the two axes (all stream crossings were placed into one of nine categories, such as Low–Low, Low–Medium, and Medium–High). Crossing 43 of the streams would warrant application of typical construction practices; crossing 33 of the streams would warrant typical construction practices with BMPs for sensitive streambed, banks, or riparian revegetation conditions to be determined by PCGP's EI during construction; crossing four streams would warrant typical construction practices with BMPs for sensitive streambed, banks, or riparian revegetation conditions to be selected by a qualified professional prior to construction based on site-specific information from pre-construction evaluation; crossing one stream would warrant typical construction practices with enhancement BMPs such as rootwad enhancement for bank stabilization.

No crossing was rated as having both high risk of project impact potential (i.e., high risk of project impacts and high risk of site response potential) and high risk of stream and site response potential. In the range of Oregon Coast coho, Pipeline project-typical BMPs would be applied to all streams while additional site-specific BMPs would applied to the other crossing depending on their rated category of risk. Stream crossings that are unstable can ultimately adversely affect aquatic resources through loss of local habitat and impacts to downstream habitat from the addition of highly unstable sediment increasing the recovery time of the specific site to stable conditions.

In addition, substrate characteristics and physical habitat features would be determined through pre-construction surveys, and the upper one foot of existing substrate would be replaced and other physical conditions matched during reconstruction after pipe installation. Clean spawning gravel would be top dressed as appropriate and composition would be based on pebble counts or other appropriate methods on a site-specific basis. PCGP would make some exceptions to this in difficult-to-access areas, in which case native material comparable to the existing surface substrate would be used. Many of these actions would be determined prior to construction based on results of the pre-construction survey (see below) and determined by a qualified EI or suitably trained professional who would have the authority to select appropriate additional site-specific BMP construction methods, bank stability actions, revegetation types and methods to help reduce the risk of instability of the crossing and potential for future erosion (GeoEngineers 2017d).

A pre-construction survey would be conducted by a technically qualified team on all stream crossings to confirm and clarify conditions developed in the aforementioned matrix analysis. This team would be professionals qualified to assess terrestrial and aquatic habitat and the geotechnical and geomorphic conditions relative to construction across stream channels and ditches. Following these surveys, if significant changes were to occur to parameters of the risk matrix for a crossing, changes would be made to risk level and appropriate final methods of crossing and BMPs applied at each stream crossing. If any crossing is moved into the "high" project impact and "high" stream response risk matrix category, a site-specific crossing design would be developed for that site. Project construction would then move forward as described in these permit documents including implementation of special additional BMPs, as described in GeoEngineers (2017d, 2017e, and 2018a), depending on individual site conditions. For waterbodies evaluated as having Low to Moderate Project Impact Potential and Low Site or Stream Response Potential in the Risk Matrix Evaluation (the Blue Management Category, with PCGP Project Typical Construction), BMPs potentially utilized for post-construction site restoration include seeding, planting, and hydromulch or erosion control blankets to minimize surface erosion while new vegetation becomes established, as outlined in the ECRP (see appendix F). Typical site revegetation and backfill will be used to address habitat issues at these sites.

For waterbodies evaluated as having Low to Moderate Project Impact Potential and Moderate Site or Stream Response Potential in the Risk Matrix Evaluation (the Yellow Management Category, having sensitive bed, bank or riparian vegetation conditions selected by the Environmental Inspector or PCGP representative during construction), special, more robust BMPs (in addition to Project Typical BMPs) would include those targeting the streambed component (stratified backfill for high gradient streams, structural fill placement, bank graded/terraced to 3:1, geotextile reinforced slope, fiber rolls) and the streambank component (stream barbs/flow deflectors, toe rock placement, riprap placement, biotechnical "vegetation" riprap, tree revetments). As indicated by GeoEngineers (2018a), typical BMPs were developed for sites in the Yellow management category to address risks posed by bed and bank instability or degradation to existing high quality aquatic habitat. These site-specific BMPs were developed based on field observations of natural analog structures and widely accepted techniques for bank restoration, bed restoration, and aquatic habitat restoration techniques; typical designs of these BMPs are provided in Appendix B to GeoEngineers (2018a).

Waterbodies evaluated as having Low to Moderate Project Impact Potential and High Site or Stream Response Potential in the Risk Matrix Evaluation (the Orange Management Category, having sensitive bed, bank or riparian vegetation conditions selected by qualified professional prior to construction based on site-specific information from pre-construction evaluation) have the highest potential risk for short- and long-term channel stability. As described in GeoEngineers (2018a), site-specific restoration plans were developed for crossings that were assessed to be within the Orange management category based on the findings of the preconstruction surveys. The need for site-specific designs is due to more complex geomorphic or hydraulic features that increase risk of channel response to the pipeline or unique, high-value habitat features. Site-specific designs were developed using results of the preconstruction surveys, including geomorphic/hydraulic/habitat observations, topographic cross-sections, and profiles collected using a hand level and stadia rod. A written description of site-specific features and restoration priorities and design drawings are presented for each crossing in Appendix C to GeoEngineers (2018a).

For waterbodies evaluated as having High Project Impact Potential and Low to Moderate Site or Stream Response Potential in the Risk Matrix Evaluation (the Green Management Category, applying Project Typical BMPs with habitat enhancement BMPs), PCGP would use Project Typical Construction BMPs (see above). Channels in this category typically are those that disturb a greater proportion of the existing floodplain or – in narrower streams – potentially disturb more varied aquatic habitat. During site restoration, however, particular effort will be made for opportunistic habitat enhancement BMPs as detailed from observations obtained during the pre-construction survey. These enhancements could include riparian planting to improve existing habitat conditions in the floodplain, placement of large wood or rock to improve in-stream habitat, or modification of existing riprap to improve habitat. A number of the typical BMPs included in Appendix B to GeoEngineers (2018a) were designed to maintain or enhance the aquatic habitat present in the stream. These structures will often act to create complexity in the channel by scouring pools and sorting gravels as well as by providing refugia for juvenile fish. Site-specific restoration plans are provided in Appendix C (GeoEngineers 2018a).

As a follow-up measure to help ensure crossing actions would not adversely affect stream bank and channel structure, PCGP would monitor stream crossings to ensure long-term success of the restoration, maintenance of fish passage, and to identify channel erosion, scour or migration that could destabilize the site or expose the pipeline. As requested by FERC, PCGP developed a monitoring plan (GeoEngineers 2018a) following consultation with a representative from FWS and NMFS (Castro 2015). The monitoring plan would be customized, where necessary, to address risks of stream crossings identified in the Risk Analysis and those identified in subsequent preconstruction surveys.

Monitoring would consist of:

- Annual visits to all stream crossings, regardless of risk level, as part of PCGP’s monitoring of pipeline integrity. These visits would be completed by PCGP staff and would note any obvious signs of channel erosion, pipeline exposure, or major shifts in restoration elements. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.
- Aerial reconnaissance would be completed annually for the life of the Pipeline and stream crossings would be reviewed for major landscape changes such as channel migration and excessive erosion. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.
- Quarterly site visits to all sites in the Orange management category (sites with low-moderate project impact potential and high site or stream response potential, see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field

measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.

- Annual site visits to 15 percent of all sites in the Blue management category (sites with low-moderate project impact potential and low site or stream response potential) and 100 percent of all sites in the Yellow management category (sites with low-moderate project impact potential and moderate site or stream response potential, see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual site visits to 50 percent of the sites in the Yellow and 100 percent of sites in the Orange management category (see GeoEngineers 2018a) by a geo-professional in Years 3, 5, 7, and 10 to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the project, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Observations would be made during all site visits on the effects of cattle/elk browsing on restoration success, and of impacts associated with recreational use.
- Revegetation planning along the right-of-way is detailed in the ECRP. The ECRP describes monitoring and performance standards for revegetation.
- Records would be maintained annually to document any significant hydrologic events (flow or rainfall) that occur in between site visits. This shall be done to better understand the site response to moderate or large flood events. As gauging stations are extremely limited over the majority of the crossings along the Pipeline route, rainfall records would be used to identify the potential flooding that may occur in between scheduled monitoring events. These climatic events would be considered during annual monitoring when evaluating site response.
- Unscheduled site visits may be completed at stream crossings on BLM and USFS jurisdiction following localized rainfall events exceeding a 25-year rainfall intensity to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual reporting in Years 1, 2, 3, 5, 7, and 10 following construction would be provided to outline observations of stream crossings and any remedial action taken to restore site conditions.
- Monitoring frequency and locations may be modified in response to demonstrating site restoration success in the Annual Monitoring reports.

Overall, these actions would reduce potential adverse effects from bank and bed stability to discountable levels to listed coho salmon.

Crossing of Unstable Slopes

Potential impact to waterbodies by deep-seated landslides and shallow-rapidly moving landslide hazards on unchannelized slopes is difficult to evaluate. Slope failure near the waterbody during Pipeline operation could result in soil and sedimentation falling into the waterbody. PCGP evaluated all likely unstable areas during selection of the proposed route, and moved the route as necessary to areas considered to have low risk (GeoEngineers 2017k). There are two mapped landslide sites identified in Table B-2 in Appendix B to Resource Report 6, which are pending access with landowner permission to complete field reconnaissance to assess potential risk to the proposed pipeline. They are located near Steinnon Creek between MPs 24BR and 25BR.

Aquatic Habitat

There also are potential indirect effect to aquatic habitat from increased suspended sediment from stream crossings. The same approach utilizing TSS concentration and exposure to evaluate levels of risk to fish (Newcombe and Jensen 1996) was applied to quantifying effects of sediment on fish habitat, termed harmful alteration, disturbance or destruction (HADD) of habitat by Anderson et al. (1996). HADD risk includes concentration and exposure to sediment along with sensitivity of the habitat affected. Most likely, suspended sediment would increase embeddedness of spawning gravels with increasing habitat effects closer to the construction location.

Anderson et al. (1996), utilizing the approach of Newcombe and Jensen (1996), used sediment concentration and duration to model the level of adverse effects to fish habitat based on empirical studies.

Anderson et al. (1996) described five severity of ill effect (SE) ranks to habitat:

SE 3: Measured change in habitat preference.
SE 7: Moderate habitat degradation measured by a change in the invertebrate community.
SE 10: Moderately severe habitat degradation as defined by measurable reductions in the productivity of habitat for extended periods (months) or over a large area (kilometers).
SE 12: Severe habitat degradation as measured by long-term (years) alterations in the ability of existing habitats to support fish or invertebrates.
SE 14: Catastrophic or total destruction of habitat in the receiving environment.

The Anderson et al. (1996) HADD model utilizes the same form as the Newcombe and Jensen (1996) models, that is:

$$z = a + b\,(\log_e x) + c\,(\log_e y)$$

where z = SE score, x = duration of exposure in hours, and y = concentration of suspended sediment in mg/l. However, constants a, b, and c in Newcombe and Jensen's Model 1 for juvenile and adult salmonids (a=1.0642, b=0.6068, and c=0.7384) differ in the Anderson et al., (1996) multivariate model for SE to habitat (a=0.032, b=1.008, and c=0.978). As a consequence, for any given duration of exposure (from 2 hours to 6 hours, see table 3.5.4-27), the TSS concentration that would produce a SEV = 3 in the Newcombe and Jensen Model 1 is less than the TSS concentration that would produce a SE = 3 in the Anderson et al. HADD habitat model. Because of nonlinearities in both models, the TSS concentration that would produce a SEV = 7 in the Newcombe and Jensen Model 1 is more than the TSS concentration that would produce a SE = 3 in the Anderson et al. HADD habitat model. The SEV and SE scores are more closely aligned at lower TSS concentrations than at higher concentrations for any given duration of exposure.

Based on the models for suspended sediment concentration and duration of exposure discussed above, estimates were made for effects to habitat of Oregon Coast coho salmon. Calculated values less than SEV 7 would likely be considered to have little or no substantial effect to functional habitat, while those equal to or greater than SEV 7 likely would be substantial relative to changes in functional habitat conditions for coho salmon. In this BA, similar levels of effect due to TSS concentrations and durations of exposure are assumed to apply to coho salmon.

During a failure of dry open-cut construction, TSS concentrations of up to 361 mg/l over background TSS concentrations could last for 6 hours (see table 3.5.4-27). If that same concentration is applied in the Anderson et al. HADD model with duration of 6 hours, the SE score is >7 but ≤8, indicating slightly more damage to habitat than "moderate habitat degradation measured by a change in the invertebrate community." To ensure a SEV score less than 7, in-stream work to repair a failed containment structure would likely have to be restricted to less than 4 hours. Thus, unless crossing failures occur in these stream crossings, there would be no substantive adverse effects to coho salmon habitat from sediment generated during stream crossings.

Freshwater Stream Invertebrates

Substrates downstream from in-stream construction sites could be impacted by sediments. Mayflies, caddisflies, and stoneflies prefer large substrate particles in riffles and are adversely affected by fine sediment deposited in interparticulate spaces (Cordone and Kelley 1961; Waters 1995; Harrison et al. 2007). Fish and benthic macroinvertebrate abundance downstream of pipeline construction sites have been reported as short-term reductions following construction-generated suspended sediment (Reid and Anderson 1999). Macroinvertebrate abundance and community composition are highly related to the degree to which substrate particles are embedded by fine material (Birtwell 1999).

Fish emigrate from construction sites and benthic taxa drift downstream to sites where sediment deposition has not affected habitat suitability (Reid and Anderson 1999). In Ontario, stream crossing construction using fluming produced less turbidity and sediment concentrations downstream than construction by wet open cutting streams; wet open cutting resulted in a significant decrease in aquatic invertebrates downstream three days post-construction (Baddaloo 1978 cited in Gartman 1984). One year after construction there were no significant differences in benthos numbers. Reid et al. (2008) summarized the results of nine wet open-cut pipeline stream crossing studies found similar results and noted all measured effects to downstream stream invertebrate population abundance or diversity (six of nine studies) were less than a year in duration with three studies having no measured effects on invertebrate abundance. In general, the percentage of type of stream benthos and invertebrate taxa affected by construction of the Pipeline would be in proportion to their abundance during the season of construction, which is likely to be relatively high as crossings would occur during the summer growing season.

Rapid colonization by benthic organisms of disturbed substrate following pipeline construction has been demonstrated elsewhere. In Pennsylvania, samples taken before and 30 days after pipeline construction revealed rapid recolonization of the disturbed and newly-exposed stream substrate by benthic macroinvertebrates (Gartman 1984). Similarly, the number and diversity of aquatic invertebrate taxa in coldwater streams in New York State were unchanged two to four years following pipeline construction from those measured prior to construction (Blais and Simpson 1997). Additionally, most studies of effects on stream invertebrates are based on wet open-cut crossings, which normally have much higher suspended sediment concentrations than the isolated dry stream crossing methods that would be used by the proposed Pipeline project. Therefore, the overall level of effect of the pipeline crossings on freshwater stream invertebrates, unless crossing sealing failures occur, would be even less than that noted by literature and would not result in substantial reduction in growth or survival of listed coho salmon individuals.

Hydrostatic Testing

Water would be required on a one-time basis near the end of construction to hydrostatically test the pipeline. Potential impacts associated with hydrostatic testing include entrainment of fish, reduced downstream flows, and impaired downstream uses if test water is withdrawn from surface waters, and erosion, scouring, and a release of chemical additives occur as a result of test water discharge. PCGP would obtain its hydrostatic test water from commercial or municipal sources or surface water rights owners, the sources of which are lakes, impoundments, and streams.

There are six locations within the range of the Oregon Coast coho ESU where water would be withdrawn for hydrostatic testing and/or dust control. Oregon Coast coho are present at only one location – at the crossing of the South Umpqua River. An estimated total of 19,508,387 gallons would be withdrawn from the six locations.

There are 19 proposed hydrostatic test break sections that are within range of Oregon Coast coho ESU. Of those, 10 hydrostatic test break sections are within 0.5 mile of a waterbody with known Oregon Coast coho habitat. Distances separating test break from waterbodies range from 100 feet (Monkey Ranch Gulch) to over 2,000 feet. There may be some risk of discharged hydrostatic test water accidentally entering the waterbodies with designated critical habitat. PCGP developed a Hydrostatic Test Plan (see appendix U) in consultation with the BLM and Forest Service as well as the Center for Lakes and Reservoirs and Aquatic Bioinvasion Research and Policy Institute (Portland State University) and ODEQ. This Plan outlines the general hydrostatic testing process and describes the BMPs to minimize or avoid potential effects that could result from hydrostatic testing, including accidental release of test water. One of the purposes of the plan was to develop BMPs to prevent the potential transfer of invasive species and pathogens from one watershed to another.

The discharge volume at each site ranges from about 0.2 to 3.3 million gallons at rates ranging from several hundred to several thousand gallons per minute. Total water used would be about 62 million gallons, with about half from impoundments or lakes, and the rest from streams, including South Umpqua River, Rogue River, North Fork Little Butte Creek, and Klamath River. Within the range of Oregon Coast ESU of coho salmon, there are six potential water sources. Four of the sources are water district sources while two are on the South Umpqua River which is not a district water source.

PCGP would minimize the potential effects of hydrostatic testing on these watersheds by adhering to the measures in its Hydrostatic Testing Plan (see appendix U), including screening intake hoses to prevent the entrainment of fish and other aquatic organisms, meeting NMFS screening criteria, and regulating the rate of withdrawal to avoid adverse impact on aquatic resources or downstream flows. Where test water cannot be returned to its withdrawal source, the water would be treated with a mild chlorine treatment and discharged to an upland location (at least 150 feet from streams with no direct discharge features) through a dewatering structure at a rate to prevent scour and erosion and to promote infiltration. PCGP would obtain all necessary appropriations, withdrawal, and discharge permits through the OWRD. With the implementation of the Hydrostatic Testing Plan and BMPs, and obtaining required permits, adequate measures would be in place to prevent direct or indirect effects to Oregon Coast coho salmon that may be in these stream systems.

One of the responsibilities of the EI is to oversee and confirm the activity to be in compliance with the requirements of FERC's Upland Plan and Wetland and Waterbody Procedures and all other environmental permits and approvals, including the multiple plans comprising the POD (see section 4.0 in the ECRP in appendix F). For example, this would include compliance with the Oregon Water Resources water appropriation Limited Use license permit conditions, which specify water withdrawal rates and volumes from specific sources. The EI would document that these permit conditions are followed and oversee that contractor's water withdrawal pumps used to withdraw surface water would be screened according to NOAA Fisheries screening criteria to prevent entrainment of aquatic species. When pumping water from a source, the pump head would be submerged and maintained on average at the center of the water column so as to prevent sucking in sediments and/or algae lying at the water level surface or sediments resting on the bed of the waterbody. The EI would also work with contractors so that the targeted ramping rate would be managed such that there is no significant decrease of river flows.

Aquatic Nuisance Species

Nonindigenous Aquatic Species (NAS) are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Currently, there are 180 reported NAS in Oregon, of which 134 are documented within the USGS hydrologic basins crossed by the proposed Pipeline (USGS 2017).

In the riverine environments crossed by the Pipeline, largemouth bass and smallmouth bass, introduced as recreational species, prey on juvenile sockeye, coho, and Chinook salmon (Tabor et al. 2007). Management priorities in Oregon concentrate on the NAS whose current or potential impacts on native species and habitats, and economic and recreational activity in Oregon, are known to be significant (Hanson and Sytsma 2001). Some of the major potential freshwater invasive species are mussels including the zebra and quagga mussels (*Dreissena polymorpha*, and *Dreissena rostriformis bugenisis*), as well as Chytrid fungus and other species of concern.

Management priorities in Oregon concentrate on the species whose current or potential impacts on native species and habitats and economic and recreational activity in Oregon are known to be significant, known as aquatic nuisance species (Hanson and Sytsma 2001).

Aquatic nuisance species could potentially be introduced into Pipeline project area waters by basin transfer through hydrostatic testing or be carried on equipment that is moved from outside of the region or between basins. PCGP has developed BMPs and guidelines to avoid the potential spread of the aquatic invasive species and pathogens of concern (see *Hydrostatic Testing Plan*, appendix U) in consultation with the BLM and Forest Service as well as the Center for Lakes and Reservoirs and Aquatic Bioinvasion Research and Policy Institute. If determined to be feasible for hydrostatic testing requirements, all water used in hydrostatic testing would be returned to its withdrawal source location after use; however, cascading water from one test section to another to minimize water withdrawal requirements may make it impractical to release water within the same watershed where the water was withdrawn. If it is not possible to return the water to the same water basin from where it was withdrawn, PCGP would employ an effective and practical water treatment method (chlorination, filtration, or other appropriate method) to disinfect the water that would be transferred across water basin boundaries. The hydrostatic test water would be treated after it is withdrawn and prior to hydrostatic testing.

PCGP would implement a three-step BMP treatment process to prevent the potential spread of invasive species and forest pathogens from non-municipal surface water sources used during hydrostatic testing. The hydrostatic test water treatment process would incorporate screening/filtration during water withdrawal, chlorine treatment, and upland discharge at least 150 feet from wetlands or waterbodies with no direct discharge to these features. All hydrostatic test water would be released through a dewatering device such as a straw bale structure or sediment bag, in a manner to promote infiltration. Further, all hydrostatic release locations would be monitored after construction to ensure noxious weeds have not become established.

As explained in the Hydrostatic Test Plan, PCGP proposes to use a treatment of 2 ppm or 2 mg/L of free chlorine residual with a detention time of 30 minutes to treat all non-municipal surface waters that would be used as a water source for hydrostatic testing purposes. Chlorinated water would be released according to the Oregon Department of Environmental Quality criteria to prevent water quality impacts, potential effects to aquatic species, and to minimize potential impacts to sensitive areas.

Mobilization of Contaminated Substances

The U.S. Forest Service reported that naturally occurring mercury exists in the vicinity of the Mars Fraction lode claim located near MP 108.7 (GeoEngineers 2017k). Natural-occurring mercury is present in the disrupted soil regolith and underlying bedrock strata throughout the upper reaches of the East Fork Cow Creek watershed. Geochemical analysis of six soil samples collected along a 2,000-foot section of a previously proposed route that crossed partly through the historic Thomason mining claims near the East Fork Cow Creek has been determined to have very low concentrations of natural-occurring mercury mineralization (GeoEngineers 2017k). The Pipeline location subsequently was rerouted approximately 2.500 feet from where the samples were taken. GeoEngineers (2017k) opined that the soils underlying the currently proposed crossing of the East Fork Cow Creek are unlikely to have concentrations of naturally occurring mercury exceeding those measured in samples obtained from the previous crossing location and most likely will have lower levels.

PCGP developed the ECRP with a number of temporary and permanent erosion control measures to minimize the potential for sediment to enter wetlands or waterbodies (see appendix F). As described in Attachment 1 to the Contaminated Substance Discovery Plan, the temporary or short-term erosion control measures/BMPs are to be employed throughout the construction phase and would be routinely monitored by an EI or authorized company representative.

The following recommendations were developed by the Forest Service in consultation with ODEQ. They were also discussed and agreed upon at the February 2, 2010 meeting to review the Contaminated Substances Discovery Plan:

- Within Riparian Reserves for all hydrologic features crossed by the pipeline between MP's 109 and 110 (figure. 5, Contaminated Substances Discovery Plan) provide 100% post-construction ground cover on all disturbed areas. Wood fiber is the preferred material. In addition, construct water bars at 50-foot intervals.
- At hydrologic features G, J, and K (figure. 5, Contaminated Substances Discovery Plan) assure that erosion control measures are in place before the fall rains and monitor for rilling, gullying and other forms of active erosion that may transport sediment into the aquatic environment. If rilling or gullying is occurring that may result in sediment transport into the aquatic environment, improve erosion control measures to preclude sedimentation.
- Inspect the construction corridor for sedimentation after each significant storm event (which would be more frequently than a bank-full event) or whenever there is a visual sediment plume downstream. If the sediment source is originating from the pipeline corridor, improve erosion control measures to preclude sedimentation.

The summary of the report in Attachment 1 to the Contaminated Substance Discovery Plan states that the proposed pipeline construction activities within the upper East Fork Cow Creek watershed are not anticipated to disturb and expose soils and bedrock strata that contain more than low amounts of natural occurring mercury mineralization, and any sediment that is generated is not likely to reach the aquatic environment due to implementation of short-term and permanent mitigation measures outlined in PCGP's ECRP and as listed in Attachment 1 to the Contaminated Substance Discovery Plan. Also, Galesville Dam, approximately 18 miles downstream of the crossing and at the boundary of Upper Cow Creek watershed, is a complete barrier to fish passage and the Oregon Coast coho salmon no longer occur in this watershed.

Fuel and Chemical Spills

Fisheries habitats could be adversely affected if petroleum products of a substantial quantity were accidentally discharged into aquatic environments. Such materials are toxic to algae, invertebrates and fish. Of the products likely to be present during construction, data compiled from a wide range of sources indicate that diesel fuels and lubricating oils are considerably more toxic to aquatic organisms than other, more volatile products (gasoline) or heavier crude oil (Markarian et al. 1994). Release of diesel fuel in freshwater habitats significantly reduced aquatic invertebrate densities and species richness at least 3 miles downstream but invertebrate densities recovered within a year (Lytle and Peckarsky 2001). Impacts to aquatic habitats that primarily affect aquatic substrates – hence spawning, incubating and rearing habitats – can remain for much longer periods (Markarian et al. 1994).

Equipment used for construction across waterbodies could potentially release hydraulic fluid comprised of a variety of compounds, the most common of which are mineral oil-based, organophosphate esters and polyalphaolefins (HHS 1997). Release from machinery can occur through faulty seals, hoses, sumps and reservoirs, or general system failure. Components of mineral oil and polyalpaolefins do appear to bioaccumulate in animals whereas larger molecular constituents in organophosphate esters can concentrate in fish, primarily partitioning in fat tissue (HHS 1997). In general, toxicity of organophosphate esters is greater than either mineral oil or polyalphaolefin-based hydraulic fluids when inhaled, ingested, and in contact with the skin for humans. Toxicities have not been clearly described for aquatic invertebrates or fish and would be dependent on specific chemical components (HHS 1997).

Inadvertent spills of fluids used during construction, such as fuels and lubricants, could contaminate wetland soils and vegetation if not sufficiently contained. To minimize the potential for spills and any impacts from such spills, PCGP's SPCCP (see appendix L) would be implemented. In general, hazardous materials, chemicals, fuels, and lubricating oils would be not be stored, nor would refueling operations or concrete coating activities be conducted within 100 feet (150 feet on BLM and Forest Service lands) of a wetland or waterbody in accordance with FERC's *Procedures* (see appendix C) and the SPCCP (see appendix L) except where no reasonable location is possible and additional containment steps have been taken. The SPCCP would be updated with site-specific information prior to construction. Adherence to these plans and procedures would results in effects to Oregon Coast coho salmon that would be discountable.

Streambed Scour

Fluvial erosion represents a potential hazard to the Pipeline where streams are capable of exposing the pipe as a result of channel migration, avulsion, widening, and/or streambed scour. The principal hazard resulting from channel migration and streambed scour is complete or partial exposure of the Pipeline within the channel from streambed and bank erosion or within the floodplain from channel migration and/or avulsion. To address this potential hazard, PCGP completed a channel migration and scour analysis (GeoEngineers 2017i and GeoEngineers 2018b). In this analysis, stream crossings along the route were evaluated with respect to potential future risk to the Pipeline that could result from channel bed scour and/or lateral migration. The evaluation was conducted in two phases: Phase I involved a desk top evaluation and small field investigation in which all stream crossings were ranked for potential risk; Phase II involved detailed field investigation and analyses of those stream crossings that were concluded to pose risk to the Pipeline based on the Phase I study.

Minimizing the effects of migration and scour hazards to the Pipeline can be accomplished with the following (GeoEngineers 2017i and GeoEngineers 2018b):

- At each channel crossing, bury the pipe below the estimated depth of streambed scour. Where bedrock is encountered at shallower depths than the estimated scour depth, the elevation of competent bedrock represents the limit of scour.
- Where feasible, place the pipe into bedrock.
- Within floodplains adjacent to migrating channels, bury the pipe below the projected depth of the channel thalweg within the 50-year channel migration zone.

The Pipeline would be designed to protect the integrity of the pipe, which may include increasing the depth of cover to more than the 5-foot minimum to accommodate the potential for long-term scour and bank stabilization. At a minimum, PCGP would design all waterbody crossings to meet U.S. Department of Transportation standards (CFR 49 Part 192). Additional depth would be evaluated and considered based on GeoEngineers' (2018b) Channel Migration and Scour Analysis or other site-specific investigations, considering the final route alignment. From the results of the Channel Migration and Scour Analysis, PCGP would bury the pipe below the estimated 100-year scour depth or into competent bedrock, whichever is shallower.

Effects to Hyporheic Exchange

The hyporheic zone is defined by the extent of surface-subsurface mixing, the hyporheic exchange that moves surface water into the surrounding alluvium and back to the river again through the porous sediment surrounding a river (Tonina and Buffington 2009). The downwelling flows of surface water supply the wetted hyporheic zone with dissolved oxygen, which sustains organisms in the aerobic environment but decomposition of organic materials in the hyporheic zone may deplete oxygen concentrations in return flows to the surface (Findlay et al. 1993; Tonina and Buffington 2009). Alternatively, nutrient enrichment to surface waters occurs with hyporheic exchange by upwelling flows (Valett et al. 1990). For example, hyporheic flow is important for surface water/groundwater interactions that influence bull trout spawning sites and use of other habitats (e.g., juvenile rearing, migration) (FWS 2005h) and presumably those of other salmonids.

GeoEngineers (2017j) developed a ranking procedure to qualitatively evaluate site conditions at waterbody crossings and the probable influence on hyporheic flow and whether a stream channel will have an active and functional hyporheic zone. The procedure assigns a value of 1 to 5 for different criteria: alluvial vs. bedrock substrate, substrate sediment size, stream flow period, presence of an upstream drainage basin, and channel gradient vs. percent drainage area contribution to the 5th field HUC upstream from the pipeline crossing. The procedure includes weighting factors emphasizing importance of some criteria over the others. In the range of Oregon Coast coho, there was a total of 7 stream crossings evaluated in the Coos Subbasin, 37 evaluated in the Coquille Subbasin, and 67 stream crossings evaluated in the South Umpqua Subbasin. None of the crossings in the Coos Subbasin and only 1 crossing in the Coquille Subbasin (Middle Fork Coquille River Watershed) was evaluated as having high sensitivity to hyporheic zone alteration. Further, 8 crossings in the South Umpqua Subbasin (2 in Myrtle Creek, 3 in Clark Branch-South Umpqua River, and 1 each in the remaining three watersheds crossed) were evaluated as having high sensitivity to hyporheic zone alteration. In all, 30 stream crossings in the three subbasins had moderate sensitivities and the remaining 62 crossings scored low sensitivity to hyporheic zone alteration.

Construction of the pipeline using dry open cut construction would require removal of native streambed and bank material from the stream. The subsequent burial of the pipeline would involve replacing those native materials back in the streambed and stream banks. At crossings with steep natural stream banks (e.g., slopes steeper than 3H:1V [horizontal to vertical]), additional stabilization measures such as compaction of backfill may be required that could locally alter stream bank permeability from pre-construction conditions. Removal and replacement of native stream material has the potential to locally disrupt the structure and organization of the hyporheic zone in the immediate area of the pipeline crossing. However, such alterations would be expected to be minimal relative to adjacent unaffected streambed and stream banks and could either increase or decrease permeability over an extremely narrow segment of a stream channel, up to 12 feet in width at the maximum trench width. Local disruption of hyporheic function by construction and presence of the pipeline would not be expected to result in measureable effects to dissolved oxygen and/or nutrient enrichment and would not adversely affect coho.

BMPs that reduce the potential impacts to the hyporheic zone include the following:

- Native material that is removed from the pipeline trench during excavation across stream channels will be used to backfill once the pipe is in place in order to minimize potential changes to preconstruction permeability.
- Trench plugs will be installed at the base of slopes adjacent to wetlands and waterbodies and where needed to avoid draining of wetlands or affecting the original wetland or waterbody hydrology.

While the potential impact of pipeline construction on hyporheic exchange is considered to be low at all stream crossings considering the proposed construction methods, PCGP proposes these additional measures to further reduce the potential for even localized impacts to water quality from hyporheic exchange at the stream crossings identified as having high hyporheic sensitivity (Appendix A to GeoEngineers 2017j):

- Document streambed stratigraphy prior to construction if possible, or if not possible, during construction to aid in site restoration. Such documentation will be conducted by staff trained in recognizing and observing river channel processes. If done during construction, this may be performed by the EI after receiving suitable training.
- Segregate active streambed gravels and cobbles from underlying streambed materials (including fractured bedrock) to their natural depth and replace gravels/cobbles to this natural pre-construction depth.
- Below active stream gravels, replace native material in a manner to match upstream and downstream stratigraphy and permeability to the maximum extent practicable.

Runoff from Permanent, Temporary, Existing Access Roads (PARs, TARs, EARs), and TEWAs

Run-off from PARs, TARs, EARs, and TEWAs can result in sediment delivery affecting stream supporting Oregon Coast coho. PCGP proposes to construct three new TARs and four new PARs within the range of Oregon Coast coho (table 3.5.4-31). Potential for sediment delivery to streams following construction of the roads was evaluated by applying sediment and drainage assessment components of the Washington Road Surface Erosion Model or WARSEM (Dube et al. 2004) which has been previously applied in Oregon (Surfleet et al. 2011). Specific WARSEM components have been used to evaluate levels of risk for delivery of sediment to streams nearest each TAR and PAR as well as nearest streams supporting ESA-species. Two TARs have low risks of sediment delivery to any stream but only one TAR has a low risk of delivery to an ESA stream – North Fork Little Butte Creek which supports Oregon Coast coho with designated critical habitat. None of the other proposed TARs and PARs have any risk of sediment delivery to streams closest to new road sites.

Similar risk analyses were conducted for portions of EARs that are known to occur within 1SPTH of streams with designated critical habitat for coho and other streams known or assumed to provide habitat for coho in the two ESUs. Finally, TEWAs that are proposed within 1SPTH of critical habitat for coho were evaluated for risks of sediment delivery to coho critical habitat. BMPs)proposed by PCGP that would be applied to PARs, TARs, EARs, and TEWAs to prevent sediment delivery in coho critical habitats and other coho-bearing streams are summarized from the ECRP (appendix F to the APDBA).

The risk analysis utilizes four modelling components required for sediment and drainage assessment as applied in WARSEM. The components that were evaluated for each TAR/PAR include:

- Dominant lithology – information source: Oregon Department of Geology and Mineral Industries, Oregon Geologic Data Compilation 6 (OGDC-6 geodatabase) available from http://www.oregongeology.org/sub/ogdc/index.htm. Dominant lithology coinciding with locations of each PAR or TAR was evaluated at each location.
- Road gradient – evaluated gradient at each PAR or TAR on topographic map using contour lines (rise divided by run) if road gradient >5 percent grade. If less than 5 percent, gradient was noted as 0 – 5%.
- Annual rainfall – information source: Western Regional Climate Center, Western U.S. Climate Historical Summaries available from https://wrcc.dri.edu/Climsum.html. Annual raifal at each location was evaluated by adjusting the average total precipitation for snowfall during the period of record for National Weather Station closest to each PAR or TAR.
- Delivery – evaluated closest distance of each PAR or TAR to any stream segment (perennial or intermittent, using National Hydrography Dataset, available at https://nhd.usgs.gov/data.html) and to each stream segment supporting ESA-listed fish using ODFW Oregon Fish Habitat Distribution Data available at https://nrimp.dfw.state.or.us/nrimp/default.aspx?pn=fishdistdata. In addition, distances of nonforested and forested vegetation intervening between road and stream segment were measured using GIS.

Technical documentation (Appendix A) in Dube et al. (2004) was used to evaluate levels of risk for erosion and sediment delivery contributed by each of these four site-specific components at each proposed PAR or TAR.

In addition to site-specific conditions, PCGP has specified road lengths and widths for each proposed PAR or TAR. Although road surfacing has not been specified, PCGP has proposed surfacing enhancements as necessary in Section 2.3 of the Transportation Management Plan (see POD). Road length, width, and surfacing are required components for use in WARSEM as well as daily average traffic volume, which is currently unknown but may be hypothesized using categorical traffic levels in technical documentation for WARSEM (Appendix A, in Dube et al. 2004) and a road age factor which is irrelevant to the evaluation of risk for sediment production since none of the proposed roads have been constructed.

The following components required for WARSEM cannot be evaluated for the PARs and TARs:

- Road prism geometry
- Cuttslope height
- Cuttslope cover
- Drainage ditch width
- Drainage ditch condition

WARSEM estimates the average annual amount of road surface erosion that is delivered to a stream from each road segment modeled by using calculations based on empirical relationships derived from road erosion research (Dube et al. 2004). The model uses the following formulas to calculate road surface erosion and delivery to a stream:

Total Sediment Delivered to a Stream from each Road Segment (in tons/year) = (Tread & Ditch Sediment + Cutslope Sediment) x Road Age Factor

Tread & Ditch = Geologic Erosion Factor x Tread Surfacing Factor x Traffic Factor x Segment Length x Road (Tread + Ditch) Width x Road Gradient Factor x Rainfall Factor x Delivery Factor

Cutslope = Geologic Erosion Factor x Cutslope Cover Factor x Segment Length x Cutslope Height x Rainfall Factor x Delivery Factor

New TARs and PARs. Some of the relevant information used to derive various "Factors" necessary for WARSEM are provided in the tables, below. Percent gradient at locations of proposed TARs and PARs and the associated Road Slope Factor is provided in table 3.5.4-31. The gradient of a road segment influences the erosion rate. Three Road Slope Factors are used in WARSEM and apply to gradients estimated in table 3.5.4-31. The steepest gradient estimated for any proposed road was 20% for TAR-101.70 which corresponds to a Road Slope Factor of 2.5. Except for that road, the other the proposed road locations are on relatively flat terrain with gradients estimated from 0 to 5% and Road Slope Factors of 0.2.

TABLE 3.5.4-31

Location and Physical Characteristics for Proposed TARs and PARs in Range of Oregon Coast Coho.

Road Identification	Fifth Field Watershed	Latitude	Longitude	Length (feet)	Width (feet)	Surface Area (acres)	Gradient (Road Slope Factor) a/
TAR-27.06	North Fork Coquille River	43°10'36.344"N	124°1'37.944"W	1,500	20	0.69	0 to 5% (0.2)
TAR-29.92	East Fork Coquille River	43°9'28.876"N	123°59'25.81"W	2,249	16	1.03	0 to 5% (0.2)
TAR-88.69	Days Creek-South Umpqua River	42°59'17.891"N	123°5'57.096"W	416	20	0.19	0 to 5% (0.2)
TAR-94.81	Days Creek-South Umpqua River	42°55'55.686"N	123°2'14.79"W	114	20	0.05	0 to 5% (0.2)
TAR 101.70	Days Creek-South Umpqua River	42°51'29.524"N	123°0'11.673"W	1,517	25	0.69	20% (2.5)
PAR-15.07	Coos Bay-Frontal Pacific Ocean	124°8'11.584"N	43°20'13.082"W	258	25	0.15	0 to 5% (0.2)
PAR-29.48	East Fork Coquille River	123°59'44.13"N	43°9'23.464"W	85	25	0.04	0 to 5% (0.2)
PAR-48.58	Middle Fork Coquille River	123°42'58.591"N	43°3'2.731"W	222	25	0.13	0 to 5% (0.2)
PAR-59.58	Olalla Creek-Lookingglass Creek	123°31'13.339"N	43°4'46.221"W	105	25	0.07	0 to 5% (0.2)
PAR-71.46	Clark Branch-South Umpqua River	123°19'41.662"N	43°3'13.832"W	692	25	*0.84*	0 to 5% (0.2)
PAR-80.03	Myrtle Creek	123°11'35.585"N	43°3'6.44"W	92	25	0.05	0 to 5% (0.2)
PAR-94.66	Days Creek-South Umpqua River	123°2'26.5"N	42°55'58.579"W	501	25	0.29	0 to 5% (0.2)

a/ Road Slope Factors: 0.2 for gradients of <5%; 1.0 for gradients of 5-10%; 2.5 for gradients >10%. See Table A-6, Appendix A, Dube et al. 2004

Erodibility of a road segment is related to soil characteristics at the site location which are related to the parent lithology and weathering. Relative erodibility for different rock types of different geologic ages that are associated with proposed TARs and PARs are provided in table 3.5.4-32 as the Geologic Erosion Factor corresponding to each lithology. The highest Geologic Erosion Factor (5) is associated with Quaternary and Tertiary volcanic ash and tuff as well as with weathered granite and other intrusive rocks. Deeply weathered sedimentary rocks that degrade to silt and sand also have the highest Geologic Erosion Factor (5). Weathered schist or gneiss from the Tertiary and older formations have moderate Geologic Erosion Factor (2), and others in table 3.5.4-32 have low Geologic Erosion Factor (1).

Rainfall strongly influences erosion and sediment transport. Instead of using the PRISM climatic model as applied in WARSEM), data from NWS cooperating stations closest to each proposed TAR and PAR were used to evaluate average annual rainfall (average monthly precipitation adjusted for average monthly snowfall, described in Equation 6, Appendix A, Dube et al. 2004) for each station's period of record. That information is provided in table 3.5.4-32. A Rainfall Factor, derived from the average annual rainfall at the closest NWS station, is computed from Equation 7, Appendix A, Dube et al. (2004) and provided in table 3.5.4-32. In general, average annual rainfall and Rainfall Factors for proposed TARs and PARs decline with distance along the Pipeline route from west to east.

TABLE 3.5.4-32

Surface Lithology and Average Annual Total Rainfall Estimated at the
National Weather Service Station (NWS) Closest to Each Proposed TAR and PAR in Range of Oregon Coast Coho.

Road Identification	Dominant Lithology a/	Geologic Erosion Factor b/	Closest NWS Station (NWS Number) c/	Period of Record	Station Distance to Road (miles)	Average Annual Rainfall d/ (inches)	Rainfall Factor e/
TAR-27.06	Quaternary fluvial terrace deposits	high (5)	Dora 2 W (352370)	1969-1999	1.4	59.15	**7.3**
TAR-29.92	Quaternary fluvial terrace deposits	high (5)	Dora 2 W (352370)	1969-1999	0.6	59.15	7.3
TAR-88.69	Jurassic granitic plutonic rocks	high (5)	Myrtle Creek 8 NE (355891)	1980-2007	7.4	38.74	3.9
TAR-94.81	Quaternary fluvial terrace deposits	high (5)	Riddle 2 NNE (357169)	1961-1990	15.9	30.18	2.7
TAR 101.70	Triassic/Jurassic serpentinite melange	low (1)	Riddle 2 NNE (357169)	1961-1990	18.9	30.18	2.7
PAR-15.07	Quaternary alluvium and estuarine sediments	high (5)	Fairview 4NE (352775)	1974-2016	7.8	66.51	8.7
PAR-29.48	Eocene mudstone and turbidite sandstone	low (1)	Dora 2 W (352370)	1969-1999	0.7	59.15	7.3
PAR-48.58	Eocene marine sedimentary rocks	low (1)	Reston (357112)	1909-2004	7.4	48.8	5.5
PAR-59.58	Quaternary fluvial terrace deposits	high (5)	Upper Olalla 1N (358788)	1978-2016	3.4	40.52	4.1
PAR-71.46	Jurassic/Cretaceous semischist and phyllite	moderate (2)	Myrtle Creek 8NE (355891)	1980-2007	8.3	38.74	3.9
PAR-80.03	Jurassic mafic composition lithologies	low (1)	Myrtle Creek 8NE (355891)	1980-2007	2.5	38.74	3.9
PAR-94.66	Quaternary surficial deposits	high (5)	Myrtle Creek 8NE (355891)	1980-2007	12.4	38.74	3.9

a/ Dominant Lithology evaluated from Oregon Department of Geology and Mineral Industries, Oregon Geologic Data Compilation 6. Available from http://www.oregongeology.org/sub/ogdc/index.htm.
b/ Geologic Erosion Factor surmised from Figure A-1 and Table A-1 in Appendix A, Dube et al. 2004.
c/ Closest NWS Station (with Cooperator Number) based on coordinates provided in individual station data, available from Western Regional Climate Center, Western U.S. Climate Historical Summaries (available from https://wrcc.dri.edu/Climsum.html).
d/ Average Annual Rainfall derived from average monthly precipitation adjusted for average monthly snowfall, described in Equation 6, Appendix A, Dube et al. (2004).
e/ Rainfall Factor derived from the average annual rainfall at the closest NWS station, computed using Equation 7, Appendix A, Dube et al. (2004).

The Delivery Factor is a key component of WARSEM and subsequent estimation of risks by erosion and road-generated sediments to aquatic resources. Sediment transport is dependent on the slope of the hillside, infiltration capacity of the soils, volume and depth of runoff water, and obstructions on the hillside (e.g., effectiveness of vegetative buffers at trapping sediment) that would slow runoff water and trap the sediment (Dube et al. 2004). While roads farther than 200 feet from a stream are assumed not to deliver sediment to streams unless a gully exists that allows for transport of sediment from the road to the stream, roads within 100 to 200 feet of a stream are assumed to allow for delivery of 10 percent of produced sediment; roads <100 feet from a stream allow for delivery of 35 percent of produced sediment, and drainage from a road to a stream allows for 100 percent of produced sediment (see Table A-10, Appendix A, Dube et al. 2004).

This simplified scheme identifies four levels for the Road Delivery Factor in WARSEM: 0, 10, 35, and 100 (see table 3.5.4-33). Although vegetation characteristics are not factors in WARSEM, distances through nonforested and forested vegetation that intervene between each proposed road and the closest stream (and closest stream supporting ESA species) are included in table 3.5.4-33. The highest Road Delivery Factor in table 3.5.4-33 is 100 (indicating delivery of 100 percent of sediment produced by the new road) for PAR-15.07 which crosses Laxstrom Gulch, a tributary to Stock Slough and a waterbody that supports Oregon Coast ESU coho which is designated critical habitat for the ESU. PAR-71.46 also crosses an intermittent tributary to the South Umpqua River (Road Delivery Factor = 100), but the tributary does not support ESA-listed species. None of the other TARs and PARs are <100 feet from any stream that supports Oregon Coast coho.

TABLE 3.5.4-33

Estimated Risks for Sediment Delivery to Any Closest Stream and Closest Stream with ESA Species from Each Proposed TAR and PAR in Range of Oregon Coast Coho with Distances of Vegetation Intervening between Road and Stream

Road Identification	Closest Stream (distance)	Flow a/	Intervening Vegetation (distance)	Road Delivery Factor b/	Closest ESA Stream (distance)	Intervening Vegetation (distance)	Road Delivery Factor b/
TAR-27.06	Middle Creek c/ (109 ft)	P	Nonforested (30 ft) Forested (73 ft)	10	Middle Creek c/ (109 ft)	Nonforested (30 ft) Forested (73 ft)	10
TAR-29.92	East Fork Coquille R. c/ (360 ft)	P	Nonforested (260 ft) Forested (100 ft)	0	East Fork Coquille R. c/ (360 ft)	Nonforested (260 ft) Forested (100 ft)	0
TAR-88.69	Days Creek c/ (132 ft)	P	Nonforested (0 ft) Forested (132 ft)	10	Days Creek c/ (132 ft)	Nonforested (0 ft) Forested (132 ft)	10
TAR-94.81	Lick Creek (105 ft)	P	Nonforested (70 ft) Forested (35 ft)	10	Lick Creek (105 ft)	Nonforested (70 ft) Forested (35 ft)	10
TAR 101.70	Trib. to Stouts Creek (220 ft)	I	Nonforested (120 ft) Forested (100 ft)	0	Stouts Creek (7,200 ft)	Nonforested (2800 ft) Forested (4400 ft)	0
PAR-15.07	Laxstrom Gulch c/ (0 ft)	P	None	100	Laxstrom Gulch c/ (0 ft)	None	100
PAR-29.48	Trib. E. Fk. Coquille R. (300 ft)	P	Nonforested (40 ft) Forested (260 ft)	0	East Fork Coquille R. c/ (600 ft)	Nonforested (430 ft) Forested (170 ft)	0
PAR-48.58	Deep Creek (103 ft)	I	Nonforested (40 ft) Forested (260 ft)	0	None	N/A	N/A
PAR-59.58	Trib. to Olalla Creek (270 ft)	P	Nonforested (270 ft) Forested (0 ft)	0	Olalla Creek c/ (1,180 ft)	Nonforested (1180 ft) Forested (0 ft)	0
PAR-71.46	Trib. to So. Umpqua R. (0 ft)	I	Nonforested (270 ft) Forested (0 ft)	100	South Umpqua River c/ (275 ft)	Nonforested (160 ft) Forested (115 ft)	0
PAR-80.03	Trib. to North Myrtle Ck. (490 ft)	I	Nonforested (4900 ft) Forested (0 ft)	0	School Hollow c/ (2,215 ft)	Nonforested (2215 ft) Forested (0 ft)	0
PAR-94.66	South Umpqua River c/ (320 ft)	P	Nonforested (60 ft) Forested (260 ft)	0	South Umpqua River c/ (320 ft)	Nonforested (60 ft) Forested (260 ft)	0

a/ Flow: P = Perennial, I = Intermittent/Ephemeral
b/ Road Delivery Factor: in WRSEM = 0, 10, 35, and 100 see Table A-10, Appendix A, Dube et al. (2004).

TABLE 3.5.4-33

Estimated Risks for Sediment Delivery to Any Closest Stream and Closest Stream with ESA Species from
Each Proposed TAR and PAR in Range of Oregon Coast Coho with Distances of Vegetation Intervening between Road and Stream

Road Identification	Closest Stream (distance)	Flow a/	Intervening Vegetation (distance)	Road Delivery Factor b/	Closest ESA Stream (distance)	Intervening Vegetation (distance)	Road Delivery Factor b/

c/ Supporting Oregon Coast ESU Coho and Critical Habitat

The products of three site-specific erodibility factors - Road Slope, Rainfall, and Geologic Erosion factors – are provided in table 3.5.3-31. The product of the three factors represents a calculated level of risk for erosion from each road's surface and has been ranked as Low (product <1), Moderate (product from 1 to 5), and High (product >5). The largest three factor product is 8.7 for PAR-15.07 due to a high Rainfall Factor and high Geologic Erosion Factor. Table 3.5.4-34 also includes the Road Delivery Factor for any stream closest to each proposed road. The four factor products (including the three Site Erodibility Factors and Road Delivery factor for any closest stream) have been ranked as None (product of 0), Low (product >0 to 20), Moderate (product >20 to 50), and High (product >50).

The risk analysis indicates there are two PARs (PAR-15.07 and PAR-71.46) with high risks of sediment delivery to any stream but only one PAR (PAR-15.07) has a high risk of sediment delivery to an ESA stream with critical habitat (Laxstrom Gulch). Three TARs (TAR-27.06, TAR-88.69, and TAR-94.81) have a moderate risk of sediment delivery to any stream and two of them have same moderate risk of delivery to ESA streams that support Oregon Coast coho with designated Critical Habitat (Middle Creek and Days Creek).

TABLE 3.5.4-34

Summary of New Road Erosion Risks and Risks of
Sediment Delivery to any Stream and ESA Stream Closest to Proposed TARs and PARs in Range of Oregon Coast Coho

	New Road Site Erodibility Factors					Any Stream Closest to New Road			ESA Stream Closest to New Road		
Road Identification	Road Slope Factor a/	Rainfall Factor b/	Geologic Erosion Factor b/	Three Factor Product	Road Erosion Risk	Road Delivery Factor c/	Four Factor Product with Delivery	Risk of Sediment Delivery to Any Stream	Road Delivery Factor c/	Four Factor Product with Delivery	Risk of Sediment Delivery to ESA Stream
TAR-27.06	0.2	7.3	5	7.3	High	10	73	Moderate	10	73	Moderate
TAR-29.92	0.2	7.3	5	7.3	High	0	0	None	0	0	None
TAR-88.69	0.2	3.9	5	3.9	Moderate	10	39	Moderate	10	39	Moderate
TAR-94.81	0.2	2.7	5	2.7	Moderate	10	27	Moderate	10	27	Moderate
TAR-101.70	2.5	2.7	1	6.8	High	0	0	None	0	0	None
PAR-15.07	0.2	8.7	5	8.7	High	100	870	High	100	870	High
PAR-29.48	0.2	7.3	1	1.5	Moderate	0	0	None	0	0	None
PAR-48.58	0.2	5.5	1	1.1	Moderate	0	0	None	N/A		N/A
PAR-59.58	0.2	4.1	5	4.1	Moderate	0	0	None	0	0	None
PAR-71.46	0.2	3.9	2	1.6	Moderate	100	156	High	0	0	None
PAR-80.03	0.2	3.9	1	0.8	Low	0	0	None	0	0	None
PAR-94.66	0.2	3.9	5	3.9	Moderate	0	0	None	0	0	None

a/ Slope Erosion Factors from table 3.5.4-31.
b/ Rainfall Factor and Geologic Erosion Factor from table 3.5.4-32.
c/ Road Delivery Factor from table 3.5.4-33.

EARs. A similar analysis was conducted for EARs that could potentially be utilized during project construction, accessing the construction right-of-way and other project components. The following analysis is limited to segments of EARs that are within 1SPTH from streams within range Oregon Coast coho, including designated critical habitats. EARs include federally-managed roads located on federally-managed lands and privately-owned lands that will be used/authorized during timber removal, construction, and operations to access the construction and operational right-of-way.

There are 79 EAR segments with dirt surfaces and 93 segments with gravel surfaces within 1 SPTH of streams in range of Oregon Coast coho. Of those, only eight segments with dirt surface EARS and 10 with gravel surfaces are within 1 SPTH riparian zones of streams with critical habitat for Oregon Coast coho. Risk estimates for sediment delivery from each of those EARs to 14 streams with critical habitat in range of Oregon Coast coho are summarized in table 3.5.4-35 utilizing the same data sets and factors (Road Slope Factor, Rainfall Factor, Geologic Erosion Factor, and Road Delivery Factor) described above for streams closest to new proposed TARs and PARs. In addition, the Road Surface Factor (1 for dirt, 0.5 for gravel) is included in a Five Factor Product is assumed to represent a level of risk for erosion from each road's surface and has been ranked as Low (product <10), Moderate (product from 10 to <100), and High (product >100) in table 3.5.4-35.

The largest five factor product in table 3.5.4-35 is 605 for the EAR associated with Wallanch Slough due to its dirt surface, high Rainfall Factor, high Geologic Erosion Factor, and direct delivery of sediment assumed since the road crosses Wallanch Slough, apparently over a structure downstream from the pipeline crossing. EARs crossing Laxstrom Gulch, also in the Coos Bay Frontal-Pacific Ocean Watershed, Steele Creek in the North Fork Coquille River Watershed, and South Fork Elk Creek in the East Fork Coquille Watershed pose high risks for sediment delivery to those streams with critical habitat for Oregon Coast coho.

TABLE 3.5.4-35

Summary of New Road Erosion Risks and Risks of Sediment Delivery to
Streams with Coho Critical Habitat by Existing Dirt and Gravel Surfaced Roads within 1 SPTH in Range of Oregon Coast Coho

Watershed and Critical Habitat with EAR	Number of EARs	Road Surface	Total Road Length (miles)	Road Surface Factor a/	Road Slope Factor b/	Rainfall Factor c/	Geologic Erosion Factor d/	Road Delivery Factor e/	Five Factor Product	Risk of Sediment Delivery to Critical Habitat
Coos Bay Frontal-Pacific Ocean										
Wallanch Slough	1	Dirt	0.29	1	0.2	6.0	5	100	605	High
Coos River	1	Dirt	0.04	1	0.2	6.0	5	35	212	High
Coos River	1	Gravel	0.03	0.5	0.2	6.0	5	35	106	High
Vogel Creek	1	Dirt	0.56	1	0.2	6.0	5	35	212	High
Laxstrom Gulch (adjacent)	1	Gravel	0.05	0.5	0.2	9.7	5	100	434	High
North Fork Coquille River										
Steele Creek (not crossed)	1	Gravel	0.29	0.5	1.0	5.5	1	100	275	High
North Fork Coquille River	1	Gravel	0.08	0.5	0.2	5.5	5	35	96	Moderate
Middle Creek	1	Gravel	0.35	0.5	0.2	5.5	5	35	96	Moderate
East Fork Coquille River										
South Fork Elk Creek	2	Dirt	0.10	1	0.2	5.5	1	100	110	High
Olalla Creek-Lookingglass Creek										
Olalla Creek	1	Dirt	0.10	1	0.2	3.0	5	35	105	High
Clark Branch-South Umpqua										
Willis Creek	2	Dirt	0.15	1	0.2	2.0	5	35	69	Moderate
Myrtle Creek										
Bilger Creek	1	Gravel	0.19	0.5	0.2	2.9	6	35	50	Moderate
Days Creek-South Umpqua River										
Fate Creek	1	Gravel	0.05	0.5	0.2	2.0	5	35	34	Moderate
Days Creek	1	Gravel	0.06	0.5	0.2	2.0	5	10	10	Moderate
Saint John Creek	2	Gravel	0.34	0.5	1.0	2.9	1	35	50	Moderate

a/ Road Surface Factors: 0.5 for gravel, 1.0 for dirt. See Table A-3, Appendix A, Dube et al. 2004
b/ Road Slope Factors: 0.2 for gradients of <5%; 1.0 for gradients of 5-10%; 2.5 for gradients >10%. See Table A-6, Appendix A, Dube et al. 2004
c/ Rainfall Factor derived from the average annual rainfall at the closest NWS station, computed using Equation 7, Appendix A, Dube et al. 2004.

d/ Geologic Erosion Factor surmised from Figure A-1 and Table A-1 in Appendix A, Dube et al. 2004 based on Dominant Lithology evaluated from Oregon Department of Geology and Mineral Industries, Oregon Geologic Data Compilation 6. Available from http://www.oregongeology.org/sub/ogdc/index.htm.
e/ Road Delivery Factor: Distance from stream, >200 feet = 0, 100 to 200 feet = 10, <100 feet = 35, and direct delivery = 100. See Table A-10, Appendix A, Dube et al. 2004.

TEWAs. Construction will primarily use a 95-foot wide construction right-of-way corridor and associated TEWAs. However, in specified areas such as wetlands, sensitive visual areas and in residential areas the construction right-of-way will be reduced to 75 feet wide to minimize disturbance. In most cases, except where topographical constraints occur, TEWAs have been located at least 50 feet away from wetland boundaries to minimize impacts to wetland buffers and riparian areas. Where TEWAs are located closer than 50 feet from a waterbody and the adjacent upland does not support cultivated or rotated cropland or other disturbed land, a modification from FERC's Wetland and Waterbody Procedures (Section V.B.2.a. & b.) has been requested.

Distances of TEWAs to Waterbodies within 1 SPTH of designated critical habitat for Oregon Coast coho were measured using GIS and digitized waterbody streambanks and TEWA polygons. Consequently, distances could change once boundaries of TEWAs are surveyed on the ground. From these estimates, there are 26 waterbodies with a total of 77 TEWAs within 1 SPTH of critical habitat for Oregon Coast coho, totaling 31.98 acres. Of those, 37 TEWAs are within 50 feet of the designated critical habitat (summarized from table 3.5.4-36).

Risk estimates for sediment delivery from each of TEWAs similar to that described above for TARs, PARs, and EARs were not conducted since the procedures in WARSEM modeling did not appear appropriate for application with TEWAs except for the road delivery factor (distance from a TEWA to a stream. All but three TEWAs within 1 SPTH of waterbodies with designated critical habitat for Oregon Coast coho are closer than 200 feet to streams, 15 TEWAs within 1 SPTH of waterbodies with designated critical habitat are < 200 feet but >100 feet to streams, and 75 TEWAs within 1 SPTH of waterbodies with designated critical habitat are <100 feet from the streams; 11 of those TEWAs appear to overlap with the waterbodies and consequently provide direct delivery of sediment. TEWAs, within each of those distance categories represent various levels of risks for sediment delivery to designated critical habitats; the TEWAs that overlap waterbodies have the highest risks (11 in range of Oregon Coast coho) of waterbodies with designated critical habitat for erosion and sediment delivery followed by other TEWAs that <50 feet but don't overlap critical habitat (66 in range of Oregon Coast coho) based on the sediment delivery distance categories in WARSEM (Table A-10, Appendix A, Dube et al. 2004).

TABLE 3.5.4-36

Individual TEWAs within One Site-Potential Tree Height of Streams with Critical Habitats in Watersheds within Range of Oregon Coast Coho

Watershed	Critical Habitat	TEWA ID	Distance (feet) to Critical Habitat	TEWA Area (acres) in 1 SPTH
Coos Bay Frontal-Pacific Ocean	Coos Bay	TEWA 0.10	102	4.13
		TEWA 1.36-N	175	0.10
	Kentuck Slough	TEWA 3.07-N	84	0.86
		TEWA 3.07-W	229	0.78
		TEWA 3.55-N	115	5.12
	Willanch Slough	TEWA 8.27-N	25	0.15
	Johnston Creek	TEWA 8.35-W	211	0.14

TABLE 3.5.4-36

Individual TEWAs within One Site-Potential Tree Height of Streams with Critical Habitats in Watersheds within Range of Oregon Coast Coho

Watershed	Critical Habitat	TEWA ID	Distance (feet) to Critical Habitat	TEWA Area (acres) in 1 SPTH
		TEWA 8.44-W	83	0.17
	Coos River	TEWA 10.71-W	71	0.07
	Vogel Creek	TEWA 11.53-N	0	1.78
		TEWA 11.33-W	114	1.10
	Laxstrom Gulch	TEWA 14.73-N	36	0.65
	Stock Slough	TEWA 15.07-W	73	0.17
		TEWA 15.12-W	0	0.14
		TEWA 15.12-N	0	0.44
		TEWA 15.26-W	0	0.19
North Fork Coquille River	Steinnon Creek	TEWA 24.32-W	5	0.19
		TEWA 24.26-N	168	0.06
		TEWA 24.26-W	239	0.03
	North Fork Coquille River	TEWA 22.59-N	67	0.17
		TEWA 23.01-W	54	0.28
		TEWA 23.09-W	100	0.24
	Middle Creek	TEWA 26.96-W	132	0.17
		TEWA 27.05-W	60	0.40
East Fork Coquille River	East Fork Coquille River	TEWA 29.61-N	31	0.20
		TEWA 29.78-W	19	0.42
		TEWA 29.87-W	44	0.36
		TEWA 29.87-N	60	0.30
	South Fork Elk Creek	TEWA 34.41-W	70	0.17
		TEWA 34.47-W	54	0.17
Olalla Creek-Lookingglass Creek	Olalla Creek	TEWA 58.56-N	175	0.07
		TEWA 58.65-W	15	0.44
		TEWA 58.79-W	28	0.34
		TEWA 58.79-N	57	0.19
	McNabb Creek	TEWA 60.44-N	0	0.04
		TEWA 60.35-W	19	0.13
		TEWA 60.52-N	63	0.03
		TEWA 60.54-W	174	0.02
Clark Branch-South Umpqua	Kent Creek	TEWA 63.93-N	27	0.12
		TEWA 63.93-W	25	0.10
		TEWA 63.99-N	151	0.21
		TEWA 63.99-W	26	0.17
	Rice Creek	TEWA 65.58-N	27	0.13
		TEWA 65.76-W	76	0.20
	Willis Creek	TEWA 66.89-N	12	0.32
		TEWA 66.89-W	24	0.44
		TEWA 66.97-W	90	0.12
	South Umpqua River	TEWA 71.24	0	0.22
		TEWA 71.31	0	0.22
Myrtle Creek	Bilger Creek	TEWA 76.31-N	105	0.06
		TEWA 76.36-N	38	0.06
		TEWA 76.36-W	14	0.98
		TEWA 76.41-W	103	0.03
		TEWA 76.41-N	146	0.22
	North Myrtle Creek	TEWA 78.99-W	31	0.13
		TEWA 79.14-W	80	0.17
		TEWA 79.13-N	70	0.11
	South Myrtle Creek	TEWA 81.16-N	70	0.17
		TEWA 81.21-W	92	0.15

TABLE 3.5.4-36

Individual TEWAs within One Site-Potential Tree Height of Streams with Critical Habitats in Watersheds within Range of Oregon Coast Coho

Watershed	Critical Habitat	TEWA ID	Distance (feet) to Critical Habitat	TEWA Area (acres) in 1 SPTH
Days Creek-South Umpqua	Fate Creek	TEWA 88.29-N	24	0.10
		TEWA 88.26-W	32	0.28
		TEWA 88.49-W	104	0.06
		TEWA 88.49-N	35	0.53
		TEWA 88.52-W	56	0.40
	Days Creek	TEWA 88.53-N	83	0.21
		TEWA 88.52-W	54	0.28
		TEWA 88.61-W	121	0.50
		TEWA 88.62-N	67	0.28
	Saint John Creek	TEWA 92.62	40	0.62
		TEWA 92.57-N	33	0.25
		TEWA 92.57-W	34	0.18
		TEWA 92.63-W	5	0.52
		TEWA 92.62-N	5	0.33
	South Umpqua River	TEWA 94.69-N	0	1.02
		TEWA 94.69-W	0	0.52
		TEWA 94.73-W	0	0.12
		TEWA 94.69-N	0	1.02
		TEWA 142.51-W	45	0.38
		TEWA 142.58-W	18	0.12
		TEWA 142.58-N	46	0.12
	NF Little Butte Creek	TEWA 145.58-N	40	0.14
		TEWA 145.58-W	50	0.16
		TEWA 145.70-W	85	0.31
		TEWA 145.70-N	65	0.28

Erosion of new road surfaces, existing road surfaces, and exposed surfaces of TEWAs within 1 SPTH have the potential for delivery to streams and could lead to adverse effects on fish and fresh water benthic invertebrates similar to those described above. As discussed in Section 2.3 of PCGP's Transportation Management Plan (see POD), PCGP will perform road surfacing structural capacity assessments and place additional road surfacing (aggregate or bituminous as appropriate) as needed for the planned use to minimize the potential for both road-related and off-road resource damage. In WARSEM modeling, the Road Tread Surfacing Factor is 1 for roads with native materials surface but is 0.2 for a gravel (aggregate) surface and 0.03 for an asphalt (bituminous) surface. Application of surfacing materials to any of the new TARs and PARs in table 3.5.4-34 with low to high risks of sediment delivery to streams would decrease levels of erosion and quantities of sediment delivered. Surfaces of all new PARs would be graveled thereby decreasing their erosion potential. Further, PARs and TARs would meet land-managing agencies' engineering design and road management standards consistent with the intended use of the road and all applicable agency BMPs; all applicable agency BMPs for erosion control will be implemented. In addition, PCGP will install appropriate erosion and sediment control BMPs along the access roads as determined necessary by PCGP's EI in cooperation with applicable agency officials. All land-managing agency roads are subject to short-term traffic restrictions and/or closures due to seasonal or unusual weather conditions, user safety or when necessary to prevent facility or resource damage.

PCGP's ECRP also identifies mitigation measures that may be required to minimize potential impacts to existing culverts prior to access road use, to allow safe construction equipment travel and prevent damage to the culverts. PCGP has completed an assessment to identify where proposed road improvements or where new permanent or temporary access roads would cross waterbodies and culvert installations would be required. The assessment used PCGP's wetland survey data where access was available. Where access was not available, the assessment used FWS' National Wetland Inventory (NWI) data[9], USGS National Hydrography Dataset (NHD) data[10], ODF statewide streams data[11], LiDAR data, and aerial photography to interpret waterbody crossings. Identified waterbody crossings were also correlated with PCGP's preliminary access road improvement plans that were completed to evaluate improvements necessary to accommodate trucks hauling pipe (Dyer Partnership 2015). The access road improvement plans (Dyer Partnership 2015) were based on field investigations and identified locations where new culverts or culvert extensions would be necessary.

The new culverts needed to cross waterbodies are located on small intermittent headwater streams where there is no fish presence. The measures outlined in PCGP's Culvert Crossing Best Management Practices (see attachment F to the ECRP in appendix F of the POD) and appropriate erosion control and revegetation measures outlined in the ECRP would be implemented during any road improvement activities. As indicated in the Culvert Crossing BMP, prior to construction, existing culverts will be investigated along all private roads and federally authorized roads (i.e., BLM and Forest Service) identified for access to the construction right-of-way. These investigations would occur on access roads where PCGP is authorized to be and/or where PCGP has negotiated an access use agreement or easement. The investigation will determine the condition and integrity of existing culverts and identify any location that may require mitigative measures to ensure construction activities do not damage or impair the existing function of the culverts. Mitigative measures may be required prior to access road use to allow safe construction equipment travel and prevent damage to the culverts. In select locations, replacement and/or modification of a culvert may be necessary. As noted above, PCGP has completed an assessment to identify where proposed road improvements would cross waterbodies and culvert installations would be required. The new culverts identified are located on small intermittent headwater streams where there is no fish presence.

The ECRP also describes the application of sediment barriers, temporary slope breakers, mulch, dust control, and permanent erosion control measures that will further minimize sediment discharges from a site after construction is complete. In forested areas, during timber clearing/right-of-way grading operations slash-filter windrows may be constructed on the downhill edge of the construction right-of-way and TEWAs, as directed by the EI. Slash-filter windrows will be constructed of logging slash, including cull logs, tree tops, limbs, and branches laid parallel to the right-of-way to effectively filter sediment, reduce runoff velocities, and prevent stream sedimentation. Sediment barriers would generally be placed as follows:

[9] https://www.fws.gov/wetlands/nwi/overview.html
[10] https://nhd.usgs.gov/data.html
[11] http://www.oregon.gov/ODF/AboutODF/Pages/MapsData.aspx

- at the base of slopes adjacent to road, wetland and waterbody crossings where sediment could flow from the construction right-of-way onto the road surface or into the wetland or waterbody;adjacent to wetland and waterbody crossings, as necessary,
- to prevent sediment flow in the wetland consistent with the requirements of FERC's Wetland and Waterbody Procedures; and
- on the down slope side of the right-of-way where it traverses steep side slopes.

The EI will inspect temporary erosion control structures at least on a daily basis in areas of active construction and equipment operation. In areas where active construction and equipment operation are not occurring, inspections will be made at least weekly. All structures will be inspected by the EI within 24 hours of 0.5 inch or greater of rainfall. The EI will be responsible for ensuring that ineffective temporary erosion control measures are repaired as soon as possible but no more than 24 hours after discovery, unless prohibited by exigent circumstances in which case repair will be effectuated as soon as possible. Whenever possible, the EI will inspect erosion control measures in advance of predicted storm events and take preventative measures to minimize the potential for off right-of-way sedimentation.

Temporary sediment barriers will be maintained in place until permanent revegetation measures are determined successful or until the upland areas adjacent to wetlands, waterbodies or roads are stabilized. The structures will be removed once the area has been successfully restored.

Mulch (certified weed free) will be applied if construction and restoration activities are interrupted for extended periods, such as when seeding cannot be completed due to seeding period restrictions. In these areas mulch will be applied uniformly over the area to cover the ground surface at a rate of two tons/acre of straw or hay or its equivalent. In addition, the mulch application rate will also be increased to 3 tons/acre on all slopes within 100 feet of waterbodies and wetlands. The mulch will consist of certified weed-free straw or wood fiber hydromulch. On federal lands, in the event that construction activities are extended beyond the dry season (i.e., May 1 to October 31), soil disturbance in excess of 0.5 acre will have effective ground cover provided or other effective BMPs will be utilized as discussed in this ECRP to prevent sedimentation beyond the approved construction right-of-way and associated TEWAs or into wetlands and waterbodies.

These provisions from the Transportation Management Plan and ECRP are consistent with BMPs identified in Appendix C to Dube et al. (2004) and will ensure that potential sediment delivery from the PARs and TARs is eliminated or minimized resulting in minimal effects to fish and freshwater benthic invertebrates.

Runoff from Facility Surfaces

There are 25 contractor and pipe storage yards, rock source and disposal sites, six new temporary access roads, four new permanent access roads, and nine aboveground facilities within the range of Oregon Coast coho. Five of the yards (North Spit Dock, Weyerhaeuser Cove Pipe Yard, Menasha, K-2, and Brunell) border on Coos Bay and another (Millington 1) borders Isthmus Slough, all designated critical habitat for coho. Several other proposed yards border or are close (<100 feet) to waterbodies inhabited by Oregon Coast coho. They include the Coquille Yard on the Coquille River and the Roth Yard on the South Umpqua River. None of the rock source and disposal sites are near waterbodies inhabited by coho although one new PAR is close to Boone

Creek and one TAR is near Middle Creek in the North Fork Coquille River watershed. Only one aboveground facility, a mainline block valve at Boone Creek Road (Coos Bay-Frontal Pacific Ocean Watershed), is close to a waterbody (Boone Creek) with critical habitat for Oregon Coast coho. The Jordan Cove Meter Station at MP 0.00 is within 440 feet of Jordan Cove.

Stored materials at the yards may include: construction mats, fencing materials, fuel and lubricants, stormwater control materials (straw bales, erosion control fabric, silt fence materials, etc.), and other construction materials. The yards would also be used for contractor office trailers and employee parking facilities. Although the yards are previously disturbed industrial sites, there is some unknown level of risk that stored materials and surface runoff could enter Oregon Coast coho critical habitat.

PCGP has consulted with the BLM, the Forest Service, and the NRCS regarding erosion control and revegetation specifications. Other appropriate agencies have been consulted as well. The Oregon Department of Agriculture Noxious Weed Control Program, as well as the BLM and the Forest Service, have been contacted regarding recommendations for the prevention and spread of noxious weeds with those incorporated into the Pipeline project-specific ECRP. Pursuant to FERC's *Procedures* (see section IV.A), PCGP has prepared a SPCCP for the Pipeline, which includes identifying all potential spill hazards at the facility (including oil) and lists the appropriate response actions and contacts for facility and emergency response personnel. All station technicians would be trained for proper handling, storage, disposal, and spill response of hazardous fluids.

Operation and Maintenance Activities

Once the Pipeline is installed, maintenance would include activities such as aerial inspections, gas flow monitoring, visual inspection of surrounding vegetation for signs of leaks, and integrity management, which includes smart pigging to investigate the interior surface of the pipe for any signs of stress cracking, pitting, and other anomalies (see the ECRP in appendix F). All of the proposed maintenance activities would be outlined in the Operations and Maintenance Plan that would be prepared according to operating regulations in DOT 49 CFR Subpart L, Part 192 and would be completed prior to going in-service. These general maintenance activities would require only surface activities and usage of the existing right-of-way, such as insertion of the pig at one of the pig launching facilities.

Potential estuarine or stream channel disturbance would occur if an integrity issue with the pipeline was found. If this were to occur, the pipeline would need to be unearthed within the right-of-way and repair work done in-water. Within stream sites, repair work could require isolated flow from the section of pipe that is to be exposed. Typically, repairs would be made to the pipe within the right-of-way (within the trench) or, depending on the site-specific conditions and nature of the repair needed, a reroute around the affected section may be considered. Impacts would be similar to those discussed above for initial installation except on a much smaller scale, because they would only involve one crossing compared to many streams. However, should repairs be needed out of the standard stream crossing window (i.e., during periods of fish spawning or egg incubation) there would be additional adverse effects to key fish resources at the specific site. The actions would include all relevant BMPs and mitigation, dependent upon site conditions and land ownership. Any future repairs would require additional permit approval from appropriate state and federal agencies that would determine the acceptable parameters of these actions. Such pipeline integrity-based, in-water projects are very infrequent.

Vegetation maintenance would be limited adjacent to waterbodies to allow a riparian strip to permanently revegetate with native plant species across the entire right-of-way. To facilitate periodic pipeline corrosion/leak surveys, a corridor centered on the pipeline and up to 30 feet wide would be maintained in an herbaceous state, with shrubs outside of this 30-foot corridor. In addition, trees that are located within 15 feet of the pipeline may be cut and removed from the right-of-way. No vegetation or tree limitations would occur beyond the 30-foot-wide corridor in riparian areas (i.e., up to 100 feet of streams on federal lands, and 25 feet non-federal lands).

Herbicide Application

Herbicides have the potential to cause toxic effects to different salmonid life stages and to other aquatic species, causing direct impacts, if used improperly. When herbicides are properly used according to label restrictions and BMPs to control noxious weeds, there is little to no chance of causing injury or mortality to fish or other aquatic organisms.

PCGP would not use herbicides for routine vegetation maintenance. However, following construction, PCGP would implement its IPM (see appendix N to PCGP's POD), which addresses control of noxious weeds and invasive plants across the Pipeline project which would include the selective use of herbicides where necessary to control noxious weeds by limited application from the ground, where allowed by landowners. The plan was developed in consultation with the ODA, BLM, and Forest Service.

The BMPs would minimize the potential spread of invasive species and minimize the potential adverse effects of control treatments. Herbicides would not be applied by aerial or broadcast spraying. Noxious weeds would be removed only by manual methods in the riparian zone defined as one site potential tree height and within Riparian Reserves that are defined as being greater than 150 feet in most areas along the route. PCGP would not directly spray, or otherwise apply, herbicides in waterbodies or in riparian zones. The risk of drift would be avoided by selectively applying herbicides from the ground.

Where weed control is necessary along the construction right-of-way, PCGP's first priority would be to employ hand and mechanical methods (pulling, mowing, biological, disking, etc.) applicable to the species to prevent the spread of potential weed infestations, where feasible. To determine if an herbicide is to be used over other control methods, PCGP would base the decision on weed characteristics and integrated weed management principles (Forest Service 2005). If herbicides are used to control noxious weed infestations, they would be used when they are the most appropriate treatment method. Spot treatments and the use of selective herbicides would be utilized to minimize impact to native or non-target species. Permits or approvals for the use of herbicides and adjuvants on federal lands would be obtained prior to use/treatment, as detailed in the IPM (see appendix N to the POD, available upon request). Considering the potential for limited use of herbicides along the route, and precautions that would be in place to prevent entry into waters, meaningful negative effects to Oregon Coast coho salmon from herbicides would be unlikely to occur.

Cumulative Effects

Cumulative effects in the marine analysis area were presented in the green sturgeon section (3.5.1.3) and would be similar for Oregon Coast ESU coho salmon. These effects include increased boat traffic in the marine analysis area, and the associated potential for increases in noise and fuel and oil spills. The increase in carrier traffic would be slight, as noted in section 3.5.1.3. The slight increase would result in a greater risk of noise impacts on Oregon Coast ESU coho salmon; however, because Project effects are expected to be minor, cumulative effects in the marine analysis area are expected to be insignificant. It appears that the background rate of spills (oil, diesel fuel) off the Oregon coast (incidence of spills in proportion to total carrier operation) by fishing carriers, recreation carriers, and other carrier types is generally low. Based on existing information, future rates of offshore releases are also expected to be low, and therefore the potential for Oregon Coast ESU coho salmon to be affected by oil and other pollutants is not expected to increase above existing levels.

Cumulative effects within the estuarine analysis area were also addressed in the green sturgeon section (section 3.5.1.3), and would be similar for Oregon Coast ESU coho salmon. As noted in this section, overall water quality in the estuary is likely to improve over time because of state and federal regulations. There is likely to be more development in the bay including marina activity, but there are no definite plans for this to occur, so these are not considered “reasonably certain” to occur and are not considered in this cumulative effects section. Therefore, no cumulative effects would occur in the estuarine analysis area to Oregon Coast ESU coho salmon associated with the proposed action and reasonably foreseeable non-federal actions.

Cumulative effects to Oregon Coast coho salmon in the riverine analysis area would be generated by timber harvesting on non-federal lands because there is no federal nexus requiring ESA consultations. Areas of LSOG forest have been monitored as a component of the NWFP. In Oregon, LSOG was evaluated in 1996 (Moeur et al. 2005), in 2006 (Moeur et al. 2011), and in 2013 (Davis et al. 2015). Differences in areas of LSOG forests were described in the four physiographic provinces that coincide with the Pipeline project; from 1993, to 2012 there was an overall net loss of LSOG on non-federal lands within the Coast Range, Klamath, and Western Cascades and Eastern Cascades provinces (see Table 7 in Davis et al. 2015).

During that period, however, areas of LSOG on non-federal lands increased by 6 percent in the Coos Bay Frontal-Pacific Ocean watershed and increased by 30 percent in the East Fork Coquille watershed but decreased by 27 percent and 23 percent within the North Fork Coquille and Middle Fork Coquille watersheds, respectively. In the South Umpqua Subbasin, LSOG decreased slightly in the Olalla Creek-Lookingglass Creek watershed (by 3.2 percent), in the Myrtle Creek watershend (by 0.4 percent), in the Days Creek-South Umpqua River watershed (by 4.5 percent) and decreased substantially in the Upper Cow Creek watershed by 81 percent between 1993 and 2012. Alternatively, LSOG increased in the Clark Branch-South Umpqua River watershed by 23 percent from 1993 to 2012. These changes in areas of LSOG from 1993 to 2012 are clearly evident in figure 3.5.4-7 and figure 3.5.4-8 and, with two exceptions, are similar to trends in other areas under the NWFP. For example, LSOG forest decreased by 26.8 percent between 1993 and 2012 in the Oregon Coast Range physiographic province, decreased by 22.3 percent in the Oregon Western Cascades, decreased by 10.1 percent in the Klamath, and decreased by 14.1 percent in the Oregon Eastern Cascades provinces (Table 7 in Davis et al. 2015). Declines in LSOG were as dramatic or more pronounced on non-federal lands in the physiographic provinces during that same period from 1993 to 2012 (Table 9 in Davis et al. 2015).

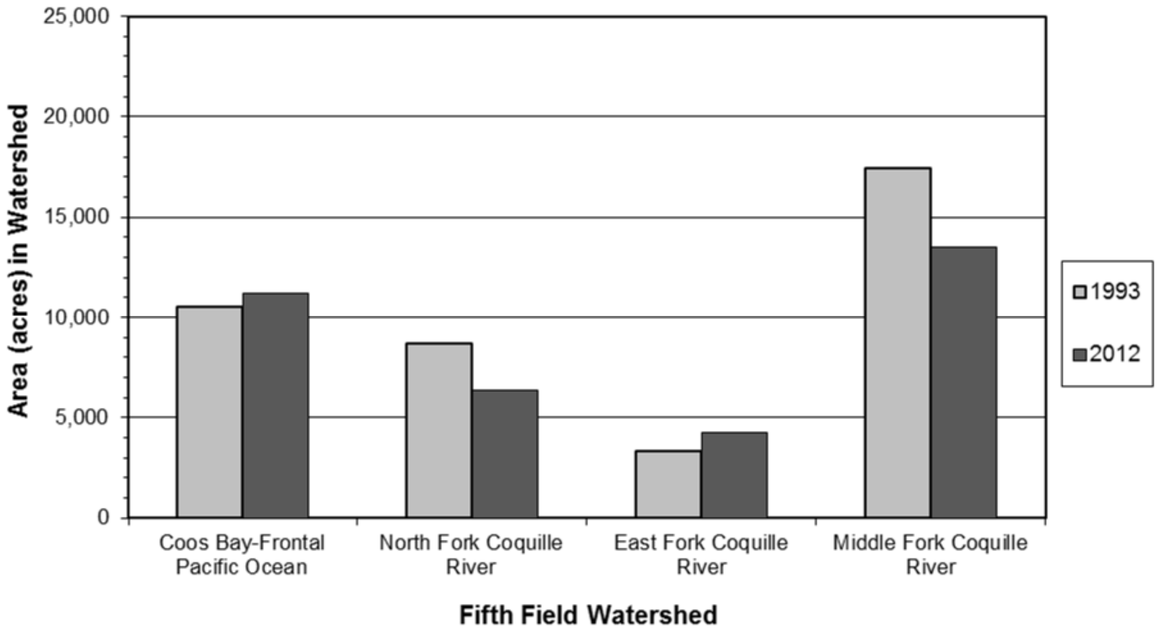

Figure 3.5.4-7 Total Areas (acres) of Late Successional–Old-Growth Forests on Non-Federal Lands in 1993 and 2012 within Four Fifth-Field Watersheds (Coos and Coquille Subbasins) within Range of Oregon Coast Coho Salmon that would be Crossed by the Pipeline Project. (Data from NWFP Interagency Regional Monitoring Program 2017)

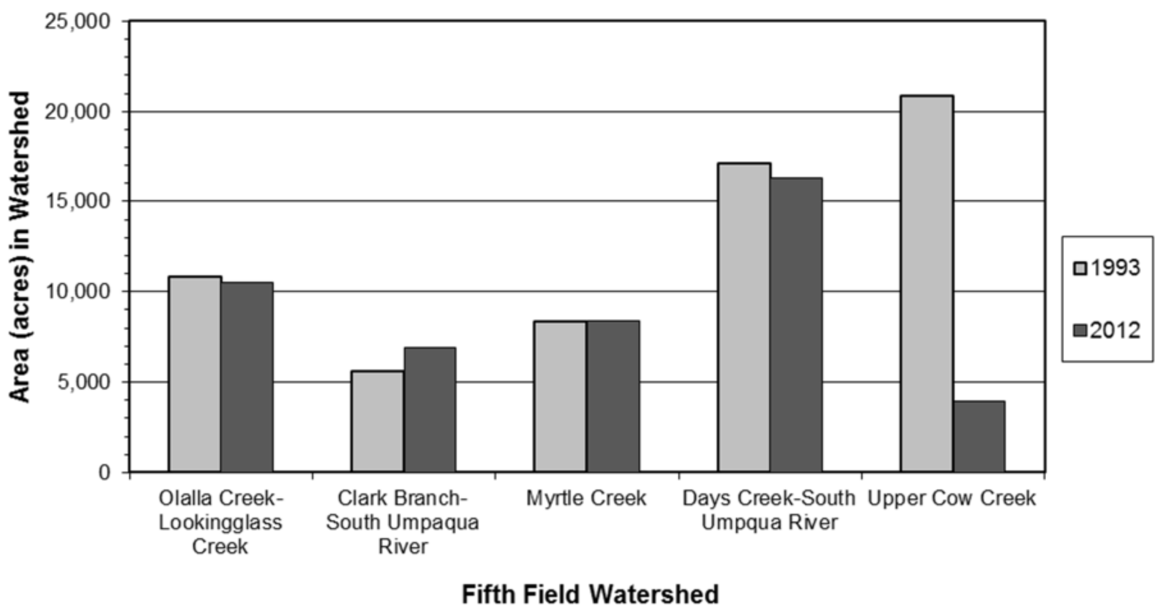

Figure 3.5.4-8 Total Areas (acres) of Late Successional-Old Growth Forests on Non-Federal Lands in 1993 and 2012 within Five Fifth-Field Watersheds (South Umpqua Subbasin) within Range of Oregon Coast Coho Salmon that Would Be Crossed by the Pipeline Project. (Data from NWFP Interagency Regional Monitoring Program 2017)

Based on the past trend there would be less LSOG on non-federal lands in the foreseeable future in all but three of the watersheds affected by the Pipeline project that are within range of coho salmon in the Oregon Coast ESU. Increased LSOG within riparian zones of some watersheds may be possible. Removal of additional LSOG within riparian zones on non-federal land would be more of a reasonably foreseeable cumulative impact. The amount of LSOG on non-federal land through 2020 would be expected to change at the same rate (acres per year) as the amounts that have changed (increased or decreased) between 1993 and 2012. Changes in area of LSOG within the nine fifth field watersheds by the same rate of change observed between 1993 and 2012 were used to predict areas of LSOG in 2020 which, depending on the watershed, are expected to decrease or increase within the nine watersheds crossed within range of Oregon Coast coho (see table 3.5.4-37).

TABLE 3.5.4-37

Estimates for Areas of Late Successional-Old Growth Forest in 2020 on Non-Federal Lands in Fifth-Field Watersheds in Range of Oregon Coast Coho Crossed by the Pipeline Project

Subbasins and Fifth-Field Watersheds	Area (acres) of LSOG on Non-Federal Land			Proportional Change in LSOG per year since 1993	Estimated Area (acres) of LSOG in 2020
	1993 a/	2012 b/	Change in Area from 1993 to 2012		
Coos Subbasin					
Coos Bay-Frontal Pacific Ocean	10,556	11,243	687	0.003	11,532
Coquille Subbasin					
North Fork Coquille River	8,662	6,344	-2,318	-0.014	5,368
East Fork Coquille River	3,303	4,280	977	0.016	4,692
Middle Fork Coquille River	17,408	13,494	-3,914	-0.012	11,846
South Umpqua Subbasin					
Olalla Creek-Lookingglass Creek	10,822	10,479	-343	-0.002	10,334
Clark Branch-South Umpqua River	5,624	6,889	1,265	0.012	7,421
Myrtle Creek	8,388	8,359	-30	0.000	8,346
Days Creek-South Umpqua River	17,109	16,333	-776	-0.002	16,007
Upper Cow Creek	20,881	3,956	-16,925	-0.043	0

a/ Data from Regional Ecosystem Office 2017 and Moeur et al. 2005
b/ Data from NWFP Interagency Regional Monitoring Program 2017 and Davis et al. 2015

Amounts of LSOG within the Pipeline project area that would be affected by construction and amounts of LSOG that would be affected within riparian zones (e.g., see table 3.5.4-30a) have been determined. The areas (acres) of all LSOG on non-federal lands within riparian zones 1 SPTH wide are provided in table 3.5.4-30a for each watershed. The data were derived by buffering all streams within each watershed (data from National Hydrography Dataset, USGS 2016) by the 1 SPTH riparian zone widths in table 3.5.4-40 in combination with old growth, 80 years and older spatial data in 2012 (NWFP Interagency Regional Monitoring Program 2017 and Davis et al. 2015) and landownership. The amounts of LSOG forest within non-federal lands in riparian zones that would be removed during Pipeline construction is provided above in table 3.5.4-30a and included in table 3.5.4-38. The Pipeline project would affect between 0 and 0.51 percent of the amount of LSOG (estimated for 2017) on non-federal lands in riparian zones for all streams in each fifth field watershed. With the estimates for areas of LSOG present in 2020, based on proportional changes in areas observed between 1993 and 2012 (table 3.5.4-31), an estimate for area of LSOG on non-federal lands in riparian zones for all streams in each fifth field watershed in 2020 is included in table 3.5.4-38. With the overall change in LSOG expected between 2017 and 2020, the relative effects of Pipeline construction on available riparian LSOG would be expected to remain about the same as current estimates of effects on non-federal lands in the foreseeable future.

TABLE 3.5.4-38

Potential for Cumulative Effects within Late Successional and Old-Growth Riparian Forests on Non-Federal Lands within the Oregon Coast Coho Salmon ESU Riverine Analysis Area

Subbasins and Fifth-Field Watersheds	Area (acres) of Riparian LSOG Present on Non-Federal Land in 2012 a/	Area (acres) of Riparian LSOG Present on Non-Federal Land in 2017 b/	Area (acres) of Riparian LSOG Affected on Non-Federal Land in 2017 c/	Percent of Riparian LSOG Affected by Project in 2017 d/	Area (acres) of Riparian LSOG Affected on Non-Federal Land in 2020 b/	Percent of Riparian LSOG Affected by Project in 2020 e/
Coos Subbasin						
Coos Bay-Frontal Pacific Ocean	2,239.5	2,277.87	0.84	0.04%	2301.29	0.04%
Coquille Subbasin						
North Fork Coquille River	1,193.64	1,109.57	0	0.00%	1062.68	0.00%
East Fork Coquille River	718.68	774.64	0	0.00%	810.83	0.00%
Middle Fork Coquille River	1,677.83	1,578.56	0.40	0.03%	1522.52	0.03%
South Umpqua Subbasin						
Olalla Creek-Lookingglass Creek	1,267.26	1,256.69	1.40	0.10%	1250.40	0.10%
Clark Branch-South Umpqua River	664.99	704.34	0	0.00%	729.34	0.00%
Myrtle Creek	746.9	746.21	3.78	0.51%	745.79	0.51%
Days Creek-South Umpqua River	1,371.84	1,355.47	0.54	0.04%	1345.76	0.04%
Upper Cow Creek	664.99	523.15	0	0.00%	456.19	0.00%
Total Area	**10,545.63**	**10,326.48**	**6.96**	**0.07%**	**10224.80**	**0.07%**

a/ Data from NWFP Interagency Regional Monitoring Program 2017.
b/ Based on the Proportional Change in LSOG per year since 1993 in table 3.5.4-37.
c/ Data from table 3.5.4-30a.
d/ For comparison to effects in 2020.
e/ Based on Area of riparian LSOG Estimated in 2020 that would be affected by Pipeline project on non-federal land in 2020

Critical Habitat

The Coos Bay estuary and 25 freshwater streams known to support coho within table 3.5.4-1 are designated critical habitat for Oregon Coast coho salmon. Critical habitat is designated to include all river reaches accessible to listed coho within the range of the Oregon Coast ESU. Critical habitat consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches in hydrologic units and counties identified in NMFS (1999b)..

Similar to critical habitat designated for coho salmon in the SONCC ESU, critical habitat included stream channels laterally to the ordinary high water mark (OHWM) (or bankfull elevation or bankfull width). NMFS also defined critical habitat in estuarine and nearshore marine zones as areas contiguous with the shoreline from the extreme high water mark out to a depth no greater than 30 meters (98 feet) below the mean low water mark (NMFS 2004). The following are PCEs for designated critical habitat for the Oregon Coast coho (NMFS 2008d):

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.
- Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks a) supporting juvenile and adult mobility and survival, b) supporting juvenile use of various of habitats that allow them to avoid high flows, avoid predators, successfully compete, begin the behavioral and physiological changes needed for life in the ocean, and ability to reach the ocean, and c) essential for nonfeeding adults to successfully swim upstream, avoid predators, and reach spawning areas on limited energy stores.
- Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.
- Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
- Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Riparian Zone Effects. Similar analyses to those above under Riparian Vegetation Removal and Modification were conducted for effects to riparian zones associated with each waterbody supporting coho critical habitat and waterbodies that are assumed to provided coho in each watershed. Areas of forested and non-forested habitats that would be affected within the riparian zones of each waterbody during construction are provided in table 3.5.4-39a and areas affected during operation are provided in table 3.5.4-39b and summarized in table 3.5.4-39c. The tables also include riparian zone areas affected by landowner, similar to tables 3.5.4-30a and 3.5.4-30b.

TABLE 3.5.4-39a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide)
Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	**MP**	**CH**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Coos Bay Frontal Pacific Ocean (HUC 1710030403)															
Trib to Coos Bay (NW-117/EE-6)	6.39R	No	Federal					**0**						**0**	**0**
			Non-Federal					**0**		12.50		0.22	0.01	**12.73**	**12.73**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**12.50**	**0**	**0.22**	**0.01**	**12.73**	**12.73**
Willanch Slough (EE-7)	8.27R	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.10			**0.10**		0.01		0.74		**0.75**	**0.85**
			Riparian Zone Total	**0**	**0.10**	**0**	**0**	**0.10**	**0**	**0.01**	**0**	**0.74**	**0**	**0.75**	**0.85**
Johnston Creek (GDX-29 (EE-8)	8.35R	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.19	0.01		**0.20**		0.37		0.61	0.02	**1.00**	**1.20**
			Riparian Zone Total	**0**	**0.19**	**0.01**	**0**	**0.20**	**0**	**0.37**	**0**	**0.61**	**0.02**	**1.00**	**1.20**
Trib. to Cooston Channel (Echo Creek) (SS-100-002)	10.21R	No	Federal					**0**						**0**	**0**
			Non-Federal			1.34		**1.34**					0.06	**0.06**	**1.40**
			Riparian Zone Total	**0**	**0**	**1.34**	**0**	**1.34**	**0**	**0**	**0**	**0**	**0.06**	**0.06**	**1.40**
Coos River (BSP-119)	11.13R	Yes	Federal					**0**						**0**	**0**
			Non-Federal					**0**		0.39		0.43	4.13	**4.95**	**4.95**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**0.39**	**0**	**0.43**	**4.13**	**4.95**	**4.95**
Vogel Creek (SS-100-005)	11.55BR	Yes	BLM-Coos Bay District	0.89				**0.89**						**0**	**0.89**
			Non-Federal					**0**		4.62		2.02	0.17	**6.81**	**6.81**
			Riparian Zone Total	**0.89**	**0**	**0**	**0**	**0.89**	**0**	**4.62**	**0**	**2.02**	**0.17**	**6.81**	**7.70**
Trib. to Stock Slough (Laxstrom Gulch) (BR-S-30)	15.18BR	Yes	Federal					**0**						**0**	**0**
			Non-Federal			0.30		**0.30**		3.00		3.66	0.04	**6.70**	**7.00**
			Riparian Zone Total	**0**	**0**	**0.30**	**0**	**0.30**	**0**	**3.00**	**0**	**3.66**	**0.04**	**6.70**	**7.00**
Stock Slough (BR-S-30)	14.82BR	Yes	Federal					**0**						**0**	**0**
			Non-Federal			0.37		**0.37**		3.00		3.66	0.04	**6.70**	**7.00**
			Riparian Zone Total	**0**	**0**	**0.37**	**0**	**0.37**	**0**	**3.00**	**0**	**3.66**	**0.04**	**6.70**	**7.00**
Stock Slough (BR-S-36)	15.32BR	Yes	Federal					**0**						**0**	**0**
			Non-Federal			0.37		**0.37**		1.96				**1.96**	**2.33**
			Riparian Zone Total	**0**	**0**	**0.37**	**0**	**0.37**	**0**	**1.96**	**0**	**0**	**0**	**1.96**	**2.33**

TABLE 3.5.4-39a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide)
Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	**MP**	**CH**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
North Fork Coquille River (HUC 1710030504)															
Steinnon Creek (BR-S-63)	24.32BR	Yes	BLM-Coos Bay District		1.13			**1.13**						**0**	**1.13**
			Non-Federal		1.10			**1.10**				0.20		**0.20**	**1.30**
			Riparian Zone Total	**0**	**2.23**	**0**	**0**	**2.23**	**0**	**0**	**0**	**0.20**	**0**	**0.20**	**2.43**
North Fork Coquille River (BSP-207)	23.06	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.75			**0.75**				0.76	0.08	**0.84**	**1.59**
			Riparian Zone Total	**0**	**0.75**	**0**	**0**	**0.75**	**0**	**0**	**0**	**0.76**	**0.08**	**0.84**	**1.59**
Middle Creek (BSP-133)	27.04	Yes	BLM-Coos Bay District	0.81		0.01		**0.82**				0.99	0.07	**1.06**	**1.88**
			Non-Federal					**0**				0.26		**0.26**	**0.26**
			Riparian Zone Total	**0.81**	**0**	**0.01**	**0**	**0.82**	**0**	**0**	**0**	**1.25**	**0.07**	**1.32**	**2.14**
East Fork Coquille River(HUC 1710030503)															
Trib. to E. Fork Coquille R. (BSP-77)	28.86	No	Federal					**0**						**0**	**0**
			Non-Federal		0.28	1.20		**1.48**						**0**	**1.48**
			Riparian Zone Total	**0**	**0.28**	**1.20**	**0**	**1.48**	**0**	**0**	**0**	**0**	**0**	**0**	**1.48**
Trib. to E. Fork Coquille R. (BSP-74)	29.30	No	Federal					**0**						**0**	**0**
			Non-Federal			1.45		**1.45**					0.52	**0.52**	**1.97**
			Riparian Zone Total	**0**	**0**	**1.45**	**0**	**1.45**	**0**	**0**	**0**	**0**	**0.52**	**0.52**	**1.97**
Trib. to E. Fork Coquille R. (BSP-76)	29.47	No	Federal					**0**						**0**	**0**
			Non-Federal			1.33		**1.33**						**0**	**1.33**
			Riparian Zone Total	**0**	**0**	**1.33**	**0**	**1.33**	**0**	**0**	**0**	**0**	**0**	**0**	**1.33**
East Fork Coquille River (BSP-71)	29.85	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.24			**0.24**				1.97		**1.97**	**2.21**
			Riparian Zone Total	**0**	**0.24**	**0**	**0**	**0.24**	**0**	**0**	**0**	**1.97**	**0**	**1.97**	**2.21**
Trib. to E. Fork Coquille R. (SS-003-007B)	30.29	No	Federal					**0**						**0**	**0**
			Non-Federal		0.19	1.86		**2.05**						**0**	**2.05**
			Riparian Zone Total	**0**	**0.19**	**1.86**	**0**	**2.05**	**0**	**0**	**0**	**0**	**0**	**0**	**2.05**
Elk Creek (BSP-57)	32.40	No	Federal					**0**						**0**	**0**
			Non-Federal		0.12	0.53		**0.65**						**0**	**0.65**

TABLE 3.5.4-39a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide)
Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	MP	CH	Landowner	Forest Habitat b/					Other Habitat b/						
				Late Successional Old Growth Forest	Mid-Seral Forest	Regenerating Forest	Clearcut, Forest	Forest Total	Forested Wetland	Nonforested Wetland	Unaltered Nonforested Habitat	Agriculture	Altered Habitat	Other Total	Total Riparian Zone Impact (acres)
			Riparian Zone Total	**0**	**0.12**	**0.53**	**0**	**0.65**	**0**	**0**	**0**	**0**	**0**	**0**	**0.65**
Trib. to Elk Creek (BSP-55)	32.40	No	Federal					**0**						**0**	**0**
			Non-Federal		0.19	0.41		**0.60**						**0**	**0.60**
			Riparian Zone Total	**0**	**0.19**	**0.41**	**0**	**0.60**	**0**	**0**	**0**	**0**	**0**	**0**	**0.60**
South Fork Elk Creek (CSP-5)	34.46	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.76	0.49		**1.25**		0.01			0.03	**0.04**	**1.29**
			Riparian Zone Total	**0**	**0.76**	**0.49**	**0**	**1.25**	**0**	**0.01**	**0**	**0**	**0.03**	**0.04**	**1.29**
Middle Fork Coquille River (HUC 1710030501)															
Big Creek	37.41	No	BLM-Coos Bay District	1.11				**1.11**						**0**	**1.11**
			Non-Federal	0				**0**						**0**	**0**
			Riparian Zone Total	**1.11**	**0**	**0**	**0**	**1.11**	**0**	**0**	**0**	**0**	**0**	**0**	**1.11**
Olalla Creek-Lookingglass Creek (HUC 1710030212)															
Trib. to Shields Creek (BSI-202)	55.90	No	Federal					**0**						**0**	**0**
			Non-Federal	0.12	0.05			**0.17**				1.30		**1.30**	**1.47**
			Riparian Zone Total	**0.12**	**0.05**	**0**	**0**	**0.17**	**0**	**0**	**0**	**1.30**	**0**	**1.30**	**1.47**
Trib. to Olalla Creek (BSI-138)	57.31	No	Federal					**0**						**0**	**0**
			Non-Federal		0.08			**0.08**		0.18		1.79	0.03	**2.00**	**2.08**
			Riparian Zone Total	**0**	**0.08**	**0**	**0**	**0.08**	**0**	**0.18**	**0**	**1.79**	**0.03**	**2.00**	**2.08**
Olalla Creek (BSP-155)	58.78	Yes	Federal					**0**						**0**	**0**
			Non-Federal		1.20			**1.20**				2.73		**2.73**	**3.93**
			Riparian Zone Total	**0**	**1.20**	**0**	**0**	**1.20**	**0**	**0**	**0**	**2.73**	**0**	**2.73**	**3.93**
Trib. to Olalla Creek (BSI-129)	59.65	No	Federal					**0**						**0**	**0**
			Non-Federal		0.40			**0.40**			0.14	0.55	0.05	**0.74**	**1.14**
			Riparian Zone Total	**0**	**0.40**	**0**	**0**	**0.40**	**0**	**0**	**0.14**	**0.55**	**0.05**	**0.74**	**1.14**
McNabb Creek (NSP-13)	60.48	Yes	Federal					**0**						**0**	**0**
			Non-Federal	0.01	0.07			**0.08**				1.06		**1.06**	**1.14**
			Riparian Zone Total	**0.01**	**0.07**	**0**	**0**	**0.08**	**0**	**0**	**0**	**1.06**	**0**	**1.06**	**1.14**
Clark Branch-South Umpqua River (HUC 1710030211)															

TABLE 3.5.4-39a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide)
Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	MP	CH	Landowner	Late Successional Old Growth Forest	Mid-Seral Forest	Regenerating Forest	Clearcut, Forest	Forest Total	Forested Wetland	Nonforested Wetland	Unaltered Nonforested Habitat	Agriculture	Altered Habitat	Other Total	Total Riparian Zone Impact (acres)
Kent Creek (BSP-240)	63.97	Yes	Federal					0						0	0
			Non-Federal			0.78		0.78			0.17		0.02	0.19	0.97
			Riparian Zone Total	0	0	0.78	0	0.78	0	0	0.17	0	0.02	0.19	0.97
Rice Creek (S2-04; BSP-227)	65.76	Yes	Federal					0						0	0
			Non-Federal		0.95			0.95			0.05	0.17		0.22	1.17
			Riparian Zone Total	0	0.95	0	0	0.95	0	0	0.05	0.17	0	0.22	1.17
Willis Creek (BSP-168)	66.95	Yes	Federal					0						0	0
			Non-Federal		0.15			0.15			0.80	0.06		0.86	1.01
			Riparian Zone Total	0	0.15	0	0	0.15	0	0	0.80	0.06	0	0.86	1.01
South Umpqua River (BSP-26)	71.27	Yes	Federal					0						0	0
			Non-Federal					0			0.10		0.22	0.32	0.32
			Riparian Zone Total	0	0	0	0	0	0	0	0.10	0	0.22	0.32	0.32
Myrtle Creek (HUC 1710030210)															
Rock Creek (EE-SS-9032)	75.33	No	Federal					0						0	0
			Non-Federal		0.78			0.78					0.07	0.07	0.85
			Riparian Zone Total	0	0.78	0	0	0.78	0	0	0	0	0.07	0.07	0.85
Trib. to Rock Creek (EE-SS-9033)	75.34	No	Federal					0						0	0
			Non-Federal		0.35			0.35						0	0.35
			Riparian Zone Total	0	0.35	0	0	0.35	0	0	0	0	0	0	0.35
Bilger Creek (BSP-1)	76.38	Yes	Federal					0						0	0
			Non-Federal		0.30			0.30			0.12	1.58	0.06	1.76	2.06
			Riparian Zone Total	0	0.30	0	0	0.30	0	0	0.12	1.58	0.06	1.76	2.06
North Myrtle Creek (NSP-37)	79.12	Yes	Federal					0						0	0
			Non-Federal	0.10	0.54			0.64						0	0.64
			Riparian Zone Total	0.10	0.54	0	0	0.64	0	0	0	0	0	0	0.64
South Myrtle Creek (BSP-172)	81.19	Yes	Federal					0						0	0
			Non-Federal		0.24			0.24			0.33	0.50	0.03	0.86	1.10
			Riparian Zone Total	0	0.24	0	0	0.24	0	0	0.33	0.50	0.03	0.86	1.10

TABLE 3.5.4-39a

Total Terrestrial Habitat (acres) Affected/Removed (a/) by Construction within Riparian Zones (One Site-Potential Tree Height Wide)
Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	**MP**	**CH**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Days Creek-South Umpqua River (HUC 1710030205)															
Fate Creek (BSP-232)	88.48	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.52			**0.52**				2.34	0.03	**2.37**	**2.89**
			Riparian Zone Total	**0**	**0.52**	**0**	**0**	**0.52**	**0**	**0**	**0**	**2.34**	**0.03**	**2.37**	**2.89**
Days Creek (BSP-233)	88.60	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.23			**0.23**				2.33	0.01	**2.34**	**2.57**
			Riparian Zone Total	**0**	**0.23**	**0**	**0**	**0.23**	**0**	**0**	**0**	**2.33**	**0.01**	**2.34**	**2.57**
Saint John Creek (ASP-303)	92.62	Yes	Federal					**0**						**0**	**0**
			Non-Federal	0.54	1.76			**2.30**					0.37	**0.37**	**2.67**
			Riparian Zone Total	**0.54**	**1.76**	**0**	**0**	**2.30**	**0**	**0**	**0**	**0**	**0.37**	**0.37**	**2.67**
South Umpqua River (ASP-196)	94.73	Yes	Federal					**0**						**0**	**0**
			Non-Federal		1.06			**1.06**			0.90		0.33	**1.23**	**2.29**
			Riparian Zone Total	**0**	**1.06**	**0**	**0**	**1.06**	**0**	**0**	**0.90**	**0**	**0.33**	**1.23**	**2.29**
All Fifth-Field Watersheds and Jurisdictions															
			Federal Subtotal	**2.81**	**1.13**	**0.01**	**0**	**3.95**	**0**	**0**	**0**	**0.99**	**0.07**	**1.06**	**5.01**
			Non-Federal Subtotal	**0.77**	**12.60**	**10.44**	**0**	**23.81**	**0**	**25.12**	**2.61**	**25.33**	**6.28**	**59.34**	**83.15**
			Total	**3.58**	**13.73**	**10.45**	**0**	**27.76**	**0**	**25.12**	**2.61**	**26.32**	**6.35**	**60.40**	**88.16**

a/ Project components considered in calculation of habitat "Removed:" PCGP construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture, and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

TABLE 3.5.4-39b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained over the Pipeline within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	**MP**	**CH**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Coos Bay Frontal Pacific Ocean (HUC 1710030403)															
Trib to Coos Bay (NW-117/EE-6)	6.39R	No	Federal					**0**						**0**	**0**
			Non-Federal					**0**		1.63		0.05	0.03	**1.71**	**1.71**
			Riparian Zone Total	**0**	**0**	**0**	**0**	0	0	1.63	0	0.05	0.03	**1.71**	**1.71**
Willanch Slough (EE-7)	8.27R	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.01			**0.01**				0.22		**0.22**	**0.23**
			Riparian Zone Total	**0**	**0.01**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0.22**	**0**	**0.22**	**0.23**
Johnston Creek (GDX-29 (EE-8)	8.35R	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.08			**0.08**		0.12		0.20	0.01	**0.33**	**0.41**
			Riparian Zone Total	**0**	**0.08**	**0**	**0**	**0.08**	**0**	**0.12**	**0**	**0.20**	**0.01**	**0.33**	**0.41**
Trib. to Cooston Channel (Echo Creek) (SS-100-002)	10.21R	No	Federal					**0**						**0**	**0**
			Non-Federal			0.36		**0.36**					0.01	**0.01**	**0.37**
			Riparian Zone Total	**0**	**0**	**0.36**	**0**	**0.36**	**0**	**0**	**0**	**0**	**0.01**	**0.01**	**0.37**
Coos River (BSP-119)	11.13R	Yes	Federal					**0**						**0**	**0**
			Non-Federal					**0**		0.10		0.13	0.27	**0.50**	**0.50**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**0.10**	**0**	**0.13**	**0.27**	**0.50**	**0.50**
Vogel Creek (SS-100-005)	11.55BR	Yes	BLM-Coos Bay District	0.28				**0.28**						**0**	**0.28**
			Non-Federal					**0**		1.35		0.40	0.02	**1.77**	**1.77**
			Riparian Zone Total	**0.28**	**0**	**0**	**0**	**0.28**	**0**	**1.35**	**0**	**0.40**	**0.02**	**1.77**	**2.05**
Trib. to Stock Slough (Laxstrom Gulch) (BR-S-30)	15.18BR	Yes	Federal					**0**						**0**	**0**
			Non-Federal			0.07		**0.07**		0.75		1.00	0.01	**1.76**	**1.83**
			Riparian Zone Total	**0**	**0**	**0.07**	**0**	**0.07**	**0**	**0.75**	**0**	**1.00**	**0.01**	**1.76**	**1.83**
Stock Slough (BR-S-30)	14.82BR	Yes	Federal					**0**						**0**	**0**
			Non-Federal			0.13		**0.13**		0.47		0.01		**0.48**	**0.61**
			Riparian Zone Total	**0**	**0.00**	**0.13**	**0**	**0.13**	**0**	**0.47**	**0**	**0.01**	**0**	**0.48**	**0.61**
Stock Slough (BR-S-36)	15.32BR	Yes	Federal					**0**						**0**	**0**
			Non-Federal			0.15		**0.15**		0.48				**0.48**	**0.63**
			Riparian Zone Total	**0**	**0**	**0.15**	**0**	**0.15**	**0**	**0.48**	**0**	**0**	**0**	**0.48**	**0.63**

TABLE 3.5.4-39b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained over the Pipeline within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	MP	CH	Landowner	Forest Habitat b/: Late Successional Old Growth Forest	Mid-Seral Forest	Regenerating Forest	Clearcut, Forest	Forest Total	Other Habitat b/: Forested Wetland	Nonforested Wetland	Unaltered Nonforested Habitat	Agriculture	Altered Habitat	Other Total	Total Riparian Zone Impact (acres)
North Fork Coquille River (HUC 1710030504)															
Steinnon Creek (BR-S-63)	24.32BR	Yes	BLM-Coos Bay District		0.29			**0.29**						**0**	**0.29**
			Non-Federal		0.29			**0.29**				0.03		**0.03**	**0.32**
			Riparian Zone Total	**0**	**0.58**	**0**	**0**	**0.58**	**0**	**0**	**0**	**0.03**	**0**	**0.03**	**0.61**
North Fork Coquille River (BSP-207)	23.06	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.20			**0.20**				0.10	0.01	**0.11**	**0.31**
			Riparian Zone Total	**0**	**0.20**	**0**	**0**	**0.20**	**0**	**0**	**0**	**0.10**	**0.01**	**0.11**	**0.31**
Middle Creek (BSP-133)	27.04	Yes	BLM-Coos Bay District	0.12				**0.12**				0.07		**0.07**	**0.19**
			Non-Federal					**0**				0.03		**0.03**	**0.03**
			Riparian Zone Total	**0.12**	**0**	**0**	**0**	**0.12**	**0**	**0**	**0**	**0.10**	**0**	**0.10**	**0.22**
East Fork Coquille River(HUC 1710030503)															
Trib. to E. Fork Coquille R. (BSP-77)	28.86	No	Federal					**0**						**0**	**0**
			Non-Federal		0.08	0.21		**0.29**						**0**	**0.29**
			Riparian Zone Total	**0**	**0.08**	**0.21**	**0**	**0.29**	**0**	**0**	**0**	**0**	**0**	**0**	**0.29**
Trib. to E. Fork Coquille R. (BSP-74)	29.30	No	Federal					**0**						**0**	**0**
			Non-Federal			0.42		**0.42**					0.12	**0.12**	**0.54**
			Riparian Zone Total	**0**	**0**	**0.42**	**0**	**0.42**	**0**	**0**	**0**	**0**	**0.12**	**0.12**	**0.54**
Trib. to E. Fork Coquille R. (BSP-76)	29.47	No	Federal					**0**						**0**	**0**
			Non-Federal			0.32		**0.32**						**0**	**0.32**
			Riparian Zone Total	**0**	**0**	**0.32**	**0**	**0.32**	**0**	**0**	**0**	**0**	**0**	**0**	**0.32**
East Fork Coquille River (BSP-71)	29.85	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.06			**0.06**				0.23		**0.23**	**0.29**
			Riparian Zone Total	**0**	**0.06**	**0**	**0**	**0.06**	**0**	**0**	**0**	**0.23**	**0**	**0.23**	**0.29**
Trib. to E. Fork Coquille R. (SS-003-007B)	30.29	No	Federal					**0**						**0**	**0**
			Non-Federal		0.08	0.58		**0.66**						**0**	**0.66**
			Riparian Zone Total	**0**	**0.08**	**0.58**	**0**	**0.66**	**0**	**0**	**0**	**0**	**0**	**0**	**0.66**
Elk Creek (BSP-57)	32.40	No	Federal					**0**						**0**	**0**
			Non-Federal		0.04	0.08		**0.12**						**0**	**0.12**

TABLE 3.5.4-39b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained over the Pipeline within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	MP	CH	Landowner	Late Successional Old Growth Forest	Mid-Seral Forest	Regenerating Forest	Clearcut, Forest	Forest Total	Forested Wetland	Nonforested Wetland	Unaltered Nonforested Habitat	Agriculture	Altered Habitat	Other Total	Total Riparian Zone Impact (acres)
			Riparian Zone Total	**0**	**0.04**	**0.08**	**0**	**0.12**	**0**	**0**	**0**	**0**	**0**	**0**	**0.12**
Trib. to Elk Creek (BSP-55)	32.40	No	Federal					**0**						**0**	**0**
			Non-Federal		0.08	0.12		**0.20**						**0**	**0.20**
			Riparian Zone Total	**0**	**0.08**	**0.12**	**0**	**0.20**	**0**	**0**	**0**	**0**	**0**	**0**	**0.20**
South Fork Elk Creek (CSP-5)	34.46	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.19	0.11		**0.30**					0.01	**0.01**	**0.31**
			Riparian Zone Total	**0**	**0.19**	**0.11**	**0**	**0.30**	**0**	**0**	**0**	**0**	**0.01**	**0.01**	**0.31**
Middle Fork Coquille River (HUC 1710030501)															
Big Creek	37.41	No	BLM-Coos Bay District	0.38				**0.38**						**0**	**0.38**
			Non-Federal	**0**				**0**				0		**0**	**0**
			Riparian Zone Total	**0.38**	**0**	**0**	**0**	**0.38**	**0**	**0**	**0**	**0**	**0**	**0**	**0.38**
Olalla Creek-Lookingglass Creek (HUC 1710030212)															
Trib. to Shields Creek (BSI-202)	55.90	No	Federal					**0**						**0**	**0**
			Non-Federal	0.01	0.02			**0.03**				0.34		**0.34**	**0.37**
			Riparian Zone Total	**0.01**	**0.02**	**0**	**0**	**0.03**	**0**	**0**	**0**	**0.34**	**0**	**0.34**	**0.37**
Trib. to Olalla Creek (BSI-138)	57.31	No	Federal					**0**						**0**	**0**
			Non-Federal		0.03			**0.03**		0.08		0.58	0.01	**0.67**	**0.70**
			Riparian Zone Total	**0**	**0.03**	**0**	**0**	**0.03**	**0**	**0.08**	**0**	**0.58**	**0.01**	**0.67**	**0.70**
Olalla Creek (BSP-155)	58.78	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.32			**0.32**				0.45		**0.40**	**0.72**
			Riparian Zone Total	**0**	**0.32**	**0**	**0**	**0.32**	**0**	**0**	**0**	**0.45**	**0**	**0.40**	**0.72**
Trib. to Olalla Creek (BSI-129)	59.65	No	Federal					**0**						**0**	**0**
			Non-Federal		0.14			**0.14**			0.03	0.14	0.01	**0.18**	**0.32**
			Riparian Zone Total	**0**	**0.14**	**0**	**0**	**0.14**	**0**	**0**	**0.03**	**0.14**	**0.01**	**0.18**	**0.32**
McNabb Creek (NSP-13)	60.48	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.01			**0.01**				0.29		**0.29**	**0.30**
			Riparian Zone Total	**0**	**0.01**	**0**	**0**	**0.01**	**0**	**0**	**0**	**0.29**	**0**	**0.29**	**0.30**
Clark Branch-South Umpqua River (HUC 1710030211)															

TABLE 3.5.4-39b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained over the Pipeline within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					**Other Habitat b/**						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	**MP**	**CH**	**Landowner**	**Late Successional Old Growth Forest**	**Mid-Seral Forest**	**Regenerating Forest**	**Clearcut, Forest**	**Forest Total**	**Forested Wetland**	**Nonforested Wetland**	**Unaltered Nonforested Habitat**	**Agriculture**	**Altered Habitat**	**Other Total**	**Total Riparian Zone Impact (acres)**
Kent Creek (BSP-240)	63.97	Yes	Federal					**0**						**0**	**0**
			Non-Federal			0.17		**0.17**			0.03			**0.03**	**0.20**
			Riparian Zone Total	**0**	**0**	**0.17**	**0**	**0.17**	**0**	**0**	**0.03**	**0**	**0**	**0.03**	**0.20**
Rice Creek (S2-04; BSP-227)	65.76	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.22			**0.22**			0.03	0.01		**0.04**	**0.26**
			Riparian Zone Total	**0**	**0.22**	**0**	**0**	**0.22**	**0**	**0**	**0.03**	**0.01**	**0**	**0.04**	**0.26**
Willis Creek (BSP-168)	66.95	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.05			**0.05**			0.13			**0.13**	**0.18**
			Riparian Zone Total	**0**	**0.05**	**0**	**0**	**0.05**	**0**	**0**	**0.13**	**0**	**0**	**0.13**	**0.18**
South Umpqua River (BSP-26)	71.27	Yes	Federal					**0**						**0**	**0**
			Non-Federal					**0**						**0**	**0**
			Riparian Zone Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Myrtle Creek (HUC 1710030210)															
Rock Creek (EE-SS-9032)	75.33	No	Federal					**0**						**0**	**0**
			Non-Federal		0.17			**0.17**					0.02	**0.02**	**0.19**
			Riparian Zone Total	**0**	**0.17**	**0**	**0**	**0.17**	**0**	**0**	**0**	**0**	**0.02**	**0.02**	**0.19**
Trib. to Rock Creek (EE-SS-9033)	75.34	No	Federal					**0**						**0**	**0**
			Non-Federal		0.09			**0.09**						**0**	**0.09**
			Riparian Zone Total	**0**	**0.09**	**0**	**0**	**0.09**	**0**	**0**	**0**	**0**	**0**	**0**	**0.09**
Bilger Creek (BSP-1)	76.38	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.12			**0.12**			0.03	0.09	0.02	**0.14**	**0.26**
			Riparian Zone Total	**0**	**0.12**	**0**	**0**	**0.12**	**0**	**0**	**0.03**	**0.09**	**0.02**	**0.14**	**0.26**
North Myrtle Creek (NSP-37)	79.12	Yes	Federal					**0**						**0**	**0**
			Non-Federal	0.04	0.14			**0.18**						**0**	**0.18**
			Riparian Zone Total	**0.04**	**0.14**	**0**	**0**	**0.18**	**0**	**0**	**0**	**0**	**0**	**0**	**0.18**
South Myrtle Creek (BSP-172)	81.19	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.08			**0.08**			0.07	0.12		**0.19**	**0.27**
			Riparian Zone Total	**0**	**0.08**	**0**	**0**	**0.08**	**0**	**0**	**0.07**	**0.12**	**0**	**0.19**	**0.27**

TABLE 3.5.4-39b

Total Terrestrial Habitat (acres) a/ within the 30-foot Wide Corridor Maintained over the Pipeline within Riparian Zones (One Site-Potential Tree Height Wide) Associated with Waterbodies Supporting Critical Habitat or Assumed Coho Habitat within Range of Oregon Coast Coho Crossed by the Pipeline

				Forest Habitat b/					Other Habitat b/						
Fifth-Field Watershed (Hydrologic Unit Code [HUC]) and Waterbody with Critical Habitat	MP	CH	Landowner	Late Successional Old Growth Forest	Mid-Seral Forest	Regenerating Forest	Clearcut, Forest	Forest Total	Forested Wetland	Nonforested Wetland	Unaltered Nonforested Habitat	Agriculture	Altered Habitat	Other Total	Total Riparian Zone Impact (acres)
Days Creek-South Umpqua River (HUC 1710030205)															
Fate Creek (BSP-232)	88.48	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.09			**0.09**				0.39		**0.39**	**0.48**
			Riparian Zone Total	**0**	**0.09**	**0**	**0**	**0.09**	**0**	**0**	**0**	**0.39**	**0**	**0.39**	**0.48**
Days Creek (BSP-233)	88.60	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.07			**0.07**				0.42		**0.42**	**0.49**
			Riparian Zone Total	**0**	**0.07**	**0**	**0**	**0.07**	**0**	**0**	**0**	**0.42**	**0**	**0.42**	**0.49**
Saint John Creek (ASP-303)	92.62	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.22			**0.22**					0.02	**0.02**	**0.24**
			Riparian Zone Total	**0**	**0.22**	**0**	**0**	**0.22**	**0**	**0**	**0**	**0**	**0.02**	**0.02**	**0.24**
South Umpqua River (ASP-196)	94.73	Yes	Federal					**0**						**0**	**0**
			Non-Federal		0.09			**0.09**			0.11		0.01	**0.12**	**0.21**
			Riparian Zone Total	**0**	**0.09**	**0**	**0**	**0.09**	**0**	**0**	**0.11**	**0**	**0.01**	**0.12**	**0.21**
All Fifth-Field Watersheds and Jurisdictions															
			Federal Subtotal	**0.78**	**0.29**	**0**	**0**	**1.07**	**0**	**0**	**0**	**0.07**	**0**	**0.07**	**1.14**
			Non-Federal Subtotal	**0.05**	**2.97**	**2.72**	**0**	**5.74**	**0**	**4.98**	**0.43**	**5.18**	**0.58**	**11.17**	**16.91**
			Total	**0.83**	**3.26**	**2.72**	**0**	**6.81**	**0**	**4.98**	**0.43**	**5.25**	**0.58**	**11.24**	**18.05**

a/ Project components considered in calculation of habitat "Removed:" PCGP construction right-of-way, temporary extra work areas, aboveground facilities, and permanent and temporary access roads (PAR, TAR).

b/ Habitat Types within Riparian Zones generally categorized as: Late Successional (Mature) or Old Growth Forest (coniferous, deciduous, mixed ≥80 years old); Mid-Seral Forests (coniferous, deciduous, mixed ≥40 but ≤80 years old); Regenerating Forest (coniferous, deciduous, mixed ≥5 but ≤40 years old); Clearcut Forests; Forested and Nonforested Wetland, Unaltered Nonforested Habitat (grasslands, sagebrush, shrublands), Agriculture, and Altered Habitats (urban, industrial, residential, roads, utility corridors, quarries).

c/ Riparian zone of Stock Slough at MP 15.11BR includes the riparian zone of Laxstrom Gulch which is adjacent to the pipeline but not crossed. Laxstrom Gulch is also designated Critical Habitat.

Effects to water temperature (shade) during construction and operation within the riparian zone of each waterbody assumed to support coho or with coho critical habitat are assumed to be directly related to areas of riparian forest removed during construction (riparian forest within the construction right-of-way, TEWAs, TARs, and PARs) and to areas of riparian forest that would be removed within the 30-foot wide operational easement for the life of the Pipeline. Riparian forest that is not in the operational easement would be restored over time, presumably attaining mid-seral status (40-80 years old) at the end of the 50-year life of the Pipeline. The magnitude of impact to riparian shade associated with each waterbody with critical habitat and assumed to be occupied by coho is directly related to the absolute and relative amounts of riparian forest removed during construction, amounts removed permanently by the operational easement, and amounts of riparian forest that would be restored within affected riparian zones.

Table 3.5.4-39c summarizes tables 3.5.4-39a and 3.5.4-39b. In table 3.5.4-39c below, the greatest absolute impact to LWD recruitment and shade within riparian zones associated with critical habitats for Oregon Coast coho would occur where the pipeline crosses Steinnon Creek, South Fork Elk Creek, Olalla Creek, Saint John Creek, and the South Fork Umpqua River where more than one acre of riparian forest would be removed at each one. Likewise, there would be high absolute impact to several streams that are known to (e.g., Tributary to Cooston Channel) or assumed (six streams) to support coho. In addition to those, relatively large amounts of riparian forest would be affected during construction at Kent Creek, Rice Creek, and North Myrtle Creek but relatively large areas of forest restoration following construction would partially offset the effects of construction. Riparian forest that would be restored would presumably attain mid-seral status (40-80 years old) at the end of the 50-year life of the Pipeline. Absolute and relative impact to forests within riparian zones (with concomitant effects to LWD recruitment and shade) associated with other affected waterbodies with critical habit for Oregon Coast coho would be less severe. The longest-term effects to riparian forest, LWD and shade would occur where late successional-old growth forest would be removed during construction: 0.89 acre at Vogel Creek (Coos Bay Frontal-Pacific Ocean Watershed), 0.81 acre at Middle Creek (North Fork Coquille River Watershed), 0.01 acre at McNabb Creek (Olalla Creek-Lookingglass Creek Watershed), 0.10 acre at North Myrtle Creek (Myrtle Creek Watershed), and 0.54 acre at Saint John Creek (Days Creek-South Umpqua River Watershed).

TABLE 3.5.4-39c

Summary Table for Effects to Riparian Zones
Associated with Critical Habitats and Assumed Occupied Habitat for Oregon Coast Coho

5th Field Watershed and Waterbody with Critical Habitat	Critical Habitat	Total Riparian Area Affected (acres)	Riparian Forest Removed by Construction (acres)	Riparian Forest Removed During Operation (acres)	Riparian Forest Restored After Construction (acres)	Percent Riparian Forest Removed	Percent Riparian Forest Removed Permanently	Percent of Riparian Zone with Restored Forest
Coos Bay-Frontal Pacific Ocean (HUC 1710030403)								
Trib to Coos Bay	No	12.73	0.00	0.00	0.00	0%	0%	0.0%
Willanch Slough	Yes	0.85	0.10	0.01	0.09	12%	1%	10.6%
Johnston Creek	Yes	1.20	0.20	0.08	0.12	17%	7%	10.0%
Trib. Cooston Channel	No	1.40	1.34	0.36	0.98	96%	26%	70.0%
Coos River	Yes	4.95	0.00	0.00	0.00	0%	0%	0.0%
Vogel Creek	Yes	7.70	0.89	0.28	0.61	12%	4%	7.9%
Trib. to Stock Slough (Laxstrom Gulch)	Yes	7.00	0.30	0.07	0.23	4%	1%	3.3%
Stock Slough	Yes	2.50	0.37	0.13	0.24	15%	5%	9.6%
Stock Slough	Yes	2.33	0.37	0.15	0.22	16%	6%	9.4%

TABLE 3.5.4-39c

Summary Table for Effects to Riparian Zones
Associated with Critical Habitats and Assumed Occupied Habitat for Oregon Coast Coho

5th Field Watershed and Waterbody with Critical Habitat	Critical Habitat	Total Riparian Area Affected (acres)	Riparian Forest Removed by Construction (acres)	Riparian Forest Removed During Operation (acres)	Riparian Forest Restored After Construction (acres)	Percent Riparian Forest Removed	Percent Riparian Forest Removed Permanently	Percent of Riparian Zone with Restored Forest
North Fork Coquille River (HUC 1710030504								
Steinnon Creek	Yes	2.43	2.23	0.58	1.65	92%	24%	67.9%
No. Fk. Coquille River	Yes	1.59	0.75	0.20	0.55	47%	13%	34.6%
Middle Creek	Yes	2.14	0.82	0.12	0.70	38%	6%	32.7%
East Fork Coquille River (HUC 1710030503)								
Trib. to E. Fork Coquille R.	No	1.48	1.48	0.29	1.19	100%	20%	80.4%
Trib. to E. Fork Coquille R.	No	1.97	1.45	0.42	1.03	74%	21%	52.3%
Trib. to E. Fork Coquille R.	No	1.33	1.33	0.32	1.01	100%	24%	75.9%
E. Fork Coquille River	Yes	2.21	0.24	0.06	0.18	11%	3%	8.1%
Elk Creek	No	0.65	0.65	0.12	0.53	100%	18%	81.5%
Trib. to Elk Creek	No	0.60	0.60	0.20	0.40	100%	33%	66.7%
South Fork Elk Creek	Yes	1.29	1.25	0.30	0.95	97%	23%	73.6%
Middle Fork Coquille River (HUC 1710030501)								
Big Creek	No	1.11	1.11	0.38	0.73	100%	34%	65.8%
Olalla Creek-Lookingglass Creek (HUC 1710030212)								
Trib. to Shields Creek	No	1.47	0.17	0.03	0.14	12%	2%	9.5%
Trib. to Olalla Creek	No	2.08	0.08	0.03	0.05	4%	1%	2.4%
Olalla Creek	Yes	3.93	1.20	0.32	0.88	31%	8%	22.4%
Trib. to Olalla Creek	No	1.14	0.40	0.14	0.26	35%	12%	22.8%
McNabb Creek	Yes	1.14	0.08	0.01	0.07	7%	1%	6.1%
Clark Branch-South Umpqua River (HUC 1710030211)								
Kent Creek	Yes	0.97	0.78	0.17	0.61	80%	18%	62.9%
Rice Creek	Yes	1.17	0.95	0.22	0.73	81%	19%	62.4%
Willis Creek	Yes	1.01	0.15	0.05	0.10	15%	5%	9.9%
South Umpqua River	Yes	0.32	0.00	0.00	0.00	0%	0%	0.0%
Myrtle Creek (HUC 1710030210)								
Rock Creek	No	0.85	0.78	0.17	0.61	92%	20%	71.8%
Trib. to Rock Creek	No	0.35	0.35	0.09	0.26	100%	26%	74.3%
Bilger Creek	Yes	2.06	0.30	0.12	0.18	15%	6%	8.7%
North Myrtle Creek	Yes	0.64	0.64	0.18	0.46	100%	28%	71.9%
South Myrtle Creek(	Yes	1.10	0.24	0.08	0.16	22%	7%	14.5%
Days Creek-South Umpqua River (HUC 1710030205)								
Fate Creek	Yes	2.89	0.52	0.09	0.43	18%	3%	14.9%
Days Creek	Yes	2.57	0.23	0.07	0.16	9%	3%	6.2%
Saint John Creek	Yes	2.67	2.30	0.22	2.08	86%	8%	77.9%
South Umpqua River	Yes	2.29	1.06	0.09	0.97	46%	4%	42.4%

Effects to LWD during construction and operation within the riparian zone of each waterbody assumed to support coho or with coho critical habitat are assumed to be directly related to areas of riparian forest removed during construction (riparian forest within the construction right-of-way, TEWAs, TARs, and PARs) and to areas of riparian forest that would be removed within the 30-foot wide operational easement for the life of the Pipeline. Riparian forest that is not in the operational easement would be restored over time, presumably attaining mid-seral status (40-80 years old) at the end of the 50-year life of the Pipeline. The magnitude of impact to LWD recruitment associated with each waterbody with critical habitat and assumed to be occupied by coho is directly related to the absolute and relative amounts of riparian forest removed during construction, amounts removed permanently by the operational easement, and amounts of riparian forest that would be restored within affected riparian zones.

The Pipeline project would result in adverse effects to freshwater critical habitat for the Oregon Coast ESU of coho salmon. Most effects would be short-term, but some would be intermediate to long-term. Minor short-term effects would occur from sedimentation during construction actions. Minor intermediate-term effects would occur from a reduction in riparian habitat due to construction and operation. Sediment disturbance at stream crossings would affect food sources for rearing fish in the short-term, and riparian plant removal would reduce LWD supply affecting habitat quality and quantity in the intermediate to long-term over small stream areas (i.e., within the less than 75 to 95-foot stream length cle aring area per crossing).

Designated critical habitat for the Oregon Coast coho does not include unoccupied areas. The lateral extent of critical was defined as the width of the stream channel defined as the ordinary high-water line (NMFS 2008d). Human actions on land outside of the stream channel can modify or degrade physical and biological features of the stream and associated PCE at the site and/or in downstream reaches of designated critical habitat. Each PCE defined for critical habitat could be adversely affected by the proposed action. Those effects have been quantified to the extent possible in the foregoing analyses and summarized below in table 3.5.4-40.

Project effects to freshwater spawning sites would likely occur prior to coho spawning in the year of construction and there would be no effects to spawning, incubation, and larval development by suspended sediment although project-generated sediment could increase gravel embeddeness downstream. Those effects would depend on precipitation and in-stream flow (potential freshets) following construction that would likely flush fines downstream. The project would remove small areas of riparian forest that would provide recruitment of LWD. The Project would temporarily decrease water quality downstream from construction sites by entrainment of sediments and temporarily limit in-stream migration during in-stream construction. In all instances, habitat suitability (HADD, Anderson et al. 1996) would temporarily decrease though not necessarily to levels that would cause moderate habitat degradation (SEV = 7).

The Project could result in short-term adverse effects to estuarine and freshwater critical habitat for the Oregon Coast ESU of coho salmon. Short-term effects to critical habitat within the estuarine analysis area would include effects to food and rearing habitat as a result of dredging the access channel, NRIs and the slip. Dredging in proximity to the Coos Bay shipping channel would decrease water quality and affect cover (aquatic vegetation, eelgrass).

In the riverine analysis area, most effects to critical habitat would be short-term while some would be intermediate to long-term. Minor short-term effects would occur primarily from sedimentation during stream crossings. Minor intermediate-term effects would occur from a reduction in riparian habitat that would affect freshwater rearing habitat due to construction and operation. Sediment disturbance at stream crossing would affect food sources for rearing fish in the short-term, and riparian plant removal would reduce LWD supply affecting habitat quality and quantity in the intermediate to long-term over small stream areas (i.e., within the less than 75- to 95-foot stream length clearing area per crossing).

TABLE 3.5.4-40

Summary of Project Effects to Critical Habitat Designated for Oregon Coast Coho within Watersheds Crossed by the Pipeline Project

Subbasins and Fifth-Field Watersheds	Total Waterbodies Crossed in Watershed	Waterbodies with Coho Affected a/			Riparian Zone Width (feet) b/	Areas (acres) of Riparian Vegetation Removed c/		
		Documented	Assumed	Total with Critical Habitat /b		Forested| Habitat	Non-forested Habitat	Total
Coos Subbasin								
Coos Bay-Frontal Pacific Ocean	13	13	0	11	225	2.32	29.16	31.47
Coquille Subbasin								
North Fork Coquille River	7	3	0	3	224	2.87	1.98	4.85
East Fork Coquille River	13	2	6	2	204	1.49	2.05	3.54
Middle Fork Coquille River	16	0	1	0	189	0.00	0.00	0.00
South Umpqua Subbasin								
Olalla Creek-Lookingglass Creek	17	2	3	2	169	1.40	4.68	6.08
Clark Branch-South Umpqua River	13	4	0	4	149	2.15	2.70	4.85
Myrtle Creek	14	3	2	3	168	1.44	2.61	4.05
Days Creek-South Umpqua River d/	15	4	9	9	164	4.09	6.03	10.12
Upper Cow Creek	8	0	0	0	187	0.00	0.00	0.00
Total	**116**	**31**	**12**	**29**		**15.77**	**49.20**	**64.97**

a/ Data from ODFW GIS database (ODFW 2014c).
b/ Based on mapped designated critical habitat for Oregon Coast coho.
c/ Riparian width of 1 SPTH, one site-potential tree height.
d/ Includes the Key Watershed designated within the Days Creek-South Umpqua River 5th field watershed.

3.5.4.4 Conservation Measures

Appendices N and O of this BA include a complete list of conservation measures proposed by JCEP and PCGP. Measures that are applicable to Oregon Coast ESU coho are summarized here. JCEP would undertake a number of measures designed to mitigate the potential construction and operation impacts on fisheries and aquatic resources as described in the above sections. Construction phase mitigation would include measures to avoid or minimize the potential impacts from construction of the slip as well as from activities in upland areas associated with construction of the LNG Terminal and related facilities. In addition, restoration activities at the Kentuck Project and at the Eelgrass Mitigation site would offset the permanent loss of intertidal, subtidal, salt marsh, and eelgrass habitat resulting from construction of the slip and access channel. During operation of the LNG Terminal, mitigation measures would be incorporated at the LNG Terminal site to minimize the potential for discharge of pollutants or hazardous materials into the bay. Additional mitigation procedures would be implemented to ensure that LNG carriers would not adversely impact marine organisms either through direct mortality or through the introduction of exotic marine species.

Conservation measures proposed by JCEP to minimize impacts from LNG carrier transit, LNG Terminal and facility construction and operations to fisheries in the marine and estuarine analysis area are compiled in tables 1, 2A, and 2B in appendix N (see discussion in section 3.3.1). JCEP has also proposed measures to rectify, repair, rehabilitate, and otherwise reduce impact to from actions noted once construction is complete; these measures are compiled in tables 3A and 3B in appendix N.

Without repeating the components proposed by the JCEP that are in appendix N, they include measures related to:

- Timing of Dredging Activities – to minimize potential impacts to juvenile salmonids and other fish/invertebrate species through the avoidance of vulnerable life stages and peak migration periods;
- Berm Construction Containment – conduct most slip dredging behind soil berm to limit sedimentation in marine waters and no Coos Bay water disposal activities;
- Dredging and Disposal Activities – use of dredge equipment and techniques to minimize the potential for turbidity and contaminant releases to the water column;
- Use of Upland Disposal of Dredge Materials – includes removal of dredged spoils by barge and containment of elutriate water;
- Control of Turbidity and Contaminants – includes monitoring, corrective actions, upland and water containment, and dredging technique;
- Stormwater Management – initial run off of all storms of a two –year return period to be contained and infiltrated, the remainder will flow to the slip;
- Timing of In-water Temporary Construction Components and Terminal Construction Components – to minimize potential impacts to juvenile salmonids and other fish/invertebrate species through the avoidance of vulnerable life stages and peak migration periods;
- Control of Acoustic Disturbance – includes impact hammer work (pilings and sheet piles) behind berm outside of marine waters and monitoring plan;
- Riprap Installation – using smallest size practical;
- Lighting – direct light to shore and at lowest levels possible design; and
- Spill Prevention and Control – includes development and implementation of an SPCCP.

Conservation measures have also been proposed by PCGP to minimize construction and operation impact in the riverine analysis area and estuarine analysis area crossed by the Pipeline. Those measures are compiled in tables 1 and 2C in appendix N and are summarized below. PCGP has also proposed measures to rectify, repair, rehabilitate, and otherwise reduce impact to waterbodies and riparian zones once construction of the Pipeline is complete. Those measures have been compiled in table 3C in appendix N. Details of some of the major conservation measures proposed by PCGP are summarized below.

Erosion Control

Many of the conservation measures in table 3C in appendix N focus on erosion control to prevent sediment from entering surface waters. Temporary erosion controls would be installed immediately after vegetation clearing and grading and would be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration is complete. At a minimum, the following temporary erosion control structures would be installed: temporary slope breakers, sediment barriers, mulch, and erosion control fabric. PCGP would install permanent slope breakers consistent with the requirements of the FERC's Plan.

Part of long-term erosion control would include a final cleanup including final grading and installation of permanent erosion control structures. Final cleanup of an area would generally occur within 10 days after backfilling the trench and not be delayed beyond the end of the next recommended seeding season. During final cleanup, PCGP would remove all construction debris and grade disturbed areas to pre-construction grades to the extent practicable. An adequate seedbed would be prepared at the conclusion of cleanup.

Temporary Slope Breakers

PCGP would install temporary slope breakers over the backfilled, recontoured construction right-of-way as specified in the FERC's Plan. The outfall of each temporary slope breaker would be to a stable, well-vegetated area or to an energy-dissipating device at the end of the slope breaker off the construction right-of-way. Slope breakers reduce runoff velocity, thereby intercepting sediment and allowing it to drop out of suspension. They also can effectively divert runoff away from a disturbed site to a stable outlet (Goldman et al. 1986).

Sediment Barriers

PCGP would primarily rely upon silt fence and staked hay or straw bales to confine sediment to the construction right-of-way. These structures would be used adjacent to wetland and waterbody crossings consistent with the requirements of the FERC's *Procedures*. Straw bales and filter fabric (silt fence) can be used together to create a highly effective sediment barrier, a combination that compensates for the limitations of each used in isolation; straw bales provide extra support and the fabric provides greater filtering capability (Goldman et al. 1986).

All straw or hay bales used for sediment barriers would be certified as weed-free. Temporary sediment barriers would be maintained in-place until permanent revegetation measures are successful or until the upland areas adjacent to wetlands, waterbodies or roads are stabilized. The structures would be removed once vegetation in the area has been successfully restored.

Erosion Control Fabric

PCGP would install erosion control fabric (such as jute or excelsior) on waterbody banks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. Although there are no measures specific to pipeline construction, data related to cut-and-fill slopes treated during construction of forest roads indicate varying effectiveness of different types of stabilization measures designed to control surface erosion (EPA 2001). On fill slopes, combining straw mulch and netting decreased erosion by 99 percent. Excelsior mulch alone decreased erosion by 92 percent on fill slopes. On cut slopes, straw mulch by itself decreased erosion in a range from 32 to 97 percent (EPA 2001). Applications of mulches and/or fabric are effective measures promoting slope stabilization until vegetation can successfully be reestablished. These measures also promote plant growth (EPA 2001).

Fish Salvage Plan

All waterbodies that would be crossed by dry open cut construction would be done prior to adult coho salmon upstream migration, within ODFW in-stream construction windows. A *Fish Salvage Plan* has been provided in appendix T. The plan has been developed to minimize adverse effects to listed salmonids (SONCC coho salmon, Oregon Coast coho salmon), non-listed salmonids (Chinook salmon, steelhead, and cutthroat trout) and listed catostomids (Lost River sucker, shortnose sucker). The portions of the plan relevant to salvaging salmonids were adapted from the protocol developed by WSDOT (2012). The protocol specifies procedures to 1) isolate the work area; 2) remove fish and dewater the work area; 3) handle, hold, and release fish; 4) document fish that have been captured, handled, held, and released; and 5) notify NMFS and FWS. Only trained professionals would conduct electroshocking and fish removal.

Revegetation

As required by the FERC's *Plan*, PCGP has identified procedures for the preparation and planting of live stakes or sprigs and for the planting bare root tree seedlings. Those procedures are included in appendix R. Within the range of Oregon Coast coho salmon, construction of the Pipeline would remove 112.96 acres of riparian forested habitats of which 16.86 acres are late-successional (mature) old-growth, 45.82 acres are mid-seral forests, and 0.07 acre is forested wetlands (see table 3.5.4-30a).

Existing forested riparian zones in which forest would be removed during construction would be re-planted with conifers to within 15 feet of each side of the centerline. Permanent effects—persisting longer than the assumed 50-year life of the Pipeline—would occur by removing 16.86 acres of late-successional (mature) old-growth riparian forest. Even though the riparian zone would be replanted, the newly planted trees would not attain late-successional or old-growth status within 50 years. Permanent effects would also last along the 30-foot wide maintenance corridor centered on the Pipeline. Those effects to former late-successional (mature) old-growth riparian forest, mid-seral riparian forest and other existing riparian vegetation are included in table 3.5.4-30b. Due to the maintenance access route in the right-of-way that would not be allowed to grow trees for the life of the Pipeline project, replanting conifers within each affected forested riparian zone would leave an estimated 28.27 acres of non-forested vegetation within former forested riparian zones over the long-term or permanently (see table 3.5.4-30b).

OHV Barriers

Limiting OHV vehicles access would reduce potential increased sedimentation to streams and human access to sensitive fish areas. In accordance with the FERC's *Plan*, the applicant must offer to install and maintain measures to control unauthorized vehicle access to the right-of-way to each landowner or manager of forested lands to install and maintain measures to control unauthorized vehicle access to the right-of-way and states that such measures may include signs; fences with locking gates; slash and timber barriers, pipe barriers, or a line of boulders across the right of way; and conifers or other appropriate trees or shrubs across the right-of-way. If allowed by the landowner, and if available, slash, stumps and or logs, if available, would be placed on the right-of-way within the riparian zones to discourage OHV crossings of streams and provide carbon and nutrients if allowed by the landowner. If not allowed, PCGP would discuss with the landowner the use of other methods, as noted above. At a minimum the area would be revegetated and re-seeded.

Streambank Stability

The root network of trees adjacent to streambanks is essential to maintaining streambank stability (WDNR 1997). Because root strength decreases significantly at distances beyond one-half the tree crown diameter, trees promoting streambank stability lie within half a tree crown diameter from the streambank. Trees within 25 feet of the streambank are assumed to promote streambank stability (WDNR 1997). Generally, trees that must be removed during construction would be cut at ground level with the roots left in place, except where located within the trenchline. Although roots would decay overtime, streambank stability would be retained by their presence until revegetation is successful.

Streambank Restoration

PCGP's ECRP (see appendix F) describes the measures that would be used to stabilize streambanks crossed by the Pipeline. PCGP would not use riprap to stabilize streambanks. The alignment has been designed at waterbody crossings to be as perpendicular to the axis of the waterbody channel, as engineering and routing constraints allow, minimizing streambank disturbance and avoiding parallel stream alignments or multiple stream crossings. Immediately after installation of a waterbody crossing, the contours of the streambed, shoreline, and streambanks would be restored to preconstruction configurations (i.e., contour/elevations) to restore the physical integrity/condition of these features and to minimize the loss of stream complexity.

PCGP has completed a scour analysis for the Pipeline project that would be used to ensure that appropriate pipeline burial depths and cover design parameters beneath channel streambeds and adjacent floodplains are utilized, so that the effects on natural stream processes would be avoided or minimized. The Pipeline project's scour analysis, which was completed by GeoEngineers, was included in PCGP's 2017 FERC certificate application.

PCGP would install erosion control fabric (such as jute or excelsior) on streambanks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. The erosion control fabric to be used on streambanks would be designed for the proposed use and would be approved by PCGP's EIs.

Consistent with the FERC's *Procedures* (section V.C.3.), during streambank restoration/recontouring, the streambanks would be returned to their preconstruction contours or to a stable configuration. Streambank revegetation measures, including supplemental riparian planting procedures are also outlined in the ECRP. The shrubs and trees planted at each site would be determined at the time of planting based on the moisture regimes and site-specific conditions at each planting location and landowner requirements.

In-Stream Gravel

Waterbodies supporting fisheries would be backfilled with material removed from the trench with the upper 1 foot of the trench backfilled with clean gravel or native cobbles. PCGP has requested a variance from section V.C.1. of the FERC's *Procedures* in fish-bearing streams that do not have gravel, cobble, or other rock substrates prior to construction. This variance was requested because many of the streams crossed are remote and are located in steep valley or ravine bottoms. Therefore hauling rock to these steams is impractical especially where these streams do not have gravel or cobble substrate characteristics prior to construction. The bottom and banks would be returned to preconstruction contours; banks would be stabilized; and temporary sediment barriers would be installed before returning flow to the waterbody channel.

Large Woody Debris

As discussed in the Direct and Indirect Effects section above in several instances, mitigation would contribute to restoring an aquatic habitat indicator's functional level, such as placement of LWD within and/or adjacent to streams and placing LWD on floodplains, where appropriate, to provide microsites for riparian vegetation and/or vegetation protection during flood events. Placement of LWD in streams and/or on streambanks has been one focal point of recent stream rehabilitation procedures (Slaney and Martin 1997; Cederholm et al. 1997; EPA 2001) as described in the *Large Woody Debris Plan* (see appendix O).

As indicated in table 3.5.4-10a and table 3.5.4-10b, baseline watershed conditions crossed by the Pipeline are lacking in LWD due to historical disturbance and LWD presence is typically below benchmark thresholds to be properly functioning. Because of the overall lack of LWD in the affected watersheds, LWD also provides an appropriate mitigation model for the Pipeline project's potential waterbody crossing impacts that are temporary, short-term, and unavoidable (see appendix O). If approved by landowners, PCGP proposes to install LWD on-site during construction as an appropriate habitat enhancement feature to mitigate for potential pipeline impacts and to benefit watershed conditions. The LWD would also serve to mitigate for potential long-term Pipeline project impacts—impacts lasting for its 50-year life—such as the loss of forested riparian vegetation within the 30-foot operational corridor (see table 3.5.4-30b, above). Even though the riparian zone would be replanted, the planted trees would not attain late-successional or old-growth status within 50 years. Placement of LWD would, in some measure, reduce though not eliminate the impact due to the removal of late-successional (mature) old-growth riparian forest.

For low-gradient streams, Cederholm et al. (1997) suggest using logs with diameters at least 18 inches (less in areas of low velocity) placed by vertical angling into the stream channel. Logs could be used to create a stepped-channel profile with the rootwads and encourage woody debris accumulations in pool margins. For streams with steeper gradients, Cederholm et al. (1997) suggest that logs with smaller diameters might be used if larger logs are unavailable. Near headwaters, LWD is often suspended over the channel so that it can become functional during periods of maximum runoff. Smaller debris may be retained during those periods and help develop pools that would be functional during summer (see Cederholm et al. 1997).

Guidelines for LWD placement, provided by ODF and ODFW (1995), suggest using the following: 1) larger diameter wood pieces because they are more effective at creating pools and complex channels which improve fish populations (see table 3.5.4-41 for minimum diameter LWD per bankfull width); 2) LWD that are at least twice the length of the waterbody bankfull width (1.5 times the bankfull width if the rootwad is attached) to increase the likelihood that the LWD would remain in place; and 3) conifer logs, especially western red cedars if available, because they are more durable. In larger waterbodies, smaller diameter, shorter LWD could be used if bundled and anchored together to provide the same benefits of the longer, larger diameter LWD (ODF and ODFW 1995).

TABLE 3.5.4-41

Minimum Diameter LWD for Placement in Waterbody Based on Bankfull Width

Bankfull Width (feet)	Minimum Diameter LWD (inches)
0 to 10	10
10 to 20	16
20 to 30	18
Over 30	22

Source: ODF and ODFW 1995.

Trees classified as late successional or old growth are assumed to have attained heights equal to the site-potential tree heights that are included above in table 3.5.4-30a as Riparian Zone Widths. Site-potential tree heights range from 225 feet (for example, the Coos Bay-Frontal Pacific Ocean Watershed) to 164 feet (as in the Days Creek-South Umpqua River Watershed). If Douglas-fir trees in the Oregon Cascades grow in height at the rate of 20 inches per year and in diameter by 0.25 inch per year (Cox 2008), a 20-inch-tall seedling planted the year after construction of the Pipeline would be an estimated 85 feet tall and 12 to 13 inches in diameter (assumed dbh) after 50 years. Trees with those dimensions would provide suitable LWD for streams with bankfull widths from zero to 10 feet but not larger streams (see table 3.5.4-41). Even in these streams recruitment of wood may be reduced as the young age of the forest would reduce recruitment from natural mortality as the rate would be less relative to older trees. But recruitment of wood is not solely dependent on natural tree mortally but includes important contributing factors such as bank erosions, disease, fires, slides, and windthrow (Reeves et al. 2003; Martin and Benda 2001; Gregory et al. 2003). LWD contribution would occur from these areas even though natural mortality contribution would be reduced.

The Pipeline would cross 50 perennial streams within the range of Oregon Coast ESU coho salmon. Forty-five of those perennial streams have existing riparian forest ranging from clear – cut forest and regenerating forest to mid-seral stage (approximately 40 to 80 years old) to older late-successional and old-growth; 39.45acres of existing riparian forest would be removed by construction. Five more perennial streams would also be crossed but construction would not affect riparian forest vegetation (see table 3.5.4-42). In addition, the Pipeline would cross 56 intermittent streams, 46 of which support riparian forest, and would affect riparian forest of 52 other intermittent streams, resulting in a total of 113.09 acres of riparian forest being removed. Six additional perennial streams and 25 intermittent streams with no riparian forest would be crossed as well (see table 3.5.4-42).

To offset impact from removal of riparian trees (reducing LWD recruitment potential) and to provide an overall benefit by enhancing stream habitat with no potential for LWD recruitment, PCGP proposes to place LWD at the waterbody flow types identified by watershed in table 3.5.4-42 (see the *Large Woody Debris Plan* in appendix O) based on the following applications:

- four pieces for each perennial stream crossed with riparian forest removed (two pieces in-stream and/or keyed into the streambank, two pieces within riparian zone on the bank);
- two pieces for each intermittent stream and unknown stream crossed with riparian forest removed (one or both LWD pieces placed in-stream, keyed into the bank, or placed on the bank);
- two pieces for each perennial, intermittent, and unknown stream crossed but with no riparian forest removed (one or both LWD pieces paced in-stream keyed into the bank, or placed on the bank); and
- one piece each for a perennial, intermittent, and unknown stream not crossed but adjacent to the construction right-of-way, with or without riparian forest removed (LWD placed on bank).

Because the construction right-of-way at stream crossings would be 75 feet wide, PCGP anticipates only enough space for two pieces of LWD, preferably with rootwads attached, either placed in-stream or with stems keyed into streambanks. Unless site-specific conditions dictate otherwise, the preferable location for each in-stream LWD is downstream from the pipeline to prevent scour of the pipe. LWD would also be placed near or adjacent to streambanks within riparian zones to provide for and/or enhance microsites for riparian vegetation and/or vegetation protection during flood events.

The LWD plan includes placing from one to four pieces of LWD per stream crossed in the stream or on the bank, depending on forest conditions, stream flow, and landowner approval. This number of pieces, if no other LWD were present in the stream reach affected by clearing, would be in the range of what is considered "desirable" by ODFW (Foster et al. 2001) for forested streams. Foster et al. (2001) noted that more than 20 LWD pieces/100 meters of stream length (i.e., 4.6 pieces/75 feet of right-of-way clearing) with more than 3 "key" pieces/100 meters (i.e., 0.7 "key" pieces/75 feet of right-of-way clearing) is considered "desirable" in way.
table 3.5.4-32 to meet habitat needs for specific stream sizes and number of streams crossed.

In all, PCGP proposes 375 pieces of LWD for placement within the nine fifth-field watersheds that coincide with Oregon Coast coho salmon ESU and designated critical habitat. Placement of LWD is subject to approval by each affected landowner. If a landowner rejects the proposed placement of LWD, the number of pieces that would have been applied on-site would be reserved and provided to appropriate watershed councils for their use and placement, preferably elsewhere within the affected fifth-field watershed.

TABLE 3.5.4-42

Proposed Application of Large Woody Debris to Waterbodies and Riparian Zones Affected by Construction of the Pipeline within the Range of Oregon Coast Coho Salmon

Fifth-Field Watershed	Watershed Parameter	Waterbody Type						Total in Watershed	Pieces of LWD Applied to Fifth-Field Watershed a/		
		Perennial		Intermittent		Unknown					
		Crossed	Adjacent	Crossed	Adjacent	Crossed	Adjacent		Crossed	Adjacent	Total
Coos Bay-Frontal Pacific Ocean (HUC 1710030403)	Area (acres) of Riparian Forest	0.42	1.09	3.05	21.32	0	0	25.88			
	Total Number of Waterbodies	4	4	5	33	0	0	19			
	With Riparian Forest	3	3	4	28	0	0	38	20	31	51
	No Riparian Forest	1	1	1	5	0	0	8	4	6	10
North Fork Coquille River (HUC 1710030504)	Area (acres) of Riparian Forest	4.00	0	0.24	3.11	0	0	7.34			
	Total Number of Waterbodies	4	0	1	5	0	0	10			
	With Riparian Forest	4	0	1	4	0	0	9	18	4	22
	No Riparian Forest	0	0	0	1	0	0	1	0	1	1
East Fork Coquille River (HUC 1710030503)	Area (acres) of Riparian Forest	7.84	0.00	8.03	3.16	0	0	19.03			
	Total Number of Waterbodies	9	0	6	7	0	0	22			
	With Riparian Forest	8	0	6	6	0	0	20	44	6	50
	No Riparian Forest	1	0	0	1	0	0	2	2	1	3
Middle Fork Coquille River (HUC 1710030501)	Area (acres) of Riparian Forest	6.42	0.33	8.03	2.60	0	0	17.38			
	Total Number of Waterbodies	6	1	8	4	0	0	19			
	With Riparian Forest	6	1	8	3	0	0	18	40	4	44
	No Riparian Forest	0	0	0	1	0	0	1	0	1	1
Olalla Creek-Lookingglass Creek (HUC 1710030212)	Area (acres) of Riparian Forest	2.90	0.06	2.36	0.00	0	0	5.32			
	Total Number of Waterbodies	4	0	13	1	0	0	18			
	With Riparian Forest	4	0	8	0	0	0	12	32	0	32
	No Riparian Forest	0	0	5	1	0	0	6	10	1	11
Clark Branch-South Umpqua River (HUC 1710030211)	Area (acres) of Riparian Forest	2.06	0	1.17	3.53	0	0	6.76			
	Total Number of Waterbodies	7	0	6	12	0	0	25			
	With Riparian Forest	4	0	4	7	0	0	15	24	7	31
	No Riparian Forest	3	0	2	5	0	0	10	10	5	15
Myrtle Creek (HUC 1710030210)	Area (acres) of Riparian Forest	5.49	0	4.30	1.54	0	0	11.33			
	Total Number of Waterbodies	7	0	7	2	0	0	16			

TABLE 3.5.4-42

Proposed Application of Large Woody Debris to Waterbodies and Riparian Zones Affected by Construction of the Pipeline within the Range of Oregon Coast Coho Salmon

Fifth-Field Watershed	**Watershed Parameter**	**Waterbody Type**						**Total in Watershed**	**Pieces of LWD Applied to Fifth-Field Watershed a/**		
		Perennial		**Intermittent**		**Unknown**					
		Crossed	**Adjacent**	**Crossed**	**Adjacent**	**Crossed**	**Adjacent**		**Crossed**	**Adjacent**	**Total**
	With Riparian Forest	7	0	5	2	0	0	14	38	2	40
	No Riparian Forest	0	0	2	0	0	0	2	4	0	4
Days Creek-South Umpqua River (HUC 1710030205)	Area (acres) of Riparian Forest	5.47	0	6.66	0.95	0	0	13.08			
	Total Number of Waterbodies	6	0	8	1	0	0	15			
	With Riparian Forest	6	0	8	0	0	0	14	40	0	40
	No Riparian Forest	0	0	0	1	0	0	1	0	1	1
Upper Cow Creek (HUC 1710030206)	Area (acres) of Riparian Forest	2.98	0.39	2.06	1.54	0	0	6.97	6.97		
	Total Number of Waterbodies	3	1	2	2	0	0	8			
	With Riparian Forest	3	1	2	2	0	0	8	16	3	19
	No Riparian Forest	0	0	0	0	0	0	0	0	0	0
Total Fifth-Field Watersheds For Oregon Coast Coho	Area (acres) of Riparian Forest	37.59	1.87	35.89	37.75	0	0	113.09			
	Total Number of Waterbodies	50	6	56	67	0	0	152			
	With Riparian Forest	45	5	46	52	0	0	148	272	57	329
	No Riparian Forest	5	1	10	15	0	0	31	30	16	46
								Total LWD	**302**	**73**	**375**

a/ Proposed schedule for applying LWD to different waterbody types, subject to landowner approval:
4 pieces for each perennial stream crossed with riparian forest removed (2 pieces in-stream, 2 pieces within riparian zone on the bank);
2 pieces for each intermittent stream and unknown stream crossed with riparian forest removed (one or both pieces placed in-stream or on bank);
2 pieces for each perennial, intermittent, and unknown stream crossed but with no riparian forest removed (one or both pieces paced in-stream or on bank).
1 piece each for perennial, intermittent, and unknown stream not crossed but adjacent to ROW with or without riparian forest removed (piece placed on bank).

PCGP anticipates that during construction, in some cases, the waterbody size, landowner restrictions, or construction constraints would limit LWD placement according to the proposed LWD schedule provided in table 3.5.4-42. Further, the overall benefit of installation of LWD at some waterbody crossings (i.e., intermittent headwater streams) may not warrant LWD placement. In these situations, PCGP's EI would record the uninstalled LWD as a deficit during construction. After construction is completed, unutilized LWD would be provided to local watershed conservation organizations or agencies for use in local enhancement projects within the affected watersheds. (Also see the discussion on the use of LWD for mitigation in appendix O.)

Stream Crossing Monitoring

PCGP's Stream Crossing Risk Analysis (GeoEngineers 2017d, 2017e, and 2018a) and appendix O.2 to PCGP's Resource Report 2) provides site-specific BMPs to restore streambed and banks for long-term stability and to restore aquatic habitat. This Risk Analysis also provides a stream crossing monitoring plan to ensure long-term success of stream restoration, maintenance of fish passage, and identification of channel erosion, scour or migration that could destabilize the site or expose the pipeline. Streambank revegetation measures are outlined in the ECRP (see appendix F). Appropriate restoration BMPs, outlined in the Site-Specific Stream Crossing Prescriptions for the Perennial Streams on BLM and National Forest lands (North State Resources 2014), would also be incorporated during construction and restoration in consultation with the agency's authorized representative and PCGP's EI or authorized representative. The monitoring plan is described in the section on Streambank Erosion and Streambed Stability, above.

3.5.4.5 Determination of Effects

Species

The Project **may affect** coho salmon in the Oregon Coast ESU because:

- several life stages and activities of coho salmon (upstream adult migration, juvenile fry rearing, and juvenile smolt out-migration) are expected to occur at various locations in the riverine analysis area during construction and operation of the proposed action;
- several life stages and activities of coho salmon (juveniles, adults) are expected to occur within the estuarine analysis area during construction and operation of the proposed action; and
- adult and juvenile coho salmon are expected to occur within the marine analysis area during operation of the proposed action.

While several project actions are not likely to cause adverse effects, those Project components that are **likely to adversely affect** coho salmon in the Oregon Coast ESU include those listed below.

- Short-term increase in noise associated with MOF land-based pile driving and in-water pile driving at various temporary construction activities throughout the bay may cause disturbance and physical injury to Oregon Coast coho if they are in proximity to the noise during construction.

- Some juvenile coho may be subject to localized entrainment by capital dredging associated with the access channel and Navigation Reliability Improvements, which will be further assessed under subsequent regulatory consultations during the project operations phase.
- Local, short-term increases in suspended sediment in Coos Bay from in-water construction, particularly during dredging, may result in behavioral effects on rearing coho salmon juveniles with physiological consequences that may affect growth and surviva.l
- Short-term effects to the benthic community and potential food resources for Oregon Coast coho would result from dredging the proposed access channel and Navigational Reliability Improvements in Coos Bay.
- Even though most juvenile coho would be of sufficient size and swimming ability to avoid the LNG carrier cooling water intake, a limited number could be entrained during spring and summer while they rear in Coos Bay concurrent with carrier loading operations.
- TSS could adversely affect juvenile coho salmon. Exposure of juvenile fry to TSS concentrations during dry open-cut construction (fluming or dam-and-pump) from 2 to 6 hours could potentially exceed SEV5 for an estimated 264 to 615 m or more downstream in some watersheds. Such an effect could cause a minor physiological stress (increased coughing rate and/or increased respiration rate).
- Individual coho salmon may be directly affected by local restoration activities at the Kentuck Project due to short-term construction-related increases in turbidity, in-water work and isolation measures.
- If a failure occurs while dry open-cut construction is underway, there could be possible adverse effects to juvenile coho (SEV of 7 or 8) including moderate habitat degradation and impaired homing by fish or major physiological stress to fish. The most likely effect could include moderate habitat degradation, impaired homing by fish, and moderate to major physiological stress, but in very limited areas may include reduced growth and reduced fish density.
- Construction requiring blasting at 22 streams that are known or assumed to support coho could cause mortality to fish by rupturing swim bladders. Adult and juvenile coho salmon would be removed and/or prevented from being within 50 feet of blasting sites to the maximum extent possible.
- Fish salvage would occur within isolated construction sites, possibly when adult and juvenile coho salmon are present. Coho salmon are considered vulnerable to electrofishing, subject to injury and mortality. Seining, electrofishing, and handling may adversely affect Oregon Coast coho salmon. A worst case estimate of 963 juvenile coho could potentially be salvaged from streams crossed by dry open-cut procedures
- Lack of LWD is a limiting factor in most streams within range of Oregon Coast coho salmon. Removal of mid-seral riparian forest (40 to 80 years old) would have long-term effects to recruitment of LWD and removal of LSOG forest (≥80 years old) would have permanent effects to recruitment of LWD because planted conifers would not attain those age classes within the 50-year life of the Project.

Critical Habitat

The Project **may affect** designated critical habitat for coho salmon in the marine analysis area, within the estuarine analysis area, and within the riverine analysis area for the Oregon Coast ESU because:

- actions associated with construction and operation of the LNG Terminal and access channel and slip would occur within designated critical habitat; and
- the Pipeline crosses designated critical habitat within Coos Bay and riverine waterbodies of the Coos, Coquille, and South Umpqua Subbasins.

Project components are **likely to adversely affect** designated critical habitat for coho salmon in the Oregon Coast ESU because:

- localized, short-term effects to the benthic community and potential food resources for Oregon Coast coho would be result from dredging the proposed access channel and Navigation Reliability Improvements in Coos Bay;
- TSS concentrations generated during dry open-cut construction and if failure of isolation structures occur, would adversely affect freshwater habitats by changing coho habitat preferences (SEV = 3) or causing moderate habitat degradations (SEV = 7 or 8);
- food resources would potentially be affected over the short-term by dry open-cut and diverted open-cut construction methods that would remove substrate and benthos at crossing sites and produce turbidity downstream in all streams likely to support Oregon Coast coho salmon;
- approximately 201 acres of riparian zone habitat associated with waterbodies within range of Oregon Coast coho ESU would be directly affected by all construction-related activities. Adverse effects to riparian zones would be mid- to long-term or permanent depending on whether mid-seral riparian forests (46 acres) or LSOG riparian forests (17 acres) are removed; and
- a failure of crossing isolation structures lasting up to 6 hours could cause a SEV score of 7 (moderate habitat degradation) or higher for at least 542 meters downstream from dry open cut crossings within seven streams with critical habitat in the Coos Bay Frontal-Pacific Ocean watershed; 1,185 meters of three streams crossed by dry open-cut with critical habitat within the North Fork Coquille River watershed; 1,999 meters of two streams crossed by dry open-cut with critical habitat within the East Fork Coquille River watershed; 1,534 meters of two streams crossed by dry open-cut with critical habitat within the Olalla Creek-Lookingglass Creek watershed; 856 meters of four streams crossed by dry open-cut with critical habitat within the Clark Branch-South Umpqua River watershed; 1,544 meters of three streams crossed by dry open-cut with critical habitat within the Myrtle Creek watershed; and 16 meters of four streams crossed by dry open-cut with critical habitat within the Days Creek-South Umpqua River watershed.

3.5.5 Lost River Sucker

3.5.5.1 Species Account and Critical Habitat

Status

The Lost River sucker was listed as a federally endangered species on July 18, 1988 (FWS 1988). The Lost River sucker was listed as endangered because of the loss of habitat and access to historical range, resulting in a declining population. A five-year review was released in August 2013 recommending no change to the current listing status as endangered.(FWS 2013k).

Threats

Lost River suckers and shortnose suckers were considered together in the final rule listing both as endangered species. Numerous factors in both species' decline were cited by FWS (1988) including historical over-fishing, dams limiting upstream movements and access to spawning habitats, introduction of non-native species that compete (fathead minnows) and prey on suckers (yellow perch, bullheads, largemouth bass, and various lepomid sunfish), and degradation of water quality due to livestock grazing, agriculture, and timber harvest. Pollution in Upper Klamath Lake has led to algal blooms with increased mortality of suckers when oxygen depletions occur due to eutrophication. Status assessments conducted in 2001 and 2002 (FWS 2002a) concluded that the Lost River sucker was threatened by the following: 1) drastically reduced adult populations and reduction in range; 2) extensive habitat loss, degradation, and fragmentation; 3) small or isolated adult populations as a result of dams; 4) poor water quality; 5) lack of sufficient recruitment; 6) entrainment into irrigation and hydropower diversions; 7) hybridization with the other native Klamath sucker species; 8) potential competition with introduced exotic fishes; and 9) lack of regulatory protection.

Many of these same issues remained as factors threatening the species' recovery in 2013 (FWS 2013k). Regulatory protection of aquatic habitats inhabited by Lost River suckers has improved with implementation of various state (Oregon and California) and federal laws that minimize effects of actions on the species and habitat during project planning and consultation. However, Lost River suckers continue to be affected by adverse water quality, habitat degradation, toxicity from blue-green algae, and entrainment into irrigation and hydropower diversions. Added to the earlier threats listed is climate change which is predicted to increase flows during winter months but decrease flows during the spawning period, from March or mid-April through May (FWS 2013k).

Two recent significant habitat improvements have been the removal of the Chiloquin Dam and restoration and reconnection of the Williamson River Delta. Additionally, about 400 habitat restoration projects have been completed or are planned for the Upper Klamath Lake Basin. The Lost River sucker has been observed using the 6,000-acre habitat area of Williamson River Delta to Upper Klamath Lake suggesting the importance of this habitat improvement for the species. Because these efforts are so recent, population-level effects have not yet been observed. However, these actions and others are believed to be significant for the improved status of this species (FWS 2013k). Nevertheless, poor water quality in Upper Klamath Lake and the Lost River continues to threaten the viability of the species. The water quality issues are most pronounced during summers when high temperatures combined with nutrient loading from pumping diked wetlands and runoff from farms, roads, and other sources cause detrimental water quality for fish. Also, lake sediments create hypereutrophic conditions which lead to depletions of dissolved oxygen and fish die-offs (FWS 2007e and 2013k). A cyanobacterium, now present in Upper Klamath Lake, undergoes massive algal blooms; photosynthesis during daylight can supersaturate water with dissolved oxygen and respiration at night can deplete dissolved oxygen with both events deleterious to Lost River suckers (FWS 2013k). Blue-green algal or cyanobacter toxins (Microcystin) have recently been found to affect liver, intestines, kidneys, heart, spleen and gills of suckers (FWS 2013k).

Population levels were estimated to be 11,000 to 23,000 at the time of listing (FWS 2013k). This was considered a substantial decline from historic levels, but these and historic estimates may not be completely accurate (FWS 2007e and 2013k). The factors contributing to the decline include the following: habitat loss of approximately 77 percent of historic range, restricted access to spawning habitat, overharvest, and increased rates of mortality resulting from entrainment in water management structures and severely impaired water quality (FWS 2007e and 2013k). All known populations across the range of current distribution have chronically low recruitment, reduced survivorship of adult fish, and reduced age-class diversity (FWS 2013k). Length-frequency analysis suggests that the last substantial recruitment to the spawning population occurred during the late 1990s (FWS 2012f). Recent additional threats to both Lost River and shortnose sucker include climate change that contributes to changes in water flow, bird predation, algal toxins and various forms of parasitism (NMFS and FWS 2013, FWS 2013k).

Species Recovery

A recovery plan for Lost River sucker and short-nose sucker was finalized on March 17, 1993 (FWS 1993b). Since then, additional information, prompted revision of the recovery plan (FWS 2012f). The recovery program goal is to stop the population decline and enhance Lost River sucker and shortnose sucker populations so that ESA protection is no longer necessary. Actions described in the recovery plan that would aid in the delisting of the Lost River sucker include improving habitat conditions through rehabilitating riparian areas and improving land management practices in the Klamath Basin watershed, developing and achieving water quality and quantity goals, and improving fish passage, spawning habitat, and other habitat conditions. Compounding effects from drought and water diversions affect lake water levels and unscreened water diversions and fish entrainment continue as threats. Substantial entrainment occurs at the river gates of the Link River Dam (FWS 2013k). Some of the suckers that pass through the gates pass downstream to the Keno Reservoir and farther along the Klamath River where they cannot return upstream. Nevertheless, there is a small population inhabiting Lake Ewauna, probably fish that survived passage through the Link River Dam and other hydroelectric canals and turbines (FWS 2013k).

Adult populations are limited by extremely low recruitment as well as by high levels of stress and mortality associated with severely impaired water quality. As a whole the species is potentially limited by the lack of habitat connectivity (FWS 2012f). However, one of the main passage barriers that reduced access to 95 percent of its river spawning habitat, the Chiloquin Dam on the Sprague River, was removed in 2008 (NMFS and FWS 2013).

Demographic-based objectives include increasing larval production, individual survival and recruitment to spawning populations, and ultimately increasing abundance in spawning populations. The objectives of restoring spawning and nursery habitat, expanding reproduction, reducing the negative impacts from water quality on all life stages, clarifying the effects of other species on all life stages, reducing entrainment, and establishing auxiliary populations comprise the threats-based objectives. The recovery strategy is intended to produce and document healthy, self-sustaining populations by reducing mortality, restoring habitat (including spawning, larval and juvenile habitats), and increasing connectivity between spawning and rearing habitats. It also involves ameliorating adverse effects of degraded water quality, disease, and non-native fish. The plan provides areas of emphasis and guidelines to direct recovery actions (FWS 2012f).

There are two recovery units for Lost River suckers, the Upper Klamath Lake Unit and Lost River Basin Unit (FWS 2012f). Upper Klamath Lake Unit includes all Lost River suckers within the lake, tributaries to Upper Klamath Lake, and reservoirs within the Klamath River including Keno Reservoir and populations below Keno Reservoir. The Lost River Basin Unit includes Clear Lake Reservoir and tributaries including Willow Creek and Boles Creek, Tule Lake, Gerber Reservoir and tributaries, and the Lost River mainstem (FWS 2012f) even though the Lost River is not included in designated critical habitat. The Lost River proper includes individual suckers in the mainstem downstream from the Clear Lake Dam to Anderson-Rose Diversion Dam, including the Lost River tributary Miller Creek, downstream from Gerber Dam. The population in the Lost River drainage below Clear Lake Dam is comprised mostly of adults (FWS 2012f).

Life History, Habitat Requirements, and Distribution

Lost River suckers are native to the Lost River and Upper Klamath River Basin but have adapted to lake habitats and are now a lake-dwelling fish that migrates into streams to spawn (Moyle 2002). It is a long-lived species, reaching ages over 30 years. Historically, Lost River suckers were found in the Lost River watershed, Tule Lake, Lower Klamath Lake, and Sheepy Lake. The present distribution of the Lost River sucker includes Upper Klamath Lake and its tributaries, Clear Lake Reservoir and its tributaries, Tule Lake and the Lost River up to Anderson-Rose Diversion Dam, the Klamath River downstream to Copco Reservoir, and probably Iron Gate Reservoir. In the Upper Klamath Lake watershed, the Lost River sucker spawning runs are primarily limited to Sucker Springs in Upper Klamath Lake and the Sprague and Williamson Rivers. Spawning runs also occur in the Wood River and in Crooked Creek (in the Upper Klamath Lake watershed). An additional run may occur in Sheepy Lake in the Lower Klamath Lake watershed and spawning has been documented in the Clear Lake watershed (FWS 1988 and 1993b).

Although sucker spawning habitat in the Lost River is very limited, Reclamation (Reclamation 2007) has documented sucker spawning below Anderson-Rose Diversion Dam, in Big Springs near Bonanza, and at the terminal end of the West Canal as it spills into the Lost River. Suitable spawning habitats with riffle areas and rocky substrates include the spillway area below Malone Dam, immediately upstream of Keller Bridge, immediately below Big Springs in the Lost River, below Harpold Dam, and adjacent to Station 48 (Reclamation 2007). Suckers are primarily bottom dwellers, remaining within 1 foot of bottom substrates. Water depths and turbidity provide cover in lakes while pools and overhanging banks provide cover features in streams. In Tule Lake, most depths are less than 1 meter and adult suckers are confined to the few locations where depths exceed 1 meter (Reclamation 2007). During periods of deteriorating water quality, especially in Upper Klamath Lake, adult suckers may utilize shallow waters with suitable water quality even though they may be more vulnerable to predators (Reclamation 2007).

Most spawning by Lost River suckers lasts from late February to early June in the larger tributaries of inhabited lakes (FWS 2007e). River spawning habitats include riffles or runs with gravel or cobble substrate, with moderate flows, and in water 8 to 50 inches deep. Some Lost River suckers have been noted to spawn in lakes, particularly at springs occurring along the shorelines (FWS 2007e). Each Lost River sucker female may produce between 44,000 and 236,000 eggs in a single spawning season; larger, older females produce more eggs and contribute more to recruitment than younger females (Reclamation 2007).

Larval Lost River suckers are present in Upper Klamath Lake from the beginning of May through mid-July. During that period, larvae utilize protective emergent vegetation along lake shorelines which provides cover from predators, currents, and turbulence and are areas of concentrated prey including zooplankton, macroinvertebrates, and periphyton (Reclamation 2007). Similar relationships within the Lost River watershed, including Tule Lake and Lost River, have not been studied but are assumed to be similar to those in Upper Klamath Lake (Reclamation 2007).

By mid-summer larval suckers have become juveniles, which, in Upper Klamath Lake, tend to occupy shoreline habitats less than 4 feet deep with and without emergent vegetation and/or shoreline vegetation. Abundance of juvenile suckers in the lake declines dramatically during late summer and early autumn. Some of the decline is due to emigration of juveniles into the Link River and parallel canals at the outlet of Upper Klamath Lake (Reclamation 2007). Adult suckers (and presumably subadults) in Upper Klamath Lake tend to inhabit deeper (>1 meter) waters in the northern half of the lake (Reclamation 2007). But, when water quality deteriorates in the north end of the lake during mid-summer with lower concentrations of dissolved oxygen, adult Lost River and shortnose suckers migrate to relatively shallow waters in Pelican Bay along the west shore (Reclamation 2007). Similar seasonal movements have not been described for suckers inhabiting Tule Lake and the Lost River although reproduction has been documented in Tule Lake and is suspected to occur in the Lost River.

In the Upper Klamath Subbasin (HUC 18010206), Lost River suckers are found in the Klamath River as far downstream as Copco Reservoir (RM 199) and possibly Iron Gate Reservoir (RM 191). The Pipeline would cross the Klamath River at RM 249. In the Lost Subbasin (HUC 18010204), Lost River suckers are found in the Lost River mainstem and Clear Lake Reservoir (Moyle 2002). In the Pipeline project vicinity, Lost River suckers spawn in the Lost River and are present in John C. Boyle Reservoir at RM 225, downstream from the Pipeline crossing (NRC 2004). In addition to collections of Lost River suckers in J.C. Boyle Reservoir, ORBIC (2017c) cites records of collections in Lake Ewauna and in the Lost River Diversion Channel connecting the Klamath River (at RM 249.8) to the Lost River at the Lost River Diversion Dam, approximately 10 river miles downstream from the pipeline crossing of the Lost River at RM 9.5.

Historically, Lost River suckers migrated in the Lost River upstream from Tule Lake (in California) to spawn near Olene and Big Springs near Bonanza (in Oregon), but Anderson-Rose Diversion Dam now blocks the migration. Lost River suckers presently occur within Tule Lake, but the population in the Lost River drainage below Clear Lake Dam is comprised mostly of adults and the Lost River functions as a population sink with no likely chance of being self-sustaining because of low recruitment and lack of access to spawning habitats (FWS 2012f). In the early 1990s, Lost River suckers were reported spawning over cobbles in the Lost River below Anderson-Rose Diversion Dam (RM 17.4) south of Merrill, Oregon and approximately 7.6 river miles downstream from the pipeline crossing of the Lost River (ORBIC 2017c). Suckers also spawn below Malone Dam, downstream from Clear Lake, also in California.

Population Status

The Lost River sucker population in Upper Klamath Lake was estimated between 11,000 and 23,000 at the time of the Final Rule listing the species as endangered (FWS 1988). That estimate was probably inaccurate although adults in Upper Klamath Lake and Clear Lake (in California) probably numbered in the tens of thousands (FWS 2007e). There had been several die-offs during the 1990s which affected the spawning population of older adults in Upper Klamath Lake. More recent information indicates possible increased recruitment of males and females with only slight population growth in the portion of the population normally spawning along the lakeshore of Upper Klamath Lake and low recruitment continues as a major concern (FWS 2007e). Limited information indicates declines of large adult suckers in Clear Lake (FWS 2007e). Lost River suckers are known to be present in J.C. Boyle Reservoir, Copco Reservoir, and Iron Gate Reservoir but reproduction in any of the reservoirs is unknown and they are not abundant in any of the three reservoirs (Reclamation 2007).

In the past, the Lost River was probably important spawning habitat for Lost River suckers migrating upstream from Tule Lake. Now, Lost River is highly modified, used primarily for distributing irrigation water, and impaired by surface runoff and agricultural drainage (Reclamation 2007). For several years there was no indication that Lost River or shortnose suckers continued to inhabit Tule Lake, but in 1991 both species were observed spawning below Anderson-Rose Diversion Dam, and sampling at Tule Lake in the early 1990s determined that small populations of both species were present (Reclamation 2007). Lost River sucker spring-spawning abundance in 2007 was estimated to be 56 percent and 75 percent of 2002 abundances for males and females respectively (FWS 2012f). Tagging studies conducted on Lost River suckers and shortnose suckers in Gerber Reservoir and Clear Lake Reservoir (both impoundments are connected to the Lost River below Gerber Dam and Clear Lake Dam, respectively) indicate that numbers of large adult suckers of both species have declined since 2000. Declines in large adult Lost River suckers have been particularly pronounced in Clear Lake Reservoir, possibly due to poor recruitment from younger age classes prior to 2000 (Barry et al. 2009).

Hewitt et al. (2015) estimated λ and other population demographic properties for the adult spawning population of Lost River suckers in Upper Klamath Lake from 2001 to 2012 (figure 3.5.5-1). In the figure, the population rate of change ($\lambda = N_{t+1} / N_t$) indicates positive or negative growth. When $\lambda > 1$, the rate of change is positive and the population (N) has grown from N_t to N_{t+1} in the next time interval. Alternatively, the population is stable when $\lambda = 1$, but when $\lambda < 1$, the population has declined from N_t to $N_{t+1.}$ The data show a declining adult spawning population but do not indicate changes in the whole population because they do not account for changes in the numbers of juveniles from year to year. With additional demographic data, Hewitt et al. (2015) concluded that the spawning population in the Upper Klamath Lake consisted "almost entirely of similarly sized individuals growing through time, with little evidence of recruitment."

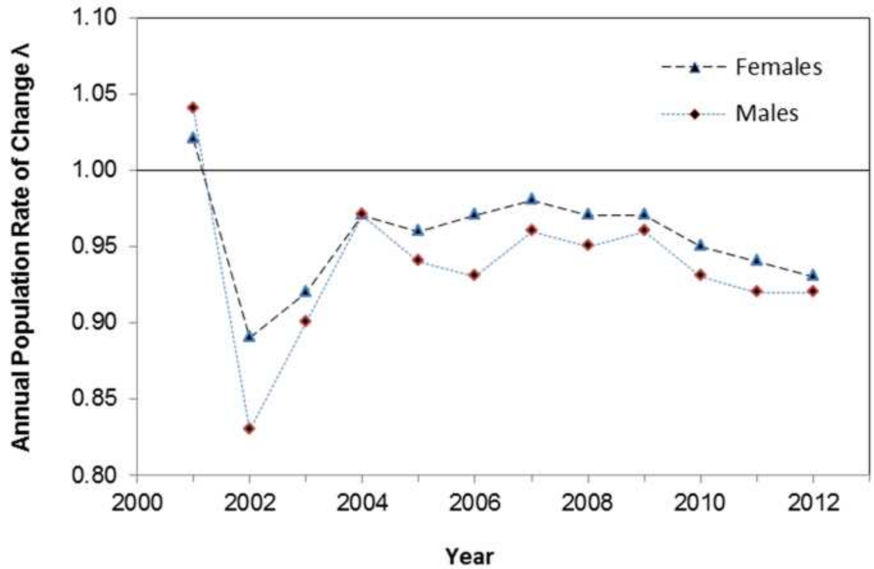

Figure 3.5.5-1. Estimates of Annual Population Rate of Change (λ) for Lost River Suckers from the Lakeshore Spawning Subpopulation, Upper Klamath Lake, Oregon. The Population is declining when λ < 1 (data from Hewitt et al. 2015).

Critical Habitat

Critical habitat for Lost River and shortnose suckers was designated in 2012 (FWS 2012g). Along the route of the Pipeline, designated critical habitat for Lost River and shortnose sucker (Unit 1 in Klamath County) includes the Link River, Lake Ewauna, and Klamath River downstream to Keno. Unit 2, in Klamath and Lake Counties, Oregon and Modoc County, California, includes Clear Lake Reservoir and tributaries and Gerber Reservoir and tributaries but does not include the Tule Lake and its tributary, the Lost River. For reasons described above (blockage by Anderson-Rose Diversion Dam), neither Tule Lake or Lost River provides spawning habitats or supports viable self-sustaining populations of Lost River suckers or shortnose suckers (FWS 2012g). The Pipeline does not coincide with critical habitat in Unit 2.

In Unit 1 (Upper Klamath Lake), there are 13 miles of critical habitat on federal land, less than 1 mile on state land, and 106 miles on lands of private/other ownership. In Unit 2 (Lost River Basin), there are 23 miles of critical habitat on federal land, less than 1 mile on state land, and 3 miles on lands of private/other ownership (FWS 2012g).

PCEs of critical habitat include (FWS 2012g):

1. **Water**. Areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity. Water must have varied depths to accommodate each life stage: Shallow water (up to 3.28 feet [1.0 meter]) for larval life stage and deeper water (up to 14.8 feet [4.5 meters]) for older life stages. The water quality characteristics should include water temperatures of less than 82.4°F (28.0°C); pH less than 9.75; dissolved oxygen levels greater than 4.0 mg/l; low levels of microcystin;

and un-ionized ammonia (less than 0.5 mg/l). Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph.

2. **Spawning and rearing habitat**. Streams and shoreline springs with gravel and cobble substrate at depths typically less than 4.3 feet (1.3 meters) with adequate stream velocity to allow spawning to occur. Areas containing emergent vegetation adjacent to open water provide habitat for rearing and facilitate growth and survival of suckers as well as protection from predation and protection from currents and turbulence.
3. **Food**. Areas that contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates.

3.5.5.2 Environmental Baseline

Analysis Area

For Lost River suckers, the riverine analysis area is limited to fresh waterbodies within the Upper Klamath Subbasin (HUC 18010206; see figure 3.5.5-2A) and Lost Subbasin (HUC 18010204; see figure 3.5.5-2B). The riverine analysis area includes two components: 1) the water column and substrate of all waterbodies crossed by the Pipeline from the point of crossing to the extent downstream where water quality is adversely affected by turbidity generated during construction and sediment generated by runoff from the construction right-of-way, and 2) waterbodies' associated riparian zones affected in the short-term during construction and in the long-term by operation. The riverine analysis area for the Lost River sucker includes two perennial flowing river crossings (Klamath River and Lost River) which likely have Lost River suckers present at the time of constructions. In addition to the two perennial waterbodies, the Pipeline would also cross 83 intermittent streams, ditches and canals; 23 additional intermittent streams, ditches, ponds and canals would be adjacent to the Pipeline, within the construction right-of-way but not crossed. There is no information to indicate that Lost River suckers occur in any of these intermittent waterbodies but they are included in the riverine analysis area for Lost River suckers.

Species Presence

The Lost River sucker has been documented within the Klamath River from Klamath Falls to Keno Reservoir (FWS 2013k). The Pipeline would cross the Klamath River at RM 249. The Lost River sucker is also known to be present from Tule Lake Sump and Clear Lake Reservoir in northern California, which are connected by the Lost River. Tule Lake Sump is at the lower terminus of the Lost River and the population in Tule Lake is isolated from upstream spawning areas by multiple dams including blockage by the Anderson-Rose Diversion Dam.

Historically, Tule Lake supported large populations of Lost River suckers but much of the historical lake bed area has been drained and transformed to agriculture and portions were engineered to receive high runoff flows from the Klamath River via the Lost River Diversion Channel and Lost River (Hodge and Buettner 2009). Dams constructed on the Lost River, including the Lost River Diversion Dam, Anderson-Rose Diversion Dam, Malone Dam, and Harpold Dam have blocked suckers from accessing spawning areas upstream in the Lost River.

Currently, Lost River sucker spawning migrations are limited from Tule Lake to the Lost River below the Anderson-Rose Diversion Dam. Lost River suckers migrate a short distance from Tule Lake to spawn in the Lost River below Anderson-Rose Diversion Dam (RM 17.4) south of

Merrill and approximately 7.6 river miles from the Pipeline crossing of the Lost River (ORBIC 2017b). As of 2006, Lost River suckers had not been detected in the Lost River from the Lost River Diversion Dam to Anderson-Rose Diversion Dam, a reach that coincides with the proposed crossing of the Lost River (FWS 2013k). Lost River suckers continue to occupy the Lost River below Anderson-Rose Diversion Dam to Tule Lake.

Very little water flows in the Lost River below the Lost River Diversion Dam except during the winter and early spring. During the irrigation season, all flows are diverted at Anderson-Rose Diversion Dam into the J-Canal for irrigation deliveries to the Tule Lake Irrigation District (Hodge and Buettner 2009). From 2006 to 2008, FWS and Reclamation placed gravels below the Anderson-Rose Diversion Dam and released flows from mid-April to early June to entice suckers to migrate from Tule Lake and spawn in the lower Lost River. Lost River suckers and shortnose suckers sporadically spawned in the graveled riffle area below the Anderson-Rose Diversion Dam and sucker larvae were documented in the Lost River during 2006 although they may have derived from Upper Klamath Lake, the Upper Lost River, and/or Clear Lake Reservoir. Reclamation salvages suckers from J-Canal, which drains into Tule Lake, suggesting that some entrained fish move into Tule Lake (Hodge and Buettner 2009).

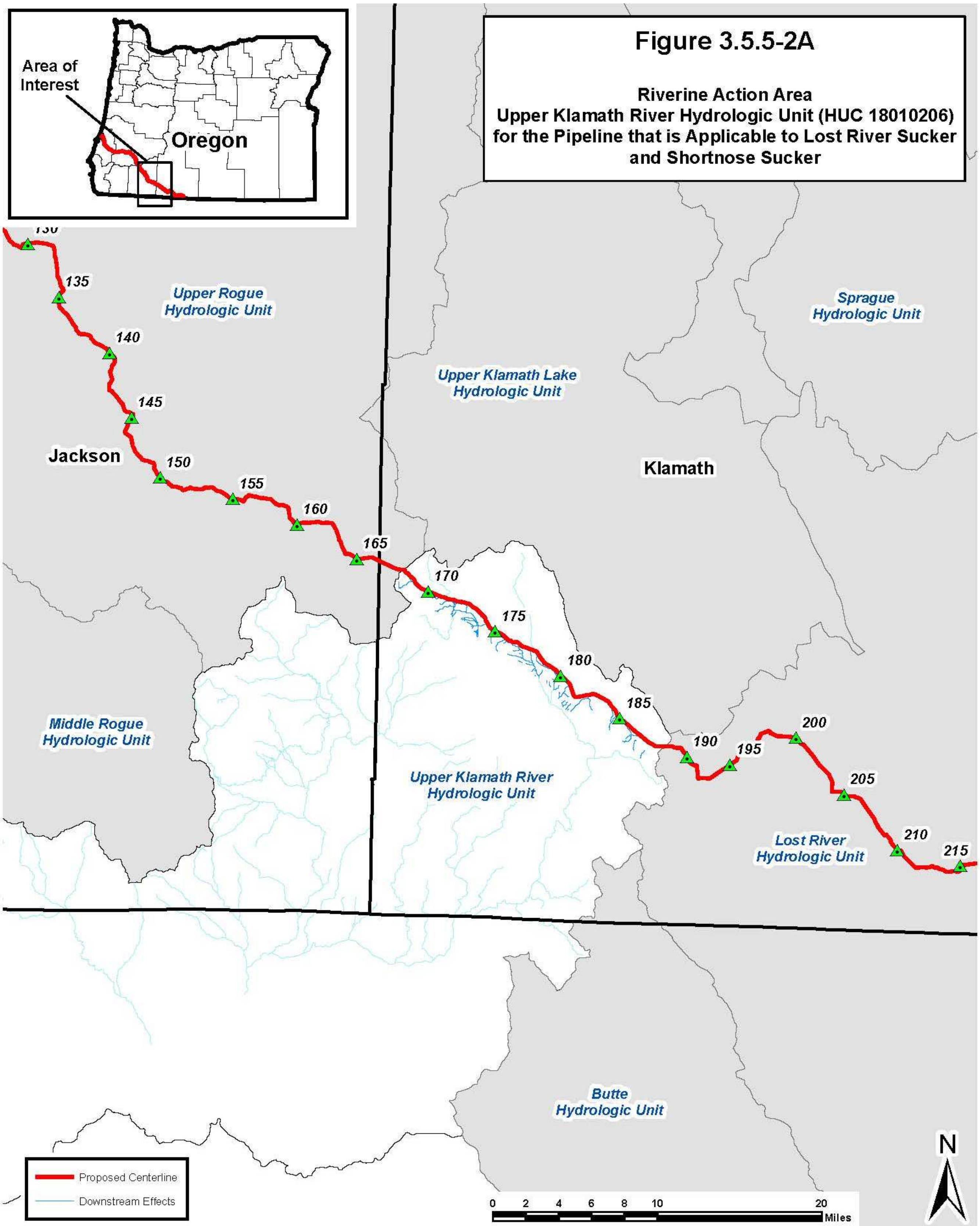
Figure 3.5.5-2A
Riverine Action Area
Upper Klamath River Hydrologic Unit (HUC 18010206)
for the Pipeline that is Applicable to Lost River Sucker
and Shortnose Sucker
Area of Interest
Oregon
Upper Rogue Hydrologic Unit
Upper Klamath Lake Hydrologic Unit
Sprague Hydrologic Unit
Jackson
Klamath
Middle Rogue Hydrologic Unit
Upper Klamath River Hydrologic Unit
Lost River Hydrologic Unit
Butte Hydrologic Unit
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
Proposed Centerline
Downstream Effects
0 2 4 6 8 10 20
Miles
N

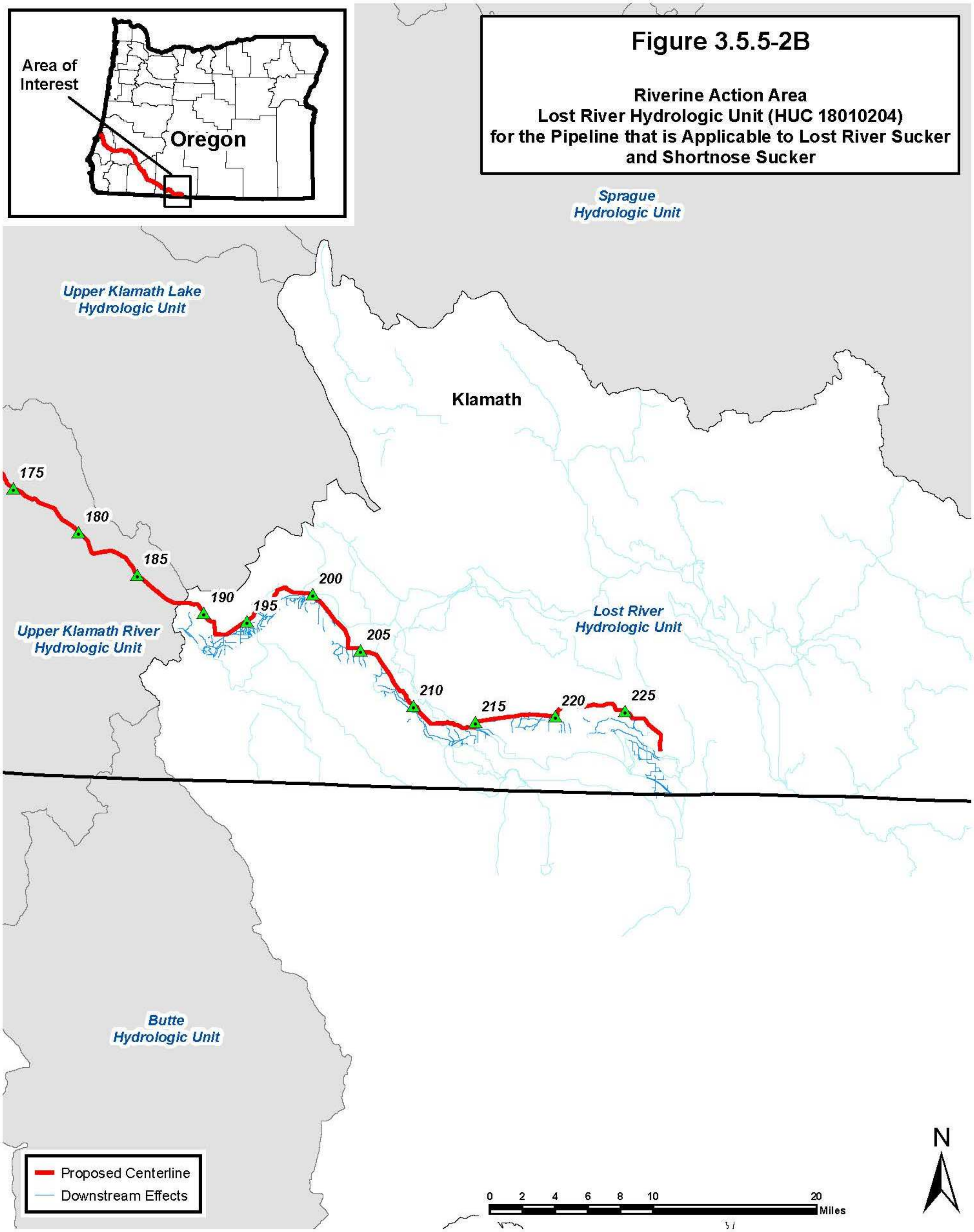

Figure 3.5.5-2B
Riverine Action Area
Lost River Hydrologic Unit (HUC 18010204)
for the Pipeline that is Applicable to Lost River Sucker
and Shortnose Sucker
Area of Interest
Oregon
Sprague Hydrologic Unit
Upper Klamath Lake Hydrologic Unit
Klamath
Upper Klamath River Hydrologic Unit
Lost River Hydrologic Unit
Butte Hydrologic Unit
175
180
185
190
195
200
205
210
215
220
225
Proposed Centerline
Downstream Effects
0 2 4 6 8 10 20 Miles
N

Tagged Lost River suckers spawning in the lower Lost River peaked from late April to mid-May and from late May to early June (Hodge and Buettner 2009). Most of the suckers that migrated into the Lost River from Tule Lake moved to below the Anderson-Rose Diversion Dam and spawn there. Larval suckers were present from May 30 to July 22, 2008. The population of Lost River suckers in Tule Lake Sump is probably in the low thousands of individuals which is higher than documented in the early 1990s (Hodge and Buettner 2009). Currently, Tule Lake functions only as a sink for Lost River sucker populations (FWS 2012g).

Regular spawning occurs in the Upper Klamath Lake and in Clear Lake Reservoir. Recruitment is low for the spawning population in Upper Klamath Lake. Clear Lake Reservoir, in California, supports a sustaining population of Lost River suckers that is critical to the species' recovery (FWS 2012f; Barry et al. 2009). Growth rates for adult Lost River suckers are greater in Clear Lake Reservoir than in Upper Klamath Lake, possibly due to younger individuals present in Clear Lake (Barry et al. 2009). Suckers spawn in Willow Creek, a tributary to Clear Lake Reservoir, during February and March when water temperatures range from 4^{o}C to 12^{o}C and larva emigrate down Willow Creek into Clear Lake Reservoir from late March to mid-April (Perkins and Scoppettone 1996). There is limited evidence of a resident population of Lost River suckers in the Lost River above Malone Dam in the Langell Valley, Oregon (FWS 2012g). However, Lost River suckers are prevented from accessing historically occupied habitats in Lost River mainstem and lower Lost River from Clear Lake Reservoir by the Malone Dam.

Historically, dewatering of canals, laterals, and drains has included biological monitoring and salvage of listed species, as needed. Canals, laterals, and drains are dewatered at the end of irrigation season which includes capture and relocation (salvage) of suckers from the canal system after dewatering occurs. Nearly all canals, laterals, and drains are either dewatered after the irrigation season, before April and after October, or have the water lowered for inspection and maintenance (NMFS and FWS 2013). Canals remain dewatered until the following spring (as early as late March) except for the input of localized precipitation-generated runoff (NMFS and FWS 2013). Reclamation's fish salvage efforts focus on the A Canal forebay in front of the fish screen, C4 Canal, D1 Canal, and D3 Canal within the Klamath Irrigation District, and J Canal within the Tule Lake Irrigation District (NMFS and FWS 2013). The Pipeline would cross the C-4-E Lateral at MP 201.63, the C-4 Lateral at MP 204.12, the C-4-F Lateral at MP 204.33, and the C-4-C Lateral at MP 205.50 in the Lake Ewauna-Klamath River watershed. In addition, the Pipeline would cross the C Canal at MP 205.96 and the C-4-7 Lateral at MP 207.40 in the Mills Creek-Lost River watershed. All six canals and laterals are presumed to be associated with the C4 Canal and may be occupied by Lost River suckers prior to dewatering. The Pipeline would not cross the A Canal, D1 Canal, the D3 Canal, or the J Canal.

Past efforts have shown that salvage of suckers is practical in some locations, but numbers of salvaged suckers are highly variable among years and sites (NMFS and FWS 2013). Occurrence of Lost River suckers in canals and ditches operated and maintained by Reclamation is possible if they are crossed before dewatering begins in October. However, based on the unpredictability of Lost River sucker occurrence at any one site at any specific time, there is no way to anticipate the species' presence during Pipeline construction. All canals, laterals, and drains operated and maintained by Reclamation would be crossed using conventional bores, thus avoiding any instream construction and conflicts with Lost River suckers if present. Irrigation ditches and roadside ditches on private land would be crossed by dry open-cut construction if water is present at the time. The connectivity of those ditches with canals, laterals, and drains operated and maintained by Reclamation is unknown, but because of their small size and functions as agricultural drains, Lost River suckers are not expected to occur.

A total of 26 streams/ditches in the Lake Ewauna-Klamath River watershed and 59 streams/ditches in the Mills Creek-Lost River watershed would be crossed (85 total) by the Pipeline. The right-of-way would not cross but would be adjacent to 23 additional streams/ditches in the two watersheds. Altogether, the Pipeline would potentially affect 108 waterbodies in the range of the Lost River sucker (see table 3.5.5-1). All but the Klamath River and Lost River have intermittent flow. There are 106 intermittent streams or ditches between MPs 188.9 and 228.1; 58 of them would be crossed by dry open cutting and 25 of them would be crossed using a conventional bore (with no instream construction). Twenty-three intermittent streams/ditches/canals would not be crossed but are present within the construction right-of-way (see table 3.5.5-1). They are expected to be dry at the time of construction.

TABLE 3.5.5-1

Waterbodies Crossed or Adjacent to the Pipeline within the Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-Lost River Watershed (HUC 1801020409) in the Range of the Lost River Sucker and Shortnose Sucker

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Fishery Construction Window c/
Lake Ewauna-Upper Klamath River (HUC 1801020412) Fifth field Watershed, Klamath County						
Trib. To Klamath River (ASI-13/SS-100-025)	18010204003103 Private	188.90	Intermittent	Dry Open-Cut	None	Jul 1 to Jan 31
Irrigation Ditch (S2-07 (ADX-63 (MOD))	18010204003315 Private	192.67	Intermittent	Dry Open-Cut	Unknown	N/A
Ditch (192.81)	180102040033481 Private	192.81	Intermittent	Adjacent to centerline within ROW	None	N/A
Ditch (ADX-67)	18010204003314 Private	192.99	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-72)	Private	193.07	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-72)	Private	193.25	Intermittent	Adjacent to centerline within TEWA	None	N/A
Ditch (ADX-73)	Private	193.47	Intermittent	Adjacent to centerline within TEWA	None	N/A
Ditch (ADX-75)	Private	194.51	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-77)	Private	194.57	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (NDX-77)	Private	194.57	Intermittent	Adjacent to centerline within TEWA	None	N/A
Irrigation Ditch (WW-001-010/(ADX-78)	18010204003303 Private	194.64	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-83)	Private	195.12	Intermittent	Adjacent to centerline within ROW	None	N/A
Ditch (ADX-84)	Private	195.18	Intermittent	Adjacent to centerline within TEWA	None	N/A
Ditch (ADX-86)	Private	195.24	Intermittent	Adjacent to centerline within TEWA	None	N/A

TABLE 3.5.5-1

Waterbodies Crossed or Adjacent to the Pipeline within the Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-Lost River Watershed (HUC 1801020409) in the Range of the Lost River Sucker and Shortnose Sucker

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Fishery Construction Window c/
Irrigation Ditch (NDX-82)	Private	195.28	Intermittent	Adjacent to centerline within TEWA	None	N/A
Drainage Ditch (ADX-87)	Private	195.32	Intermittent	Adjacent to centerline within TEWA	None	N/A
Ditch (ADX-19	Private	195.46	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-22)	Private	195.46	Intermittent	Adjacent to centerline within TEWA	None	N/A
Wetland Ditch (ADX-20)	Private	195.47	Intermittent	Adjacent to centerline within ROW	None	N/A
Ditch (GDX-4)	Private	195.67	Intermittent	Dry Open-Cut	None	N/A
Ditch (GDX-3)	Private	195.73	Intermittent	Dry Open-Cut	None	N/A
Ditch (GDX-2)	Private	195.91	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-30)	Private	196.53	Intermittent	Dry Open-Cut	None	N/A
Drainage Ditch (ADX-31)	Private	196.53	Intermittent	Adjacent to centerline within ROW	None	N/A
Irrigation Canal (ADX-32)	18010204000790 Private	196.64	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-36)	Private	196.76	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-38)	18010204003183 Private	196.78	Intermittent	Dry Open-Cut	None	N/A
Weyerhaeuser Pond (AL-34)	Private	196.78	Industrial Pond	Adjacent to centerline within ROW	None	N/A
Irrigation Ditch (ADX-39)	18010204003183 Private	196.89	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-40)	Private	197.08	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (DX-GM-1)	Private	197.22	Intermittent	Adjacent to centerline within ROW	None	NA
Irrigation Ditch (DX-GM-3)	Private	197.28	Intermittent	Adjacent to centerline within ROW	None	NA
Klamath River (ASP151)	18010204002564 State	199.38	Perennial	HDD	Lost River Sucker Shortnose Sucker	Jul 1 to Jan 31
Irrigation Canal (ADX-293	Private	200.41	Intermittent	Adjacent to centerline within ROW	None	N/A
Irrigation Canal (No. 1 Drain) (ADX-294)	18010204003246 BOR	200.54	Intermittent	Bore	Unknown	N/A
Irrigation Ditch (ADX-94)	18010204003251 Private	201.49	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-96) (C-4-E Lateral)	1217823421646 BOR	201.63	Intermittent	Bore	Unknown	N/A
Roadside Ditch (ADX-99)	Private	203.97	Intermittent	Dry Open-Cut	None	N/A

TABLE 3.5.5-1

Waterbodies Crossed or Adjacent to the Pipeline within the Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-Lost River Watershed (HUC 1801020409) in the Range of the Lost River Sucker and Shortnose Sucker

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Fishery Construction Window c/
Irrigation Canal (C-4 Lateral) (ADX-100)	18010204001225 BOR	204.12	Intermittent	Bore	Unknown	N/A
Irrigation Canal (C-4-F Lateral) (ADX-101)	18010204001222 BOR	204.33	Intermittent	Bore	Unknown	N/A
Ditch (ADX-103)	Private	204.50	Intermittent	Adjacent to centerline within TEWA	None	N/A
Ditch No. 3 Drain (ADX-105)	18010204003757 BOR	204.74	Intermittent	Bore	Unknown	N/A
Irrigation Canal (ADX-106)	Private	204.91	Intermittent	Dry Open-Cut	None	N/A
Ditch (C-4-C Lateral) (ADX-109)	18010204001218 BOR	205.50	Intermittent	Bore	Unknown	N/A
Mills Creek-Lost River (HUC 1801020409) Fifth field Watershed [8], Klamath County						
Ditch (ADX-110)	Private	205.94	Intermittent	Bore	Unknown	N/A
Canal (C Canal) (ADX-111)	18010204004021 BOR	205.96	Intermittent	Bore	Unknown	N/A
Wetland Ditch (ADX-112)	18010204009070 Private	205.97	Intermittent	Bore	Unknown	N/A
Irrigation Ditch (D-2 Lateral) (ADX-113)	BOR	206.51	Intermittent	Bore	Unknown	N/A
Roadside Drainage Ditch (5-A Drain) (ADX-115)	18010204004039 BOR	207.26	Intermittent	Bore	Unknown	N/A
Irrigation Lateral (C-4-7 Lateral) (ADX-116)	18010204001229 BOR	207.40	Intermittent	Bore	Unknown	N/A
Irrigation Drain 5-A Drain (ADX-117)	18010204001237 BOR	207.42	Intermittent	Bore	Unknown	N/A
Irrigation Drain (5-A Drain) (ADX-118)	18010204001237 BOR	207.60	Intermittent	Bore	Unknown	N/A
Irrigation Drain (5-A Drain) (ADX-119)	18010204001237 BOR	207.99	Intermittent	Bore	Unknown	N/A
Irrigation Ditch (ADX-120)	Private	208.07	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-121)	Private	208.07	Intermittent	Dry Open-Cut	None	N/A
Drainage Ditch Irrigation Drain (5-A Drain) (ADX-123)	18010204001237 BOR	208.18	Intermittent	Dry Open-Cut	Unknown	N/A
Ditch (ADX-124)	Private	208.23	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-125)	Private	208.28	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-126)	Private	208.29	Intermittent	Dry Open-Cut	None	N/A
Roadside Drainage Ditch (ADX-128)	Private	208.78	Intermittent	Bored	None	N/A

TABLE 3.5.5-1

Waterbodies Crossed or Adjacent to the Pipeline within the Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-Lost River Watershed (HUC 1801020409) in the Range of the Lost River Sucker and Shortnose Sucker

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Fishery Construction Window c/
Roadside Drainage Ditch (ADX-129)	Private	208.85	Intermittent	Dry Open-Cut	None	N/A
Irrigation Drain 5-K Drain (ADX-130)	18010204001229 BOR	209.02	Intermittent	Bore	Unknown	N/A
Roadside Drainage Ditch (ADX-131)	Private	209.05	Intermittent	Bored	None	N/A
Roadside Drainage Ditch (ADX-133)	Private	209.15	Intermittent	Bore	None	N/A
Irrigation C-9 Lateral (ADX-134)	BOR	209.15	Intermittent	Bore	Unknown	N/A
Irrigation Ditch (ADX-135)	Private	209.16	Intermittent	Bore	None	N/A
Roadside Ditch (ADX-142)	Private	210.16	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (No. 5 Drain) (Trib. to Lost River) (ADX-143/ SS-003-001)	18010204004367 BOR	210.26	Intermittent	Bore	Unknown	N/A
Irrigation Ditch 5-H Drain (Trib. to Lost River) (ADX-260)	18010204015577 BOR	210.85	Intermittent	Bore	Unknown	N/A
Irrigation Ditch (ADX-261)	Private	210.87	Intermittent	Dry Open-Cut	None	N/A
Ditch (NDX-29/SS-003-002)	Private	211.32	Intermittent	Dry Open-Cut	None	N/A
Ditch (NDX-92)	Private	211.52	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (SS-003-004 (NDX-93))	Private	211.53 211.68	Intermittent	Dry Open-Cut	None	N/A
Lost River (NSP001)	18010204004545 State	212.07	Perennial	Dry Open-Cut	Lost River Sucker Shortnose Sucker	Jul 1 to Mar 31
Irrigation Ditch (ADX-318 EDX-55/EDX-90))	18010204004940 Private	213.23	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX 318)	18010204004940 Private	213.45	Intermittent	Adjacent to ROW	None	N/A
Irrigation Ditch (ADX-274)	BOR	213.85	Intermittent	Bore	Unknown	N/A
G Canal (G Canal) (ADX-275)	18010204001228 BOR	213.87	Intermittent	Bore	Unknown	N/A
Pond (Edge-2)	Private	214.28	Intermittent	Adjacent to centerline within ROW	None	N/A
Unnamed Creek (ASI-51)	18010204004618 Private	216.10	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Unnamed Creek (ASI0-2)	18010204004618 Private	216.11	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Unnamed Creek (ASI-50)	18010204004617 Private	216.30	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Unnamed Creek (ASI-49)	18010204004627 Private	216.44	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31

TABLE 3.5.5-1

Waterbodies Crossed or Adjacent to the Pipeline within the Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-Lost River Watershed (HUC 1801020409) in the Range of the Lost River Sucker and Shortnose Sucker

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Fishery Construction Window c/
Trib. to D Canal (ASI-136)	18010204001993 Private	218.09	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to D Canal (ASI-137)	18010204004701 Private	218.46	Intermittent	Dry Open-Cut (Streambed-bedrock)	None	Jul 1 to Mar 31
Trib. to D Canal (ASI-291)	18010204004701 Private	219.69	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Excavated Pond (NL-116)	18010204001267 Private	219.70	Pond	Off ROW – Temp Extra Workspace	None	N/A
Trib. to V Canal (SS-502-012)	Private	220.72	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-013	18010204004906 Private	221.15	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-013b	18010204004906 Private	221.15	Intermittent	Adjacent to centerline within ROW	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-014	18010204004906 Private	221.30	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502.016	Private	221.72	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-003b	Private	222.79	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-003a	Private	222.80	Intermittent	Adjacent to centerline within ROW	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-004	18010204004894 Private	222.99	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502.005	Private	223.08	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-006	Private	223.12	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502.023	Private	223.39	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-011	Private	223.54	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-009a	Private	224.03	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-009	Private	224.04	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-008	Private	224.17	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-007	Private	224.21	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-021	Private	224.44	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal (SS-502-025 (ASI-140))	18010204001318 Private	225.96	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-024	18010204004977 Private	225.99	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-020	Private	227.14	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Trib. to V Canal SS-502-017	Private	227.57	Intermittent	Dry Open-Cut	None	Jul 1 to Mar 31
Agricultural Pond (AL-288)	Private	228.13	Pond	Off ROW Within TEWA	None	N/A

TABLE 3.5.5-1

Waterbodies Crossed or Adjacent to the Pipeline within the Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-Lost River Watershed (HUC 1801020409) in the Range of the Lost River Sucker and Shortnose Sucker

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/ (potential for blasting) d/	Species Present b/	Fishery Construction Window c/

a/ Dry open cut crossing methods include flume or dam-and-pump procedures. Dam-and-pump methods would be utilized where streambed blasting is anticipated to eliminate blasting around the flume. The dam-and-pump crossing method is the preferred crossing procedure in steep incised drainage valleys where worker safety may be compromised when placing ("threading") the pipe string under the flume pipe and where there is a risk of upsetting the flume during this operation. The dam-and-pump crossing method is also the preferred crossing method on small streams under low flow conditions during the recommended ODFW-recommended in-water work period. PCGP proposes temporary/short-term fish passage restriction when completing dam-and-pump crossings within the ODFW-recommended in-water work period.

b/ ORBIC (2017b)

c/ Assumes fisheries construction windows only apply to those waterbodies flowing at the time of construction and windows do not apply to HDD crossings.

d/ Streambed bedrock based on PCGP's Wetland and Waterbody delineation surveys. Streambed bedrock may require special construction techniques to ensure pipeline design depth. Special construction techniques may include rock hammering, drilling and hammering, or blasting. The need for blasting would be determined by the construction contractor and would only be initiated after ODFW blasting permits are obtained.

Habitat

The Lost River has been highly altered to meet the needs of agriculture and to reduce the threat of flooding, and therefore habitat is fragmented and disconnected by dams lacking fish passage (NMFS and FWS 2013). Much of the water flowing through the lower Lost River channel comes from Upper Klamath Lake through the A Canal. Consequently, water in the Lost River is high in nutrients and is reused many times by different users causing nutrient concentrations to be increased. Water flowing in the Lost River eventually empties into the Tule Lake NWR as return flow from irrigation (no water is released through the Anderson-Rose Diversion Dam) and can be pumped to the Lower Klamath NWR before flowing to the Klamath River via the Klamath Straits Drain (NMFS and FWS 2013). The extensive alterations of the Lost River watershed, along with inputs from Upper Klamath Lake and agricultural drainage, have contributed to seasonally poor water quality, and the Lost River is listed by the State of Oregon for exceedances in temperature, dissolved oxygen (DO), pH, algal biomass, and ammonia toxicity (NMFS and FWS 2013).

Dams continue to limit passage and sucker migration, impose isolation of subpopulations, and decrease available spawning habitats which raise the possibility of facilitating hybridization between several sucker species. Dams may also cause stream channel changes, alter water quality, and provide habitat for exotic fish that prey on suckers or compete with them for food and habitat. Although there are seven major dams in the Klamath Basin that may affect the migration patterns of listed suckers, only the Link River Dam has been recently equipped with a fish ladder that was designed specifically for sucker passage. Fish ladders are present at J.C. Boyle and Keno dams and, although suckers have been observed to use the ladders, they were not designed for sucker passage and generally are inadequate for sucker passage (Reclamation 2007).

Lost River suckers continue to inhabit the Klamath River above Keno. Lost River suckers may enter the Klamath River from Upper Klamath Lake by passing through the gates at Link River Dam. Lost River suckers that survive passing through the hydroelectric facilities either die due to poor summer water quality conditions or pass downstream into the Klamath Reservoirs. At that point, fish are unlikely to return and believed to be lost from the breeding population (FWS 2007e and 2013k). The Pipeline would cross the Klamath River using HDD.

Adverse water quality is the most critical threat to the Lost River sucker (FWS 2007e). Klamath River and Klamath Lake have been designated as water quality impaired, including for nutrient loads which are enhanced by drainage of irrigation water from agricultural lands adjacent to Klamath Lake. Construction of dikes and drainage systems converted wetlands to agricultural use. Soils high in organic content were subject to mineralization processes which released nutrients into the aquatic system, especially phosphorous and nitrogen (Rykbost and Charlton 2001).

High levels of phosphorous in Klamath Lake have led to extreme eutrophication events that promote algal blooms dominated by the blue-green algae, *Aphanizomenon flos-aquae,* that reach or nearly reach theoretical biological maxima (NRC 2004). As a consequence, portions of Upper Klamath Lake develop conditions of oxygen depletion or are anoxic, and accumulate high concentrations of ammonia which has resulted in mass mortality of fish, including adult suckers (NRC 2004). Lost River suckers are likely to experience high mortality if exposed to one or more of the following: pH $\geq$ 9.8, ammonia (unionized) concentration $\geq$ 0.34 mg/l, water temperatures $\geq$29.4^{o}C ($\geq$85^{o}F), and dissolved oxygen (DO) concentration $\leq$ 2.3 mg/l (Bellerud and Saiki 1995). Seasonally low DO concentrations occur throughout the Lost River, and can be especially low in reservoirs where concentrations < 2 mg/L have been reported as lasting from a day to several weeks in Anderson-Rose, Harpold, and Wilson reservoirs, with DO concentrations near 0 mg/L observed in some reservoirs (NMFS and FWS 2013).

No assessments have been conducted for either of the two fifth-field watersheds that would be crossed by the Pipeline in the Lost Subbasin: Lake Ewauna-Klamath River (HUC 1801020412) and Mills Creek-Lost River (HUC 1801020409). Likewise, no stream reaches have been sampled under ODFW's Aquatic Inventories Project in either of the fifth-field watersheds. Nevertheless, modifications and degradation of aquatic habitats have been documented by FWS (1993b and 2012f), USGS (Dileanis et al. 1996), Reclamation (2007), and the NRC (2004).

Dams limit passage and fish migration, impose isolation of subpopulations, and decrease available spawning habitats (Reclamation 2007). Klamath River and Klamath Lake have been designated as water quality impaired, including for nutrient loads which are enhanced by drainage of irrigation water from agricultural lands adjacent to Klamath Lake. Construction of dikes and drainage systems converted wetlands to agricultural use. Soils high in organic content were subject to mineralization processes which released nutrients into the aquatic system, especially phosphorous and nitrogen (Rykbost and Charlton 2001). Sediment accumulation rates in Upper Klamath Lake indicate substantial annual increases since the late 1880s due to deforestation, drainage of wetlands, agriculture, livestock production and irrigation (Reclamation 2007).

High levels of phosphorous in Klamath Lake have led to extreme eutrophication events that promote algal blooms dominated by the blue-green algae, *Aphanizomenon flos-aquae,* that reach or nearly reach theoretical biological maxima (NRC 2004). As a consequence, portions of Upper Klamath Lake develop conditions of oxygen depletion or are anoxic and accumulate high concentrations of ammonia which has resulted in mass mortality of fish (NRC 2004).

There are no recent long-term water discharge data for waterbodies in the Lost River watershed. The A Canal connects the Link River to the Lost River via the B Canal. According to USGS Gage 11507200, there is no flow in the A Canal between November and March (see figure 3.5.5-3), corresponding to periods of water diversions from the Klamath River, discussed above.

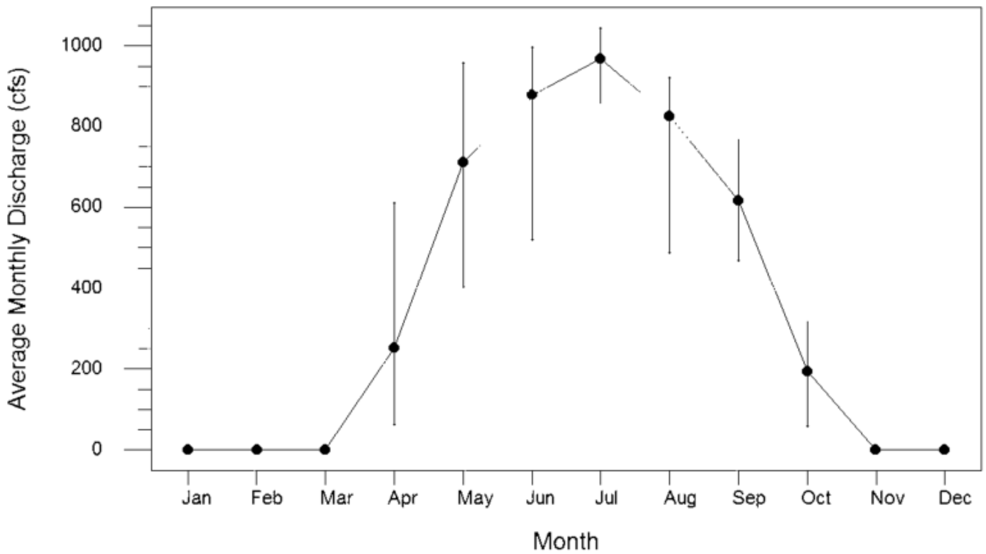

Figure 3.5.5-3 Average Monthly Discharge in the A Canal (USGS Gage 11507200) from 1960 to 1981. Vertical lines show maximum and minimum discharges for months during the periods of record.

Adequate flow and habitat conditions in the Lost River are likely during the spring and summer, with higher river flows supplemented by releases from Clear Lake and Gerber reservoirs (NMFS and FWS 2013k). Irrigation releases typically start in April. Flows in the Upper Lost River are very low during the fall and winter because flows from Clear Lake and Gerber reservoirs are considerably reduced, but winter flows do increase downstream from tributary and spring contributions (NMFS and FWS 2013).

Critical Habitat

Designated critical habitat for the Lost River sucker is present within the Pipeline project area. The Pipeline would cross the Klamath River at RM 249 which is within critical habitat Unit 1, Klamath County (FWS 2012g). Unit 1 includes Upper Klamath Lake and Agency Lake, together with some wetland habitat; portions of the Williamson and Sprague Rivers; Link River; Lake Ewauna; and the Klamath River from the outlet of Lake Ewauna downstream to Keno Dam. PCEs include (FWS 2012g):

1. **Water**. Areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity.
2. **Spawning and rearing habitat**. Streams and shoreline springs with gravel and cobble substrate at depths typically less than 1.3 m (4.3 feet) with adequate stream velocity to allow spawning to occur. Areas identified in PCE1 containing emergent vegetation adjacent to open water, which provides habitat for rearing and for growth and survival of suckers.

3. **Food**. Areas that contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates.

Critical habitat Unit 2 includes Clear Lake Reservoir and its principal tributary, Willow Creek. Unit 2 does not coincide with the Pipeline route.

3.5.5.3 Effects of the Proposed Action

In the riverine analysis area, only the Klamath River and the Lost River are inhabited by Lost River sucker based on available information (ORBIC 2017b), although Lost River suckers enter the canal system within both sub-basins and are regularly salvaged by Reclamation once canals are drained (Hodge and Buettner 2009). In the Lake Ewauna-Upper Klamath watershed, 19 intermittent streams would be crossed by dry open-cut and 6 others by boring. In the Mills Creek-Lost River watershed, 40 intermittent streams would be crossed by dry open-cut and 19 others by boring. There is no information documenting that Lost River suckers would be present in any of those intermittent streams, which include canals and ditches, at the time of construction (discussed above). The Lost River would be crossed using dry open-cut construction.

Direct and Indirect Effects

Timing to Life History Functions

The Klamath River (MP 199.38) and the Lost River (MP 212.07) are the only perennial waterbodies crossed by the Pipeline on Construction Spread 5. The ODFW (2008) allows instream construction in the Klamath River (above Keno) from July 1 to January 31 and in the Lost River (below Bonanza) from July 1 to March 31. PCGP has requested that the HDD crossing of the Klamath River be allowed to occur outside of ODFW's in-water construction windows to ensure that enough time is provided to successfully complete the crossings. PCGP proposes to cross the Klamath River using an HDD between July and October. The Lost River would be crossed by dry-open crossing methods during the ODFW-recommended crossing window (July 1 to March 31). Occasionally individual Lost River suckers have been found in this stream region, so it is possible that Lost River suckers may be present in the Lost River where the Pipeline would cross during the non-spawning period.

Species Presence

In the vicinity of the Pipeline, Lost River suckers occur in the Lake Ewauna-Klamath River 5th field watershed and the Mills Creek-Lost River 5th field watershed. The pipeline route crosses the Lake Ewauna-Klamath River 5th field watershed for about 17.24 miles (MPs 188.41 to 205.65) and the Mills Creek-Lost River 5th field watershed for 23.15 miles (MPs 205.66 to 228.81). The Pipeline will cross 26 waterbodies in the Lake Ewauna-Klamath River, one by HDD, six by conventional bore, and 19 by dry open-cut, and will cross 59 waterbodies in the Mills Creek-Lost River watershed, 20 by conventional bore and 39 by dry open-cut.

Potential effects to Lost River suckers inhabiting the Klamath River by HDD construction are discussed below. Because there will be no instream work for any of the conventional bore crossings, no effects to Lost River suckers are expected in those 26 streams, canals, drains or ditches that are maintained by the Bureau of Reclamation (BOR). Potential effects to Lost River suckers and shortnose suckers are possible in waterbodies crossed by dry open-cut, including the Lost River (known to be occupied by Lost River suckers) with the exception of 26 waterbodies crossed between MP 214.38 and MP 228.81. At MP 214.38, the pipeline route deviates from the general west to east direction and proceeds north, up a 9 percent slope (climbing from 4,100 feet to 4,360 feet elevation) to MP 215.04, and then continues to the east along a ridgeline (paralleling powerline corridors) to MP 228.81. In that segment, the route crosses 26 waterbodies that are intermittent headwater drainages with unlikely (due to steep slopes) or no pathways (no connectivity) for Lost River suckers to enter from lowland BOR canals, drains or ditches that might support Lost River suckers and shortnose suckers. No effects to Lost River suckers and shortnose suckers would occur by crossing those 26 waterbodies.

Potential effects to Lost River suckers are possible during dry open-cuts of 19 waterbodies crossed in the Lake Ewauna-Klamath River watershed and the remaining 13 waterbodies west of MP 214.38 crossed in the Mills Creek-Lost River watershed included in table 3.5.5-2. Except for the Lost River and one irrigation ditch at MP 194.64, none of the waterbodies have been mapped by the Klamath Project. Consequently, connectivity of those other 30 waterbodies (classified as ditches) to larger canals and laterals that may seasonally support Lost River suckers and shortnose suckers cannot be determined.

TABLE 3.5.5-2

Waterbodies Crossed by Dry Open-Cut Construction within the
Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-
Lost River Watershed (HUC 1801020409) that May Be Occupied by Lost River Suckers and/or Shortnose Suckers

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/	Species Present b/	Fishery Construction Window c/
Lake Ewauna-Upper Klamath River (HUC 1801020412) Fifth field Watershed, Klamath County						
Trib. To Klamath River (ASI-13/SS-100-025)	18010204003103 Private	188.90	Intermittent	Dry Open-Cut	None	Jul 1 to Jan 31
Irrigation Ditch (S2-07 (ADX-63 (MOD))	18010204003315 Private	192.67	Intermittent	Dry Open-Cut	Unknown	N/A
Ditch (ADX-67)	18010204003314 Private	192.99	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-72)	Private	193.07	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-75)	Private	194.51	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-77)	Private	194.57	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (WW-001-010/(ADX-78)	18010204003303 Private	194.64	Intermittent	Dry Open-Cut	None	N/A
Ditch (GDX-4)	Private	195.67	Intermittent	Dry Open-Cut	None	N/A
Ditch (GDX-3)	Private	195.73	Intermittent	Dry Open-Cut	None	N/A
Ditch (GDX-2)	Private	195.91	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-30)	Private	196.53	Intermittent	Dry Open-Cut	None	N/A
Irrigation Canal (ADX-32)	18010204000790 Private	196.64	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-36)	Private	196.76	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-38)	18010204003183 Private	196.78	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-39)	18010204003183 Private	196.89	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-40)	Private	197.08	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-94)	18010204003251 Private	201.49	Intermittent	Dry Open-Cut	None	N/A
Roadside Ditch (ADX-99)	Private	203.97	Intermittent	Dry Open-Cut	None	N/A
Irrigation Canal (ADX-106)	Private	204.91	Intermittent	Dry Open-Cut	None	N/A

TABLE 3.5.5-2

Waterbodies Crossed by Dry Open-Cut Construction within the
Lake Ewauna- Klamath River Watershed (HUC 1801020412) and Mills Creek-
Lost River Watershed (HUC 1801020409) that May Be Occupied by Lost River Suckers and/or Shortnose Suckers

Waterbodies Crossed and Waterbody ID	NHD Waterbody Reach Code and/or Jurisdiction	Pipeline Milepost (MP)	Waterbody Type	Proposed Crossing Method a/	Species Present b/	Fishery Construction Window c/
Mills Creek-Lost River (HUC 1801020409) Fifth field Watershed, Klamath County						
Irrigation Ditch (ADX-120)	Private	208.07	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-121)	Private	208.07	Intermittent	Dry Open-Cut	None	N/A
Ditch (ADX-124)	Private	208.23	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-125)	Private	208.28	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-126)	Private	208.29	Intermittent	Dry Open-Cut	None	N/A
Roadside Drainage Ditch (ADX-129)	Private	208.85	Intermittent	Dry Open-Cut	None	N/A
Roadside Ditch (ADX-142)	Private	210.16	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (ADX-261)	Private	210.87	Intermittent	Dry Open-Cut	None	N/A
Ditch (NDX-29/SS-003-002)	Private	211.32	Intermittent	Dry Open-Cut	None	N/A
Ditch (NDX-92)	Private	211.52	Intermittent	Dry Open-Cut	None	N/A
Irrigation Ditch (SS-003-004 (NDX-93))	Private	211.53 211.68	Intermittent	Dry Open-Cut	None	N/A
Lost River (NSP001)	18010204004545 State	212.07	Perennial	Dry Open-Cut	Lost River Sucker Shortnose Sucker	Jul 1 to Mar 31
Irrigation Ditch (ADX-318 EDX-55/EDX-90))	18010204004940 Private	213.23	Intermittent	Dry Open-Cut	None	N/A

a/ Dry open cut crossing methods include flume or dam-and-pump procedures. Dam-and-pump methods would be utilized where streambed blasting is anticipated to eliminate blasting around the flume. The dam-and-pump crossing method is the preferred crossing procedure in steep incised drainage valleys where worker safety may be compromised when placing ("threading") the pipe string under the flume pipe and where there is a risk of upsetting the flume during this operation. The dam-and-pump crossing method is also the preferred crossing method on small streams under low flow conditions during the recommended ODFW-recommended in-water work period. PCGP proposes temporary/short-term fish passage restriction when completing dam-and-pump crossings within the ODFW-recommended in-water work period.

b/ ORBIC (2017)

c/ Assumes fisheries construction windows only apply to those waterbodies flowing at the time of construction

Suspended Sediment by Pipeline Crossing Methods

Potential occurrence of Lost River suckers in waterbodies crossed by dry open-cut are included in table 3.5.5-2. Dry crossing methods would result in minimal impacts, including temporary increases in suspended sediments in restricted areas. One HDD and 25 conventional bores would be installed without in-water work and would not directly affect the aquatic environment and associated species, except in the unlikely event of an inadvertent return during an HDD crossing, which could affect stream suspended sediment levels as discussed below. The Klamath River would be crossing with an HDD.

Since all streams/ditches crossed, except for the Klamath River and Lost River, are minor or intermediate channels, any construction required would be done in the dry, reducing potential for any adverse suspended sediment conditions downstream. Additionally, road crossings where fish may be present would be constructed to meet ODFW fish passage standards so fish movement would not be blocked. While some elevated sediment may occur downstream, effects would be unsubstantial to Lost River sucker due to the implementation of approved construction methods.

Suspended Sediment – Dry Open Cut

Pipeline crossings of surface waterbodies could cause some downstream turbidity and sedimentation. The type of crossing and the existing stream sediment characteristics affect turbidity and suspended sediment in streams. The dry crossing methods to be used are flumed or dam-and-pump:

- **Flume.** The flume method typically is used to cross small to intermediate flowing waterbodies that are either fish-bearing or non-fish-bearing streams. The flume technique involves diversion of stream flow into a carefully positioned steel pipe of suitable diameter to convey the maximum flow of the stream across the work area, and ensures that stream flow rate is not interrupted.
- **Dam-and-Pump.** With the dam-and-pump method, stream flow is diverted around the work area by pumping water through hoses over or around the construction work area. The goal of this technique is to create a relatively "dry" work area to avoid or minimize the transportation of heavy sediment loads and turbidity downstream of the crossing. This crossing method may be used on all waterbodies where stream flow can be diverted by pumping around the work area.

As noted in section 3.5.3.3, Coho Salmon (SONCC ESU), dry open cutting (fluming, dam-and-pump, or some combination of the two) generates small amounts of turbidity compared to wet open-cut procedures. However, adult suckers appear to prefer deep, turbid water but are often forced to utilize shallow, clear water during degraded water quality conditions in the summer (NRC 2004). The amounts of turbidity generated by dry open-cut construction may cause minor short-term adverse effects to Lost River suckers if they are within several hundred feet downstream of the Lost River crossing site. However, guidance for evaluating effects of exposure and dose of suspended sediments on catostomids (including Lost River sucker) is not available, similar to documentation for salmonids (e.g., Newcombe and Jensen 1996). Crossing of the intermittent channels are planned to occur in the dry so suspended sediment increases should be very low when flow is returned to the channels, as channel conditions would be stabilized. Should some crossing occur when flow is present, some suspended sediment levels would be more elevated. However, considering 1) the small size of these intermittent streams and ditches, 2) the short duration of construction activity at each crossing location, 3) the expectation that suckers would not be present in these streams/ditches, even when flowing (all crossings are more than two miles from flowing channels, which are irrigation channels), and 4) the apparent tolerance of this species for turbid water, any elevated suspended sediment would not cause adverse effects to Lost River suckers in these intermittent flow crossings.

There is a possibility that following construction, future flows returning to the ditches listed in table 3.5.5-2 could potentially indirectly affect suckers by mobilizing sediment replaced over the trench. Mobilized sediments could lead to downstream sediment impacts on forage species, streambank erosion and stability (geotechnical stability), and surface flow retention. However, during delineation of the ditches, field personnel reported stream gradients at ditches as <1% and many had mud substrates, both observations indicative of low instream flows and velocities in the ditches. Consequently, flows returning in the ditches after dry open-cut construction may not be sufficient to mobilize native materials replaced in the trench. PCGP (in the ECRP/appendix F) has proposed to install erosion control matting to cover channel bottoms where revegetation of the channel bottom is required. Erosion control matting, anchored with staples to the channel sides and bottom, could be similarly used at irrigation ditches to minimize risk of sediment mobilization, downstream sediment impacts on forage species (zooplankton such as cladocerans – water fleas – and benthic insects such as chironomid midge larvae and amphipods), and streambank erosion and stability. Use of erosion control matting would allow materials replaced as bottom substrate and restored ditch banks to consolidate without eroding until the matting degrades.

Suspended Sediment – HDD

The HDD installation method is considered an effective technique for avoiding in-stream impacts by eliminating the need for in-stream excavation (Reid and Anderson 1998; Reid et al. 2004). According to GeoEngineers' (2017g) analysis for construction using HDD across the Klamath River (see appendix E), the design length of the Klamath River HDD crossing would be approximately 2,300 feet. The proposed Klamath River entry point would be in an agricultural field about 950 feet east of the river bank and the exit would be an open area about 370 feet west of the river bank. The HDD design indicates there would be between 70 and 140 feet of streambed cover in the river channel over the pipe. There is no direct in-stream disturbance so no suspended sediment increases would occur unless there is an unplanned drilling failure. There is a moderate to high risk of hydraulic fracture from the entry point to about 900 feet to the west, all within the east bank of the river. The portion of HDD beneath the river would be below bedrock with low risk of a release of drilling mud (inadvertent return). The risk of inadvertent return would be moderate to high within 425 feet from the HDD exit point on the west bank of the Klamath River due to presence of stiff silt alluvium (GeoEngineers 2017g). Though the risk of releasing drilling mud directly beneath the riverbed is low, such a release could have impacts on the aquatic environment and species.

Inadvertent Release of Drilling Muds (Inadvertent Return). However, there is a potential for impact as a result of the HDD process. Drilling requires use of a drilling mud for lubrication of the bit and removal of cuttings. A non-toxic, biodegradable bentonite clay mixture makes up drilling mud. Because the drilling mud is under pressure during drilling, if the bit encounters substrate fractures or channels, it is possible for bentonite to escape from the drilled hole (termed an "inadvertent return"). Bentonite can escape to the surface through fractures in the drilled substrate. Bentonite by itself is a non-toxic drilling mud (Breteler et al. 1985; Hartman and Martin 1984; Sprague and Logan 1979) although according to Reid and Anderson (1998), the toxicity of bentonite (sodium montmorillonite) in fresh water ranges from 5,000 to 19,000 ppm (mg/liter) based on 96-hour tests for LC50 (the concentration at which 50 percent of the test population dies after 95 hours of exposure) on rainbow trout. The toxicity classifications based on LC50 values ranged from "slightly toxic" to "practically non-toxic" (Reid and Anderson 1998). In other tests, toxicities to lake whitefish and rainbow trout demonstrated threshold concentrations of 16,613 and 49,838 ppm (mg/liter), respectively (Reid and Anderson 1998). More recently, toxicity to rainbow trout (LC50, 96-hour) was reported to be 19,000 mg/l (ClearTech 2015). LC50 concentrations > 10,000 ppm would be considered "practically non-toxic" (Reid and Anderson 1998). As with any fine particulate material, bentonite can interfere with oxygen exchange by gills and the degree of interference generally increases with water temperature.

The summary by Reid and Anderson (1998) provides a substantive description of effects to streams and habitat in the cases with inadvertent returns.

Drilling mud releases during HDD construction can result from:

1. Circulation losses through highly permeable gravels;
2. Mud migration along rock joints or fractures which intersect with the river bottom;
3. Loss of pilot hole directional control resulting in the intersection with the river bottom or approach slope'
4. Drilling mud pressures exceeding ground stress, widening existing or creating new fractures (hydraulic fracturing), allowing for mud migration;
5. Substantially different elevations of entry and exit drill locations. Resulting pressure head differences can cause substantial upland leakages of drilling muds once the drill bit nears the ground surface or when it breaks the surface.

Drilling mud releases may surface through river and streambeds, wetland bottoms, or at upland locations. The volume of mud released to the surface would depend on:

1. Porosity of the substrate transporting the mud;
2. Extent and size of the porous material;
3. Pressure exerted on the mud by the hydraulic system;
4. Viscosity of the mud at the time of exposure;
5. Whether mud circulation can be maintained.

Magnitude of effects by mud releases to fish, streams and habitat would depend on the following (page numbers referenced from Reid and Anderson, 1998):

6. Toxicity of the drilling mud components and additives (pages 57-59 and Table 1);
1. Increased sediment loads (page 59);
2. Effects to hydrological conditions that would cause poor conditions for wetland plant establishment and growth (pages 59-60);
3. Release into streams and rivers could cause increases in the downstream drift of stream macroinvertebrates (page 60);
4. Effects on fish would depend on level of exposure (e.g., concentration) and duration of exposure and lifestage of fish present, timing of release, and ability of the watercourse to remove or incorporate the released muds without degrading existing habitats (page 61).

The report by Reid and Anderson (1998) summarizes the general effects, known or hypothesized, associated with drilling mud releases but does not provide specific effects associated with each of the instances of inadvertent returns cited.

Likewise, Canadian Pipeline Water Crossing Committee (1999) reported that drill mud seepage occurred in 36 of 146 HDD cases reviewed with most significant leakage occurring at the drill entry or exit points due to different pressure heads with large differences in elevation between the two points. Leakage also occurred during reaming or pull-back. However, the report did not describe the effects to fish, streams, and habitat in the cases with leakages or inadvertent returns.

Potential inadvertent returns are more common near the HDD drill entry and exit locations; however, impacts to waterbodies are minimized by locating the drill entry and exit points away from the waterbody. The probability of an inadvertent return may increase when the drill bit is working nearest the surface (see GeoEngineers 2017g), but is dependent on numerous factors including substrate characteristics, head pressure of the drilling mud, topography, elevation, and subsurface hydrology. PCGP has proposed an HDD crossing of the Klamath River and designed this crossing such that areas of greatest risk from inadvertent return are on uplands and not adjacent to the waterbody where much greater depth would be achieved, and inadvertent return potential is reduced.

Hydraulic fracture typically occurs when the drill path passes through relatively weak cohesive soils with low shear strength or very loose granular soils. Loose and silty sands and soft to medium stiff silts and clays typically have a higher hydraulic fracture potential. Medium dense to dense sands and gravels and very stiff to hard silts and clays have a low to moderate hydraulic fracture potential. Unfractured rock, because of its high shear strength, typically has a low potential for hydraulic fracture. HDD installations with greater depth or in formations with higher shear strength may reduce the potential for hydraulic fracturing (see appendix E).

If an inadvertent return occurs into the river, drilling fluid would enter the waterway causing short-term, temporary water quality impacts downstream of the Pipeline project area including sedimentation and turbidity. Should this occur, fish would likely avoid the immediate vicinity of any elevated suspended sediment within this larger river crossing area.

Sediments discharged into aquatic systems have the potential, depending on the concentrations, to cause hyperplasia, hypertrophy, and necrosis of fish gill tissues and impair fish vision making it difficult to feed and also making the fish more susceptible to predation. However, these effects typically occur after relatively long-term exposure to concentrated sedimentation. If drilling fluid accumulates in the substrate, it can adversely impact the quality and quantity of aquatic habitat available for aquatic species including salmonid spawning habitat and benthic macroinvertebrate rearing habitat. Drilling fluid that accumulates in the substrate may cover up food sources, and smother fish eggs and other aquatic life in the riverbed. However, significant impacts to substrate from inadvertent returns are not likely in large river systems because of the anticipated high water volumes and velocities within large rivers.

The rheologic properties of drilling fluid allow it to remain suspended within the water column for prolonged periods of time; thus the drilling fluid would likely settle out in very slow moving water downstream of the release. The distance of expected transport would likely prevent significant concentrations of the fluid from accumulating in one area of the Klamath River. If drilling fluid is inadvertently released into the river, the behavioral avoidance response of Lost River sucker is presumed to be triggered within the immediate vicinity of the release and the fish are expected to return and utilize the affected area shortly after the inadvertent release has been erved andPCGP developed its *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations* (see appendix D), which describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The HDD Contingency Plan also includes procedures for cleanup of drilling mud releases. If significant concentrations of drilling fluid are found during monitoring as a result of a release, the following possible corrective measures would be taken:

1. Deployment of containment structures, if feasible, and removal of drilling mud from substrate and streambanks if possible.
2. Increase the drilling fluid viscosity in an attempt at sealing the point at which fluid is leaving the drilled hole. The drilling operation may be suspended for a short period (i.e.,

overnight) to allow the fractured zone to become sealed with the higher viscosity drilling fluid.

3. If increasing the drilling fluid viscosity is ineffective, lost circulation materials (LCM) may be introduced into the hole by incorporating them in the drilling fluid and pumping the material down-hole. The drilling operation may again be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the LCMs.
4. Depending on the location of the fractured zone, a steel casing may be installed that is of sufficient size to receive the largest expected down-hole tools for the crossing. This casing installation provides a temporary conduit for drilling fluids to flow while opening the remaining section of the hole to a diameter acceptable for receiving the proposed pipe sections. To alleviate future concerns with the steel casing after the HDD installation is completed, the casing is generally extracted from the hole prior to or just after completing the HDD installation. However, there have been instances when attempts at extracting the steel casing were unsuccessful.
5. In the event drilling fluid flow is not regained through the annulus of the drilled hole and a steel casing installation is not utilized, the HDD contractor may elect to install a grout mixture into the drilled hole in an attempt to seal the fractured zone. The down-hole drilling assembly is generally extracted and existing hole is re-drilled to the point at which it had previously been drilled prior to having encountered the loss of drilling fluid.

In some instances, it may be determined that the existing hole encountered a zone of unsatisfactory soil material and the hole may have to be abandoned. If the hole is abandoned, it would be filled with cuttings and drilling fluid.

Overall, at the site of any inadvertent return, the amount of drilling mud released into a waterbody would be low. The HDD location would be under the Klamath River, with large volumes of water and moderate flows, where the drilling mud would be diluted. If an inadvertent release of drilling mud from an HDD occurred it would have minor short-term adverse effects to aquatic resources including Lost River sucker.

Entrainment and Entrapment

Waterbody crossings using the "dry" crossing methods, flume or dam-and-pump, may result in some fish being entrapped in streams. Flumes and dams would be completely installed and functioning before any instream trenching disturbance occurs. Construction across a waterbody would take up to four days using dry open cut methods, but less for small and intermediate streams. Fish inadvertently left within the dammed-off construction zone could be killed by impingement on pump intakes used to dewater the construction zone or would likely die once all water was removed. Waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence are included in table 3.5.5-2.

For typical crossings once streamflow is diverted through the flume pipe, but before trenching begins, fish trapped in any water remaining in the work area between the dams would be removed and released (salvaged) using the *Fish Salvage Plan* (see Fish Salvage Plan under section 3.5.5.4 or appendix T for details). Salvage methods could include seines and/or dip nets and electrofishing. Seining would be the primary method used to salvage fish but electrofishing methods may be used if all fish cannot be removed from the area potentially dewatered. The *Fish Salvage Plan* incorporates these methods to minimize adverse effects to listed fish.

Suckers as a group (family Catostomidae) appear to be susceptible to many of the same deleterious effects from electroshocking that were described above for salmonids (Snyder 2004). Although records of the effects by electroshock to Lost River suckers have not been compiled, responses by river carpsucker, longnose sucker, white sucker, and razorback sucker among others indicate that they are particularly susceptible to spinal injuries and hemorrhages by electrofishing (Snyder 2004). Reclamation has salvaged fish from canals throughout the Klamath Project each fall since 1991 following dewatering using electrofishing techniques (Reclamation 2008). Reclamation has noted that if electrofishing is found to injure juvenile suckers, they would pursue other techniques to salvage fish (Reclamation 2008). Sucker mortalities (Lost River suckers, shortnose suckers, and Klamath largescale suckers) have occurred during salvage operations, whether due to electrofishing stress or to low levels of dissolved oxygen (Peck 2000 and 2001). Reclamation has also done annual fish salvages in the forebay of a fish screen facility using backpack electrofishers and beach seines This annual salvage procedure alleviates potential mass mortality of all fish at the fish screen as water is removed (Reclamation 2007).

All methods of capture and holding have risks of stress, injury, or mortality of fish. In conjunction to implementation of the *Fish Salvage Plan*, PCGP would contract with either ODFW or a qualified consultant to capture the fish. Fish removal personnel will be approved by ODFW and NMFS for this listed species. Personnel who would handle and/or remove fish on federal lands would also be approved by the Forest Service or the BLM, or the work would be done directly by agency personnel if approved by ODFW. Overall, some listed juvenile Lost River sucker may suffer injury or mortality, but with the implementation of Pipeline project conservation measures the numbers would be slight.

Acoustic Shock and Underwater Noise

There would be no blasting or use of mounted hydraulic impact hammer to cross the Lost River where Lost River suckers may be present during crossing or any of the 31 ditches with potential species presence included in table 3.5.5-2. Use of back-hoes for dry open-cut construction would not produce sound levels to cause harm to Lost River suckers, as discussed for SONCC coho salmon in section 3.5.3.3.

Riparian Vegetation Removal, Modification and LWD Loss

Aquatic resources, including Lost River suckers and habitat components, could be affected as a result of removal of vegetation and instream habitat at the waterbody crossing sites as required for construction. Short-term, physical habitat disruption would occur during trenching activities. Long-term degradation of habitats could occur if the stream contours are modified in the area of the crossing; the flow patterns are changed; or erosion of the bed, banks, or adjacent upland areas introduces sediment into the waterbody. Loss of riparian vegetation along the banks would remove an important source of terrestrial food for aquatic organisms, and potentially increase mass slope failures adjacent to waterbodies.

Because HDD would be used to cross the Klamath River, only 0.04 acre (Urban or Built-up land) within the Klamath River riparian zone (extending 117 feet or one site-potential tree height from each river bank) would be affected. No forested riparian vegetation would be affected. Construction across the Lost River would disturb approximately 1.35 acres of agricultural land within the riparian zone (extending 119 feet from each river bank). Similar to the Klamath River crossing, no forest riparian vegetation would be affected or removed and all effects would be to agricultural land. Riparian zones associated with the Klamath River and Lost River crossings are on land owned by the State of Oregon. Riparian Zones for all other waterbodies crossed that are within range of the Lost River sucker are on private lands. All crossings other than the Klamath River and Lost River are on intermittent streams/ditches/canals with very limited low-growing riparian vegetation and would have unsubstantial reduction in near stream vegetation from crossing clearing. Likewise, as there are few trees in the riparian area along the route in the range of the Lost River sucker, there would be no change in LWD supply to any stream system from construction of right of way clearing or maintenance.

Overall, there would be no substantial change in riparian vegetation or LWD supply along the route where Lost River sucker may be present. Ecological function (e.g., supply of shade, future LWD, and organic input) of the riparian conditions would be maintained and adverse effects to Lost River sucker would not occur from right-of-way clearing at stream crossings.

Water Temperature

Lost River suckers are susceptible to high water temperatures 85°F or higher (Bellerud and Saiki 1995). As discussed above, no riparian vegetation would be removed that otherwise would provide shade. Consequently, water temperature would not be affected by construction within the Lost River and Klamath River.

Aquatic Habitat

There also are potential indirect effects to aquatic habitat from increased suspended sediment from stream crossings. As discussed for SONCC coho salmon, suspended sediment released during stream crossing construction may have downstream habitat effects as well as direct fish effects such as changing substrate conditions (e.g., elevated fines) that may affect benthic food resources. Only one stream, the Lost River, is known to be crossed with stream bottom substrate-disturbing activities during flowing periods; 31 ditches with potential for species included in table 3.5.5-2 are expected to be crossed in the dry and could have suckers present in the crossing area. While the actual magnitude of sediment generated during crossing the Lost River is not known, estimates of sediment generated by dry open-cut construction along other portions of the route and implementation of BMPs would not result in short-term sediment elevations that could have substantial downstream adverse habitat effects that would indirectly affect the Lost River sucker or the species habitat.

Freshwater Stream Invertebrates

Substrates downstream from in-stream construction sites could be impacted by sediments which could affect forage species used by Lost River suckers. Mayflies, caddisflies, and stoneflies prefer large substrate particles in riffles and are adversely affected by fine sediment deposited in interparticulate spaces (Cordone and Kelley 1961; Waters 1995; Harrison et al. 2007). Suckers feed on benthic organisms including algae and invertebrates so reductions could affect their growth and survival. Fish and benthic macroinvertebrate abundance downstream of pipeline construction sites have been reported as short-term reductions (Reid and Anderson 1999). Macroinvertebrate abundance and community composition are highly related to the degree to which substrate particles are embedded by fine material (Birtwell 1999). Data below wet open-cut crossings, which generate much higher sediment levels than dry cut crossings, generally found negative changes in benthic invertebrate populations were not apparent within a year (Reid et al. 2008) and some data found rapid recolonization of substrate within 30 days (Gartman 1984). Therefore, the overall level of effect of the pipeline crossings on waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence included in table 3.5.5-2 (unless sealing failures at isolation structures occur) would be even less than those noted by literature and would not result in substantial reduction in growth or survival of listed Lost River individuals.

Streambank Erosion and Streambed Stability

Clearing and grading activities during construction could increase erosion along streambanks resulting in higher turbidity levels in the waterbodies crossed. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. Erosion, sedimentation, and higher turbidity levels related to the Pipeline project could affect aquatic resources in waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence (included in table 3.5.5-2). The degree of impact on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size.

Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. The degree of impact on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size. To minimize these impacts, PCGP would use temporary equipment bridges, mats, and pads to support equipment that must cross the waterbody (perennial, intermittent, and ephemeral if water is present) or work in saturated soils adjacent to the waterbody. PCGP would also install sediment barriers, such as silt fences and straw/hay bales, across the right-of-way at the edge of waterbodies throughout construction except for short periods when the removal of these sediment barriers is necessary to dig the trench, install the pipe, and restore the right-of way. Practices to minimize streambank erosion are provided in the ECRP (see appendix F).

The FWS expressed concerns that more detailed site-specific information on bank material, streambed composition, shoreline vegetation and other information is needed to adequately ensure that actions occurring at a stream crossing do not significantly increase streambank erosion and streambed instability. PCGP, in response to these requests, conducted an assessment of crossing conditions of all streams suitable for analysis based on the FWS risk matrix (GeoEngineers 2017d, 2017e, 2018a). As discussed for SONCC coho salmon, PCGP used this matrix to rate crossings for risk of potential stream bank and channel changes. Based on the GeoEngineers (2017d, 2017e, 2018a) Risk Matrix analysis, the Lost River crossing has a “high” level of risk based on existing stream site sensitivity based on the landscape/stream type (channel characteristics), riparian conditions (essentially none), and bed conditions (sand). If any crossing is moved into the “high” impact and “high” stream response risk matrix category, a site-specific crossing design would be developed for that site. Construction would then move forward as described in the permit documents including implementation of special additional BMPs, as described in GeoEngineers (2017d, 2017e, and 2018a), depending on individual site conditions and may include such actions as changes in bank material and bank angle modifications, specific substrate composition used, plants used on the bank, artificial stabilizing bank material, rootwad enhancement, and various other actions. These actions would reduce potential adverse effects from bank and bed stability to unsubstantial levels to the listed Lost River sucker.

Hydrostatic Testing

Water would be required on a one-time basis near the end of construction to hydrostatically test the pipeline. Potential impacts associated with hydrostatic testing include entrainment of fish; transfer of exotic organisms between basins; reduced downstream flows and impaired downstream uses if test water is withdrawn from surface waters; and erosion, scouring, and a release of chemical additives as a result of test water discharge. PCGP would obtain its hydrostatic test water from commercial or municipal sources or surface water rights owners, the sources of which are lakes, impoundments, and streams.

Within the range of Lost River sucker, there are four potential water sources, including John C. Boyle Reservoir, Keno Reservoir, Klamath River, and High Line Canal. There are 5 potential discharge locations, all of which are within the right-of-way. None of the hydrostatic test break sections are in the vicinity of a waterbody with known Lost River sucker occupancy or critical habitat. Discharge volume at each site ranges from 0.63 to 4.6 million gallons. The largest withdrawal is proposed from the Klamath River or High Line Canal. Water withdrawn from Keno Reservoir at Keno Dam will be from designated critical habitat for Lost River suckers. Water will also be withdrawn from John. C. Boyle Reservoir at the Spencer Bridge. Although the reservoir is not included in designated critical habitat, Lost River suckers are expected to be present. Water withdrawals from occupied habitats risk entrainment and impingement. The screening of intake hoses would be used to prevent the entrainment of fish and other aquatic organisms, meeting NMFS screening criteria. The rate of withdrawal would also be regulated to avoid adverse impact on aquatic resources or downstream flows (NMFS 1997c).

PCGP would minimize the potential effects of hydrostatic testing by adhering to the measures in its *Hydrostatic Testing Plan* (see appendix U). Where test water cannot be returned to its withdrawal source, the water would be treated and discharged to an upland location (at least 150 feet from wetlands or waterbodies with no direct discharge to these features) through a dewatering device at a rate to prevent scour and erosion and to promote infiltration. PCGP would obtain all necessary appropriations, withdrawal, and discharge permits through the OWRD. With the implementation of the *Hydrostatic Testing Plan* and BMPs and by obtaining required permits, adequate measures would be in place to prevent direct or indirect effects of hydrostatic testing to Lost River sucker that may be in some of the stream systems.

Aquatic Nuisance Species

NAS are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Currently, there are 180 reported NAS in Oregon, of which 134 are documented within the USGS hydrologic basins crossed by the Pipeline (USGS 2017).

In the riverine environments crossed by the Pipeline, largemouth and smallmouth bass, introduced as recreational species, prey on juvenile sockeye, coho, and Chinook salmon (Tabor et al. 2007). Additionally, up to 20 exotic species (many of which can reside in streams including largemouth bass, yellow perch, and fathead minnow) are present in the range of Lost River sucker and are suspected to compete and prey on them (FWS 2013). Management priorities in Oregon concentrate on aquatic nuisance species, which are the species whose current or potential impacts on native species and habitats and economic and recreational activity in Oregon are known to be significant (Hanson and Sytsma 2001). Some of the major potential freshwater invasive species are Chytrid fungus and mussels, including the zebra and quagga mussels (*Dreissena polymorpha*, and *Dreissena rostriformis bugenisis*).

Aquatic nuisance species could potentially be introduced into Pipeline project area waters by interbasin transfer of hydrostatic testing water or by being carried on equipment that is moved from outside of the region or between basins. PCGP has developed BMPs and guidelines to avoid the potential spread of aquatic invasive species (see *Hydrostatic Testing Plan* in appendix U) in consultation with the BLM and Forest Service as well as with ODEQ and the Center for Lakes and Reservoirs and Aquatic Bioinvasion Research and Policy Institute (Portland State University).

If determined to be feasible, all water used in hydrostatic testing would be returned to its withdrawal source location after use; however, cascading water from one test section to another to minimize water withdrawal requirements may make it impractical to release water within the same watershed where the water was withdrawn. If it is not possible to return the water to the same hydrologic basin from which it was withdrawn, PCGP would employ an effective and practical water treatment method (chlorination, screening/filtration, or other appropriate method) to disinfect the water that would be transferred across basin boundaries. The hydrostatic test water would be treated after it is withdrawn and prior to hydrostatic testing.

PCGP would implement a three-step BMP treatment process to prevent the potential spread of invasive species and forest pathogens from non-municipal surface water sources used during hydrostatic testing. The hydrostatic test water treatment process would incorporate screening/filtration during water withdrawal, chlorine treatment, and upland discharge at least 150 feet from wetlands or waterbodies with no direct discharge to these features. All hydrostatic test water would be released through a dewatering device such as a straw bale structure or sediment bag, in a manner to promote infiltration. Further, all hydrostatic release locations would be monitored after construction to ensure noxious weeds have not established.

As explained in the *Hydrostatic Testing Plan*, PCGP proposes to use a treatment of 2 ppm or 2 mg/L of free chlorine residual with a detention time of 30 minutes to treat all non-municipal surface waters that would be used as a water source for hydrostatic testing purposes. Chlorinated water would be released according to the Oregon Department of Environmental Quality criteria to prevent water quality impacts, potential effects to aquatic species, and minimize potential impacts to sensitive areas.

The potential for dispersal of aquatic nuisance organisms by other construction equipment and vehicles from one basin to another is remote. The BMPs in the noxious weed control procedures outlined in the ECRP (see appendix F) and the Integrated Pest Management Plan (see appendix N to the POD) would be employed to prevent the introduction and spread of invasive species from construction. With the implementation of these noxious weed control measures, introduction of nonnative species or movement of species between basins should not occur, resulting in no adverse effects to the listed Lost River sucker.

Fuel and Chemical Spills

Fisheries habitats could be adversely affected if petroleum products were accidentally discharged into aquatic environments including waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence that are included in table 3.5.5-2. Such materials are toxic to algae, invertebrates, and fish. Of the products likely to be present during construction, data compiled from a wide range of sources indicate that diesel fuels and lubricating oils are considerably more toxic to aquatic organisms than other, more volatile products (gasoline) or heavier crude oil (Markarian et al. 1994). For example, one study reported that release of diesel fuel in freshwater habitats significantly reduced aquatic invertebrate densities and species richness at least three miles downstream but invertebrate densities recovered within a year (Lytle and Peckarsky 2001). Impacts to aquatic habitats that primarily affect aquatic substrates—hence spawning, incubating and rearing habitats—can remain for much longer periods (Markarian et al. 1994).

Equipment used for construction across waterbodies could potentially release hydraulic fluid comprised of a variety of compounds, the most common of which are mineral oil-based, organophosphate esters, and polyalphaolefins (HHS 1997). Release from machinery can occur through faulty seals, hoses, sumps, and reservoirs, or general system failure.

Inadvertent spills of fluids used during construction, such as fuels and lubricants, could contaminate wetland soils and vegetation if not sufficiently contained. To minimize the potential for spills and any impacts from such spills, PCGP's SPCCP (see appendix L) would be implemented. In general, hazardous materials, chemicals, fuels, lubricating oils, and concrete-coating activities would not be stored, nor would refueling operations be conducted, within 100 feet (150 feet on BLM and NFS lands) of a wetland or waterbody in accordance with FERC's *Procedures* (see appendix C) and the SPCCP (see appendix L) except where no reasonable location is possible and additional containment steps have been taken. The SPCCP would be updated with site-specific information prior to construction. Adherence to these plans and procedures would result in effects to the listed Lost River sucker that would be unsubstantial.

Runoff from Facility Surfaces

There are nine contractor and pipe storage yards, one rock source and disposal site, two new temporary access roads, two new permanent access roads, and three aboveground facilities, including the Klamath Compressor Station, within the range of Lost River suckers.

Two of the yards, K-Falls Memorial Dr 1 Yard and K-Falls Memorial Dr 2 / Bair Yard, border the Klamath River, and the K-Falls - Industrial Oil Yard is about 235 feet from the Klamath River which is designated critical habitat for Lost River suckers. The Klamath Compressor Station is about 700 feet from the T Canal for which there are no records of Lost River sucker being present (construction and operation of the compressor station would not affect suckers even if present).

Stored materials at the yards may include: construction mats, fencing materials, fuel and lubricants, stormwater control materials (straw bales, erosion control fabric, silt fence materials, etc.), and other construction materials. The yards would also be used for contractor office trailers and employee parking facilities. Although the yards are previously disturbed industrial sites, stored materials and surface runoff could enter Lost River sucker critical habitat. Runoff from any of these sites would be mitigated through measures provided in PCGP's ECRP (see appendix F).

Operation and Maintenance Activities

Once installed, maintenance of the pipeline would include activities such as aerial inspections, gas flow monitoring, visual inspection of surrounding vegetation for signs of leaks, and integrity management, which includes smart pigging to investigate the interior surface of the pipe for any signs of stress cracking, pitting, and other anomalies (see the ECRP, appendix F). All of the proposed maintenance activities would be outlined in the Operations and Maintenance Plan that would be prepared according to operating regulations in DOT 49 CFR Subpart L, Part 192 and would be completed prior to the Pipeline going in-service. These general maintenance activities would require only surface activities and usage of the existing right-of-way, such as insertion of the pig at one of the pig launching facilities.

The potential stream channel disturbance would occur if an integrity issue with the pipeline were found at a crossing location. If this were to occur, the pipeline would need to be unearthed within the right-of-way and repair work done in-water. Within stream sites, repair work could require isolated flow from the section of pipe that is to be exposed. Typically, repairs would be made to the pipe within the right-of-way (within the trench) or, depending on the site-specific conditions and nature of the repair needed, a reroute around the affected section may be considered.

Impacts would be similar to those discussed above for initial installation except on a much smaller scale, because they would only involve one crossing compared to many crossings. However should repairs be needed out of the standard stream crossing window (i.e., during periods of fish spawning or egg incubation) there would be additional adverse effects to key fish resources at the specific site. The actions would include all relevant BMPs and mitigation, dependent upon site conditions and land ownership. Any future repairs would require additional permit approval from appropriate state and federal agencies which would determine the acceptable parameters of these actions. Such pipeline integrity-based in-water projects are very infrequent.

Vegetation maintenance would be limited adjacent to waterbodies to allow a riparian strip to permanently revegetate with native plant species across the entire right-of-way. To facilitate periodic pipeline corrosion/leak surveys, a corridor centered on the pipeline and up to 10 feet wide would be maintained in an herbaceous state, with scrubs outside of this 10 foot corridor. In addition, trees that are located within 15 feet of the pipeline may be cut and removed from the right-of-way. No vegetation or tree limitations would occur beyond the 30 foot wide corridor in riparian areas (i.e., up to 100 feet of streams on federal lands, and up to 25 feet of streams on non-federal lands). Since most native riparian vegetation along the Pipeline route has been altered by agriculture, the effects of maintaining the 30-foot wide corridor on Lost River sucker instream habitat would be minimal.

Herbicide Application

Herbicides have the potential to cause toxic effects to different sucker life stages and to other aquatic species, causing direct impacts, if used improperly. When herbicides are properly used according to label restrictions and BMPs to control noxious weeds, there is little to no chance of causing injury or mortality to fish or other aquatic organisms.

PCGP would not use herbicides for routine vegetation maintenance. However, following construction, PCGP would implement an Integrated Pest Management Plan (IPM - appendix N to PCGP's POD) that addresses control of noxious weeds and invasive plants across the Pipeline project which would include the selective use of herbicides where necessary to control noxious weeds by limited application from the ground, where allowed by landowners. The Integrated Pest Management Plan was developed in consultation with the ODA, BLM, and Forest Service. The BMPs would minimize the potential spread of invasive species and minimize the potential adverse effects of control treatments. Herbicides would not be applied by aerial or broadcast spraying. Noxious weeds would be removed only by manual methods in the riparian zone adjacent to streams, ditches and canals within the range of Lost River suckers. PCGP would not directly spray, or otherwise apply, herbicides in waterbodies or in riparian zones. The risk of drift would be avoided by selectively applying herbicides from the ground.

Where weed control is necessary along the construction right-of-way, PCGP's first priority would be to employ hand and mechanical methods (pulling, mowing, biological, disking, etc.) applicable to the species to prevent the spread of potential weed infestations, where feasible. To determine if an herbicide is to be used over other control methods, PCGP would base the decision on weed characteristics and integrated weed management principles (Forest Service 2005). If herbicides are used to control noxious weed infestations, they would be used when they are the most appropriate treatment method. Spot treatments and the use of selective herbicides would be utilized to minimize impact to native or non-target species. Permits or approvals for the use of herbicides and adjuvants on federal lands would be obtained prior to use/treatment, as detailed in the IPM (see appendix N to the POD, available upon request). Considering the potential for limited use of herbicides along the route and precautions that would be in place to prevent entry into waters, meaningful negative effects to the Lost River sucker from herbicides would be unlikely to occur.

Cumulative Effects

Within the action area, 100 percent of all lands are non-federal within the John C. Boyle Reservoir-Klamath River watershed, 99 percent are non-federal lands within the Lake Ewauna-Klamath River watershed, and 94 percent are non-federal lands within the Mills Creek-Lost River watershed. Degradation of water quality due to livestock grazing, agriculture, and timber harvest has resulted in severe pollution in Upper Klamath Lake. That in turn has led to algal blooms with increased mortality of suckers when oxygen depletions occur due to eutrophication particularly during summers when high temperatures combine with nutrient loading from pumping diked wetlands and runoff from farms. Past actions that have led to increased mortality have been due to private enterprise on private lands. Cumulative impact to Lost River suckers would include those same or similar actions which are reasonably foreseeable during the next 4 years. Cumulative impact from non-federal actions on non-federal lands are ongoing and will continue into the future. The effect from the construction and operation of the Project is anticipated to be temporary and localized and would not measurably contribute to the current or future cumulative effects upon this species.

Critical Habitat

Designated critical habitat for the Lost River sucker within the Pipeline project area is present only at the Klamath River crossing. The Pipeline would cross the Klamath River at RM 249, which is within critical habitat Unit 1, Klamath County (FWS 2012g). Unit 1 includes Upper Klamath Lake and Agency Lake, together with some wetland habitat; portions of the Williamson and Sprague Rivers; Link River; Lake Ewauna; and the Klamath River from the outlet of Lake Ewauna downstream to Keno Dam. Some or all of the three PCEs noted above (water, spawning and rearing habitat, and food) could be affected during the HDD across the Klamath River if an inadvertent return occurred with release of bentonite into the water column; the same effects to critical habitat that were described as Direct and Indirect Effects, above, would occur.

Only 0.04 acre within the Klamath River riparian zone (extending 117 feet or one site-potential tree height from each river bank) would be affected by construction, and all of that area is in an existing industrial facility.

3.5.5.4 Conservation Measures

Conservation measures have been proposed by PCGP to minimize construction and operation impact to waterbodies and riparian zones. Those measures have been compiled in table 2C in appendix N and apply to Lost River suckers.

PCGP has also proposed measures to rectify, repair, and rehabilitate and otherwise reduce impact to waterbodies and riparian zones once construction of the Pipeline is complete. Those measures have been compiled in table 3C in appendix N.

Details of some of the major conservation measures to be implemented by PCGP are summarized below.

Erosion Control

Many of the conservation measures in table 3C in appendix N focus on erosion control to prevent sediment from entering surface waters. Temporary erosion controls would be installed immediately after vegetation clearing and grading and would be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration is complete. At a minimum, the following temporary erosion control structures would be installed: temporary slope breakers, sediment barriers, mulch, and erosion control fabric. PCGP would install permanent slope breakers consistent with the requirements of FERC's *Plan*. Part of long-term erosion control would include a final cleanup including final grading and installation of permanent erosion control structures. Final cleanup of an area would generally occur within 10 days after backfilling the trench and not be delayed beyond the end of the next recommended seeding season. During final cleanup, PCGP would remove all construction debris and grade disturbed areas to preconstruction grades to the extent practicable. An adequate seedbed would be prepared at the conclusion of cleanup.

Temporary Slope Breakers

PCGP would install temporary slope breakers over the backfilled, recontoured construction right-of-way as specified in FERC's *Plan*. The outfall of each temporary slope breaker would be to a stable, well-vegetated area or to an energy-dissipating device at the end of the slope breaker off the construction right-of-way. Slope breakers reduce runoff velocity, thereby intercepting sediment and allowing it to drop out of suspension. They also can effectively divert runoff away from a disturbed site to a stable outlet (Goldman et al. 1986).

Sediment Barriers

PCGP would primarily rely upon silt fence and staked hay or straw bales to confine sediment to the construction right-of-way. These structures would be used adjacent to wetland and waterbody crossings consistent with the requirements of FERC's *Procedures*. Straw bales and filter fabric (silt fence) can be used together to create a highly effective sediment barrier, a combination that compensates for the limitations of each used in isolation; straw bales provide extra support and the fabric provides greater filtering capability (Goldman et al. 1986).

All straw or hay bales used for sediment barriers would be certified as weed-free. Temporary sediment barriers would be maintained in-place until permanent revegetation measures are successful or until the upland areas adjacent to wetlands, waterbodies or roads are stabilized. The structures would be removed once vegetation in the area has been successfully restored.

Erosion Control Fabric

PCGP would install erosion control fabric (such as jute or excelsior) on waterbody banks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. Although there are no measures specific to pipeline construction, data related to cut-and-fill slopes treated during construction of forest roads indicate varying effectiveness of different types of stabilization measures designed to control surface erosion (EPA 2001). On fill slopes, combining straw mulch and netting decreased erosion by 99 percent. Excelsior mulch alone decreased erosion by 92 percent on fill slopes. On cut slopes, straw mulch by itself decreased erosion in a range from 32 to 97 percent (EPA 2001). Applications of mulches and/or fabric are effective measures promoting slope stabilization until vegetation can successfully be reestablished. These measures also promote plant growth (EPA 2001).

Fish Salvage Plan

Lost River suckers can potentially occur within the construction right-of-way on the Lost River at the time of construction. Since the Lost River would be crossed using dry open-cut technology, fish salvage procedures (see section 3.5.3.4 in coho salmon SONCC ESU) may occur while fish, including Lost River suckers, are within isolated construction sites. Since suckers in general appear to be vulnerable to electroshocking, PCGP's fish salvage plan in the Lost River may have to avoid use of electroshock, relying instead on seining and dip netting as described in section 3.5.3.4.

A *Fish Salvage Plan* has been provided in appendix T. The plan has been developed to minimize adverse effects to listed salmonids (SONCC coho, Oregon Coast coho), non-listed salmonids (Chinook salmon, steelhead, and cutthroat trout) and listed catostomids (Lost River sucker, shortnose sucker). The portions of the plan relevant to salvaging salmonids were adapted from the protocol developed by WSDOT (2011b). The protocol specifies procedures for 1) isolating the work area, 2) removing fish and dewatering the work area, 3) handling, holding, and releasing fish, 4) documenting fish that have been captured, handled, held, and released, and 5) notifying NMFS and FWS. The same protocol would generally be followed during salvage of Klamath Basin suckers. However, salvage operations within the crossing where these suckers may be present would include the latest *Handling Guidelines for Klamath Basin Suckers* (Reclamation 2008). These guidelines may be updated frequently. Some of the main factors in handling are the requirement of having a 0.5 percent saline solution of un-chlorinated well water to place any captured listed sucker in should it be collected during fish salvage operations. Aeration would also be supplied and the container a sucker is placed into would have been coated with a commercially available slime coat. Fish would be retained in this solution until released upstream of the capture site unless otherwise indicated through agreement with FWS.

OHV Barriers

Limiting OHV access would reduce potential increased sedimentation to streams and human access to sensitive fish areas. In accordance with FERC's *Plan*, the applicant must offer to install and maintain measures to control unauthorized vehicle access to the right-of-way to each landowner or manager of forested lands. Such measures may include signs; fences with locking gates; slash and timber barriers, pipe barriers, or a line of boulders across the right of way; and conifers or other appropriate trees or shrubs across the right-of-way. If allowed by the landowner, and if available, slash, stumps, and/or logs would be placed on the right-of-way within the riparian zones to discourage OHV crossings of streams and to provide carbon and nutrients. If not allowed, PCGP would discuss with the landowner the use of other methods, as noted above. At a minimum, the area would be revegetated and re-seeded.

Streambank Stability

The root network of trees adjacent to streambanks is essential to maintaining streambank stability (WDNR 1997). Because root strength decreases significantly at distances beyond one-half the tree crown diameter, trees promoting streambank stability lie within half a tree crown diameter from the streambank. Trees within 25 feet of the streambank are assumed to promote streambank stability (WDNR 1997). Generally, trees that must be removed during construction would be cut at ground level with the roots left in place, except where located within the trenchline. Although roots would decay overtime, streambank stability would be retained by their presence until revegetation is successful.

Streambank Restoration

PCGP's ECRP (see appendix F) describes the measures that would be used to stabilize streambanks crossed by the Pipeline. PCGP would not use riprap to stabilize streambanks. The alignment has been designed at waterbody crossings to be as perpendicular to the axis of the waterbody channel as engineering and routing constraints allow, minimizing streambank disturbance and avoiding parallel stream alignments or multiple stream crossings. Immediately after installation of a waterbody crossing, the contours of the streambed, shoreline, and streambanks would be restored to preconstruction configurations (i.e., contour/elevations) to restore the physical integrity/condition of these features and to minimize the loss of stream complexity.

PCGP has completed a scour analysis for the Pipeline project that would be used to ensure that appropriate pipeline burial depths and cover design parameters beneath channel streambeds and within adjacent floodplains are utilized, so that the effects on natural stream processes would be avoided or minimized. The Pipeline's scour analysis, which was completed by GeoEngineers, was included in PCGP's September 2017 FERC certificate application.

PCGP would install erosion control fabric (such as jute or excelsior) on streambanks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. The erosion control fabric to be used on streambanks would be designed for the proposed use and would be approved by PCGP's environmental inspectors (EIs).

Consistent with the FERC's *Procedures* (section V.C.3.), during streambank restoration/recontouring, the streambanks would be returned to their preconstruction contours or to a stable configuration. The Lost River is included in the application of the conservation measure. Streambank revegetation measures, including supplemental riparian planting procedures are also outlined in the ECRP. The shrubs and trees planted at each site would be determined at the time of planting based on the moisture regimes and site-specific conditions at each planting location and landowner requirements.

In-stream Gravel

Pipeline trenches across the Lost River and other perennial waterbodies within the Upper Klamath River Subbasin and Lost River Subbasin would be backfilled with material removed from the trench with the upper one foot of the trench backfilled with clean gravel or native cobbles of a size appropriate for resident fish, including suckers. The bottom and banks would be returned to preconstruction contours, banks would be stabilized, and temporary sediment barriers would be installed before returning flow to the waterbody channel.

Stream Crossing Risk Matrix

The FWS expressed concerns that more detailed site-specific information on bank material, streambed composition, shoreline vegetation, and other information is needed to adequately ensure that actions occurring at a stream crossing do not significantly increase streambank erosion and streambed instability. Follow-up surveys, site designs, and additional site actions resulting from these surveys as described below would reduce risk of stream bank and bed instability in Lost River sucker habitat to unsubstantial adverse effects levels.

PCGP, in response to these requests, has conducted an assessment of crossing conditions of all streams suitable for analysis based on the FWS risk matrix (GeoEngineers 2017d, 2017e, and 2018a). GeoEngineers, using a combination of field and GIS data, rated proposed stream crossings based on the matrix along the entire route including 19 stream, ditch, and canal crossings in the range of Lost River sucker. The matrix has two axes rating the crossing based on the impact potential at the crossing and the relative stream response potential at the crossing. Each crossing was rated as low, medium, or high for each of the two axes (all stream crossings were placed into one of nine categories, such as Low–Low, Low–Medium, and Medium–High).

No crossing within the range of Lost River sucker was rated as having both high risk of Pipeline project impact potential (i.e., high risk of impacts and high risk of site response potential) and high risk of stream and site response potential. For any crossing in this category, PCGP would develop a site-specific crossing plan, similar to that required by FERC for stream crossings over 100 feet wide. All crossings that would have an open cut within the range of the Lost River sucker had moderate or low ratings for the two categories. The Lost River crossing was rated moderate project impact potential and high for the relative stream response potential.

Those stream crossings that were rated to have a low or moderate project impact potential would be crossed using project-typical BMPs. The remaining stream crossings would have a variety of site-specific BMP actions taken to reduce the probability of stream bank and bed erosion or instability from project actions (see pre-construction surveys below). Stream crossings that are unstable can ultimately adversely affect aquatic resources from such factors as loss of local habitat, impacts to downstream habitat from addition of high unstable sediment, and increased recovery time of the specific site to stable conditions.

A pre-construction survey would be conducted by a technically qualified team on all stream crossings to confirm and clarify conditions developed in the aforementioned matrix analysis. This team would be composed of professionals qualified to assess terrestrial and aquatic habitat and the geotechnical and geomorphic conditions relative to pipeline construction across stream channels and ditches. Following these surveys, if significant changes were to occur to parameters of the risk matrix for a crossing, changes would be made to risk level and appropriate final methods of crossing and BMPs made at each stream crossing. If any crossing is moved into the "high" project impact and "high" stream response risk matrix category, a site-specific crossing design would be developed for that site. Construction would then move forward as described in permit documents including implementation of special additional BMPs, as described in GeoEngineers (2017d, 2017e, and 2018a), depending on individual site conditions. Special additional BMPs may include such actions as changes in bank material and bank angle, specific substrate composition used, plants used on the bank, artificial stabilizing bank material, rootwad enhancement, and various other actions.

As a follow-up measure to help ensure crossing actions would not adversely affect stream bank and channel structure, PCGP would monitor stream crossings to ensure long-term success of the restoration, maintenance of fish passage, and to identify channel erosion, scour or migration that could destabilize the site or expose the pipeline. As requested by FERC, PCGP developed a monitoring plan (GeoEngineers 2017e, 2018a) following consultation with a representative from FWS and NMFS (Castro 2015). The monitoring plan would be customized, where necessary, to address risks of stream crossings identified in the Risk Analysis and those identified in subsequent preconstruction surveys.

Monitoring would consist of:

- Annual visits to all stream crossings, regardless of risk level, as part of PCGP's monitoring of pipeline integrity. These visits would be completed by PCGP staff and would note any obvious signs of channel erosion, pipeline exposure, or major shifts in restoration elements. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.
- Aerial reconnaissance would be completed annually for the life of the Pipeline and stream crossings would be reviewed for major landscape changes such as channel migration and excessive erosion. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.
- Quarterly site visits to all sites in the Orange management category (see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross sectional area.
- Annual site visits to 15 percent of all sites in the Blue management category and 100 percent of all sites in the Yellow management category (see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual site visits to 50 percent of the sites in the Yellow and 100 percent of sites in the Orange management category (see GeoEngineers 2018a) by a geo-professional in Years 3, 5, 7, and 10 to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline project, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.

- Observations would be made during all site visits on the effects of cattle/elk browsing on restoration success, and of impacts associated with recreational use.
- Revegetation planning along the right-of-way is detailed in the ECRP. The ECRP describes monitoring and performance standards for revegetation.
- Records would be maintained annually to document any significant hydrologic events (flow or rainfall) that occur in between site visits. This shall be done to better understand the site response to moderate or large flood events. As gauging stations are extremely limited over the majority of the crossings along the Pipeline route, rainfall records would be used to identify the potential flooding that may occur in between scheduled monitoring events. These climatic events would be considered during annual monitoring when evaluating site response.
- Unscheduled site visits may be completed at stream crossings on BLM and USFS jurisdiction following localized rainfall events exceeding a 25-year rainfall intensity to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual reporting in Years 1, 2, 3, 5, 7, and 10 following construction would be provided to outline observations of stream crossings and any remedial action taken to restore site conditions.
- Monitoring frequency and locations may be modified in response to demonstrating site restoration success in the Annual Monitoring reports

Overall, these actions would reduce potential adverse effects from bank and bed stability to the listed Lost River sucker to unsubstantial levels.

3.5.5.5 Determination of Effects

Species

The Pipeline project **may affect** Lost River suckers because:

- Lost River suckers occur within the Upper Klamath and Lost River Subbasins, which would be affected during construction of the proposed action.

While several Pipeline project actions are not likely to cause adverse effects, those resulting effects from Pipeline project components that are **likely to adversely affect** Lost River suckers include:

- Lost River suckers could occur in 19 waterbodies crossed by dry open-cut construction in the Lake Ewauna-Klamath River watershed and in 13 waterbodies west of MP 214.38 (including the Lost River) crossed in the Mills Creek-Lost River watershed and be indirectly affected by elevated suspended sediment levels, streambank erosion and stability, and aquatic nuisance species introductions; and
- adults and juveniles subject to fish salvage within the isolated construction sites at 31 ditches crossed by dry-open cuts and the Lost River could be affected if electroshocking is used and stressed if seining is used.

Critical Habitat

The Pipeline project is **not likely to adversely affect** designated critical habitat for the Lost River sucker because:

- HDD would avoid critical habitat in the Klamath River.

3.5.6 Shortnose Sucker

3.5.6.1 Species Account and Critical Habitat

Status

The shortnose sucker was listed as a federally endangered species on July 18, 1988 (FWS 1988). The shortnose sucker was listed as endangered because of the loss of habitat and access to historical range, resulting in a declining population. A five-year review was released in August 2013 recommending no change to the current listing status as endangered (FWS 2013o).

Threats

Lost River suckers and shortnose suckers were considered together in the final rule listing both as endangered species. Numerous factors in both species' decline were cited by FWS (1988) including historical over-fishing, dams limiting upstream movements and access to spawning habitats, introduction of non-native species that compete (fathead minnows) and prey on suckers (yellow perch, bullheads, largemouth bass, and various lepomid sunfish), and degradation of water quality due to livestock grazing, agriculture, and timber harvest. Pollution in Upper Klamath Lake has led to algal blooms with increased mortality of suckers when oxygen depletions occur due to eutrophication. Status assessments conducted in 2001 and 2002 (FWS 2002a) concluded that the shortnose sucker was threatened by the following: 1) drastically reduced adult populations and reduced range; 2) extensive habitat loss, degradation, and fragmentation; 3) small or isolated adult populations as a result of dams; 4) poor water quality; 5) lack of sufficient recruitment; 6) entrainment into irrigation and hydropower diversions; 7) hybridization with the other native Klamath sucker species; 8) potential competition with introduced exotic fishes; and 9) lack of regulatory protection.

Many of these same issues remained as factors threatening the species' recovery in 2013 (FWS 2013l). Regulatory protection of aquatic habitats inhabited by shortnose suckers has improved with implementation of various state (Oregon and California) and federal laws that minimize effects of actions on the species and habitat during project planning and consultation. However, shortnose suckers continue to be affected by adverse water quality, habitat degradation, toxicity from blue-green algae, and entrainment into irrigation and hydropower diversions. Added to the earlier threats listed is climate change which is predicted to increase flows during winter months but decrease flows during the spawning period, from March or mid-April through May (FWS 2013l).

Approximately 400 habitat restoration projects have been completed or are planned for the Upper Klamath Lake Basin to help offset historical habitat loss. Shortnose suckers have been observed using the 6,000-acre habitat area of Williamson River Delta to Upper Klamath Lake where restoration has occurred. Additionally, the Chiloquin Dam on the Sprague River in 2008 was removed, which unblocked 75 miles of stream believed to be migration and spawning habitat. Because these efforts are so recent, population-level effects have not yet been observed. However, these actions and others are believed to be significant toward the improved status of this species (FWS 2013l). Nevertheless, poor water quality in Upper Klamath Lake and the Lost River continues to threaten the viability of the species. The water quality issues are most pronounced during summers when high temperatures combined with nutrient loading from pumping diked wetlands and runoff from farms, roads, and other sources cause detrimental water quality for fish species. Also, lake sediments create hypereutrophic conditions which lead to depletions of dissolved oxygen and fish die-offs (FWS 2007f, 2013l). A cyanobacterium, now present in Upper Klamath Lake, undergoes massive algal blooms; photosynthesis during daylight can supersaturate water with dissolved oxygen and respiration at night can deplete dissolved oxygen with both events deleterious to shortnose suckers (FWS 2013l). Blue-green algal or cyanobacter toxins (Microcystin) have recently been found to affect liver, intestines, kidneys, heart, spleen, and gills of suckers (FWS 2013l).

Population levels were estimated to be about 2,700 individuals in 1984 prior to listing. Although this estimate is likely inaccurate, it was substantially lower than historic population levels (FWS 2013l). This decrease in abundance was due to the following factors: habitat loss of approximately 77 percent of historic range, restricted access to spawning habitat, overharvest, and increased rates of mortality resulting from entrainment in water management structures and severely impaired water quality (FWS 2007f, 2013l). Population levels in Upper Klamath Basin are not well known, but production is affected by lack of suitable spawning habitat and spawning success. The Tule Lake population has better survival conditions than that of the Upper Klamath Lake system primarily due to better water quality. Length-frequency analysis suggests that the last substantial recruitment to the spawning population occurred during the late 1990s (FWS 2012f).

Species Recovery

Actions described in the recovery plan that would aid in the delisting of the shortnose sucker include improving habitat conditions through rehabilitating riparian areas and improving land management practices in the Klamath Basin watershed, developing and achieving water quality and quantity goals, and improving fish passage, spawning habitat, and other habitat conditions.

A recovery plan for Lost River sucker and shortnose sucker was finalized on March 17, 1993 (FWS 1993b). Since then additional information prompted revision of the recovery plan (FWS 2012f). The recovery program goal is to stop the population decline and enhance Lost River sucker and shortnose sucker populations so that ESA protection is no longer necessary.

At the time of listing, population declines were related to loss or degradation of spawning, rearing, and adult habitats. Only about 25 percent of the original habitat remains. Reductions in habitat quality compound the effects of reduced habitat quantity and availability on Lost River sucker and shortnose sucker abundance. In addition to habitat, factors currently limiting species recovery include high mortality of larvae and juveniles due to reduced rearing habitat, entrainment in water management structures, poor water quality, and adverse effects (predation, competition) from non-native, introduced fish species. Compounding effects from drought and water diversions affect lake water levels and unscreened water diversions and fish entrainment continue as threats. Substantial entrainment occurs at the river gates of the Link River Dam (FWS 2013l). Some of the shortnose suckers that pass through the gates pass downstream to the Keno Reservoir and farther along the Klamath River where they cannot return upstream. Nevertheless, there is a small population inhabiting Lake Ewauna, probably fish that survived passage through the Link River Dam and other hydroelectric canals and turbines (FWS 2013l).

Adult populations are limited by extremely low recruitment as well as by high levels of stress and mortality associated with severely impaired water quality. As a whole the species is potentially limited by the lack of habitat connectivity (FWS 2012f). However, one of the main passage barriers that reduced access to 95 percent of its river spawning habitat, the Chiloquin Dam on the Sprague River, was removed in 2008 (NMFS and FWS 2013).

Demographic-based objectives include increasing larval production, individual survival, and recruitment to spawning populations, and ultimately increasing abundance in spawning populations. The objectives of restoring spawning and nursery habitat, expanding reproduction, reducing the negative impacts from water quality on all life stages, clarifying the effects of other species on all life stages, reducing entrainment, and establishing auxiliary populations comprise the threats-based objectives. The recovery strategy is intended to produce and document healthy, self-sustaining populations by reducing mortality, restoring habitat (including spawning, larval, and juvenile habitats), and increasing connectivity between spawning and rearing habitats. It also involves ameliorating adverse effects of degraded water quality, disease, and non-native fish. The plan provides areas of emphasis and guidelines to direct recovery actions (FWS 2012f).

There are two recovery units for shortnose suckers, the Upper Klamath Lake Unit and Lost River Basin Unit (FWS 2012f). Upper Klamath Lake Unit includes all shortnose suckers within the lake, tributaries to Upper Klamath Lake, and reservoirs within the Klamath River including Keno Reservoir and populations below Keno Reservoir. The Lost River Basin Unit includes Clear Lake Reservoir and tributaries including Willow Creek, Boles Creek, Tule Lake, Gerber Reservoir and tributaries, and the Lost River mainstem (FWS 2012f) even though the Lost River is not included in designated critical habitat. The Lost River proper includes individual suckers in the mainstem downstream from the Clear Lake Dam to Anderson-Rose Diversion Dam, including the Lost River tributary Miller Creek, downstream from Gerber Dam. The population in the Lost River drainage below Clear Lake Dam is comprised mostly of adults (FWS 2012f).

Life History, Habitat Requirements, and Distribution

Shortnose suckers are native to the Upper Klamath River Basin and Lost River Basin but have adapted to lake habitats and spawn in larger tributary rivers associated with lakes (Moyle 2002), generally from February through early May. Larval stages persist from May through July (Reclamation 2007). Although Lost River suckers may live to 43 years old, shortnose suckers are shorter-lived, surviving to 25 years old; females attain sexual maturity at 4 years old while Lost River sucker females are sexually mature at 6 to 9 years old (Reclamation 2007). Shortnose sucker females may produce 72,000 eggs per spawning season, generally fewer than Lost River suckers.

River spawning habitats include riffles or runs with gravel or cobble substrate, with moderate flows, and in water 4 to 51 inches deep. Shortnose suckers have historically spawned in lakes, particularly at springs occurring along the shorelines (FWS 2007f). Currently, shortnose suckers are found in Upper Klamath Lake and its tributaries, Klamath River downstream to Iron Gate Reservoir, Clear Lake Reservoir and its tributaries, Gerber Reservoir and its tributaries, the Lost River, and Tule Lake. In the Upper Klamath Lake watershed, shortnose sucker spawning runs are primarily limited to the Sprague and Williamson Rivers, although spawning runs may also be present in the Wood River and in Crooked Creek. Shortnose sucker spawning has also been recorded in the Clear Lake watershed (FWS 1988) and Gerber Reservoir watershed (FWS

1994a). Adult and juvenile shortnose suckers prefer turbid, highly productive but shallow lakes that are cool in the summer with adequate dissolved oxygen and water that is moderately alkaline (FWS 2007f).

As discussed for Lost River suckers, a small population of several hundred adult shortnose suckers exists in Tule Lake but, the population in the Lost River drainage below Clear Lake Dam is comprised mostly of adults, and the Lost River functions as a population sink with no likely chance of being self-sustaining because of low recruitment and lack of access to spawning habitats (FWS 2012f). Shortnose suckers have resident populations in both lake and some riverine habitats, including Lost River, Willow Creek, and other tributaries of Clear Lake and Gerber Reservoir (Reclamation 2007). Shortnose suckers have been documented spawning below Anderson-Rose Dam, in Big Springs near Bonanza, and at the terminal end of the West Canal as it spills into the Lost River. Suitable spawning habitats with riffle areas and rocky substrates include the spillway area below Malone Dam, immediately upstream of Keller Bridge, immediately below Big Springs in the Lost River, below Harpold Dam, and adjacent to Station 48 (Reclamation 2007). Seasonal movements of shortnose suckers are similar to those described for Lost River suckers.

Population Status

At the time of the Final Rule, estimates of the shortnose sucker population could not be made. Nevertheless, there was very little recruitment to the population and that, plus mortality from fish die-offs and fishing, indicated a declining trend (FWS 2007f). Continued efforts to estimate shortnose sucker populations have been based on several approaches which indicate a declining population with nearly no measurable recruitment in Upper Klamath Lake and limited survival of adults past the age of sexual maturity. Shortnose suckers attain sexual maturity when 4 to 6 years old and survival after entering the spawning population was estimated at only 3.6 years indicating insufficient time for reproduction to sustain the population (FWS 2007f).

For several years there was no indication that shortnose suckers continued to inhabit Tule Lake, but in 1991 both sucker species were observed spawning below Anderson-Rose Dam, and sampling at Tule Lake in the early 1990s determined that small populations of the two species were present (Reclamation 2007). Estimates of shortnose sucker annual survival rates in Upper Klamath Lake between 1995 and 2004 indicate that the population is likely to be decreasing, although the survival estimates appear to be imprecise (Reclamation 2007).

Shortnose sucker spring-spawning abundance in 2007 was estimated to be 42 percent and 48 percent of 2001 abundancies for males and females respectively (FWS 2012f). Tagging studies conducted on Lost River suckers and shortnose suckers in Gerber Reservoir and Clear Lake (both impoundments are connected to the Lost River below Gerber Dam and Clear Lake Dam, respectively) indicated that numbers of large adult suckers of both species had declined since 2000. Declines in large adult shortnose suckers have been particularly pronounced in Clear Lake Reservoir, possibly due to poor recruitment from younger age classes prior to 2000 (Barry et al. 2009).

Hewitt et al. (2015) estimated λ and other population demographic properties for the adult spawning population of shortnose suckers in Upper Klamath Lake from 2001 to 2012 (figure 3.5.6-1). In the figure, the population rate of change ($\lambda = N_{t+1} / N_t$) indicates positive or negative growth. When $\lambda > 1$, the rate of change is positive and the population (N) has grown from N_t to N_{t+1} in the next time interval. Alternatively, the population is stable when $\lambda = 1$, but when $\lambda < 1$, the population has declined from N_t to N_{t+1}. The data show a declining adult spawning population but does not indicate changes in the whole population because it does not account for changes in the numbers of juveniles from year to year. With additional demographic data, Hewitt et al. (2015) concluded that current spawning population is a subset of the individuals that were present in the late 1990s. Both male and female shortnose suckers appear to have reached senescence. Low estimates of survival from 2010 to 2012 may indicate increased mortality is occurring as a result of older age classes.

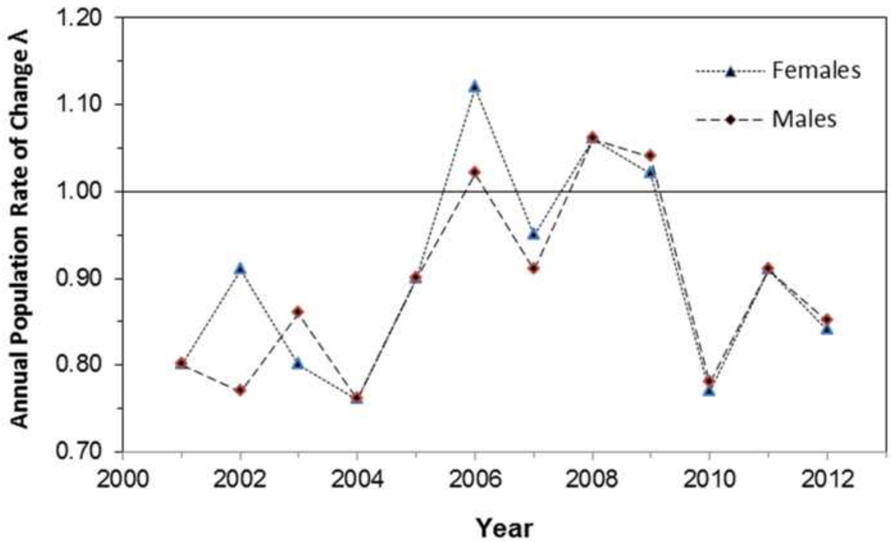

Figure 3.5.6-1. Estimates of Annual Population Rate of Change (λ) for Shortnose Suckers from the Spawning Population in Upper Klamath Lake, Oregon. The Population is declining when λ < 1 (data from Hewitt et al. 2015).

Critical Habitat

Critical habitat for the Lost River sucker and shortnose sucker was proposed by FWS in 1994 (FWS 1994a). Critical habitat for Lost River and shortnose suckers was re-proposed in 2011 and designated in 2012 (FWS 2012g). Along the route of the Pipeline, designated critical habitat for Lost River and shortnose sucker (Unit 1 in Klamath County) includes the Link River, Lake Ewauna, and the Klamath River downstream to Keno. Unit 2 in Klamath and Lake Counties, Oregon and Modoc County, California includes Clear Lake Reservoir and tributaries and Gerber Reservoir and tributaries, but does not include Tule Lake and its tributary, the Lost River. For reasons described above (blockage by Anderson-Rose Diversion Dam), neither Tule Lake or Lost River provides spawning habitats or supports viable self-sustaining populations of Lost River or shortnose suckers (FWS 2012g). The Pipeline does not coincide with critical habitat in Unit 2.

In Unit 1 (Upper Klamath Lake), there are 13 miles of critical habitat on federal land, less than 1 mile on state land, and 106 miles on lands of private/other ownership. In Unit 2 (Lost River Basin), there are 23 miles of critical habitat on federal land, less than 1 mile on state land, and 3 miles on lands of private/other ownership (FWS 2012g).

PCEs of critical habitat include (FWS 2012g):

1. Water. Areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity. Water must have varied depths to accommodate each life stage: shallow water (up to 3.28 ft [1.0 m]) for larval life stage and deeper water (up to 14.8 ft [4.5 m]) for older life stages. The water quality characteristics should include water temperatures of less than 82.4°F (28.0°C); pH less than 9.75; dissolved oxygen levels greater than 4.0 mg/l; low levels of microcystin; and un-ionized ammonia (less than 0.5 mg/l). Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph.
2. Spawning and rearing habitat. Streams and shoreline springs with gravel and cobble substrate at depths typically less than 4.3 ft (1.3 m) with adequate stream velocity to allow spawning to occur. Areas containing emergent vegetation adjacent to open water provide habitat for rearing and facilitate growth and survival of suckers as well as protection from predation and protection from currents and turbulence.
3. Food. Areas that contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates.

3.5.6.2 Environmental Baseline

Analysis Area

For shortnose suckers, the riverine analysis area is limited to fresh waterbodies within the Upper Klamath Subbasin (HUC 18010206; see Lost River sucker figure 3.5.5-2A) and Lost Subbasin (HUC 18010204; see figure 3.5.5-2B). The riverine analysis area includes two components: 1) the water column and substrate of all waterbodies crossed by the Pipeline from the point of crossing to the extent downstream where water quality is adversely affected by turbidity generated during construction and sediment generated by runoff from the construction right-of-way; and 2) waterbodies' associated riparian zones affected in the short-term during construction and in the long-term by operation. The riverine analysis area for the shortnose sucker includes two perennial flowing river crossings (Klamath and Lost River) and 106 intermittent streams, ditches, and canals that would either be crossed or are in the right-of-way. The two perennial flowing rivers likely have shortnose suckers present. In addition to the 2 perennial waterbodies, the Pipeline will also cross 83 intermittent streams, ditches and canals; 23 additional intermittent streams, ditches, ponds and canals would be adjacent to the Pipeline, within the construction right-of-way, but not crossed. There is no information to indicate that shortnose suckers occur in any of these intermittent waterbodies but they are included in the riverine analysis area for shortnose suckers.

Species Presence

Shortnose suckers are found in Upper Klamath Lake and its tributaries, Klamath River downstream to Iron Gate Reservoir, in Clear Lake Reservoir and its tributaries, Gerber Reservoir and its tributaries, the Lost River, and Tule Lake (FWS 2013l). Shortnose sucker spawning has also been recorded in the Clear Lake watershed (FWS 1988) and Gerber Reservoir watershed (FWS 1994a). In the Upper Klamath Subbasin (HUC 18010206) shortnose sucker are found in the Klamath River as far downstream as Copco Reservoir and possibly Iron Gate Reservoir. In the Lost River Subbasin, they are found in the Lost River mainstem below Anderson-Rose Diversion Dam, above Malone Dam, and in Clear Lake Reservoir (Moyle 2002).

Shortnose suckers spawn in the Lost River and are present in John C. Boyle Reservoir, downstream from the pipeline crossing at RM 225 (NRC 2004). In addition to collections of shortnose suckers in John C. Boyle Reservoir, ORBIC (2012) cites records of spawning in the Link River. Shortnose suckers have been documented from Lake Ewauna and in the Lost River Diversion Canal. Currently, shortnose suckers migrate a short distance from Tule Lake to spawn in the Lost River below Anderson-Rose Diversion Dam (RM 17.4) south of Merrill and approximately 7.6 river miles from the pipeline crossing of the Lost River (ORBIC 2017b). Suckers also spawn in the Lost River below Malone Dam, downstream from Clear Lake Reservoir. A population inhabits the Tule Lake sumps at the terminus of the Lost River (FWS 2007f). That population is isolated from upstream spawning habitats in the Lost River by the Anderson-Rose Diversion Dam and the population is not self-sustaining (FWS 2007f). As of 2006, shortnose suckers had been documented in the Lost River from the confluence with Miller Creek to Tule Lake, a reach that coincides with the proposed pipeline crossing of the Lost River (FWS 2013l). Shortnose suckers continue to occupy the Lost River below Anderson-Rose Diversion Dam to Tule Lake (Hodge and Buettner 2009).

Within the Pipeline project area, the shortnose sucker has been documented within the Klamath River from Klamath Falls to Keno Reservoir. The Pipeline would cross the Klamath River at RM 249. The shortnose sucker is also known to be present from Tule Lake Sump and Clear Lake Reservoir in northern California, which are connected by the Lost River. Tule Lake Sump is at the lower terminus of the Lost River and the population in Tule Lake is isolated from upstream spawning areas by multiple dams including blockage by the Anderson-Rose Diversion Dam.

Historically, dewatering of canals, laterals, and drains has included biological monitoring and salvage of listed species, as needed. Canals, laterals, and drains are dewatered at the end of irrigation season which includes capture and relocation (salvage) of suckers from the canal system after dewatering occurs. Nearly all canals, laterals, and drains are either dewatered after the irrigation season, before April and after October, or have the water lowered for inspection and maintenance (NMFS and FWS 2013). Canals remain dewatered until the following spring (as early as late March) except for the input of localized precipitation-generated runoff (NMFS and FWS 2013). Reclamation’s fish salvage efforts focus on the A Canal forebay in front of the fish screen, C4 Canal, D1 Canal, and D3 Canal within the Klamath Irrigation District, and J Canal within the Tule Lake Irrigation District (NMFS and FWS 2013). The Pipeline would cross the C-4-E Lateral at MP 201.63, the C-4 Lateral at MP 204.12, the C-4-F Lateral at MP 204.33, and the C-4-C Lateral at MP 205.50 in the Lake Ewauna-Klamath River watershed. In addition, the Pipeline would cross the C Canal at MP 205.96 and the C-4-7 Lateral at MP 207.40 in the Mills Creek-Lost River watershed. All six canals and laterals are presumed to be associated with the C4 Canal and may be occupied by shortnose suckers prior to dewatering. The Pipeline would not cross the A Canal, D1 Canal, the D3 Canal, or the J Canal.

Past efforts have shown that salvage of suckers is practicable in some locations, but numbers of salvaged suckers are highly variable among years and sites (NMFS and FWS 2013). Occurrence of shortnose suckers in canals and ditches operated and maintained by Reclamation is possible if they are crossed before dewatering begins in October. However, based on the unpredictability of shortnose sucker occurrence at any one site at any specific time, there is no way to anticipate the species’ presence during construction.

All canals, laterals, and drains operated and maintained by Reclamation would be crossed using conventional bores, thus avoiding any instream construction and conflicts with shortnose suckers if present. Irrigation ditches and roadside ditches on private land would be crossed by dry open-cut construction if water is present at the time. The connectivity of those ditches with canals, laterals, and drains operated and maintained by Reclamation is unknown. Because of their small size and function as agricultural drains, shortnose suckers are not expected to occur. A total of 26 streams/ditches in the Lake Ewauna-Klamath River watershed and 59 streams/ditches in the Mills Creek-Lost River watershed would be crossed (85 total) by the Pipeline. The right-of-way would not cross but would be adjacent to 23 additional streams/ditches in the two watersheds. Altogether, the Pipeline would potentially affect 108 waterbodies in the range of the shortnose sucker included in table 3.5.5-1 (in Lost River sucker section 3.5.5). All but the Klamath River and Lost River have intermittent flow. There are 106 intermittent streams or ditches between MPs 188.9 and 228.1; 58 would be crossed by dry open cutting and 25 of them would be crossed using a conventional bore (with no instream construction). Twenty-three intermittent streams/ditches/canals would not be crossed but are present within the construction right-of-way (see table 3.5.5-1). They are also expected to be dry at the time of construction.

Habitat

The Lost River has been highly altered to meet the needs of agriculture and reduce the threat of flooding, and therefore habitat is fragmented and disconnected by dams lacking fish passage (NMFS and FWS 2013). Much of the water flowing through the lower Lost River channel comes from Upper Klamath Lake through the A Canal. Consequently, water in the Lost River is high in nutrients and is reused many times by different users causing nutrient concentrations to be increased. Water flowing in the Lost River eventually empties into the Tule Lake NWR as return flow from irrigation (no water is released through the Anderson-Rose Diversion Dam) and can be pumped to the Lower Klamath NWR before flowing to the Klamath River via the Klamath Straits Drain (NMFS and FWS 2013). The extensive alterations of the Lost River watershed, along with inputs from Upper Klamath Lake and agricultural drainage, have contributed to seasonally poor water quality and the Lost River is listed by the State of Oregon for exceedances in temperature, dissolved oxygen (DO), pH, algal biomass, and ammonia toxicity (NMFS and FWS 2013).

Dams continue to limit passage and sucker migration, impose isolation of subpopulations, and decrease available spawning habitats which raise the possibility of facilitating hybridization between several sucker species (Reclamation 2007). Dams may also cause stream channel changes, alter water quality, and provide habitat for exotic fish that prey on suckers or compete with them for food and habitat (Reclamation 2007). Although there are seven major dams in the Klamath Basin that may affect the migration patterns of listed suckers, only the Link River Dam has been recently equipped with a fish ladder that was designed specifically for sucker passage (Reclamation 2007). Fish ladders are present at John C. Boyle and Keno Dams and, although suckers have been observed to use the ladders, they were not designed for sucker passage and generally are inadequate for sucker passage (Reclamation 2007).

The Link River Dam regulates water flows downstream to Lake Euwana, Keno Reservoir, and the Klamath River. The river gates on the dam do not protect fish from becoming entrained and numerous juvenile suckers are drawn through the dam gates. Shortnose suckers that survive passing through the hydroelectric facilities either die due to poor summer water quality conditions or pass downstream into the Klamath Reservoir. At that point, fish cannot return and are believed to be lost from the breeding population (FWS 2007f).

Adverse water quality is the most critical threat to the shortnose sucker (FWS 2007f). Klamath River and Klamath Lake have been designated as water quality impaired, including for nutrient loads which are enhanced by drainage of irrigation water from agricultural lands adjacent to Klamath Lake. Construction of dikes and drainage systems converted wetlands to agricultural use. Soils high in organic content were subject to mineralization processes which released nutrients into the aquatic system, especially phosphorous and nitrogen (Rykbost and Charlton 2001).

High levels of phosphorous in Klamath Lake have led to extreme eutrophication events that promote algal blooms dominated by the blue-green algae *Aphanizomenon flos-aquae* that reach or nearly reach theoretical biological maxima (NRC 2004). As a consequence, portions of Upper Klamath Lake develop conditions of oxygen depletion or are anoxic, and accumulate high concentrations of ammonia, which has resulted in mass mortality of fish, including adult suckers (NRC 2004). Shortnose suckers are likely to experience high mortality if exposed to one or more of the following: pH 9.8 or higher, ammonia (unionized) concentration 0.34 mg/l or higher, water temperatures 29.4°C (≥85°F) or higher, and DO concentrations 2.3 mg/l or less (Bellerud and Saiki 1995). Seasonally low DO concentrations occur throughout the Lost River and can be especially low in reservoirs where concentrations < 2 mg/L have been reported as lasting from a day to several weeks in Anderson-Rose, Harpold, and Wilson Reservoirs, with DO concentrations near 0 mg/L observed in some reservoirs (NMFS and FWS 2013).

No assessments have been conducted for either of the two fifth-field watersheds that would be crossed by the Pipeline in the Lost Subbasin: Lake Ewauna-Klamath River (HUC 1801020412) and Mills Creek-Lost River (HUC 1801020409). Likewise, no stream reaches have been sampled under ODFW's Aquatic Inventories Project in either of the fifth-field watersheds. Nevertheless, modifications and degradation of aquatic habitats have been documented by FWS (1993b and 2012f), USGS (Dileanis et al. 1996), Reclamation (2007), and the NRC (2004), among others.

There are no recent long-term water discharge data for waterbodies in the Lost River watershed. The A Canal connects the Link River to the Lost River via the B Canal. According to USGS Gage 11507200, there is no flow in the A Canal between November and March (see figure 3.5.5-4, in section 3.5.5, Lost River sucker), consistent with periods of water diversions from the Klamath River, discussed above. Adequate flow and habitat conditions in the Lost River are likely during the spring and summer with higher river flows supplemented by releases from Clear Lake and Gerber reservoirs (NMFS and FWS 2013). Irrigation releases typically start in April. Flows in the Upper Lost River are very low during the fall and winter because flows from Clear Lake and Gerber reservoirs are considerably reduced, but winter flows do increase downstream from tributary and spring contributions (NMFS and FWS 2013).

Critical Habitat

Designated critical habitat for the shortnose sucker is present within the Pipeline project area. The Pipeline would cross the Klamath River at RM 249, which is within critical habitat Unit 1, Klamath County (FWS 2012g). Unit 1 includes Upper Klamath Lake and Agency Lake, together with some wetland habitat; portions of the Williamson and Sprague Rivers; Link River; Lake

Ewauna; and the Klamath River from the outlet of Lake Ewauna downstream to Keno Dam. PCEs include (FWS 2012g):

1. **Water.** Areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity.
2. **Spawning and rearing habitat.** Streams and shoreline springs with gravel and cobble substrate at depths typically less than 1.3 meters (4.3 feet) with adequate stream velocity to allow spawning to occur. Areas identified in PCE 1 containing emergent vegetation adjacent to open water, which provide habitat for rearing and for growth and survival of suckers.
3. **Food.** Areas that contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates.

Critical habitat Unit 2 includes Clear Lake Reservoir and its principal tributary, Willow Creek. Unit 2 does not coincide with the Pipeline project area.

3.5.6.3 Effects of the Proposed Action

In the riverine analysis area, only the Klamath River and the Lost River are inhabited by shortnose suckers based on available information (ORBIC 2017b) although shortnose suckers enter the canal system within both sub-basins and are regularly salvaged by Reclamation once canals are drained after the irrigation season (Hodge and Buettner 2009). In the Lake Ewauna-Upper Klamath watershed, 19 intermittent streams would be crossed by dry open-cut and 6 others by boring. In the Mills Creek-Lost River watershed, 40 intermittent streams would be crossed by dry open-cut and 19 others by boring. There is no information documenting that shortnose suckers would be present in any of those intermittent streams, which include canals and ditches, at the time of construction (discussed above). The Lost River will be crossed using dry open-cut construction.

Direct and Indirect Effects

<u>Timing</u>

The Klamath River (MP 199.38) and the Lost River (MP 212.07) are the only perennial waterbodies crossed by the ipeline on Construction Spread 5. The ODFW (2008) allows instream construction in the Klamath River (above Keno) from July 1 to January 31 and in the Lost River (below Bonanza) from July 1 to March 31. PCGP has requested that HDD crossing the Klamath River be allowed to occur outside of ODFW's in-water construction windows to ensure that enough time is provided to successfully complete the crossings. PCGP proposes cross the Klamath River using HDD crossing methods between July and October. The Lost River would be crossed by dry-open crossing methods during the ODFW-recommended crossing window (July 1 to March 31). Spawning occurs within limited areas of the Lost River (Reclamation 2007), and occasional individual shortnose suckers have been found in this stream region, so it is possible that shortnose suckers be present in the Lost River where the Pipeline would cross during the non-spawning period.

<u>Species Presence</u>

In the vicinity of the Pipeline, shortnose suckers occur in the Lake Ewauna-Klamath River 5th field watershed and the Mills Creek-Lost River 5th field watershed. The pipeline route crosses the Lake Ewauna-Klamath River 5th field watershed for about 17.24 miles (MPs 188.41 to

205.65) and the Mills Creek-Lost River 5th field watershed for 23.15 miles (MPs 205.66 to 228.81). The Pipeline will cross 26 waterbodies in the Lake Ewauna-Klamath River, one by HDD, six by conventional bore, and 19 by dry open-cut, and will cross 59 waterbodies in the Mills Creek-Lost River watershed, 20 by conventional bore and 39 by dry open-cut.

Potential effects to shortnose suckers inhabiting Klamath River by HDD construction are discussed below. Since there will be no instream work for any of the conventional bore crossings, no effects to shortnose suckers are expected in those 26 streams, canals, drains or ditches that are maintained by the BOR. Potential effects to shortnose suckers are possible in waterbodies crossed by dry open-cut, including the Lost River (known to be occupied by shortnose suckers) with the exception of 26 waterbodies crossed between MP 214.38 and MP 228.81. At MP 214.38, the pipeline route deviates from the general west to east direction and proceeds north, up a 9 percent slope (climbing from 4,100 feet to 4,360 feet elevation) to MP 215.04, and then continues to the east along a ridgeline (paralleling powerline corridors) to MP 228.81. In that segment, the route crosses 26 waterbodies that are intermittent headwater drainages with unlikely (due to steep slopes) or no pathways (no connectivity) for shortnose suckers to enter from lowland BOR canals, drains or ditches that might support Lost River suckers and shortnose suckers. No effects to shortnose suckers would occur by crossing those 26 waterbodies.

Potential effects to shortnose suckers are possible during dry open-cuts of 19 waterbodies crossed in the Lake Ewauna-Klamath River watershed and the remaining 13 waterbodies west of MP 214.38 crossed in the Mills Creek-Lost River watershed included in table 3.5.5-2 (in Lost River sucker section 3.5.5). Except for the Lost River and one irrigation ditch at MP 194.64, none of the waterbodies have been mapped by the Klamath Project. Consequently, connectivity of those other 30 waterbodies (classified as ditches) to larger canals and laterals that may seasonally support shortnose suckers cannot be determined.

Suspended Sediment by Pipeline Crossing Methods

Potential occurrence of shortnose suckers in waterbodies crossed by dry open-cut are included in table 3.5.5-2. Dry crossing methods would result in minimal impacts, including temporary increases in suspended sediments in restricted areas. One HDD and 25 conventional bores would be installed without in-water work and would not directly affect the aquatic environment and associated species (except in the case of an inadvertent return during an HDD crossing, which could affect stream suspended sediment levels as discussed below). The Klamath River would be crossed with an HDD.

Since all streams/ditches crossed, except for the Klamath River and Lost River, are minor or intermediate channels, any construction required would be done in the dry, reducing potential for any adverse suspended sediment conditions downstream. Additionally, road crossings where fish may be present would be constructed to meet ODFW fish passage standards so fish movement would not be blocked. While some elevated sediment may occur downstream, effects would be unsubstantial to shortnose sucker due to the implementation of approved construction methods.

Suspended Sediment – Dry Open Cut

Pipeline crossings of surface waterbodies would cause some downstream turbidity and sedimentation. The type of crossing and stream sediment characteristics can affect turbidity and suspended sediment in streams. The dry crossing methods to be used are flumed or dam-and-pump:

- **Flume.** The flume method typically is used to cross small to intermediate flowing waterbodies that are either fish-bearing or non-fish-bearing streams. The flume technique involves diversion of stream flow into a carefully positioned steel pipe of suitable diameter to convey the maximum flow of the stream across the work area and ensures that stream flow rate is not interrupted.
- **Dam-and-Pump.** With the dam-and-pump method, stream flow is diverted around the work area by pumping water through hoses over or around the construction work area. The goal of this technique is to create a relatively "dry" work area to avoid or minimize the transportation of heavy sediment loads and turbidity downstream of the crossing. This crossing method may be used on all waterbodies where stream flow can be diverted by pumping around the work area.

As noted in section 3.5.3.3, Coho Salmon (SONCC ESU), dry open-cutting (fluming, dam-and-pump, or some combination of the two) generates small amounts of turbidity compared to wet open-cut procedures. However, adult suckers appear to prefer deep, turbid water but are often forced to utilize shallow, clear water during degraded water quality conditions in the summer (NRC 2004). The amounts of turbidity generated by dry open-cut construction may cause minor short-term adverse effects to shortnose suckers if they are within several hundred feet downstream of the Lost River crossing site. However, guidance for evaluating effects of exposure and dose of suspended sediments on catostomids (including shortnose sucker) is not available, similar to documentation for salmonids (e.g., Newcombe and Jensen 1996). Crossing of the intermittent channels is planned to occur in the dry so suspended sediment increases should be very low when flow is returned to the channels, as channel conditions would be stabilized. Should a crossing occur when flow is present, some suspended sediment levels would be more elevated. However, considering 1) the small size of these intermediate streams/ditches, 2) the short duration of construction activity at each crossing location, 3) the expectation that suckers would not be present in these streams/ditches, even when they are flowing, and 4) the apparent tolerance of this species for turbid water, these elevated suspended sediment levels would not cause substantial adverse effects to shortnose suckers in these intermittent flow crossings.

There is a possibility that following construction, future flows returning to the ditches listed in table 3.5.5-2 could potentially indirectly affect suckers by mobilizing sediment replaced over the trench. Mobilized sediments could lead to downstream sediment impacts on forage species, streambank erosion and stability (geotechnical stability), and surface flow retention. However, during delineation of the ditches, field personnel reported stream gradients at ditches as <1% and many had mud substrates, both observations indicative of low instream flows and velocities in the ditches. Consequently, flows returning in the ditches after dry open-cut construction may not be sufficient to mobilize native materials replaced in the trench. PCGP (in the ECRP/appendix F) has proposed to install erosion control matting to cover channel bottoms where revegetation of the channel bottom is required. Erosion control matting, anchored with staples to the channel sides and bottom, could be similarly used at irrigation ditches to minimize risk of sediment mobilization, downstream sediment impacts on forage species (zooplankton such as cladocerans – water fleas – and benthic insects such as chironomid midge larvae and amphipods), and streambank erosion and stability. Use of erosion control matting would allow materials replaced as bottom substrate and restored ditch banks to consolidate without eroding until the matting degrades.

Suspended Sediment – HDD

The HDD installation method is considered an effective technique for avoiding in-stream impacts by eliminating the need for in-stream excavation (Reid and Anderson 1998; Reid et al. 2004). According to GeoEngineers' (2017g) analysis for construction using HDD across the Klamath River (see appendix E), the design length of the Klamath River HDD crossing would be approximately 2,300 feet. The proposed Klamath River entry point would be in an agricultural field about 950 feet east of the river bank and the exit would be an open area about 370 feet west of the river bank. The HDD design indicates there would be between 70 and 140 feet of streambed cover in the river channel over the pipe. .There is no direct in-stream disturbance so no suspended sediment increases would occur unless there is an unplanned drilling failure. There would be a moderate to high risk of hydraulic fracture from the entry point to about 900 feet to the west, all within the east bank of the river. The portion of HDD beneath the river would be below bedrock with a low risk of a release of drilling mud ("inadvertent return"). The risk of inadvertent return would be high within 425 feet from the HDD exit point on the west bank of the Klamath River due to presence of stiff silt alluvium (GeoEngineers 2017g). Though the risk of releasing drilling mud directly beneath the riverbed is low, such a release could have impacts on the aquatic environment and species.

Inadvertent Release of Drilling Muds (Inadvertent Return). However, there is a potential for impact as a result of the HDD process. Drilling requires use of a drilling mud for lubrication of the bit and removal of cuttings. A non-toxic, biodegradable bentonite clay mixture makes up drilling mud. Because the drilling mud is under pressure during drilling, if the bit encounters substrate fractures or channels, it is possible for bentonite to escape from the drilled hole (termed an "inadvertent return"). Bentonite can escape to the surface through fractures in the drilled substrate. Bentonite by itself is a non-toxic drilling mud (Breteler et al. 1985; Hartman and Martin 1984; Sprague and Logan 1979) although according to Reid and Anderson (1998), the toxicity of bentonite (sodium montmorillonite) in fresh water ranges from 5,000 to 19,000 ppm (mg/liter) based on 96-hour tests for LC50 (the concentration at which 50 percent of the test population dies after 95 hours of exposure) on rainbow trout. The toxicity classifications based on LC50 values ranged from "slightly toxic" to "practically non-toxic" (Reid and Anderson, 1998). In other tests, toxicities to lake whitefish and rainbow trout demonstrated threshold concentrations of 16,613 and 49,838 ppm (mg/liter), respectively (Reid and Anderson, 1998). LC50 concentrations > 10,000 ppm would be considered "practically non-toxic" (Reid and Anderson 1998). As with any fine particulate material, bentonite can interfere with oxygen exchange by gills and the degree of interference generally increases with water temperature.

The summary by Reid and Anderson (1998) provides a substantive description of effects to streams and habitat in the cases with inadvertent returns.

Drilling mud releases during HDD construction can result from:

1. Circulation losses through highly permeable gravels;
2. Mud migration along rock joints or fractures which intersect with the river bottom;
3. Loss of pilot hole directional control resulting in the intersection with the river bottom or approach slope;
4. Drilling mud pressures exceeding ground stress, widening existing or creating new

fractures (hydraulic fracturing), allowing for mud migration;
5. Substantially different elevations of entry and exit drill locations. Resulting pressure head differences can cause substantial upland leakages of drilling muds once the drill bit nears the ground surface or when it breaks the surface.

Drilling mud releases may surface through river and streambeds, wetland bottoms, or at upland locations. The volume of mud released to the surface would depend on:

1. Porosity of the substrate transporting the mud;
2. Extent and size of the porous material;
3. Pressure exerted on the mud by the hydraulic system;
4. Viscosity of the mud at the time of exposure;
5. Whether mud circulation can be maintained.

Magnitude of effects by mud releases to fish, streams and habitat would depend on the following (page numbers referenced from Reid and Anderson, 1998):

1. Toxicity of the drilling mud components and additives (pages 57-59 and Table 1);
2. Increased sediment loads (page 59);
3. Effects to hydrological conditions that would cause poor conditions for wetland plant establishment and growth (pages 59-60);
4. Release into streams and rivers could cause increases in the downstream drift of stream macroinvertebrates (page 60);
5. Effects on fish would depend on level of exposure (e.g., concentration) and duration of exposure and lifestage of fish present, timing of release, and ability of the watercourse to remove or incorporate the released muds without degrading existing habitats (page 61).

The report by Reid and Anderson (1998) summarizes the general effects, known or hypothesized, associated with drilling mud releases but does not provide specific effects associated with each of the instances of inadvertent returns cited.

Likewise, Canadian Pipeline Water Crossing Committee (1999) reported that drill mud seepage occurred in 36 of 146 HDD cases reviewed with most significant leakage occurring at the drill entry or exit points due to different pressure heads with large differences in elevation between the two points. Leakage also occurred during reaming or pull-back. However, the report did not describe the effects to fish, streams, and habitat in the cases with leakages or inadvertent returns.

Potential inadvertent returns are more common near the HDD drill entry and exit locations; however, impacts to waterbodies are minimized by locating the drill entry and exit points away from the waterbody.

If an inadvertent return occurs into the river, drilling fluid would enter the waterway causing short-term, temporary water quality impacts downstream of the Pipeline project area including sedimentation and turbidity. Should this occur, fish would likely avoid the immediate vicinity of any elevated suspended sediment within this larger river crossing area.

If drilling fluid accumulates in the substrate, it can adversely impact the quality and quantity of aquatic habitat available for aquatic species including catostomid (sucker) spawning habitat and benthic macroinvertebrate rearing habitat. Drilling fluid that accumulates in the substrate may cover up food sources and smother fish eggs and other aquatic life in the riverbed. However, significant impacts to substrate from inadvertent returns are not likely in large river systems because of the anticipated high water volumes and velocities within large rivers. PCGP developed its *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations* (see appendix D), which describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The HDD Contingency Plan also includes procedures for cleanup of drilling mud releases. As discussed above for Lost River suckers, if drilling fluid is inadvertently released into the Klamath River and significant concentrations are found during monitoring as a result of a release, the following possible corrective measures would be taken:

1. Deployment of containment structures, if feasible, and removal of drilling mud from substrate and streambanks if possible.
2. Increase the drilling fluid viscosity in an attempt at sealing the point at which fluid is leaving the drilled hole. The drilling operation may be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the higher viscosity drilling fluid.
3. If increasing the drilling fluid viscosity is ineffective, lost circulation materials (LCM) may be introduced into the hole by incorporating them in the drilling fluid and pumping the material down-hole. The drilling operation may again be suspended for a short period (i.e., overnight) to allow the fractured zone to become sealed with the LCMs.
4. Depending on the location of the fractured zone, a steel casing may be installed that is of sufficient size to receive the largest expected down-hole tools for the crossing. This casing installation provides a temporary conduit for drilling fluids to flow while opening the remaining section of the hole to a diameter acceptable for receiving the proposed pipe sections. To alleviate future concerns with the steel casing after the HDD installation is completed, the casing is generally extracted from the hole prior to or just after completing the HDD installation. However, there have been instances when attempts at extracting the steel casing were unsuccessful.
5. In the event drilling fluid flow is not regained through the annulus of the drilled hole and a steel casing installation is not utilized, the HDD contractor may elect to install a grout mixture into the drilled hole in an attempt to seal the fractured zone. The down-hole drilling assembly is generally extracted and existing hole is re-drilled to the point at which it had previously been drilled prior to having encountered the loss of drilling fluid.

In some instances, it may be determined that the existing hole encountered a zone of unsatisfactory soil material and the hole may have to be abandoned. If the hole is abandoned, it would be filled with cuttings and drilling fluid.

Overall, at the site of any inadvertent return, the amount of drilling mud released into a waterbody would be low. The HDD location would be under the Klamath River with large volumes of water and swift flows where the drilling mud would be diluted. If an inadvertent release of drilling mud from an HDD occurred it would have minor short-term adverse effects to aquatic resources including shortnose sucker.

Movement Blockage

Dry open-cut construction is expected to block short-term movements of shortnose sucker, possibly in the Lost River, but likely not in other crossings as shortnose sucker would unlikely be present in these areas. Restrictions on movement would be at most short-term. The fluming process is expected to require about 36 to 96 hours of in-stream work while dam-and-pump construction is expected to require between 20 and 56 hours of in-stream work (Reid et al. 2004).

During this time, fish may be exposed to suspended sediment levels that they may avoid. Flumes would maintain streamflow and fish might move upstream or downstream through the flume, but fish would be unable to move past a dam-and-pump crossing until it was removed. Flumes and dams would be removed as soon as possible following backfilling of the trench. Normal migration of adult shortnose suckers to spawning areas would likely be in the mid-winter to spring as spawning occurs from late February to early June, so short-term blockages could affect spawning migration due to the in-stream work extending to the end of March. Overall, the levels of suspended sediment and physical structure blockages would not cause substantial delays to shortnose sucker movement, resulting in unsubstantial effects to shortnose sucker individuals.

Entrainment and Entrapment

Waterbody crossings using the "dry" crossing methods, flume or dam-and-pump, may result in some fish being entrapped in streams. Flumes and dams would be completely installed and functioning before any instream trenching disturbance occurs. Construction across a waterbody would take up to four days using dry open cut methods, but less for small and intermediate streams. Fish inadvertently left within the dammed-off construction zone could be killed by impingement on pump intakes used to dewater the construction zone or would likely die once all water was removed. Waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence are included in table 3.5.5-2.

For typical crossings once streamflow is diverted through the flume pipe, but before trenching begins, fish trapped in any water remaining in the work area between the dams would be removed and released (salvaged) using the *Fish Salvage Plan* (see Fish Salvage Plan under section 3.5.6.4 or appendix T for details). Salvage methods could include seines and/or dip nets and electrofishing. Seining would be the primary method used to salvage fish but electrofishing methods may be used if all fish cannot be removed from the area potentially dewatered. The *Fish Salvage Plan* incorporates these methods to minimize adverse effects to listed fish.

Suckers as a group (family Catostomidae) appear to be susceptible to many of the same deleterious effects from electroshocking that were described above for salmonids (Snyder 2004). Although records of the effects by electroshock to shortnose suckers have not been compiled, responses by river carpsucker, longnose sucker, white sucker, and razorback sucker among others indicate that they are particularly susceptible to spinal injuries and hemorrhages by electrofishing (Snyder 2004). Reclamation has salvaged fish from canals throughout the Klamath Project each fall since 1991 following dewatering using electofishing techniques (Reclamation 2008). Reclamation has noted that if electrofishing is found to injure juvenile suckers, they would pursue other techniques to salvage fish (Reclamation 2008). Sucker mortalities (Lost River suckers, shortnose suckers, and Klamath largescale suckers) have occurred during salvage operations, whether due to electrofishing stress or to low levels of DO (Peck 2000 and 2001). Reclamation has also done annual fish salvages in the forebay of a fish screen facility using backpack electrofishers and beach seines. This annual salvage procedure alleviates potential mass mortality of all fish at the fish screen as water is removed (Reclamation 2007).

All methods of capture and holding have risks of stress, injury, or mortality of fish. In conjunction to implementation of the *Fish Salvage Plan*, PCGP would contract with either ODFW or a qualified consultant to capture the fish. Fish removal personnel will be approved by ODFW and NMFS for this listed species. Personnel who would handle and/or remove fish on federal lands would also be approved by the Forest Service or the BLM, or the work would be done directly by agency personnel if approved by ODFW. Overall, some listed juvenile shortnose sucker may suffer injury or mortality, but with the implementation of conservation measures the numbers would be slight.

Acoustic Shock and Underwater Noise

There would be no blasting or use of mounted hydraulic impact hammer to cross the Lost River where shortnose suckers may be present or any of the 31 ditches with potential species presence included in table 3.5.5-2. Use of back-hoes for dry open-cut construction would not produce sound levels to cause harm to shortnose suckers, as discussed for SONCC coho salmon in section 3.5.3.3.

Riparian Vegetation Removal, Modification, and LWD Loss

Aquatic resources, including shortnose suckers and their habitat components, could be affected as a result of removal of vegetation and instream habitat at the waterbody crossing sites as required for construction. Short-term physical habitat disruption would occur during trenching activities. Long-term degradation of habitats could occur if the stream contours are modified in the area of the crossing, the flow patterns are changed, or erosion of the bed, banks, or adjacent upland areas introduces sediment into the waterbody. Loss of riparian vegetation along the banks would remove an important source of terrestrial food for aquatic organisms; and potentially increase mass slope failures adjacent to waterbodies.

Because HDD would be used to cross the Klamath River, only 0.04 acre (Urban or Built-up land) within the Klamath River riparian zone (extending 117 feet or one site-potential tree height from each river bank) would be affected. No forested riparian vegetation would be affected. Construction across the Lost River would disturb approximately 1.35 acres of agricultural land within the riparian zone (extending 119 feet from each river bank). Similar to the Klamath River crossing, no forested riparian vegetation would be affected or removed and all effects would be to agricultural land. Riparian zones associated with the Klamath River and Lost River crossings are on land owned by the State of Oregon. Riparian Zones for all other waterbodies crossed that are within range of the shortnose sucker are on private lands. All crossings other than the Klamath River and Lost River are on intermittent streams/ditches/canals with very limited low-growing riparian vegetation and would have unsubstantial reduction in near-stream vegetation from crossing clearing. Likewise, as there are few trees in the riparian area along the route in the range of the shortnose sucker, there would be no change in LWD supply to any stream system from construction of right-of-way clearing or maintenance.

Overall, there would be no substantial change in riparian vegetation or LWD supply along the route where shortnose sucker may be present. As a result, ecological function (e.g., supply of shade, future LWD, and organic input) of the riparian conditions would be maintained and adverse effects to the shortnose sucker would not occur from right-of-way clearing at stream crossings.

Water Temperature

Shortnose suckers are susceptible to water temperatures 85°F or higher (Bellerud and Saiki 1995) but prefer water temperatures between 60 and 77°F (FWS 2007f). As discussed above, no riparian vegetation would be removed that otherwise would provide shade. Consequently, water temperature would not be affected by construction in the Lost River and Klamath River.

Aquatic Habitat

There also are potential indirect effects to aquatic habitat from increased suspended sediment from stream crossings. As discussed for SONCC coho salmon, suspended sediment released during stream crossing construction may have downstream habitat effects as well as direct fish effects such as changing substrate conditions (e.g., elevated fines) that may affect benthic food resources. Only one stream, the Lost River, is known to be crossed with stream bottom substrate-disturbing activities during flowing periods; 31 ditches with potential for species included in table 3.5.5-2 are expected to be crossed in the dry and could have suckers present in the crossing area. Estimates of sediment generated by dry open-cut construction along other portions of the Pipeline route and implementation of BMPs would not result in short-term sediment elevations that could have substantial downstream adverse habitat effects that would indirectly affect the shortnose sucker or the species habitat.

Freshwater Stream Invertebrates

Substrates downstream from in-stream construction sites could be impacted by sediments which could affect forage species used by shortnose suckers. Mayflies, caddisflies, and stoneflies prefer large substrate particles in riffles and are adversely affected by fine sediment deposited in interparticulate spaces (Cordone and Kelley 1961; Waters 1995; Harrison et al. 2007). Suckers feed on benthic organisms including algae and invertebrates so reductions could affect their growth and survival. Fish and benthic macroinvertebrate abundance downstream of pipeline construction sites have been reported as short-term reductions (Reid and Anderson 1999). Macroinvertebrate abundance and community composition are highly related to the degree to which substrate particles are embedded by fine material (Birtwell 1999). Data below wet open-cut crossings, which generate much higher sediment levels than dry-cut crossings, generally found negative changes in benthic invertebrate populations were not apparent within a year (Reid et al. 2008) and some data found rapid recolonization of substrate within 30 days (Gartman 1984). Therefore, the overall level of effect of the pipeline crossings on waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence included in table 3.5.5-2 (unless crossing sealing failures at isolation structures occur), would be even less than those noted by literature and would not result in substantial reduction in growth or survival of listed shortnose sucker individuals.

Streambank Erosion and Streambed Stability

Clearing and grading activities during construction could increase erosion along streambanks resulting in higher turbidity levels in the waterbodies crossed. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. Erosion, sedimentation, and higher turbidity levels related to the Pipeline project could affect aquatic resources in waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence (included in table 3.5.5-2). The degree of impact on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size.

Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, runoff, and the transportation of sediments into waterbodies. The degree of impact on aquatic organisms due to erosion would depend on sediment loads, stream velocity, turbulence, streambank composition, and sediment particle size. To minimize these impacts, PCGP would use temporary equipment bridges, mats, and pads to support equipment that must cross the waterbody (perennial, intermittent, and ephemeral if water is present) or work in saturated soils adjacent to the waterbody. PCGP would also install sediment barriers, such as silt fence and straw/hay bales, across the right-of-way at the edge of waterbodies throughout construction except for short periods when the removal of these sediment barriers is necessary to dig the trench, install the pipe, and restore the right-of way. Practices to minimize streambank erosion are provided in the ECRP (see appendix F).

The FWS expressed concerns that more detailed site-specific information on bank material, streambed composition, shoreline vegetation, and other information is needed to adequately ensure that actions occurring at a stream crossing do not significantly increase streambank erosion and streambed instability. PCGP, in response to these requests, conducted an assessment of crossing conditions of all streams suitable for analysis based on the FWS risk matrix (GeoEngineers 2017d and 2017e). As discussed for SONCC coho salmon, PCGP used this matrix to rate crossings for risk of potential stream bank and channel changes. Based on the GeoEngineers (2017d and 2017e) Risk Matrix analysis, the Lost River crossing has a "high" level of risk based on existing stream site sensitivity based on the landscape/stream type (channel characteristics), riparian conditions (essentially none), and bed conditions (sand). If any crossing is moved into the "high" impact and "high" stream response risk matrix category, a site-specific crossing design would be developed for that site. Construction would then move forward as described in the permit documents including implementation of special additional BMPs, as described in GeoEngineers (2017d and 2017e), depending on individual site conditions and may include such actions as changes in bank material and bank angle modifications, specific substrate composition used, plants used on the bank, artificial stabilizing bank material, rootwad enhancement, and various other actions. These actions would reduce potential adverse effects from bank and bed stability to unsubstantial levels to the listed shortnose sucker.

Hydrostatic Testing

Water would be required on a one-time basis near the end of construction to hydrostatically test the pipeline. Potential impacts associated with hydrostatic testing include entrainment of fish; transfer of exotic organisms between basins; reduced downstream flows and impaired downstream uses if test water is withdrawn from surface waters; and erosion, scouring, and release of chemical additives as a result of test water discharge. PCGP would obtain its hydrostatic test water from commercial or municipal sources or surface water rights owners, the sources of which are lakes, impoundments, and streams.

Within the range of the shortnose sucker, there are four potential water sources, including John C. Boyle Reservoir, Keno Reservoir, Klamath River, and High Line Canal. There are 5 potential discharge locations, all of which are within the right-of-way. None of the hydrostatic test break sections are in the vicinity of a waterbody with known shortnose sucker occupancy or critical habitat. Discharge volume at each site ranges from 0.63 to 4.6 million gallons. The largest withdrawal is proposed from the Klamath River or High Line Canal. Water withdrawn from Keno Reservoir at Keno Dam would be from designated critical habitat for shortnose suckers. Water will also be withdrawn from John C. Boyle Reservoir at the Spencer Bridge. Although the reservoir is not included in designated critical habitat, shortnose suckers are expected to be present. As with Lost River suckers, water withdrawals from occupied habitats risk entrainment and impingement. The screening of intake hoses would be used to prevent the entrainment of fish and other aquatic organisms, meeting NMFS screening criteria. The rate of withdrawal would also be regulated to avoid adverse impact on aquatic resources or downstream flows (NMFS 1997c).

PCGP would minimize the potential effects of hydrostatic testing by adhering to the measures in its *Hydrostatic Testing Plan* (see appendix U). Where test water cannot be returned to its withdrawal source, the water would be treated and discharged to an upland location (at least 150 feet from wetlands or waterbodies with no direct discharge to these features) through a dewatering device at a rate to prevent scour and erosion and to promote infiltration. PCGP would obtain all necessary appropriations, withdrawal, and discharge permits through the OWRD.

With the implementation of the *Hydrostatic Testing Plan* and BMPs and by obtaining required permits, adequate measures would be in place to prevent direct or indirect effects of hydrostatic testing to shortnose sucker that may be in some of the stream systems.

Aquatic Nuisance Species

NAS are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Currently, there are 180 reported NAS in Oregon, of which 134 are documented within the USGS hydrologic basins crossed by the Pipeline (USGS 2017).

In the riverine environments crossed by the Pipeline, largemouth and smallmouth bass, introduced as recreational species, prey on juvenile sockeye, coho, and Chinook salmon (Tabor et al. 2007). Additionally, up to 20 exotic species (many of which can reside in streams including largemouth bass, yellow perch, and fathead minnow) are present in the range of shortnose sucker and are suspected to compete and prey on them (FWS 2013). Management priorities in Oregon concentrate on aquatic nuisance species, which are the species whose current or potential impacts on native species and habitats and economic and recreational activity in Oregon are known to be significant (Hanson and Sytsma 2001). Some of the major potential freshwater invasive species are Chytrid fungus and mussels, including the zebra and quagga mussels (*Dreissena polymorpha*, and *Dreissena rostriformis bugenisis*).

Aquatic nuisance species could potentially be introduced into Pipeline project area waters by interbasin transfer of hydrostatic testing water or by being carried on equipment that is moved from outside of the region or between basins. PCGP has developed BMPs and guidelines to avoid the potential spread of aquatic invasive species (see *Hydrostatic Testing Plan* in appendix U*)* in consultation with the BLM and Forest Service as well as with ODEQ and the Center for Lakes and Reservoirs and Aquatic Bioinvasion Research and Policy Institute (Portland State University).

If determined to be feasible, all water used in hydrostatic testing would be returned to its withdrawal source location after use; however, cascading water from one test section to another to minimize water withdrawal requirements may make it impractical to release water within the same watershed where the water was withdrawn. If it is not possible to return the water to the same basin from which it was withdrawn, PCGP would employ an effective and practical water treatment method (chlorination, screening/filtration, or other appropriate method) to disinfect the water that would be transferred across basin boundaries. The hydrostatic test water would be treated after it is withdrawn and prior to hydrostatic testing.

PCGP would implement a three-step BMP treatment process to prevent the potential spread of invasive species and forest pathogens from non-municipal surface water sources used during hydrostatic testing. The hydrostatic test water treatment process would incorporate screening/filtration during water withdrawal, chlorine treatment, and upland discharge at least 150 feet from wetlands or waterbodies with no direct discharge to these features. All hydrostatic test water will be released through a dewatering device such as a straw bale structure or sediment bag in a manner to promote infiltration. Further, all hydrostatic release locations would be monitored after construction to ensure noxious weeds have not established.

As explained in the *Hydrostatic Testing Plan*, PCGP proposes to use a treatment of 2 ppm or 2 mg/L of free chlorine residual with a detention time of 30 minutes to treat all non-municipal surface waters that would be used as a water source for hydrostatic testing purposes. Chlorinated water would be released according to the Oregon Department of Environmental Quality criteria to prevent water quality impacts, potential effects to aquatic species, and minimize potential impacts to sensitive areas.

The potential for dispersal of aquatic nuisance organisms by other construction equipment and vehicles from one basin to another is remote. The BMPs in the noxious weed control procedures outlined in the ECRP (see appendix F) and the Integrated Pest Management Plan (see appendix N to the POD) would be employed to prevent the introduction and spread of invasive species from construction. With the implementation of these noxious weed control measures, introduction of nonnative species or movement of species between basins should not occur, resulting in no adverse effects to the listed shortnose sucker.

Fuel and Chemical Spills

Fisheries habitats could be adversely affected if petroleum products were accidentally discharged into aquatic environments including waterbodies crossed by dry open-cut (the Lost River and 31 ditches) with known or potential species presence that are included in table 3.5.5-2. Such materials are toxic to algae, invertebrates, and fish. Of the products likely to be present during construction, data compiled from a wide range of sources indicate that diesel fuels and lubricating oils are considerably more toxic to aquatic organisms than other, more volatile products (gasoline) or heavier crude oil (Markarian et al. 1994). For example, one study reported that release of diesel fuel in freshwater habitats significantly reduced aquatic invertebrate densities and species richness at least three miles downstream but invertebrate densities recovered within a year (Lytle and Peckarsky 2001). Impacts to aquatic habitats that primarily affect aquatic substrates—hence spawning, incubating, and rearing habitats—can remain for much longer periods (Markarian et al. 1994).

Equipment used for construction across waterbodies could potentially release hydraulic fluid comprised of a variety of compounds, the most common of which are mineral oil-based, organophosphate esters, and polyalphaolefins (HHS 1997). Release from machinery can occur through faulty seals, hoses, sumps and reservoirs, or general system failure.

Inadvertent spills of fluids used during construction, such as fuels and lubricants, could contaminate wetland soils and vegetation if not sufficiently contained. To minimize the potential for spills and any impacts from such spills, PCGP's SPCCP (see appendix L) would be implemented. In general, hazardous materials, chemicals, fuels, lubricating oils, and concrete-coating activities would not be stored, nor would refueling operations be conducted, within 100 feet (150 feet on BLM and NFS lands) of a wetland or waterbody in accordance with FERC's

Procedures (see appendix C) and the SPCCP (see appendix L) except where no reasonable location is possible and additional containment steps have been taken. The SPCCP would be updated with site-specific information prior to construction. Adherence to these plans and procedures would result in effects to the listed shortnose sucker that would be unsubstantial.

Runoff from Facility Surfaces

There are nine contractor and pipe storage yards, one rock source and disposal site, two new temporary access roads, two new permanent access roads, and three aboveground facilities including the Klamath Compressor Station within the range of shortnose suckers.

Two of the yards, K-Falls Memorial Dr 1 Yard and K-Falls Memorial Dr 2 / Bair Yard, border the Klamath River, and the K-Falls - Industrial Oil Yard is about 235 feet from the Klamath River which is designated critical habitat for shortnose suckers. The Klamath Compressor Station is about 700 feet from the T Canal, for which there are no records of shortnose sucker being present (construction and operation of the compressor station would not affect suckers even if present).

Stored materials at the yards may include: construction mats, fencing materials, fuel and lubricants, stormwater control materials (straw bales, erosion control fabric, silt fence materials, etc.), and other construction materials. The yards would also be used for contractor office trailers and employee parking facilities. Although the yards are previously disturbed industrial sites, there is some unknown level of risk that stored materials and surface runoff could enter shortnose sucker critical habitat. Runoff from any of these sites would be mitigated through measures provided in PCGP's ECRP (see appendix F).

Operation and Maintenance Activities

Once installed, maintenance of the pipeline would include activities such as aerial inspections, gas flow monitoring, visual inspection of surrounding vegetation for signs of leaks, and integrity management, which includes smart pigging to investigate the interior surface of the pipe for any signs of stress cracking, pitting, and other anomalies (see the ECRP, appendix F). All of the proposed maintenance activities would be outlined in the Operations and Maintenance Plan that would be prepared according to operating regulations in DOT 49 CFR Subpart L, Part 192 and would be completed prior to the Pipeline going in-service. These general maintenance activities would require only surface activities and usage of the existing right-of-way, such as insertion of the pig at one of the pig launching facilities.

The potential stream channel disturbance would occur if an integrity issue with the pipeline were found at a crossing location. If this were to occur, the pipeline would need to be unearthed within the right-of-way and repair work done in-water. Within stream sites, repair work could require isolated flow from the section of pipe that is to be exposed. Typically, repairs would be made to the pipe within the right-of-way (within the trench) or, depending on the site-specific conditions and nature of the repair needed, a reroute around the affected section may be considered.

Impacts would be similar to those discussed above for initial installation except on a much smaller scale because they would only involve one crossing compared to many crossings. However, should repairs be needed out of the standard stream crossing window (i.e., during periods of fish spawning or egg incubation) there would be additional adverse effects to key fish resources at the specific site. The actions would include all relevant BMPs and mitigation, dependent upon site conditions and land ownership. Any future repairs would require additional permit approval from appropriate state and federal agencies which would determine the acceptable parameters of these actions. Such pipeline integrity-based in-water projects are very infrequent.

Vegetation maintenance would be limited adjacent to waterbodies to allow a riparian strip to permanently revegetate with native plant species across the entire right-of-way. To facilitate periodic pipeline corrosion/leak surveys, a corridor centered on the pipeline and up to 10 feet wide would be maintained in an herbaceous state, with scrubs outside of this 10 foot corridor. In addition, trees that are located within 15 feet of the pipeline may be cut and removed from the right-of-way. No vegetation or tree limitations would occur beyond the 30 foot wide corridor in riparian areas (i.e., up to 100 feet of streams on federal lands and up to 25 feet of streams on non-federal lands). Since most native riparian vegetation along the Pipeline route has been altered by agriculture, the effects of maintaining the 30-foot wide corridor on Lost River sucker instream habitat would be minimal.

Herbicide Application

Herbicides have the potential to cause toxic effects to different sucker life stages and to other aquatic species, causing direct impacts, if used improperly. When herbicides are properly used according to label restrictions and BMPs to control noxious weeds, there is little to no chance of causing injury or mortality to fish or other aquatic organisms.

PCGP would not use herbicides for routine vegetation maintenance. However, following construction, PCGP would implement an Integrated Pest Management Plan (IPM - appendix N to PCGP's POD) that addresses control of noxious weeds and invasive plants across the Pipeline project which would include the selective use of herbicides where necessary to control noxious weeds by limited application from the ground, where allowed by landowners. The Integrated Pest Management Plan was developed in consultation with the ODA, BLM, and Forest Service. The BMPs would minimize the potential spread of invasive species and minimize the potential adverse effects of control treatments. Herbicides would not be applied by aerial or broadcast spraying. Noxious weeds would be removed only by manual methods in the riparian zone adjacent to streams, ditches and canals within the range of shortnose suckers. PCGP would not directly spray, or otherwise apply, herbicides in waterbodies or in riparian zones. The risk of drift would be avoided by selectively applying herbicides from the ground.

Where weed control is necessary along the construction right-of-way, PCGP's first priority would be to employ hand and mechanical methods (pulling, mowing, biological, disking, etc.) applicable to the species to prevent the spread of potential weed infestations, where feasible. To determine if an herbicide is to be used over other control methods, PCGP would base the decision on weed characteristics and integrated weed management principles (Forest Service 2005). If herbicides are used to control noxious weed infestations, they would be used when they are the most appropriate treatment method. Spot treatments and the use of selective herbicides would be utilized to minimize impact to native or non-target species. Permits or approvals for the use of herbicides and adjuvants on federal lands would be obtained prior to use/treatment, as detailed in the IPM (see appendix N to the POD, available upon request). Considering the potential for limited use of herbicides along the route and precautions that would be in place to prevent entry into waters, meaningful negative effects to the shortnose sucker from herbicides would be unlikely to occur.

Cumulative Effects

Within the action area, 100 percent of all lands are non-federal within the John C. Boyle Reservoir-Klamath River watershed, 99 percent are non-federal lands within the Lake Ewauna-Klamath River watershed, and 94 percent are non-federal lands within the Mills Creek-Lost River watershed. Degradation of water quality due to livestock grazing, agriculture, and timber harvest has resulted in severe pollution in Upper Klamath Lake. That in turn has led to algal blooms with increased mortality of suckers when oxygen depletions occur due to eutrophication particularly during summers when high temperatures combine with nutrient loading from pumping diked wetlands and runoff from farms. Past actions that have led to increased mortality have been due to private enterprise on private lands. Cumulative impacts on shortnose suckers would include those same or similar actions which are reasonably foreseeable during the next four years. Cumulative impact from non-federal actions on non-federal lands are ongoing and will continue into the future. The effect from the construction and operation of the Project is anticipated to be temporary and localized and would not measurably contribute to the current or future cumulative effects upon this species.

Critical Habitat

Designated critical habitat for the shortnose sucker is present within the Pipeline project area. The Pipeline would cross the Klamath River at RM 249, which is within critical habitat Unit 1, Klamath County (FWS 2012g). Unit 1 includes Upper Klamath Lake and Agency Lake, together with some wetland habitat; portions of the Williamson and Sprague Rivers; Link River; Lake Ewauna; and the Klamath River from the outlet of Lake Ewauna downstream to Keno Dam. Some or all of the three PCEs noted above (water, spawning and rearing habitat, and food) could be affected during the HDD across the Klamath River if a inadvertent return occurred with release of drilling mud into the water column; the same effects to critical habitat that were described as Direct and Indirect Effects, above, would occur.

Only 0.04 acre within the Klamath River riparian zone (extending 117 feet or one site-potential tree height from each river bank) would be affected by construction, and all of that area is in an existing industrial facility.

3.5.6.4 Conservation Measures

Conservation measures have been proposed by PCGP to minimize construction and operation impact to waterbodies and riparian zones within the riverine analysis area. Those measures have been compiled in table 2C in appendix N and apply to shortnose suckers.

PCGP has also proposed measures to rectify, repair, and rehabilitate and otherwise reduce impact to waterbodies and riparian zones once construction of the Pipeline is complete. Those measures have been compiled in table 3C in appendix N.

Details of some of the major conservation measures to be implemented by PCGP are summarized below.

Erosion Control

Many of the conservation measures in table 3C in appendix N focus on erosion control to prevent sediment from entering surface waters. Temporary erosion controls would be installed immediately after vegetation clearing and grading and would be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration is complete. At a minimum, the following temporary erosion control structures would be installed: temporary slope breakers, sediment barriers, mulch, and erosion control fabric. PCGP would install permanent slope breakers consistent with the requirements of FERC's *Plan*. Part of long-term erosion control would include a final cleanup including final grading and installation of permanent erosion control structures. Final cleanup of an area would generally occur within 10 days after backfilling the trench and not be delayed beyond the end of the next recommended seeding season. During final cleanup, PCGP would remove all construction debris and grade disturbed areas to preconstruction grades to the extent practicable. An adequate seedbed would be prepared at the conclusion of cleanup.

Temporary Slope Breakers

PCGP would install temporary slope breakers over the backfilled, recontoured construction right-of-way as specified in FERC's *Plan*. The outfall of each temporary slope breaker would be to a stable, well-vegetated area or to an energy-dissipating device at the end of the slope breaker off the construction right-of-way. Slope breakers reduce runoff velocity, thereby intercepting sediment and allowing it to drop out of suspension. They also can effectively divert runoff away from a disturbed site to a stable outlet (Goldman et al. 1986).

Sediment Barriers

PCGP would primarily rely upon silt fence and staked hay or straw bales to confine sediment to the construction right-of-way. These structures would be used adjacent to wetland and waterbody crossings consistent with the requirements of FERC's *Procedures*. Straw bales and filter fabric (silt fence) can be used together to create a highly effective sediment barrier, a combination that compensates for the limitations of each used in isolation; straw bales provide extra support and the fabric provides greater filtering capability (Goldman et al. 1986).

All straw or hay bales used for sediment barriers would be certified as weed-free. Temporary sediment barriers would be maintained in-place until permanent revegetation measures are successful or until the upland areas adjacent to wetlands, waterbodies or roads are stabilized. The structures would be removed once vegetation in the area has been successfully restored.

Erosion Control Fabric

PCGP would install erosion control fabric (such as jute or excelsior) on waterbody banks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. Although there are no measures specific to pipeline construction, data related to cut-and-fill slopes treated during construction of forest roads indicate varying effectiveness of different types of stabilization measures designed to control surface erosion (EPA 2001). On fill slopes, combining straw mulch and netting decreased erosion by 99 percent. Excelsior mulch alone decreased erosion by 92 percent on fill slopes. On cut slopes, straw mulch by itself decreased erosion in a range from 32 to 97 percent (EPA 2001). Applications of mulches and/or fabric are effective measures promoting slope stabilization until vegetation can successfully be reestablished. These measures also promote plant growth (EPA 2001).

Fish Salvage Plan

Shortnose suckers can potentially occur within the construction right-of-way on the Lost River at the time of construction. Since the Lost River would be crossed using dry open-cut technology, fish salvage procedures (see section 3.5.3.4 for coho salmon SONCC ESU) may occur while fish, including shortnose suckers, are within isolated construction sites. Since suckers in general appear to be vulnerable to electroshocking, PCGP's fish salvage plan in the Lost River may have to avoid use of electroshock, relying instead on seining and dip-netting as described in section 3.5.3.4.

A *Fish Salvage Plan* has been provided in appendix T. The plan has been developed to minimize adverse effects to listed salmonids (SONCC coho, Oregon Coast coho), non-listed salmonids (Chinook salmon, steelhead, and cutthroat trout), and listed catostomids (Lost River sucker, shortnose sucker). The portions of the plan relevant to salvaging salmonids were adapted from the protocol developed by WSDOT (2011b). The protocol specifies procedures to 1) isolate the work area; 2) remove fish and dewater the work area; 3) handle, hold, and release fish; 4) document fish that have been captured, handled, held, and released; and 5) notify NMFS and FWS. The same protocol would generally be followed during salvage of Klamath Basin suckers. However, salvage operations within the crossing where these suckers may be present would include the latest *Handling Guidelines for Klamath Basin Suckers* (Reclamation 2008). These guidelines may be updated frequently. Some of the main factors in handling are the requirement of having a 0.5 percent saline solution of unchlorinated well water to place any captured listed sucker in should it be collected during fish salvage operations. Aeration would also be supplied and the container a sucker is placed into would have been coated with a commercially available slime coat. Fish would be retained in this solution until released upstream of the capture site unless otherwise indicated through agreement with FWS.

OHV Barriers

Limiting OHV access would reduce potential increased sedimentation to streams and human access to sensitive fish areas. In accordance with FERC's *Plan*, the applicant must offer to install and maintain measures to control unauthorized vehicle access to the right-of-way to each landowner or manager of forested lands. Such measures may include signs; fences with locking gates; slash and timber barriers, pipe barriers, or a line of boulders across the right of way; and conifers or other appropriate trees or shrubs across the right-of-way. If allowed by the landowner, and if available, slash, stumps, and/or logs would be placed on the right-of-way within the riparian zones to discourage OHV crossings of streams and to provide carbon and nutrients. If not allowed, PCGP would discuss with the landowner the use of other methods, as noted above. At a minimum, the area would be revegetated and re-seeded.

Streambank Stability

The root network of trees adjacent to streambanks is essential to maintaining streambank stability (WDNR 1997). Because root strength decreases significantly at distances beyond one-half the tree crown diameter, trees promoting streambank stability lie within half a tree crown diameter from the streambank. Trees within 25 feet of the streambank are assumed to promote streambank stability (WDNR 1997). Generally, trees that must be removed during construction would be cut at ground level with the roots left in place, except where located within the trenchline. Although roots would decay over time, streambank stability would be retained by their presence until revegetation is successful.

Streambank Restoration

PCGP's ECRP (see appendix F) describes the measures that would be used to stabilize streambanks crossed by the Pipeline. PCGP would not use riprap to stabilize streambanks. The alignment has been designed at waterbody crossings to be as perpendicular to the axis of the waterbody channel as engineering and routing constraints allow, minimizing streambank disturbance and avoiding parallel stream alignments or multiple stream crossings. Immediately after installation of a waterbody crossing, the contours of the streambed, shoreline, and streambanks would be restored to preconstruction configurations (i.e., contour/elevations) to restore the physical integrity/condition of these features and to minimize the loss of stream complexity.

PCGP has completed a scour analysis that would be used to ensure that appropriate pipeline burial depths and cover design parameters beneath channel streambeds and within adjacent floodplains are utilized, so that the effects on natural stream processes would be avoided or minimized. The Pipeline project's scour analysis, which was completed by GeoEngineers, was included in PCGP's September 2017 FERC certificate application.

PCGP would install erosion control fabric (such as jute or excelsior) on streambanks at the time of recontouring. The fabric would be anchored using staples or other appropriate devices. The erosion control fabric to be used on streambanks would be designed for the proposed use and would be approved by PCGP's environmental inspectors (EIs).

Consistent with the FERC's *Procedures* (section V.C.3.), during streambank restoration/recontouring, the streambanks would be returned to their preconstruction contours or to a stable configuration. The Lost River is included in the application of the conservation measure. Streambank revegetation measures, including supplemental riparian planting procedures, are also outlined in the ECRP. The shrubs and trees planted at each site would be determined at the time of planting based on the moisture regimes and site-specific conditions at each planting location and landowner requirements.

In-stream Gravel

Pipeline trenches across the Lost River and other perennial waterbodies within the Upper Klamath River Subbasin and Lost River Subbasin would be backfilled with material removed from the trench with the upper 1-foot of the trench backfilled with clean gravel or native cobbles of a size appropriate for resident fish, including suckers. The bottom and banks would be returned to preconstruction contours; banks would be stabilized; and temporary sediment barriers would be installed before returning flow to the waterbody channel.

Stream Crossing Risk Matrix

The FWS expressed concerns that more detailed site-specific information on bank material, streambed composition, shoreline vegetation, and other information is needed to adequately ensure that actions occurring at a stream crossing do not significantly increase streambank erosion and streambed instability. Follow-up surveys, site designs, and additional site actions resulting from these surveys as described below would reduce the risk of stream bank and bed instability in shortnose sucker habitat to unsubstantial adverse effects levels.

PCGP, in response to these requests, has conducted an assessment of crossing conditions of all streams suitable for analysis based on the FWS risk matrix (GeoEngineers 2017d, 2017e, and 2018a). GeoEngineers, using a combination of field and GIS data, rated proposed stream crossings based on the matrix along the entire route including 19 stream, ditch, and canal crossings in the range of shortnose sucker. The matrix has two axes rating the crossing based on the project impact potential at the crossing and the relative stream response potential at the crossing. Each crossing was rated as low, medium, or high for each of the two axes (all stream crossings were placed into one of nine categories, such as Low–Low, Low–Medium, and Medium–High).

No crossing within the range of the shortnose sucker was rated as having both high risk of project impact potential (i.e., high risk of project impacts and high risk of site response potential) and high risk of stream and site response potential. For any crossing in this category, PCGP would develop a site-specific crossing plan, similar to that required by FERC for stream crossings over 100 feet wide. All crossings that would have an open cut within the range of the shortnose sucker had moderate or low ratings for the two categories. The Lost River crossing was rated moderate project impact potential and high for the relative stream response potential.

Those stream crossings that were rated to have a low or moderate project impact potential would be crossed using project-typical BMPs. The remaining stream crossings would have a variety of site-specific BMP actions taken to reduce the probability of stream bank and bed erosion or instability from project actions (see pre-construction surveys below). Stream crossings that are unstable can ultimately adversely affect aquatic resources from such factors as loss of local habitat, impacts to downstream habitat from addition of high unstable sediment, and increased recovery time of the specific site to stable conditions.

A pre-construction survey would be conducted by a technically qualified team on all stream crossings to confirm and clarify conditions developed in the aforementioned matrix analysis. This team would be composed of professionals qualified to assess terrestrial and aquatic habitat and the geotechnical and geomorphic conditions relative to construction across stream channels and ditches. Following these surveys, if significant changes were to occur to parameters of the risk matrix for a crossing, changes would be made to risk level and appropriate final methods of crossing and BMPs made at each stream crossing. If any crossing is moved into the "high" project impact and "high" stream response risk matrix category, a site-specific crossing design would be developed for that site. Construction would then move forward as described in permit documents including implementation of special additional BMPs, as described in GeoEngineers (2017d, 2017e, and 2018a), depending on individual site conditions. Special additional BMPs may be such actions as changes in bank material and bank angle, specific substrate composition used, plants used on the bank, artificial stabilizing bank material, rootwad enhancement, and various other actions.

As a follow-up measure to help ensure crossing actions would not adversely affect stream bank and channel structure, PCGP would monitor stream crossings to ensure long-term success of the restoration, maintenance of fish passage, and to identify channel erosion, scour or migration that could destabilize the site or expose the pipeline. As requested by FERC, PCGP developed a monitoring plan (GeoEngineers 2017e and 2018a) following consultation with a representative from FWS and NMFS (Castro 2015). The monitoring plan would be customized, where necessary, to address risks of stream crossings identified in the Risk Analysis and those identified in subsequent preconstruction surveys.

Monitoring would consist of:

- Annual visits to all stream crossings, regardless of risk level, as part of PCGP's monitoring of pipeline integrity. These visits would be completed by PCGP staff and would note any obvious signs of channel erosion, pipeline exposure, or major shifts in restoration elements. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.

- Aerial reconnaissance would be completed annually for the life of the Pipeline and stream crossings would be reviewed for major landscape changes such as channel migration and excessive erosion. Potential problem areas would be subsequently visited by PCGP and a geoprofessional.
- Quarterly site visits to all sites in the Orange management category (see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross sectional area.
- Annual site visits to 15 percent of all sites in the Blue management category and 100 percent of all sites in the Yellow management category (see GeoEngineers 2018a) for 2 years post construction to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual site visits to 50 percent of the sites in the Yellow and 100 percent of sites in the Orange management category (see GeoEngineers 2018a) by a geo-professional in Years 3, 5, 7, and 10 to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the project, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Observations would be made during all site visits on the effects of cattle/elk browsing on restoration success, and of impacts associated with recreational use.
- Revegetation planning along the right-of-way is detailed in the ECRP. The ECRP describes monitoring and performance standards for revegetation.
- Records would be maintained annually to document any significant hydrologic events (flow or rainfall) that occur in between site visits. This shall be done to better understand the site response to moderate or large flood events. As gauging stations are extremely limited over the majority of the crossings along the Pipeline route, rainfall records would be used to identify the potential flooding that may occur in between scheduled monitoring events. These climatic events would be considered during annual monitoring when evaluating site response.
- Unscheduled site visits may be completed at stream crossings on BLM and USFS jurisdiction following localized rainfall events exceeding a 25-year rainfall intensity to monitor revegetation success, structural stability of the restoration elements, any changes to fish passage potential resulting from the Pipeline, evidence of channel migration, erosion, head-cutting, or other stream channel movement that could influence stream or pipeline stability. Field measurements would be taken to monitor adjustments to the channel profile and cross-sectional area.
- Annual reporting in Years 1, 2, 3, 5, 7, and 10 following construction would be provided to outline observations of stream crossings and any remedial action taken to restore site conditions.

- Monitoring frequency and locations may be modified in response to demonstrating site restoration success in the Annual Monitoring reports.

Overall, these actions would reduce potential adverse effects from bank and bed stability to the listed shortnose sucker to unsubstantial levels.

3.5.6.5 Determination of Effects

Species

The Pipeline project **may affect** shortnose suckers because:

- shortnose suckers occur within the Upper Klamath River and Lost River Subbasins, which would be affected during construction of the proposed action.

While several Pipeline project actions are not likely to cause adverse effects, those resulting effects from Pipeline components that are **likely to adversely affect** shortnose suckers include:

- the possibility that shortnose suckers could occur within the Lost River when it would be crossed by the Pipeline and be affected by elevated suspended sediment levels;
- shortnose suckers could occur in 19 waterbodies crossed by dry open-cut construction in the Lake Ewauna-Klamath River watershed and in 13 waterbodies west of MP 214.38 (including the Lost River) crossed in the Mills Creek-Lost River watershed and be indirectly affected by elevated suspended sediment levels, streambank erosion and stability, and aquatic nuisance species introductions; and
- adults and juveniles subject to fish salvage within the isolated construction site at 31 ditches crossed by dry-open cuts and the Lost River could be affected if electroshocking is used and stressed if seining is used.

Critical Habitat

The Pipeline project is **not likely to adversely affect** designated critical habitat for the shortnose sucker because:

- HDD would avoid critical habitat in the Klamath River.

3.6 INVERTEBRATES

3.6.1 Vernal Pool Fairy Shrimp

Vernal pool fairy shrimp (*Branchinecta lynchi*) are small crustaceans, usually less than 2.4 cm (1 inch) long that live for only one season while there is water in a vernal pool. They can be found from Tulare County, California, north into Jackson County, Oregon.

3.6.1.1 Species Account and Critical Habitat

Status

On September 19, 1994, the final rule to list the vernal pool fairy shrimp as threatened was published in the Federal Register (FWS 1994b). In 2003, the FWS designated 839,460 acres of critical habitat for this species (FWS 2003a). In 2005, FWS (2005f) reevaluated the economic exclusions made in the 2003 final rule and excluded approximately 241,640 acres of land from the final 2003 designation for economic reasons. In 2006, the FWS produced species-specific unit descriptions and maps for the 597,821 acres of critical habitat designated for the vernal pool fairy shrimp, which included 7,574 acres of critical habitat in Jackson County, Oregon (FWS 2006e).

Threats

The FWS identified significant threats to vernal pool fairy shrimp by urbanization, conversion of wetlands to agriculture, indirect impacts from timber operations, grazing, mining, OHV use, road construction, right-of-way designation, hazard mitigation and post-disaster repairs, and other man-made changes in hydrologic patterns. In many cases, vernal pool complexes inhabited by the shrimp occurred on private land in areas of proposed or ongoing road, utility, residential, and commercial developments; the FWS was concerned that landowners could knowingly destroy vernal pool habitats (FWS 1994b, 2005e, and 2012h). Vernal pool contamination from runoff of surrounding areas may also injure or kill vernal pool fairy shrimp (FWS 2006e). Other factors noted as threats to vernal pool fairy shrimp in the final rule include stochastic events, which can have disproportionate effects on small, isolated populations and may result in local extirpations. Pools and pool complexes supporting vernal pool fairy shrimp are usually small, and unforeseen natural and human-caused catastrophic events threaten some sites (FWS 1994b).

In the 2007 five-year review of the vernal pool fairy shrimp, FWS determined threats to the species have not decreased since the time of listing in 1994 (FWS 2007g). The loss and modification of vernal pool habitat due to urban development, agricultural conversion, and infrastructure construction continue to be primary threats to the shrimp. For example, where the species is found in Southern Oregon (Medford Region), human population growth increased by 29.5 percent between 1990 and 2000 (FWS 2007g), although population growth slowed somewhat to 18.6 percent between 2000 and 2010 (GNRO 2012). FWS (2011f) has initiated another 5-year review for wildlife and plants in the Klamath Basin, including the vernal pool fairy shrimp.

Species Recovery

In November 2012, the FWS finalized a recovery plan for vernal pool species within the Rogue River and Illinois Valleys (FWS 2012h). The recovery plan (FWS 2012h) takes an ecosystem-based approach for recovery of three federally listed species, including the vernal pool fairy shrimp, and seven other rare species, and includes more Oregon-specific direction for recovery of the vernal pool fairy shrimp than previously provided in *The Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (FWS 2005e).

The recovery goal specific to the vernal pool fairy shrimp is (FWS 2012h):

- Recover the vernal pool fairy shrimp within its Klamath Mountains Recovery Zone (Agate Desert, Table Rocks, and White City area).

The recovery objectives included in the recovery plan are (FWS 2012h):

- Stabilize and protect populations of the vernal pool fairy shrimp within its Klamath Mountains Vernal Pool Region so further decline in species status and range are prevented.
- Minimize or eliminate the threats that caused the species to be listed and any newly identified threats.

- Conduct research necessary to refine downlisting and recovery criteria.
- Promote natural ecosystem processes and functions by protecting and conserving intact vernal pool-mounded prairie complexes and seasonally wet meadows within the recovery planning area.

The recovery plan includes the following delisting criteria for vernal pool fairy shrimp in the Klamath Mountain Region (FWS 2012h):

- At least 80 percent (9 of 11) of the occurrences within the Klamath Mountain Vernal Pool Region have been protected.
- At least 85 percent of suitable vernal pool habitat within the Klamath Mountain Vernal Pool Region has been protected.
- Develop and implement habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function, especially hydrology function that contribute to population viability for all protected habitat.
- Cyst banking actions have been completed for the vernal pool fairy shrimp from at least one population in each of the three major core area groups (Agate Desert, Table Rocks, and White City).
- Status surveys, five-year status reviews, and population monitoring show vernal pool fairy shrimp populations within the Klamath Mountain Vernal Pool Region are viable (self-sustaining) and have been maintained (stable, increasing, or showing only minor declines from high population levels) for a 10-year monitoring period.

The recommended recovery and long-term conservation actions are (FWS 2012h):

- Protect vernal pool, wet meadow, and sloped mixed-conifer forest habitats.
- Manage, restore, and monitor vernal pool and wet meadow habitat.
- Conduct rangewide population status surveys.
- Conduct research essential to the conservation and recovery of the species.
- Enhance public awareness and participation in the recovery of the species.
- Develop a post-delisting monitoring plan.

Life History, Habitat Requirements, and Distribution

This freshwater crustacean is endemic to California and the Agate Desert of southern Oregon. The vernal pool fairy shrimp has an ephemeral life cycle and only inhabits vernal pools, or seasonal wetlands that fill with water during fall and winter rains. They are known to occupy a variety of vernal pool habitats, from small, clear, sandstone rock pools to large, turbid, alkaline, grassland valley floor pools. Vernal pools in which the shrimp has been collected have water temperatures ranging from 40 to 73°F, with low to moderate amounts of salinity or total dissolved solids (FWS 2005e). Individuals hatch from cysts during winter storms and require water temperatures of 50°F or lower to hatch. The time to maturity and reproduction is dependent on temperature, ranging between 18 and 147 days, with a mean of 39.7 days. The shrimp can die when water temperatures rise to about 75°F. Flooding and wildlife movement within and between vernal pool complexes allow the shrimp to disperse between individual pools, indicating that vernal pool fairy shrimp populations are defined by entire pool complexes, rather than individual pools (FWS 2007g).

Vernal pool fairy shrimp are found in 28 counties across the Central Valley and Coast ranges of California, and the inland valleys of southern California and southern Oregon (FWS 2005e). The shrimp was discovered in Jackson County, Oregon in 1998 at two distinct vernal pool habitats: on alluvial fan terraces associated with Agate-Winlo soil complexes in the Agate Desert, and in the Table Rocks area on Randcore-Shoat soil complexes underlain by lava bedrock (FWS 2005e). In Oregon, the vernal pool fairy shrimp is associated with the same vernal pool habitats as the large-flowered woolly meadowfoam and Cook's lomatium plant species (discussed below). The Agate Desert comprises the northern extent of the vernal pool fairy shrimp's range (FWS 2005e), where vernal pool fairy shrimp are located on non-Federal lands in three small Nature Conservancy Preserves totaling 297 acres, and within the 720-acre ODFW's Denman Wildlife Management Area (FWS 2007g).

Population Status

Actual numbers of fairy shrimp are not available, given their short life-span, and the nature of their reproduction (FWS 2012h); therefore, population (or species distribution) can only be inferred from the loss of vernal pool habitat. The historical distribution of vernal pool fairy shrimp is not known, especially in the Agate Desert in Oregon where it was recently discovered in 1998. However, it is estimated that vernal pool habitat in the Agate Desert has likely declined by 75 percent from historical extent (FWS 2007g). Additionally, over 40 percent of the vernal pool habitats remaining in Oregon have been degraded. Vernal pool fairy shrimp have been documented in 50 percent of the pools sampled in the Agate Desert Preserve, which is the highest percentage compared with other locales where the species is found (i.e., California) (FWS 2005e).

Critical Habitat

Within the Rogue Valley, 7,574 acres have been designated as critical habitat for the vernal pool fairy shrimp within the following quadrangles in Jackson County: Shady Cove, Eagle Point, Boswell Mountain, Brownsboro, and Sams Valley (FWS 2006e). When determining areas of critical habitat for the vernal pool fairy shrimp, FWS focused on the principal biological or physical PCEs that that are essential to the conservation of the species (FWS 2003c). Specifically, FWS (2003c) determined that two essential PCEs would apply to all critical habitat designated for vernal pool fairy shrimp:

1. vernal pools, swales, and other ephemeral wetland features of needed size and depth that become inundated during winter rains and hold water for the time necessary for life cycle completion, including but not limited to, Northern Hardpan, Northern Claypan, Northern Volcanic Mud Flow, and Northern Basalt Flow vernal pools; and,
2. the geographic, topographic, and edaphic features that support systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within a matrix of surrounding uplands that together form what are known as vernal pool complexes.

3.6.1.2 Environmental Baseline

Analysis Area

Similar to the botanical analysis area that is described below for vernal pool plant species (see large-flowered woolly meadowfoam, section 3.7.3.2), the analysis area for the vernal pool fairy shrimp extends 250 feet each side of the Pipeline project (construction right-of-way, TEWAs) on lands that have potential habitat (Agate-Winlo soil complex) for the vernal pool fairy shrimp. Additionally, the analysis area extends 250 feet from the perimeter of four proposed pipe storage yards that are located within the Vernal Pool Complex – Agate Desert, Jackson County, Oregon where this species is known to occur, as shown in figure 3.6.1-1. This is a distance (250 feet) in which indirect effects from the Proposed Action could occur to vernal pools supporting this species (FWS 2011h).

Species Presence

Three proposed pipe storage yards (Burrill Lumber, Avenue F & 11th Street, and WC Short) are within proximity to federally-designated critical habitat units VERFS 3A and 3B in Denman Wildlife Management Area (WMA) and Agate Desert Preserve, and occur within the Agate-Winlo soil complex. A fourth proposed pipe storage yard (Rogue Aggregates) is 1 to 2 miles southwest/west of critical habitat units VERFS 4B and 3C (see figure 3.6.1-1) but does not occur within Agate-Winlo soil complex. Surveys within critical habitat units in the vicinity of proposed pipe storage yards have documented vernal pool fairy shrimp. The most recent observations were in 2004 and 2005 where 15 to 25 percent of the vernal pools sampled were occupied by fairy shrimp (ORBIC 2017b):

- VERFS 3A (Denman WMA):
  - 2004: eight pools occupied out of 53 sampled.
  - 2005: one pool occupied out of 31 sampled.
- VERFS 3B (Agate Desert Preserve, Denman WMA):
  - 2001: 11 occupied out of 43 sampled.
  - 2002: 11 occupied out of 62 sampled.
  - 2003: 35 pools occupied out of 99 sampled (complete habitat survey).
  - 2004: 12 pools occupied out of 25 sampled.
  - 2005: 2 occupied out of 8 sampled.
- VERFS 3C (Whetstone Savanna Preserve):
  - 2001: 1 pool occupied out of 3 sampled.
  - 2002: 75 occupied out of 271 sampled.
  - 2003: 28 occupied out of 80 sampled.
  - 2004: no survey.
  - 2005: 0 occupied out of 7 sampled.
- VERFS 4B (Lower Table Rock ACEC, Medford BLM): 3 individuals observed in 2004.

Project-Specific Surveys

In 2015, a survey protocol for Branchiopods, including vernal pool fairy shrimp, was published by the FWS (2015b). A complete survey consists of one wet season survey and one dry season survey conducted and completed within a 3-year period. Although potential vernal pool habitat that could be occupied by vernal pool fairy shrimp has been identified either through on-site surveys and/or off-site observations (table 3.6.1-1), no protocol vernal pool fairy shrimp surveys have been conducted for the Pipeline project because of landowner denial. Figure 3.6.1-3, identifies areas in the vicinity of the proposed pipe storage yards that have been evaluated for vernal pools on-site, areas that have been evaluated for habitat from off-site observations, and areas where vernal pool habitat was observed, and, where permitted, surveyed for large-flowered woolly meadowfoam or Cook's lomatium. At the time of ESA plant surveys, no surveys for vernal pool fairy shrimp were conducted and since ESA plant surveys, access to survey for vernal pool fairy shrimp, and other species has been denied.

In 2007, SBS identified vernal pool habitat in and near possible pipe storage yards in Jackson County that could provide habitat for two federally-listed plants (large-flowered woolly meadowfoam and Cook's lomatium, discussed in sections 3.7.3 and 3.7.4, respectively), as well as vernal pool fairy shrimp. Surveys for the federally-listed plants occurred in the proposed Burrill Lumber pipe yard and Rogue Aggregates pipe yard in 2007; no vernal pools were identified in the two proposed pipe storage yards, although approximately 4.4 acres of high quality suitable vernal pool habitat was observed 850 to 1,165 feet east of Burrill Lumber pipe storage yard where large-flowered woolly meadowfoam was documented (see figure 3.7.3-1 for large-flowered woolly meadowfoam; SBS 2008b). No surveys within Avenue F & 11th Street and WC Short pipe storage yards have been permitted by the landowner. Based on aerial photography and off-site observation in April 2018, Avenue F and 11th and WC Short pipe yard do not appear to contain vernal pools: Avenue F and 11th pipe yard is highly disturbed and graded, with railroad and docking faciltities located on the southern edge of the yard, and WC short pipe yard is an existing train yard that would assist moving and off-loading pipe. Although no vernal pools have been observed in Avenue F and 11th pipe yard, there is a long drainage ditch that runs along the northern edge of the pipe yard and paved Avenue F road and extends south along the western edge of the yard; the drainage has very little movement and could be considered low quality vernal pool habitat (approximately 0.45 acre) for the vernal pool fairy shrimp. No potential vernal pools have been identified in WC Short. In 2007, PCGP also identified suitable vernal pool habitat within two previously proposed pipe yards that are no longer proposed for use by the Pipeline project (approximately 10.5 acres of higher quality suitable vernal pool habitat located 100 feet south of Avenue F & 11th Street pipe storage yard and approximately 0.55 acre of higher quality vernal pool habitat located 860 feet north of Avenue F & 11th Street pipe storage yard, [SBS 2008b]). Although potentially suitable vernal pool habitat has been documented in proposed Jackson County pipe yards, no protocol surveys for vernal pool fairy shrimp are proposed. because PCGP would avoid using sections of the proposed pipe storage yards within 250 feet of any vernal pool habitat (extent of indirect effects), or PCGP would not pursue use of the pipe yard (see Conservation Measures, section 3.6.1.4).

In addition to potentially suitable vernal pool habitat in the vicinity of or within proposed pipe yards in Jackson County, nine vernal pools (approximately 0.2 acre) within and adjacent to the proposed right-of-way (MPs 145.30 to 145.40) were identified on private lands during botanical surveys conducted in 2007 and 2008. The vernal pools were surveyed for Cook's lomatium and large-flowered woolly meadowfoam in 2007 and 2008, and no plants were observed (SBS 2008b). Although this area is outside of the known range for vernal pool fairy shrimp, and the closest known occupied habitat is located approximately 8.2 miles west in critical habitat unit VERFS 2B, the vernal pools may provide suitable habitat for the vernal pool fairy shrimp because the pools occur within the appropriate soils type (Agate-Winlo) for vernal pool fairy shrimp (see figure 3.6.1-2). However, since botanical surveys in 2007 and 2008, no additional surveys have been permitted; therefore, no wetland delineations according to appropriate protocols have been completed to confirm vernal pool (wetland) presence within and adjacent to the construction right-of-way between MPs 145.30 and 145.40, and no protocol surveys for vernal pool fairy shrimp have occurred in these potentially suitable vernal pools. Once survey access is permitted, PCGP will conduct wetland delineations. If vernal pool habitat is confirmed during wetland delineations, PCGP would conduct surveys for vernal pool fairy shrimp following the 2015 FWS survey protocol by a certified surveyor – either two full wet season surveys completed within a 5-year period or two consecutive seasons of one full wet season survey and one dry season survey (or visa versa) (FWS 2015b). Surveys would not commence until a permit to survey is acquired from the FWS. PCGP will assume presence of vernal pool fairy shrimp until further surveys either determine no vernal pools present and/or protocol surveys for the fairy shrimp determine absence.

TABLE 3.6.1-1

Summary of Habitat Evaluated for Potential Vernal Pool Habitat within the Analysis Area [1]

General Landowner	Vernal Pool Habitat Status	Total Acres Surveyed [2]	Acres Surveyed [3]			Acres Not Surveyed [4]		
			Project [5]	Buffer [6]	Total	Project [5]	Buffer [6]	Total
Jackson County Pipe Yards [7]; MPs 145.3-145.4 (355 acres within botanical analysis area) [6]								
Federal	Vernal Pool [8]	0			0			0
	Vernal Pool Complex [9]	0			0			0
	Not Habitat	0			0			0
	Total	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Non-Federal	Vernal Pool [8]	16.5	0.03	2.92	2.94	0.12	0.36	0.48
	Vernal Pool Complex [9]	42.23	1.37	3.44	4.81	5.8	9.75	15.55
	Not Habitat	285.24	89.39	51.83	141.22	44.79	129.47	174.26
	Total	*343.97*	*90.79*	*58.18*	*148.97*	*50.71*	*139.58*	*190.29*
Total	Vernal Pool [8]	16.5	0.03	2.92	2.94	0.12	0.36	0.48
	Vernal Pool Complex [9]	42.23	1.37	3.44	4.81	5.8	9.75	15.55
	Not Habitat	285.24	89.39	51.83	141.22	44.79	129.47	174.26
	Total	***343.97***	***90.79***	***58.18***	***148.97***	***50.71***	***139.58***	***190.29***

1 Area evaluated for vernal pool dependent ESA species analyzed in this BA (large-flowered woolly meadowfoam, Cook's lomatium, and vernal pool fairy shrimp) included habitat in Agate-Winlo soil complex, within 250 feet of proposed Pipeline components located in Jackson County; area was evaluated on-site, where permitted, or off-site from existing roads and/or 2016 aerial photography to identify vernal pool habitat. Surveys for botanical species occurred in vernal pools documented during on-site evaluations; no surveys have been conducted to-date for vernal pool fairy shrimp.

2 Acres provided in this column considers all on-site evaluations/surveys to-date, including areas that have been subsequently rerouted or dropped (i.e., pipe yards) since habitat evaluations and surveys were initiated in 2007. Surveys for botanical species occurred within vernal pool habitat.

3 Acres Surveyed: includes area within 250-feet of the Pipeline (right-of-way and pipe yards) that had habitat evaluated on-site for vernal pool habitat. Protocol surveys were conducted within identified vernal pool habitat for ESA botanical species (large-flowered woolly meadowfoam and Cook's lomatium); no surveys have been conducted to-date for vernal pool fairy shrimp.

4 Acres Not Surveyed: includes areas evaluated off-site that were either denied access or are outside of the targeted survey area (Jackson County pipe yards); the majority of habitat that occurs within 250 feet of Jackson County pipe yards is industrial. Off-site observations identified potentially suitable vernal pool habitat (0.48 acre) that would require surveys once access is permitted; all other habitat is not suitable for ESA species. Area (acres) does not include suitable vernal pool habitat that occurs within 250 feet of Burrill Lumber pipe yard within Ken Denman State Game Management Reserve; habitat is located across Agate Road (paved and raised) from Burrill Lumber pipe yard (9.45 acres).

5 Project includes: right-of-way, temporary extra work area, and pipe yards.

6 Buffer (botanical analysis area) includes area within 250-foot buffer around the pipe yards in Jackson County, as well as between MPs 145.3 and 145.4 along the Pipeline right-of-way that crosses Agate-Winlo soil complex.

7 Jackson County Pipe Storage Yards considered: Burrill Lumber, Ave F and 11th Street, WC Short, and Rogue Aggregates.

8 Vernal pool habitat observed during on-site and off-site evaluations: includes all vernal pool wetlands documented, including ditches with vernal pool characteristics.

9 Vernal Pool Complex includes upland habitat within 100 feet of vernal pool habitat (see footnote #8).

Note: most area that remains to be surveyed occurs on private lands; surveys would continue as access becomes available.

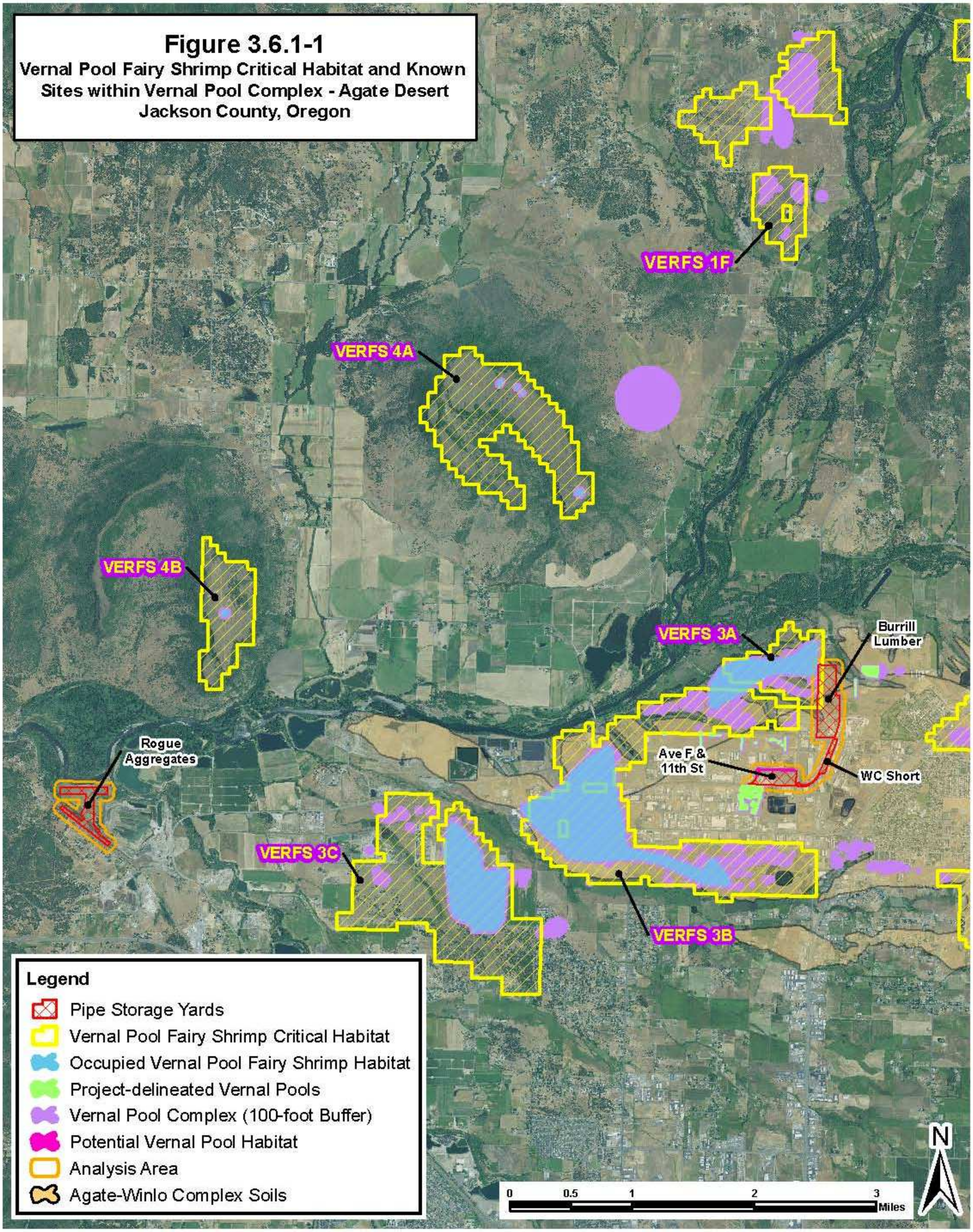
Figure 3.6.1-1
Vernal Pool Fairy Shrimp Critical Habitat and Known Sites within Vernal Pool Complex - Agate Desert Jackson County, Oregon
VERFS 1F
VERFS 4A
VERFS 4B
VERFS 3A
Burrill Lumber
Rogue Aggregates
Ave F & 11th St
WC Short
VERFS 3C
VERFS 3B
Legend
Pipe Storage Yards
Vernal Pool Fairy Shrimp Critical Habitat
Occupied Vernal Pool Fairy Shrimp Habitat
Project-delineated Vernal Pools
Vernal Pool Complex (100-foot Buffer)
Potential Vernal Pool Habitat
Analysis Area
Agate-Winlo Complex Soils
0 0.5 1 2 3 Miles
N

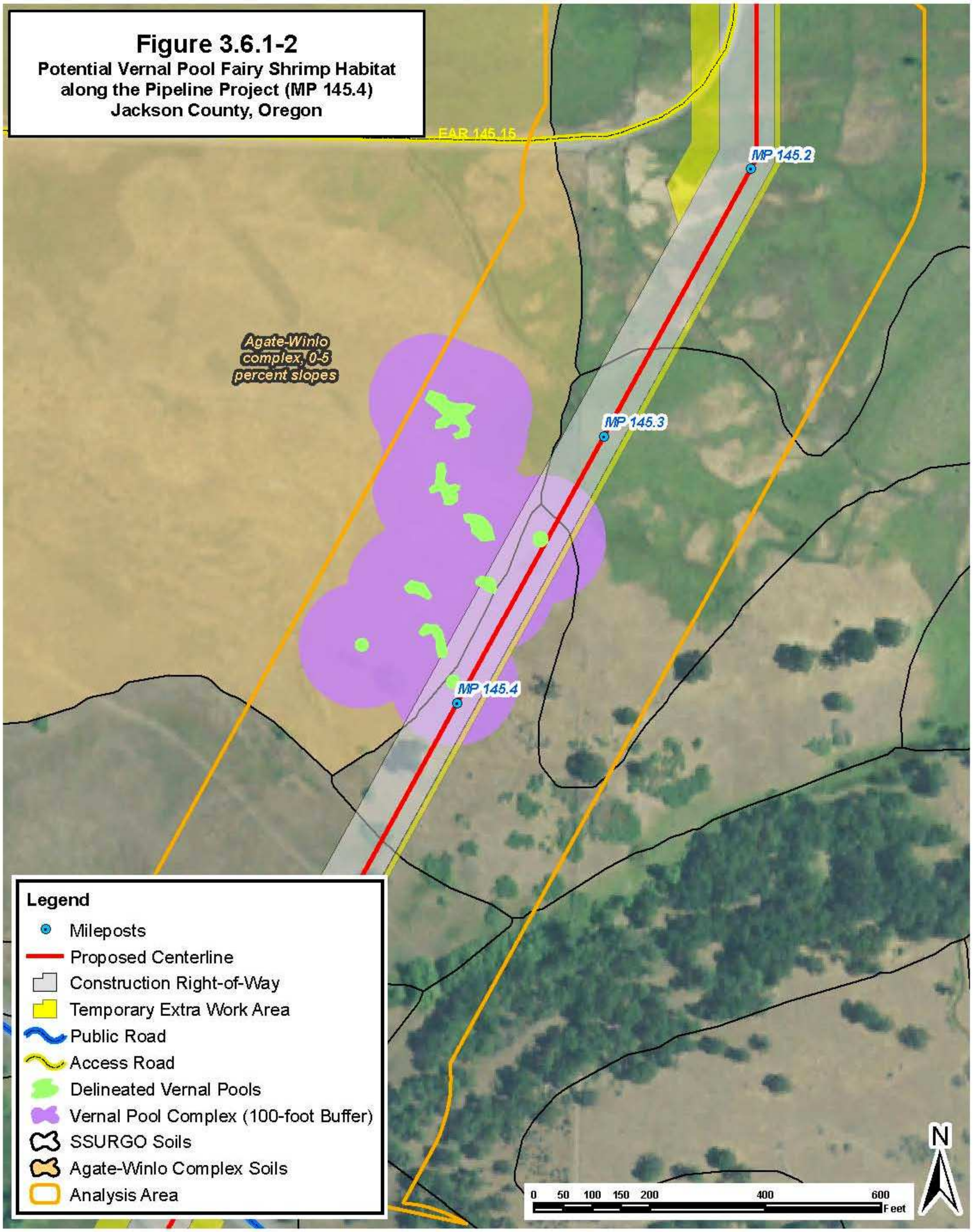

Figure 3.6.1-2
Potential Vernal Pool Fairy Shrimp Habitat along the Pipeline Project (MP 145.4)
Jackson County, Oregon
EAR 145.15
MP 145.2
MP 145.3
MP 145.4
Agate-Winlo complex, 0-5 percent slopes
Legend
Mileposts
Proposed Centerline
Construction Right-of-Way
Temporary Extra Work Area
Public Road
Access Road
Delineated Vernal Pools
Vernal Pool Complex (100-foot Buffer)
SSURGO Soils
Agate-Winlo Complex Soils
Analysis Area
0 50 100 150 200 400 600
Feet
N

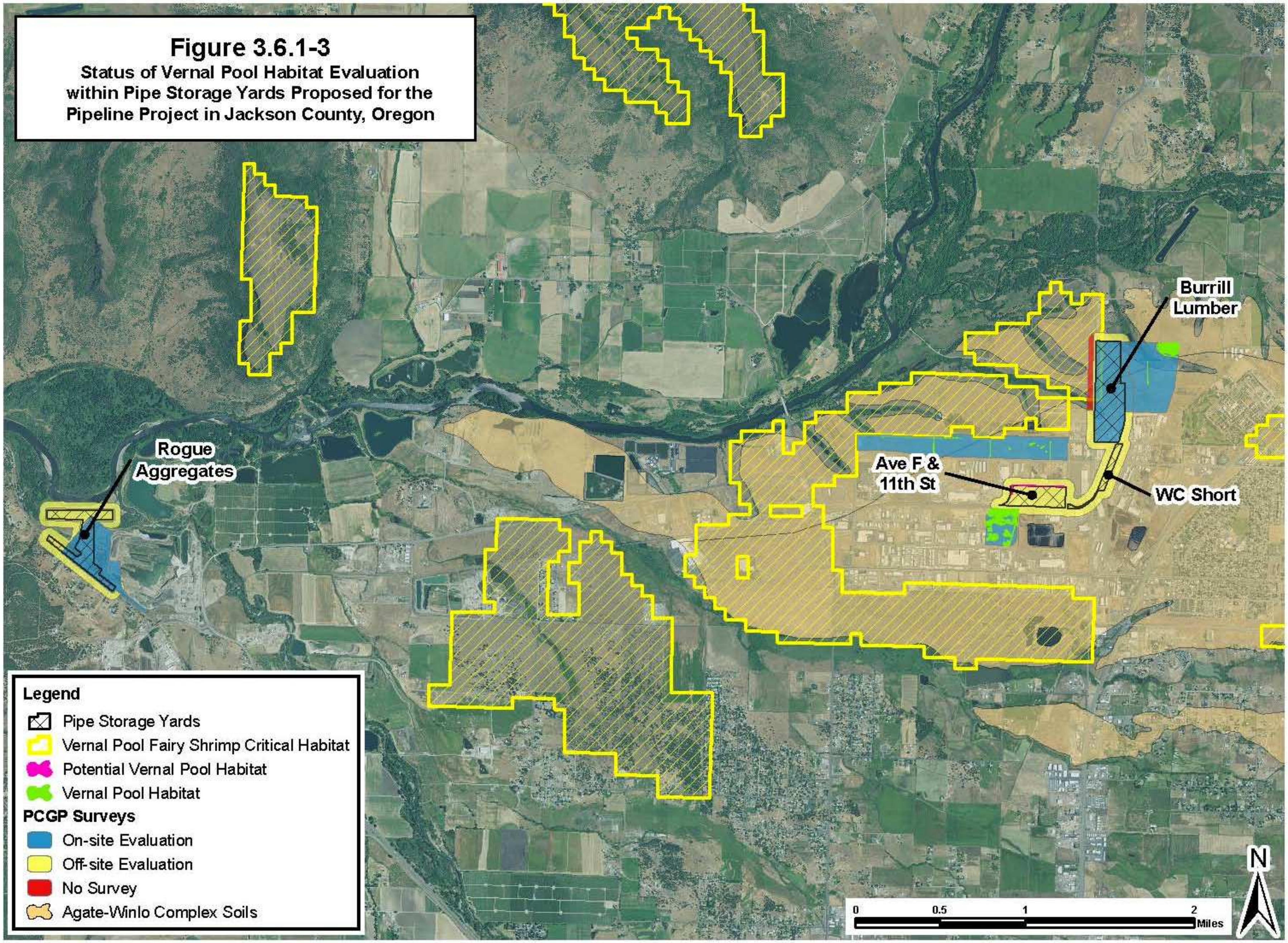
Figure 3.6.1-3
Status of Vernal Pool Habitat Evaluation within Pipe Storage Yards Proposed for the Pipeline Project in Jackson County, Oregon
Burrill Lumber
Rogue Aggregates
Ave F & 11th St
WC Short
Legend
Pipe Storage Yards
Vernal Pool Fairy Shrimp Critical Habitat
Potential Vernal Pool Habitat
Vernal Pool Habitat
PCGP Surveys
On-site Evaluation
Off-site Evaluation
No Survey
Agate-Winlo Complex Soils
0
0.5
1
2
Miles
N

Critical Habitat

Four pipe storage yards (Rogue Aggregates, Burrill Lumber, Ave F & 11th Street, and WC Short) are proposed within Eagle Point and Sams Valley quadrangles where ten designated critical habitat units are within 3 miles of the proposed yards. Figure 3.6.1-1 identifies locations of proposed pipe storage yards in relation to federally-designated critical habitats for vernal pool fairy shrimp.

One critical habitat unit (VERFS 3A), which is centered on the Ken Denman WMA, was delineated such that it crosses over the top of Agate Road (paved surface) and encompasses a 25-foot wide band of previously disturbed areas used for lumber processing within the western portion of proposed Burrill Lumber pipe storage yard. However, FWS (2017e) indicated that CHU VERFS 3A was incorrectly delineated and should be delineated to the western edge of Agate Road right-of-way and not cross over the road and into Burrill Lumber property. Burrill Lumber pipe storage yard and its surrounding was surveyed for vernal pool habitat in 2007; no suitable habitat for vernal pool fairy shrimp was observed within the proposed Burrill Lumber pipe storage area (SBS 2008b). Survey data reported by ORBIC (2017b) documented vernal pool fairy shrimp within suitable habitats in critical habitat unit VERFS 3A on the western side of Agate Road, but no occupied habitat occurs within the proposed boundaries of the Burrill Lumber pipe yard. Another critical habitat unit (VERFS 3B) is in the vicinity of three proposed pipe storage yards (Burrill Lumber, Avenue F & 11th Street and WC Short), ranging from 915 feet to 2,500 feet. Two other critical habitat units (VERFS 4B and VERFS 3C) occur within 1 to 2 miles of Rogue Aggregates pipe storage yards. Survey data reported by ORBIC (2017b) have documented vernal pool fairy shrimp in all critical habitat units in the vicinity of proposed pipe storage yards.

3.6.1.3 Effects of the Proposed Action

Direct and Indirect Effects

Because of the rarity of vernal pool fairy shrimp, any direct impact resulting in species take or habitat loss would be a significant hindrance to its recovery. Direct effects to the shrimp and its habitat could be expected in vernal pools and upland habitat 100 feet from delineated vernal pools (vernal pool complex; FWS 2011h). Examples of potential direct impacts could include possible disturbance to pools from driving or storing equipment or pipes near or on vernal pools or wetlands, pipeline construction through vernal pools, or draining or modifying hydrology to pools containing live shrimp or their cysts. Those actions could directly destroy or disturb vernal pool fairy shrimp cysts (during the dry season) or live shrimp (during the wet season). Proposed pipe storage yards in Jackson County are located on lands where past heavy industrial uses have occurred. Since no vernal pool habitat has been documented in surveyed Jackson County proposed pipe storage yards, and since vernal pool habitats would be avoided in unsurveyed pipe storage yards by at least 250 feet (see Conservation Measures, below), no vernal pool fairy shrimp or potentially suitable vernal pool habitat would be directly impacted from use of pipe storage yards. On the other hand, direct impact to vernal pool fairy shrimp could occur if fairy shrimp or hibernating cysts are present in nine vernal pools within and adjacent to the Pipeline right-of-way (MPs 145.34 to 145.40). Although the vernal pools identified along the right-of-way are outside the known range of vernal pool fairy shrimp, these pools may support vernal pool fairy shrimp since they are within the soils (Agate-Winlo) appropriate for this species (see figure 3.6.1-2). Therefore, PCGP will assume presence of vernal pool fairy shrimp within the boundaries of vernal pools unless future wetland delineations determine no vernal pool presence and/or protocol surveys for the species determine fairy shrimp absence.

Indirect effects to vernal pool fairy shrimp and their habitat could occur with increased road use for access to pipe storage yards, truck and heavy equipment use within pipe yards, as well as construction and restoration activities where these activities occur near or are adjacent to suitable or potentially suitable habitat. Increased dust deposition in vernal pool habitats could affect vegetation and vernal pool physical or chemical properties (pH, water quality, turbidity, sedimentation, temperature). Soil compaction and sediment mobilization during use of pipe storage yards or construction of the Pipeline along the right-of-way may indirectly affect hydrology upon which vernal pools and associated vegetation are dependent. Indirect effects to hydrology could occur if within 250 feet of proposed activities (FWS 2011h). Run-off from proposed pipe storage yards may result in the delivery of harmful elements to habitats, including increased sediment loading, since pipe yards were often previously used for industrial or timber processing, and soils may contain residual components which could negatively affect fairy shrimp or their habitats. Also, road use adjacent to or near suitable or potentially suitable vernal pool fairy shrimp habitat may increase the risk of introduction of non-native, weedy species that could compete with native plant species associated with the vernal pool fairy shrimp. Construction of the Pipeline near potential suitable vernal pools near MPs 145.34 and 145.40 could also indirectly affect this species, if vernal pool wetlands (and vernal pool complex [upland habitat within 100 feet of vernal pool wetlands]) are present within 250 feet of Pipeline construction.

Based on the above analysis, construction and operation of the Pipeline between MPs 145.3 and 145.4 may directly or indirectly affect fairy shrimp associated with up to 0.19 acre of vernal pool wetlands (and 4.59 acres of vernal pool complex [upland habitat within 100 feet of vernal pool wetlands]) located within 250 feet of proposed Pipeline activities. Of this acreage, 0.03 acre of vernal pool habitat (and 1.18 acres of vernal pool complex) would be directly affected within the Pipeline right-of-way (see table 3.6.1-2). PCGP will implement a number of BMPs to minimize direct and indirect potential impacts to vernal pool wetlands during Pipeline construction (see section 3.6.1.4, Conservation Measures).

TABLE 3.6.1-2

Vernal Pool Habitat Directly / Indirectly Affected by the Pipeline Project within 250 feet of the Pipeline Right-of-Way (MPs 145.3 - 145.4)

Vernal Pool Complex	**Pipeline Right-of-Way**	**Buffer (250 feet)**	**Total**
Vernal Pool / Wetlands	0.03	0.16	0.19
Upland Habitat (100-foot Buffer)	1.18	3.41	4.59
Total	*1.21*	*3.57*	*4.78*

No direct or indirect effects to potential vernal pools are expected from use of proposed pipe storage yards in Jackson County, including 0.48 acre of potential vernal pool wetlands (and 15.55 acres of vernal pool complex) identified from off-site observations within or

adjacent to proposed pipe yards (see table 3.6.1-1). Within the vicinity of Jackson County pipe yards, vernal pool habitat is within 250 feet of Burrill Lumber pipe yard and Avenue F & 11th Street pipe yard; however, all vernal pool habitat is either separated by an existing paved access road (west of Burrill Lumber) or an existing railroad bed (south of Avenue F & 11th Street), and activities within proposed pipe yards would not be expected to adversely affect vernal pool wetlands. Although a drainage has been identified on the north and west edges of Avenue F & 11th Street pipe yard, Pipeline use, if any, would be located farther than 250 feet from the potential vernal pool habitat. Although no direct or indirect effects from use of pipe yards by the Pipeline project would be expected, road use adjacent to or near suitable habitat could increase the risk of introduction or spread of noxious weeds (see Conservation Measures, section 3.6.1.4).Cumulative Effects

Additional projects within the analysis area are anticipated as human population growth continues in the region. Residential, commercial, and industrial development are likely to occur in the foreseeable future. Human population in Jackson County grew a little more than 5 percent between 2010 and 2016. The Jackson County planning department is currently reviewing multiple permit applicantions for reasonably foreseeable projects proposed within and around the core vernal pool areas near the Project. Although Jackson County was not able to provide a comprehensive list or details regarding these reasonably foreseeable projects, development in and around vernal pool fairy shrimp habitat could be detrimental to the species if the proper conservation measures are not implemented. However, any developments that could potentially affect vernal pool habitat would be required to comply with COE and Oregon Department of State Lands requirements, which would reduce the likelihood of cumulative negative effects to this species and their habitats.

Critical Habitat

The FWS (2003c) identified two PCEs when designating critical habitat that considers soil moisture and aquatic environment required, as well as upland areas that may be associated with maintaining the aquatic and drying phases of the vernal pool or complexes. Vernal pools on the Agate Desert Preserve in the vicinity of proposed pipe storage yards in Jackson County, Oregon, generally consist of remnant parcels of disturbed or degraded vernal pool habitat and are threatened by indirect effects of adjacent land use, including alteration of hydrology (FWS 2007g). Williamson et al. (2005, cited in FWS 2007g) indicate that surface or subsurface changes to water flow could have deleterious effects on vernal pool ecosystem function protected areas within or adjacent to altered watersheds. Rains et al. (2006, cited in FWS 2007g) also indicated that small changes in local land use may have considerable impacts on vernal pools and their hydrology. Hydrology can also be altered by non-native grasses that occur commonly in vernal pool complexes.

One proposed pipe storage yard (Burrill Lumber) is located within the far eastern edge of FWS-delineated critical habitat unit VERFS 3A; however, FWS (2017e) indicated that this critical habitat unit was incorrectly delineated and its eastern border should have been delineated on the western edge of Agate Road right-of-way. No other pipe yards are located within 250 feet (distance of potential indirect effects to vernal pool wetlands) of delineated critical habitat (see figure 3.6.1-1). No direct impacts from the proposed action to vernal pool fairy shrimp critical habitat are expected since equipment and pipe storage would not occur on pools or wetlands (or vernal pool complex – upland habitat within 100 feet of vernal pool wetlands) in delineated critical habitat, nor would traffic to and from the pipe storage yards drive near or on pools within the designated critical habitat units.

Because the Burrill Lumber pipe yard location has been surveyed by qualified biologists, and they have documented that there is no suitable or potentially suitable habitat within the proposed Burrill Lumber pipe yard, there would be no direct impacts from the proposed action to vernal pool fairy shrimp critical habitat since equipment and pipe storage would not occur near or on pools or wetlands, nor would traffic to and from the pipe storage yards drive near or on pools within the designated critical habitat units. Possible indirect effects to the critical habitat units may occur as a result of increased dust deposition and stormwater runoff, and the potential for an increased risk of accidental spills in areas that are adjacent to the critical habitat units. Increased fugitive dust might impact vernal pool habitat within VERFS 3A as dust settles, affecting associated vegetation and vernal pool physical or chemical properties (pH, water quality, turbidity, sedimentation, and temperature). Indirect effects to hydrology within 250 feet of suitable or potentially suitable vernal pool habitat within VERFS 3A is not expected since existing, paved Agate Road occurs between currently disturbed Burrill Lumber pipe yard and VERFS 3A. However, use of Agate Road adjacent to the critical habitat unit and use of Burrill Lumber pipe storage yard may increase the introduction of non-native, weedy species.

Applying conservation measures identified below (section 3.6.1.4) and use/alteration/restoration of pipe storage yards should minimize effects to vernal pool habitat and/or vernal pool fairy shrimp within VERFS 3A.

3.6.1.4 Conservation Measures

PCGP has eliminated from further consideration the following previously proposed pipe storage yards to avoid potential effects to high-quality vernal pool habitat: Avenue C and 7th Street-Elite Cabinet & Door, Medford Industrial Park and a portion of the previously delineated Burrill Lumber yard that included high quality vernal pool habitat east of the currently proposed yard. To avoid impacts to potential vernal pool habitat along the northern and western edge of Avenue F and 11th Street pipe yard, PCGP would avoid using portions of Avenue F and 11th Street pipe storage yard within 250 feet of potential vernal pool habitat (boundary of indirect effects) or no longer pursue use of the pipe yard, similar to actions taken in previously proposed pipe storage yards with vernal pool habitat.

When survey access is permitted along the right-of-way between MPs 145.30 and 145.40, PCGP would conduct wetland delineations according to appropriate protocols to confirm vernal pool (wetland) presence/absence. If wetland delineations confirm the presence of vernal pools along the right-of-way, PCGP would have a certified surveyor conduct surveys for vernal pool fairy shrimp following the 2015 FWS vernal pool fairy shrimp survey protocol (FWS 2015b). Surveys would not commence until a permit for surveys is obtained from the FWS. If this species is identified during survey efforts, or if vernal pool fairy shrimp survey efforts do not occur at this location due to construction time constraints, PCGP would evaluate a potential reroute to avoid vernal pools by at least 250 feet with the landowner. If a reroute between MPs 145.30 and 145.40 is not possible, PCGP would discuss potential mitigation options with FWS to offset direct and indirect effects from Pipeline construction to potential vernal pool fairy shrimp within vernal pools (0.19 acre) (and vernal pool complex [4.59 acres] - upland habitat within 100 feet of vernal pools) within 250 feet of the Pipeline (see table 3.6.1-2). Additionally, PCGP would erect a silt fence on the west side of the right-of-way within 250 feet of the vernal pools located between MPs 145.27 and 145.44 to avoid or minimize any potential effects to surface drainage or current hydrologic conditions (FWS 2012h) and to prevent construction personnel and vehicles from incidentally affecting the vernal pools complex outside of the permitted right-of-way.

To minimize potential effects to vernal pools within 250 feet of the Pipeline project, PCGP would control fugitive dust along the construction right-of-way and at proposed pipe storage yards, as described in the Air, Noise and Fugitive Dust Control Plan (see appendix B to the POD). Applying water to pipe yards and along the right-of-way near MPs 145.34 to 145.40 would reduce the potential for adverse effects from fugitive dust to vernal pool habitat that is in proximity to the Pipeline. PCGP would also implement site-appropriate BMPs outlined in the ECRP (see appendix F) to mitigate the potential for increased sediment mobilization, thereby reducing any potential impacts to water quality in vernal pools. To minimize the potential spread of invasive species to vernal pool habitats, PCGP would implement BMPs outlined in the Integrated Pest Management Plan (see appendix N to the POD). Within 250 feet of vernal pools located in Agate-Winlo soils complex, all treatment for control of noxious and invasive weeds would occur through hand pulling or other approved hand-operated mechanical methods. Further, as per FERC requirements, all on-site construction personnel would receive instruction regarding the presence of listed species and the importance of and methods for avoiding impacts to this species and its habitat.

3.6.1.5 Determination of Effects

Species

The Project **may affect** vernal pool fairy shrimp because:

- potentially suitable habitat for vernal pool fairy shrimp has been identified in the vicinity of four proposed Jackson County pipe storage yards, as well as within and adjacent to the Pipeline right-of-way from MPs 145.34 and 145.40.

The Project is **likely to adversely affect** vernal pool fairy shrimp because:

- direct or indirect impacts to vernal pool fairy shrimp is possible from Pipeline construction within or adjacent to nine potentially suitable vernal pools identified between MPs 145.34 to 145.40 within Agate-Winlo soils, if the species is present.

Critical Habitat

A **not likely to adversely affect** determination is warranted for vernal pool fairy shrimp critical habitat because:

- although proposed Burrill Lumber pipe yard occurs within 250 feet from a designated vernal pool fairy shrimp critical habitat unit (VERFS 3A), it is separated from the critical habitat unit by Agate Road, which is a two-lane paved road that acts as a barrier to hydrologic connectivity that is considered a definitive boundary to the area of effects;
- Burrill Lumber pipe yard has been previously disturbed, and additional surface disturbances and/or soil compaction by heavy machinery from use within Burrill Lumber pipe storage yard should be minimal. Also, Agate Road is located between Burrill Lumber pipe yard and critical habitat unit VERFS 3A, which is raised and paved, and

would serve as an existing barrier between the pipe yard and critical habitat unit. Therefore, use of the Burrill Lumber pipe storage yard is not expected to adversely modify geographic, topographic, and edaphic features potentially within 250 feet of the yard that support systems of hydrologically interconnected pools, swales, and other ephemeral wetlands and depressions within the matrix of surrounding uplands (PCE 2); and

- proposed conservation measures would reduce and mitigate the potential for increased sediment mobilization, increased fugitive dust, and the potential spread of invasive species to suitable vernal pool habitats.

3.7 PLANTS

3.7.1 Applegate's Milk-vetch

The Applegate's milk-vetch (*Astragalus applegatei*) is a slender perennial of the pea (Fabaceae) family. It is known only in Klamath County, Oregon. The plant can be found in flat-lying, seasonally moist, strongly alkaline soils with sparse native grasses dominated by greasewood (*Sarcobatus vermiculatus*).

3.7.1.1 Species Account and Critical Habitat

Status

Applegate's milk-vetch was listed as endangered on July 28, 1993 (FWS 1993c). It was believed to be extinct until its rediscovery in 1983 and at the time of listing was only known from two extant sites.

Threats

In the five-year review of Applegate's milk-vetch, FWS identified continued destruction, modification, or curtailment of its habitat or range due to urban and commercial development, and loss of habitat through competition with non-native weeds as the principal threats to the species survival (FWS 2009c). According to the FWS' *Applegate's Milk-Vetch Recovery Plan* (1998b), habitat loss and modification due to development and hydrologic manipulation also continue to threaten Applegate's milk-vetch. Portions of the Ewauna Flat population have been destroyed by urban development on private land and more are at risk because they occupy industrially-zoned properties. Construction of ditches and dikes in the Klamath Basin alter the hydrologic character of Applegate's milk-vetch habitat. The FWS concluded that these changes could result in lethally dry conditions, or may indirectly impact the species by introducing drought-tolerant and exotic plants (FWS 1998b).

Several other factors were identified in the decision to list the Applegate's milk-vetch. Overutilization for commercial, recreational, and scientific purposes was a potential threat at the time of listing because the known locations of these rare plants are easily accessible by road. FWS also identified predation from rabbits and cattle as obstacles to the plant's survival (FWS 1993c). Additionally, because of the small number of populations, a limited gene pool, and the small number of plants in the total population, the FWS determined that the potential for extinction from stochastic events (fires or floods) is a threat to the species (FWS 1993c).

Species Recovery

The *Applegate's Milk-Vetch Recovery Plan* was drafted with the goal to increase the stability of Applegate's milk-vetch so that it can be down-listed. The two main objectives of the recovery plan (FWS 1998b) are to:

- increase the species' representation to at least six areas with a minimum of two populations occurring at each of the three recovery areas identified in the plan; and
- develop management strategies that provide for long-term stability.

To achieve the two objectives, the recovery plan recommends the following actions:

- conserve natural and introduced Applegate's milk-vetch populations;
- develop long-term, off-site seed storage;
- conduct research on population sustainability, population establishment and augmentation techniques, efficacy of habitat management strategies, and the plant's edaphic and hydrologic requirements; and
- develop and implement an outreach program.

The five-year review of Applegate's milk-vetch (FWS 2009d) reported that since the recovery plan was published, three new occurrences of Applegate's milk-vetch have been found. The review states that recovery criteria should be modified to include opportunities to achieve self-sustaining populations at the newly discovered sites. Specifically, the five-year review suggests that Applegate's milk-vetch would be considered for downlisting to threatened status when (FWS 2009d):

- *At least two natural and/or introduced self-sustaining populations are preserved in each of the three recovery areas (Ewauna Flat, Miller Island, and Worden), for a total of six or more populations in habitat permanently secured and managed for the benefit of the species. A minimum of 4,500 reproductive plants is needed for a recovery area to meet the downlisting threshold. Self-sustaining populations are defined as containing a minimum of 1,500 reproductive plants, plus sufficient individuals in younger age classes to suggest population stability or growth.*

Applegate's milk-vetch population establishment techniques have not been successful and additional transplantation methods will continue to be investigated (Gisler 2002; ORBIC 2007). FWS also recommended further research on the impacts of weed competition on Applegate's milk-vetch, pollination and self-fertilization processes, and herbivory and predation processes (FWS 1998b).

Life History, Habitat Requirements, and Distribution

Soils in typical Applegate's milk-vetch habitats are characterized as being gray in color, slightly alkaline, with a shallow water table and groundwater with a relatively high salinity due to periodic flooding and evaporation (TNC 1999). Applegate's milk-vetch grows only in flat-lying, seasonally moist, alkaline soils with underlying clay hardpans. The underlying clay hardpans provide seasonal soil moisture, saturation and retention, forming a hydrological regime which may be a requirement for dry summer months when flowering and seeding occur (FWS 1998d). Alkaline soils may support mycorrhizal fungi and rhizobium bacteria beneficial to the survival and growth of the milk-vetch (FWS 1998d). As with other plants growing under extreme conditions of alkalinity, heavy metals, and/or salinity, Applegate's milk-vetch may benefit from alkaline soils to help reduce competition from other species (FWS 1998d).

The vegetative community in which Applegate's milk-vetch sites occurs is classified as interior alkali grassland (TNC 1999). The species' habitat was historically characterized by sparse, native bunch grasses and patches of bare soil, allowing for some seed dispersal by wind. Today, dense coverage of the habitat by introduced grasses and weeds means seed dispersal is highly localized, with most seedling establishment found adjacent to mature plants (FWS 1998d). Flowering usually begins in early June and ends in August. Reproduction takes place exclusively by seeds, which are shed soon after flowering. Pollination is thought to be mediated by butterflies (e.g., *Lycaedes argyrognomon* and Melissa blue butterfly, *Plebejus melissa*) and polylectic bees (Yamamoto 1985), although the plant is also capable of seed production through self-fertilization.

Since the publication of the recovery plan in 1998, there have been numerous cooperative efforts made by Oregon Department of Agriculture, ORBIC, TNC, the FWS, and private landowners to conduct inventories for Applegate's milk-vetch throughout most of its historical range. It is known to occur only in the Lower Klamath Basin (the plain containing Lower Klamath Lake), near the city of Klamath Falls in southern Oregon. Three new sites discovered since publication of the recovery plan include the Collins tract, the Klamath Falls Airport, and the Washburn Way-Railroad track (FWS 2009d), and plants have been discovered in two other areas within the Lower Klamath Basin [Klamath West (2009) and Woods Line State Trail (2013)] (ORBIC 2017b).

Population Status

At the time of listing, this species was known from only two extant sites (Miller Island and Ewauna Flat) that supported approximately 30,000 plants and one historical site (Keno; FWS 1993c). One additional site (Klamath Falls) had been documented shortly after the listing, but this site was extirpated in 1992 prior to the completion of the 1998 recovery plan and lumped together with the Ewauna Flat population (FWS 2009d). In the 1998 recovery plan, there were three known extant populations in Klamath County, numbering about 12,000 plants (FWS 1998d): the Ewuana Flat population contained an estimated 11,500 individuals within three sub-populations, the Miller Island population contained less than 500 plants within four small sub-populations on approximately one acre, and a third population discovered in 1997 (Worden) included three plants (FWS 1998d). Since the recovery plan, three additional sites were discovered (Collins Tract, Klamath Falls Airport, and Washburn Way-Railroad) for a total of six known extant sites and an estimate of 33,800 plants (FWS 2009d). The largest population is located near the Klamath Falls Airport where more recent surveys in 2012 and 2013 documented an estimated 24,000 plants (USDOT 2015). ORBIC (2017b) identified two additional areas where Applegate's milkvetch had not been previously documented: 1) approximately 1,260 plants documented by FWS and TNC in 2009 on either side of the railroad tracks on the west side of Klamath River (Mallard), and 2) 100 to 200 or more plants documented in an abandoned railroad right-of-way (OC&E Woods Line State Trail) in 2013. These two areas represent new populations (sites), bringing the known current total of extant populations to eight. Table 3.7.1-1 provides a summary of Applegate's population status at the time of federal listing in 1993, the draft recovery plan in 1998, and latest available status (FWS 2009d and USDOT 2015).

Local populations (table 3.7.1-1) range from nine plants in the Worden site to thousands of plants in two sites (Klamath Airport and Collins Tract sites). Multi-year trend data have been collected at The Nature Conservancy Preserve site near Ewauna Lake. These data document a downward decline in the subpopulation from 30,000 to approximately 2,200 plants in 2008 (FWS 2009d).

TABLE 3.7.1-1

Summary of Applegate's Milk-vetch Population Status by Site at the Time of Federal Listing (1993), Publication of the Recovery Plan (1998), and Most Recent

Site Name	Ownership	Number of Plants at Time of Listing (1993)	Number of Plants at Time of Recovery Plan (1998)	Most Recent	Current Status
Ewauana Flat Preserve	The Nature Conservancy	Up to 30,000 plants	Approximately 11,500 plants	Approximately 2,198 plants	Declining
OC&E Woods Line State Trail	State of Oregon	Undiscovered	Undiscovered	100 to 200+ plants	Unknown
Mallard	City of Klamath Falls & Private	Undiscovered	Undiscovered	675 plants	Unknown
Miller Island	State of Oregon	30 to 80 plants	Fewer than 500 plants	112 plants	Unknown
Keno	Private	Historical (extirpated)	Historical (extirpated)	Historical (extirpated)	Extirpated
Worden	Private	Undiscovered	3 plants	9 plants	Unknown
Collins Tract	Private	Undiscovered	Undiscovered	10,143 plants	Unknown
Klamath Falls Airport	City of Klamath Falls	Undiscovered	Undiscovered	24,000 plants	Unknown
Washburn Way-Railroad	Private	Undiscovered	Undiscovered	307 plants	Unknown
Klamath Falls	Private	Believed to have been extirpated	13 plants found in 1994	Extirpated	Extirpated

Sources: FWS 1993c, 1998d, 2009d; USDOT 2015; ORBIC 2017a.

Critical Habitat

Critical habitat has not been designated for Applegate's milk-vetch.

3.7.1.2 Environmental Baseline

Analysis Area

The botanical analysis area extends to 30 meters (98 feet) each side of the Pipeline project (construction right-of-way, TEWAs, UCSAs, rock source and disposal sites, and proposed storage yards) on lands that have potential habitat for listed plant species. This area generally corresponds to the extent of the area surveyed for sensitive and listed plant species during surveys conducted between 2007 and 2017 and correlates to a distance that indirect effects to plants would be expected. Survey for this species targeted all flat areas with moist alkaline soils with native grasses and greasewood (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands).

Species Presence

The Pipeline project is located within known or historic Applegate's milk-vetch range between MPs 191.20 to 214.30 within the Lake Ewauna-Klamath River 5th field watershed. Herbarium records indicate that a known historical population (1937), now presumed extirpated (ORBIC 2017b), occurred near the Pipeline project (MP 191.2 to MP 191.97; see the Keno Site included in table 3.7.1-1). Efforts to relocate this species in the historic area have been unsuccessful (FWS 1998d; SBS 2008a and 2017a). The Pipeline project also occurs within the Collins Tract population between MPs 195.35 and 196.50. Plants have been documented north and south of the proposed Pipeline (MP 195.5 to MP 196.7) (ORBIC 2017b; SBS 2008a and 2017a). Estimates of more than 10,000 plants at multiple sites in the Collins Tract area were made in 2008, extending from across the Klamath River from and adjacent to the Lower Klamath National Wildlife Refuge and State Wildlife Area (FWS 2009d; ORBIC 2017b). Botanical surveys conducted by PCGP between 2007 and 2008 located three new sites for Applegate's milk-vetch in the Collins Tract (SBS 2008a), discussed further, below. The Collins Tract site was revisited in 2010 by FWS and only one sub-population was documented in the area with 21 plants (ORBIC 2017b).

At another location within and adjacent to proposed Klamath Falls Memorial Drive 2 pipe storage yard, the FWS and The Nature Conservancy documented approximately 1,260 plants in 2009 near the Klamath River on either side of railroad tracks (survey site Klamath West; ORBIC 2017b).

Project-Specific Surveys

Habitat Surveyed. Prior to beginning field surveys in 2007 for the Pipeline project, botanists with SBS conducted a habitat review to identify potential habitat and delineate survey areas for Applegate's milk-vetch within the botanical analysis area, including existing roads identified for access to the construction right-of-way. Aerial photographs and knowledge of regional landscape and biological features (soils, geology, topography, elevation, target species habitat, and associated plant community habitat) were used to determine potential habitat for Applegate's milk-vetch. These same methods were applied to determine areas of suitable habitat in new locations where the proposed right-of-way has been relocated since 2007.

Surveys were conducted for this species where survey permission was granted within the vicinity of the Pipeline project (within at least 50 or 100 feet of the Pipeline project on non-federal and federal lands, respectively and where permitted) and along proposed access roads (within at least 50 feet of access roads where road improvements are proposed and surveys permitted). Most surveys were conducted in 2007 and 2008, but additional surveys have been conducted since 2008 in areas of reroutes, minor route adjustments, and areas with survey permission. Areas where Applegate's milkvetch were documented during previous Pipeline survey efforts were also resurveyed. Surveys have continued in 2018 and the data are currently under review.

Overall, 865.56 acres have been surveyed by the Applicant from 2007 through 2017 for Applegate's milkvetch within the vicinity of the proposed Pipeline, including previously proposed routes and project components, alternate routes, and along access roads that are no longer considered for the Pipeline project. Approximately 726.78 acres have been identified as potential habitat requiring surveys within the botanical analysis area (30 meters of the Pipeline project) between MPs 191.70 and 214.30 in Klamath County, including habitat identified in and around proposed pipe storage yards north of the Pipeline along the Klamath River and near the Klamath Airport (table 3.7.1-2). Of this habitat, access was granted to about 553.14 acres

(307.47 acres within the Pipeline right-of-way), of which 109.05 acres (61.82 acres within the Pipeline right-of-way) were considered suitable habitat for Applegate's milk-vetch.

TABLE 3.7.1-2

Summary of Potential Suitable Applegate's Milk-Vetch Habitat within the Right-of-Way and Botanical Analysis Area

General Landowner	Suitable Habitat Status	Total Acres Surveyed [1] (2007-2017)	Acres Surveyed			Acres Not Surveyed [4]		
			Project [2]	Buffer [3]	Total	Project [2]	Buffer [3]	Total
MPs 191.7 – 214.3 (1,270.35 acres within botanical analysis area)								
Federal	Suitable Habitat	0	0	0	0	0	0	0
	Not Habitat	0	0	0	0	0	0	0
	Unknown	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Total	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Non-Federal	Suitable Habitat	215.14	61.82	47.23	109.05	0.35	1.34	1.70
	Not Habitat	650.43	245.66	198.44	444.09	N/A	N/A	N/A
	Unknown	N/A	N/A	N/A	N/A	76.60	97.04	173.64
	Total	*865.56*	*307.47*	*245.67*	*553.14*	*76.95*	*97.04*	*173.64*
Total	Suitable Habitat	215.14	61.82	47.23	109.05	0.35	1.34	1.70
	Not Habitat	650.43	245.66	198.44	444.09	N/A	N/A	N/A
	Unknown	N/A	N/A	N/A	N/A	76.60	97.04	173.64
	Total	**865.56**	**307.47**	**245.67**	**553.14**	**76.95**	**97.04**	**173.64**

[1] Acres provided in this column considers all surveys to-date (through 2017), including areas that have been subsequently rerouted or dropped (i.e., pipe yards) since surveys were initiated in 2007.
[2] Project includes: right-of-way, temporary extra work area, uncleared storage area, rock storage, pipe yards, aboveground facilities.
[3] Buffer (botanical analysis area) includes area within 30 meters (98 feet) of habitat removal and within 50 feet either side of an existing access road identified with possible road improvements.
[4] Areas not surveyed are either denied access or were not surveyed because of recent modification in Proposed Route that occurred after the flowering season, as well as areas outside of the targeted survey area (i.e., 30-meter analysis area vs. 50-foot targeted survey area on non-federal lands). "Not Habitat" was determined from adjacent survey parcel information, aerial photography, or "drive-by;" no surveys would be necessary and acres are not included.

Note: Surveys have continued in 2018 and the data are currently under review. Most area that remains to be surveyed occurs on private lands; surveys would continue as access becomes available.

Approximately 173.64 acres (76.95 acres within the Pipeline project) of potentially suitable habitat for Applegate's milk-vetch have not been surveyed within the botanical analysis area either where survey access has not been granted or within areas of recent Pipeline modifications. PCGP would continue to survey habitat where permission is granted. Since permission to survey on non-federal lands targeted an area of at least 50 feet from the Pipeline project, it is very likely that habitat within the "buffer" (30-meter botanical analysis) area would likely not be surveyed. Where survey access has been denied, PCGP would conduct surveys in suitable habitat within the Pipeline project prior to construction. If the assumption is made that a similar percent of this area is suitable (compared to the areas where surveys have been completed in the botanical analysis area), then approximately 34.21 acres of unsurveyed habitat within the botanical analysis (19.7 percent of 76.95 acres, or 15 acres within the Pipeline right-of-way) are likely suitable Applegate's milk-vetch habitat.

Survey Results. Applegate's milk-vetch plants were documented by SBS (and FWS) during surveys in 2008 in the vicinity of MPs 195.5 and 196.6; all observations were associated with the previously documented Collins Tract population. Applegate's milk-vetch plants within the Collins Tract population were first discovered in 1998 (table 3.7.1-1). Additional field surveys since 1998, including efforts by PCGP, discovered several additional sub-populations that increased the known number of plants and occupied habitat at the Collins Tract site: in 2007 ORBIC discovered two large sub-populations, each several acres in size (Roninger 2008), and expanded survey efforts by FWS and SBS in 2008 discovered several sub-populations clusters (which includes the adjacent landowner JWTR LLC) (Roninger 2008; SBS 2008b). In 2008, the entire Collins Tract was found to contain 10,133 plants within 19 sub-populations on 32.3 acres within a larger 250-acre area, which, by Recovery Plan standards (see FWS 1998d), would qualify as a self-sustaining population (see figure 3.7.1-1). The 19 individual sub-population clusters ranged from a single plant to thousands of plants. The Applegate's milk-vetch located at the Collins Tract site were in habitat slightly different than other known populations: soil was less alkaline and not associated with the usual vegetative structure (i.e., very little or no rabbitbrush present). Also, weeds present within this area include cheatgrass, mouse barley, and sweet clover (SBS 2008b). This area was revisited in 2018 and no new sites were documented; data from survey efforts are currently under review.

In 2013 and 2014, SBS re-surveyed around the Collins Tract, but no Applegate's milk-vetch plants were observed within 100 feet of the Pipeline project (SBS 2013a and 2014). However, plants in a larger sub-population documented in 2008 (#15) approximately 100 feet southeast of MP 195.6 were observed within a fence. Also in 2014, surveyors noted that one smaller sub-population (#17) documented in 2008 south of MP 195.9 was at the site of a salt lick where the ground had been trampled to bare dirt and was likely extirpated (see figure 3.7.1-1).

In 2007, a portion of Klamath Falls Memorial Drive 2 / Bair proposed pipe storage yard was surveyed, where permitted; no Applegate's milkvetch plants or suitable habitat were observed (SBS 2008b). The area of the proposed pipe storage yard that plants were documented by FWS and TNC in 2009 (Klamath West survey site; ORBIC 2017c) had not been surveyed for the Pipeline project in 2008 due to a lack of landowner permission and a slightly different pipe yard configuration (see figure 3.7.1-2).

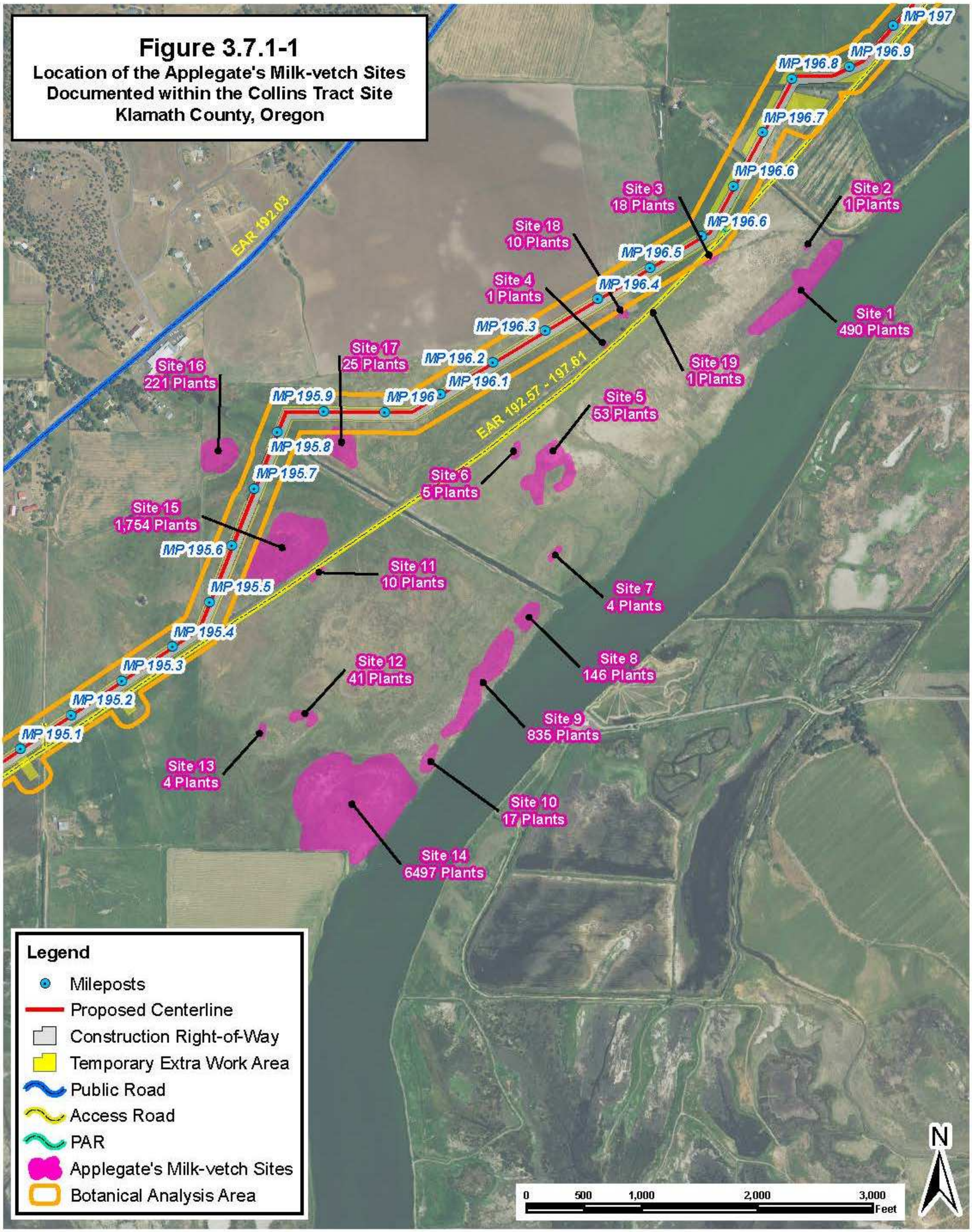

Figure 3.7.1-1
Location of the Applegate's Milk-vetch Sites
Documented within the Collins Tract Site
Klamath County, Oregon
MP 197
MP 196.9
MP 196.8
MP 196.7
MP 196.6
MP 196.6
MP 196.5
MP 196.4
MP 196.3
MP 196.2
MP 196.1
MP 196
MP 195.9
MP 195.8
MP 195.7
MP 195.6
MP 195.5
MP 195.4
MP 195.3
MP 195.2
MP 195.1
EAR 192.03
EAR 192.57 - 197.61
Site 1
490 Plants
Site 2
1 Plants
Site 3
18 Plants
Site 4
1 Plants
Site 5
53 Plants
Site 6
5 Plants
Site 7
4 Plants
Site 8
146 Plants
Site 9
835 Plants
Site 10
17 Plants
Site 11
10 Plants
Site 12
41 Plants
Site 13
4 Plants
Site 14
6497 Plants
Site 15
1,754 Plants
Site 16
221 Plants
Site 17
25 Plants
Site 18
10 Plants
Site 19
1 Plants
Legend
Mileposts
Proposed Centerline
Construction Right-of-Way
Temporary Extra Work Area
Public Road
Access Road
PAR
Applegate's Milk-vetch Sites
Botanical Analysis Area
0
500
1,000
2,000
3,000
Feet
N

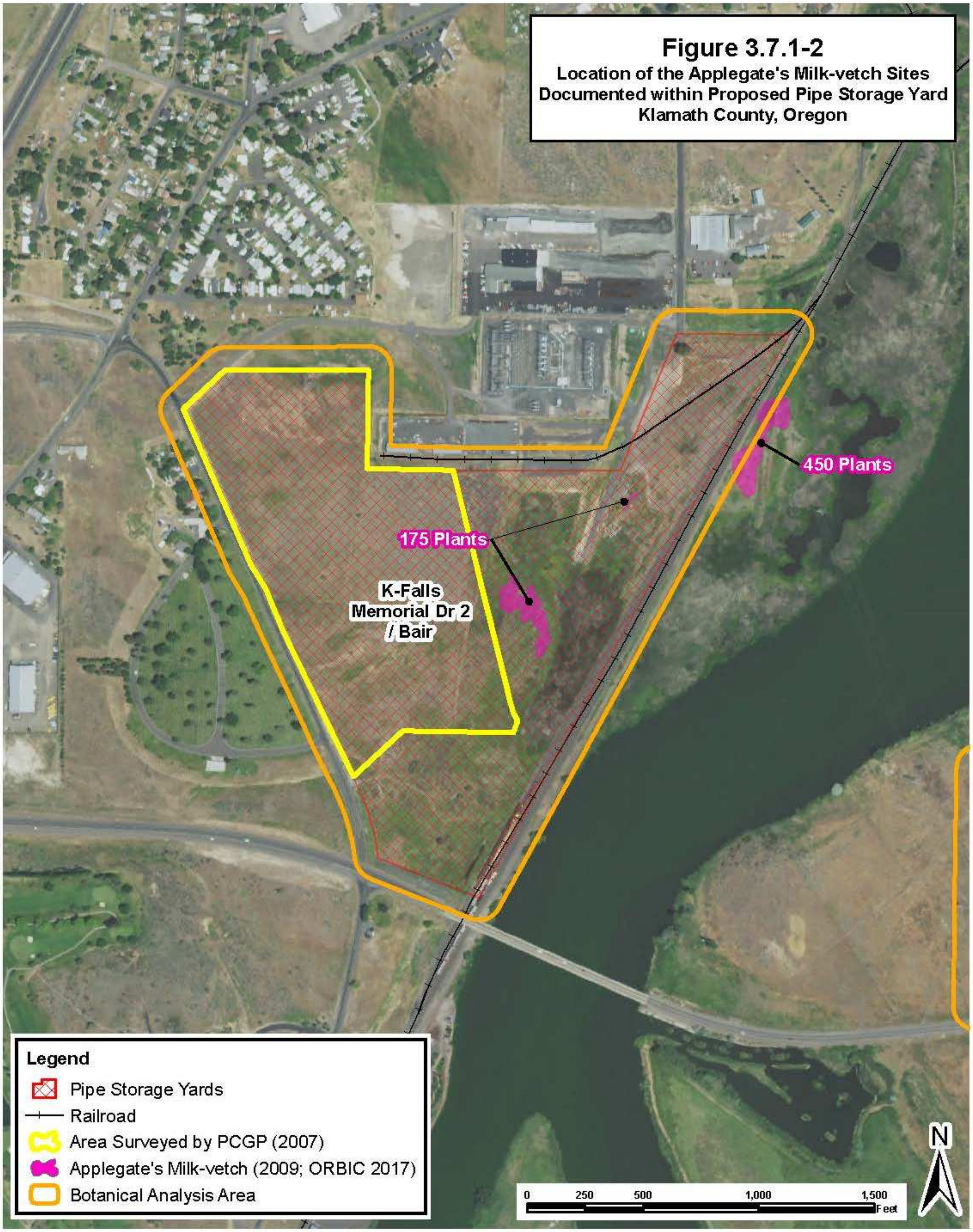
Figure 3.7.1-2
Location of the Applegate's Milk-vetch Sites
Documented within Proposed Pipe Storage Yard
Klamath County, Oregon
450 Plants
175 Plants
K-Falls
Memorial Dr 2
/ Bair
Legend
Pipe Storage Yards
Railroad
Area Surveyed by PCGP (2007)
Applegate's Milk-vetch (2009; ORBIC 2017)
Botanical Analysis Area
0
250
500
1,000
1,500
Feet
N

Critical Habitat

Critical habitat has not been designated for Applegate's milk-vetch.

3.7.1.3 Effects of the Proposed Action

The Pipeline project could affect federal threatened and endangered plant species (discussed here for Applegate's milk-vetch, and below for other plant species in their respective sections) through one or more of the following pathways:

1. Direct mortality of plants and/or destruction of seed banks during clearing and grading, construction, and reclamation.
2. Fragmentation and isolation of existing populations and areas of suitable habitat.
3. Damage or mortality of plants and/or seed banks due to increased off-road vehicle use in the Pipeline project area.
4. Increased populations of invasive noxious weed species that interfere with growth and survival of listed plants.
5. Damage or mortality of individual plants by dust deposited on photosynthetic surfaces during construction.
6. Changes in characteristics (shade, temperature, soil moisture, species composition, etc.) that alters suitable habitat.
7. Loss of pollinators due to habitat alteration, dust, and/or increased presence of invasive, noxious weeds.
8. Accidental release of toxic compounds during construction and/or operation.

Direct and Indirect Effects

The 1998 Recovery Plan identifies the small numbers and limited distribution as a threat to Applegate's milk-vetch because the possibility of extirpation due to random mortality events; therefore, any loss of plants could be considered significant because those plants could be a genetic link for subpopulations. The original 2007 Pipeline route coincided with five sub-populations within the Collins Tract site. In response to recommendations and discussions with state and federal agencies, PCGP rerouted the alignment north of its original 2007 route (FERC 2009) to lower elevations and wetter soils to avoid individual plants documented during surveys in 2008, as well as to avoid additional potential habitat (see figure 3.7.1-1 and figure A-1 in appendix V2). No direct effects to individual plants or suitable habitat in the Collins Tract population are expected. Surveys by FWS and TNC in 2009 identified approximately 175 plants within proposed Klamath Falls Memorial Drive 2 / Bair pipe storage yard. PCGP would survey for Applegate's milkvetch in the Klamath Falls Memorial Drive 2 / Bair pipe storage yard prior to avoid using portions of that pipe storage yard by at least 30 meters of documented and previously documented (i.e., ORBIC 2017c) Applegate's milk-vetch plants. Therefore, no direct impacts to individual plants at this pipe storage yard would be expected.

Although no known plants would be directly impacted by the Pipeline project in the Collins Tract site or within the proposed Klamath Falls Memorial Drive 2 / Bair pipe storage yard, surveys of all potential suitable habitats within the Pipeline project area have not been completed to date due to lack of access granted by landowners or more recent Pipeline alignments; therefore, it is possible that unidentified plants may occur within the proposed construction right-of-way or work areas. These plants could be in areas that would be directly impacted by the Pipeline project; however, PCGP has developed conservation measures aimed at avoiding or minimizing the risk of impacting unknown plants (see section 3.7.1.4, Conservation Measures and Applegate's milk-vetch mitigation plan, appendix V2).

Suitable habitats as well as plants within 30 meters of the Pipeline project may be indirectly impacted as a result of: 1) changes in hydrology and soil characteristics, 2) an increase in invasive weeds, and 3) alterations of vegetation cover and species composition. Impacts from fugitive dust created during construction and travel on unpaved access roads could also affect the photosynthetic surfaces of Applegate's milkvetch plants in the Pipeline vicinity; although dust abatement measures during construction would be employed according to PCGP's Air, Noise and Fugitive Dust Control Plan that would minimize the potential for this impact (see appendix B to the POD). These indirect impacts could negatively impact Applegate's milkvetch plants and habitat suitability since plants within the Collins Tract population are located within 30 meters (98 feet) of Pipeline project disturbance; the closest mapped sub-population (sub-population 17) is approximately 63 feet south of TEWA 195.74-W near MP 195.9 (see figure 3.7.1-1). However, to minimize potential impacts to critical life cycles, PCGP would construct the Pipeline between MPs 195.4 and 196.6 outside of the growing and reproductive season for this plant (after September 15 but before April 30). Construction of the Pipeline could also affect groundwater flow patterns located at the Collins Tract site, but since the Pipeline would be constructed outside of the irrigation season between MPs 195.4 and 196.6, shallow ground water perched on top of restrictive subsoil horizons is not expected to be present during construction. Travel along the existing paved access road (EAR 192.57-197.61) should not affect Applegate's plants within the Collins Tract population located adjacent to the access road. Indirect effects to plants within the Klamath Falls Memorial Drive 2 / Bair pipe storage yard should be minimized since PCGP would not utilize portions of the yard within 30 meters (98 feet) of documented plants. Indirect effects to unidentified Appelegate's milk-vetch and potentially suitable habitat could also occur in the vicinity of the Pipeline project that has not been surveyed to-date.

After construction, PCGP would restore the construction right-of-way back to approximate original contours to ensure that drainage patterns are restored and would reseed the affected area using a species mix recommended by FWS that is appropriate for the area. Impacts to Applegate's milk-vetch related to operation of the Pipeline would result from the monitoring and treatment of noxious weeds, which could affect non-targeted species (such as Applegate's milk-vetch) if they are near treatment areas. No other maintenance impacts are expected within the range of Applegate's milk-vetch because the permanent easement would be maintained in an herbaceous/shrub state, which would provide conditions similar to Applegate's milk-vetch suitable habitat.

Cumulative Effects

Because the extent of this species on these non-federal lands is unknown, it is not known if there are reasonably foreseeable actions that might occur on non-federal lands within areas currently occupied by this species. As the FWS's authority generally does not extend to listed plants on private or state lands,[12] all federally listed plants located on these lands could be considered at

[12] The ESA does not protect plants outside federal land unless there is a federal nexus. Therefore, activities that occur on private or state lands that could affect listed plants but which do not have federal nexus are not required to consult with the FWS. Plants may not be removed from lands under federal jurisdiction, and activities with a federal nexus must consult with the FWS.

risk of adverse effects from activities that could negatively impact the species. Other reasonably foreseeable projects on non-federal lands that could adversely affect this species include residential, commercial, and industrial development, grazing, as well as expanding agricultural areas.

The Applicant has committed to mitigating for any Pipeline project-related impacts to Applegate's milk-vetch, regardless of land ownership.

Critical Habitat

Critical habitat has not been designated for Applegate's milk-vetch; therefore, critical habitat for this species would not be impacted by the proposed action.

3.7.1.4 Conservation Measures

PCGP has developed a mitigation plan for Applegate's milkvetch (see Attachment 2 within the *Federally-listed Plant Conservation Plan*, appendix v2) to address how avoidance, minimization, seed collection, restoration, and other conservation measures would be applied to protect Applegate's milkvetch. This mitigation plan describes how PCGP has avoided direct impacts to documented plants within the Collins Tract population between MPs 195.5 and 196.6 through route modifications (see Figure A-1, appendix V2), as well as how PCGP would avoid documented plants within the Klamath Falls Memorial Drive 2 / Bair pipe storage yard by at least 30 meters (98 feet). Additionally, the plan describes construction methods that would minimize impact to Applegate's milkvetch plants and suitable habitat. For example, in Collins Tract population between MPs 195.35 and 196.50, PCGP would install trench plugs on either side of wetland ditch crossings to maintain the original wetland hydrology, as specified in FERC's Wetland and Waterbody Construction and Mitigation Procedures (VI.C.1.). After construction, the trench would be backfilled with the native trench spoil material generally in the same order that the trench was excavated. After the Pipeline is sufficiently covered with backfill material, the backfill in the trench would be compacted by tamping with the backhoe bucket or roller in a manner to prevent damage to the Pipeline. Subsequent trench backfilling would occur in lifts and compacted by tamping or rolling in an effort to restore approximate original soil physical conditions (densities / permeability).

When access to the construction right-of-way is granted, surveys for Applegate's milk-vetch would be conducted in potential habitat (previously surveyed or unsurveyed) and additional plants located during surveys would be avoided, if feasible. FWS would be notified of survey results and, if the species is present, the avoidance/conservation measures described in the Applegate's milkvetch mitigation plan (see appendix V2) would be implemented. The following lists some of the measures in the plan that would minimize or avoid effects to Applegate's milkvetch plants and habitat:

- Surveying and flagging the construction right-of-way and TEWAs to clearly mark the limits of construction disturbance (i.e., clearing/grading).
- To avoid listed plant species located within the Pipeline project, the construction right-of-way may be narrowed or necked down in some areas (i.e., in areas adjacent to listed plant species), and some TEWAs or UCSAs may be eliminated or a portion of the area removed from Pipeline use when feasible.

- Where feasible, the EI would monitor the survey and flagging efforts and would provide additional protective buffers or neckdowns to ensure protection of adjacent plant populations or provide additional avoidance. The EI would consult with PCGP's Chief Inspector and the construction contractor during construction to determine where additional buffer protections or neckdowns could be accommodated without affecting construction safety.
- Plant populations would be protected by safety fence and silt fence to ensure these plants are not inadvertently impacted by Pipeline activities.
- Topsoil would be segregated from trench spoil to maintain the soil seed bank, as well as maintain microrhyzoids with which the species' root system is associated. Topsoil salvaging would occur within the vicinity of affected populations after species-specific seed, bulb, or whole plant salvage has occurred. The salvaged topsoil would be returned to its original location during restoration.
- The construction right-of-way would be restored to its original contours and reseeded with an appropriate seed mixture recommended by FWS prior to the following growing season. PCGP would monitor revegetation success in the area reseeded between MPs 195.5 to 196.6, and other areas reseeded considering milk-vetch for five years after construction.
- PCGP would collect and bag seeds of any affected milkvetch plants prior to seed dispersal (June to July) and provide these seeds to a suggested repository. If permission is granted by the property owner, PCGP would use the collected seed to plant outside of the permanent right-of-way after construction (e.g., see replanting measures proposed for Applegate's milk-vetch).
- Wetland mats would be used in travel areas in saturated soil areas to minimize soil rutting and soil compaction and protect existing plants that may be present.
- To control the potential noxious weed invasion, the Applicant would implement the procedures outlined in their *Noxious Weed Control Plan* (see appendix N to the POD). Equipment would be inspected and cleaned of potential noxious weed seed or plant parts.

3.7.1.5 Determination of Effects

Species

The Project **may affect** Applegate's milk-vetch because:

- suitable habitat is present within the botanical analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Applegate's milk-vetch because:

- potential suitable habitat occurs along the proposed route and comprehensive surveys have not been conducted in all areas; therefore, it is possible that unidentified plants occur within the proposed construction right-of-way and work area; and
- indirect impacts to Applegate's milkvetch plants and habitat are likely within 30 meters of the Pipeline project.

Critical Habitat

Critical habitat has not been designated for Applegate's milk-vetch.

3.7.2 Gentner's Fritillary

The Gentner's fritillary (*Fritillaria gentneri*) is a perennial in the lily family *(*Liliaceae). The plant grows on the edge of woodlands, with an overstory of Oregon white oak (*Quercus garryana*) and Pacific madrone (*Arbutus menziessii*), and also occurs in open chapparal and grassland environments, at elevations between 300 to 1,230 meters (approximately 1,000 to 4,200 feet). It is found in small, scattered locations in the Rogue and Klamath River watersheds in Jackson and Josephine counties, Oregon, with one small population recently discovered in northern California (FWS 2003d and 2016e).

3.7.2.1 Species Account and Critical Habitat

Status

Gentner's fritillary was listed as endangered on December 10, 1999 (FWS 1999b). Although this lily may have originated as a result of hybridization, it is considered a valid species.

Threats

A key factor in the FWS 1999 listing of Gentner's fritillary was the present or threatened destruction, modification, or curtailment of its habitat and range. FWS identified residential and utility development and agricultural conversion as the causes for these destroyed locations in its relatively isolated population. At that time, 73 percent of the known plants were in a central core area within a 7-mile radius of the Jacksonville Cemetery. FWS noted that habitat loss due to ongoing or future development might occur at 42 percent of the occupied sites (19 plots—all within the central core area; FWS 1999b). Loss of habitat is still a major threat to Gentner's fritillary. In the species' recovery plan (FWS 2003d), FWS identified agricultural, urban and residential development, timber harvest, road and trail improvement, and recreation as ongoing threats to the very narrow geographic range and small population size of the plant. The areas most threatened are on private lands. Habitat conversion due to fire suppression continues to be a problem, as well as weed and non-native plant proliferation and herbicide use. Species persistence and recovery is hampered by the very structure of its remaining populations, which are scattered, isolated, and small in size and number. These small populations are at high risk of decline because they lack reserves to ward off stochastic loss, overutilization for commercial and recreational purposes, diseases, climatic shifts, herbivory, localized natural disturbances, and decrease in genetic diversity (FWS 1999b and 2003d).

Species Recovery

A species recovery plan was released by FWS in 2003 that created four recovery units to delineate areas that are necessary for the viability and recovery of Gentner's fritillary. The objective of the recovery plan is to remove threats to the extent that Gentner's fritillary is no longer in danger of extinction and can be downlisted or delisted. The recommended recovery actions are listed below (FWS 2003d):

- Provide private landowners with information on identification and management of habitat.

- Establish a minimum of eight *Fritillaria* management areas, with at least two distributed within each of four recovery units.
- Conduct surveys and research essential to conservation and recovery.
- Develop off-site germplasm banks to maintain reproductive materials.
- Review and revise recovery plan as needed, based on accumulation of new data.

The recovery strategies for the recovery units include rehabilitation of habitat, restoration of historical sites, and augmentation of existing populations including expansion into nearby suitable habitat (FWS 2003d). Recovery units are considered individually necessary to the long-term viability of the species. The objective within each established recovery unit is to have at least 750 flowering plants to downgrade its status to threatened or 1,000 plants to delist the species, monitored biannually for at least 15 years. This recovery unit total may consist of many management areas within each recovery unit, including management areas as small as five flowering plants. Maintaining the subpopulations or population clusters within each recovery unit is important to preserve the genetic diversity within the species, ensure its long-term viability, and reduce the vulnerability of the species to extirpation from random catastrophic events (FWS 2003d).

Based on a 2013 monitoring report, only one of the four mapped recovery units (Unit 4) has attained over 1,000 flowering plants in the last two years; the other three recovery units have been below 750 flowering plants in the past 10 years (FWS 2016e), including Recovery Unit 3 that is located in northeastern Jackson County and is crossed by the Pipeline (MPs 117.7 to 142.2). Thirteen *Fritillaria* Management Areas (FMAs) have been established, which is one of the recommended actions identified to assist recovery of the species. Each recovery unit contains at least two FMAs and one of the FMAs occurs outside of the recovery units (FWS and BLM 2015 in FWS 2016e). Recovery unit boundaries will be revised and additional FMAs will be established to meet the recovery plan criteria (FWS 2016e). The Indian Creek FMA is the closest to the Pipeline and is approximately 1 mile southwest of MP 128.

Life History, Habitat Requirements, and Distribution

Gentner's fritillary is often found in grassland habitats within, or on the edge of dry, mixed forest types where overstory can be dominated by Oregon white oak, madrone, Douglas-fir, and ponderosa pine. It occurs at a wide range of elevations, from 1,000 to 4,200 feet, in the rural foothills of the Rogue River Valley of Josephine and Jackson Counties (FWS 2003d and 2016e; SBS 2008c). It is usually associated with shrubs that provide protection from the wind and sun.

The perennial reproduces clonally by means of numerous small bulblets that break off larger bulbs and form new plants. Sexual reproduction appears to be a sporadic or episodic event for the species, although observations suggest hummingbirds and some species of bees may pollinate the plant. Blooming season usually lasts from April through May, and plants must reach a minimum size before flowering (FWS 2003d).

The distribution of Gentner's fritillary is characterized by distinct clusters. The species is highly localized, with the populations occurring within a 30-mile radius of Jacksonville, Oregon, with approximately 45 percent of the plants occurring within an 11-mile radius (FWS 2003d). Since the 2003 publication of the recovery plan, nine new Gentner's fritillary populations (approximately 131 flowering plants within 1.6 acres) have been detected outside of the four recovery unit boundaries (FWS 2016e).

Population Status

It is often difficult to census populations of Gentner's fritillary because individuals can remain dormant for one or more years underground and not flower. Also, flowering plants can be grazed by deer or cattle before identification and counting can be performed and sometimes it cannot be distinguished from other non-flowering and co-occurring *Fritilleria* species, such as scarlet fritillary or chocolate lily (FWS 2003d). In 2001, Gentner's fritillary was estimated at 1,696 flowering individuals in Jackson and Josephine counties, and just south of the border in California (FWS 2003d). For over 10 years, BLM has monitored Gentner's fritillary flowers and leaves on 58 sites across all four recovery units and has observed that flowering plants at most sites fluctuate annually. The results indicate that flowering plant total has been generally increasing over the past seven years, with the exception of 2001 and 2014 (FWS 2016e). In 2013, it was estimated that approximately 2,907 plants occurred within the four recovery units, as well as outside the recovery units (Table 1 in FWS 2016e). Most Gentner's fritillary sites include a small number of individual plants, ranging from one to 450 individual plants (mean of 16 plants). The largest number of plants occurs on BLM lands, with 1,653 counted in 2005 during annual monitoring of 56 known sites (SBS 2008c). Inventories on other monitored sites counted 940 plants on private lands in Jacksonville and 424 at Pickett Creek (SBS 2008c).

Critical Habitat

Critical habitat has not been designated for Gentner's fritillary.

3.7.2.2 Environmental Baseline

Analysis Area

The botanical analysis area extends to 30 meters (98 feet) each side of the Pipeline project (construction right-of-way, TEWAs, UCSAs, rock source and disposal sites, and proposed storage yards) on lands that have potential habitat for listed plant species. This area generally corresponds to the extent of the area surveyed for sensitive and listed plant species during surveys conducted between 2007 and 2017, and correlates to a distance that indirect effects to plants could occur. Habitats that were focused on during the survey for this species included grassland habitats near the edge of forests (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands).

Species Presence

The analysis area crosses the species' range from approximately MPs 113 through 155. Between 1948 and 2015, approximately 68 sites of Gentner's fritillary have been reported within 25 miles southwest and 6 miles northwest of the Pipeline between MPs 117 and 143, of which many locations are likely extirpated based on habitat conditions (i.e., canopy encroachment) and development (ORBIC 2017c). The proposed Pipeline would cross Gentner's fritillary Recovery Unit 3, which is one of four clusters of fritillary sites proposed for conservation management within the 2003 recovery plan. One of the most vigorous plant populations in Recovery Unit 3 is approximately 1.2 miles southeast of MP 134.4 in the Obenchain Mountain area within the BLM Medford District (Friedman 2006; ORBIC 2017b; SBS 2008a). In 2005, observations at the site reported 19 plants but just one plant in 2009 with the population rated as poor viability (ORBIC

2017c). Pipe storage yards in Jackson County are located more than three miles away from several documented populations in Sam's Valley (Friedman 2006). None of the previously known sites mentioned above are located within the botanical analysis area but they are still within the recovery unit; the closest plant provided by ORBIC (2017c), outside of plants documented for the Pipeline (see below), was documented by Medford BLM in 2010, approximately 500 feet northeast of MP 127.5. Botanical surveys by PCGP between 2007 and 2018 located five sites that contain Gentner's fritillary, as described below.

Project-Specific Surveys

Habitat Surveyed. Prior to beginning field surveys in 2007 for the Pipeline project, botanists with SBS conducted a habitat review to identify potential habitat and delineate survey areas for Gentner's fritillary within the botanical analysis area, including potentially suitable habitats adjacent to existing roads identified for access to the construction right-of-way. Aerial photographs and knowledge of regional landscape and biological features (soils, geology, topography, elevation, target species habitat, and associated plant community habitat) were used to determine the location of potential habitat for Gentner's fritillary. These same methods were applied to determine areas of suitable habitat in new locations where the proposed right-of-way has been relocated since 2007.

Recommended two-year surveys were conducted for this species where survey permission was granted within the vicinity of the Pipeline project (within at least 50 or 100 feet of the Pipeline project on non-federal and federal lands, respectively and where permitted) and along proposed access roads (within at least 50 feet of access roads where road improvements are proposed and surveys permitted). Most surveys were conducted in 2007 and 2008, but additional two-year surveys have been conducted since 2008 in areas of reroutes, minor route adjustments, and areas where survey permission was subsequently granted. Additionally, PCGP initiated two-year survey protocols in 2017 within previously surveyed suitable habitat where Pipeline project survey efforts are or will be 10 years old prior to the completion of the Pipeline, per direction included in the 2016 5-year review (FWS 2016e). Surveys have continued in 2018 and the data are currently under review.

Overall, approximately 2,130.91 acres have been surveyed by PCGP from 2007 through 2017 for Gentner's fritillary within the vicinity of the proposed Pipeline, including previously proposed routes and project components, alternate routes considered, and along access roads that are no longer considered for the Pipeline project. Within the 30-meter botanical analysis area of the Pipeline, approximately 1,720 acres between MPs 113 and 155 have been identified as potential suitable habitat requiring surveys (see table 3.7.2-1). Of this habitat, access was granted to about 1,467 acres (588 acres within the Pipeline project), including within 50 feet of access roads where road improvements have been proposed. Some of the areas surveyed on private lands or areas surveyed on federal lands within recent reroutes only received one year of surveys; habitat on federal lands were surveyed again in 2018.

TABLE 3.7.2-1

Summary of Potential Suitable and Survey Status for Gentner's Fritillary Habitat within the Botanical Analysis Area

General	Suitable	Total Acres	Acres Surveyed (RESURVEYED [4])	Acres Not Surveyed [5]

Landowner	Habitat Status	Surveyed [1] (2007-2017)	Project [2]	Buffer [3]	Total	Project [2]	Buffer [3]	Total
MPs 113.0 - 155.0 (1,720.45 acres within botanical analysis area)								
Federal	Suitable Habitat	729.74	196.01 (128.14)	300.78 (208.23)	496.78 (336.36)	0	8.56	8.56
	Not Habitat	168.26	52.57	63.74	116.31	N/A	N/A	N/A
	Unknown	N/A	N/A	N/A	N/A	0	0	0
	Total	*898.00*	*248.58*	*364.52*	*613.10*	*0.00*	*8.56*	*8.56*
Non-Federal	Suitable Habitat	952.81	290.96	439.64	730.60	49.92	92.02	141.94
	Not Habitat	280.10	48.46	75.14	123.59	N/A	N/A	N/A
	Unknown	N/A	N/A	N/A	N/A	0.48	89.89	90.37
	Total	*1,232.91*	*339.41*	*514.78*	*854.19*	*50.40*	*181.91*	*232.31*
Total	Suitable Habitat	1,682.55	486.96 (128.14)	740.42 (208.23)	1,227.38 (336.36)	49.92	100.57	150.49
	Not Habitat	448.36	101.03	138.88	239.91	N/A	N/A	N/A
	Unknown	N/A	N/A	N/A	N/A	0.48	89.89	90.37
	Total	**2,130.91**	**587.99 (128.14)**	**879.30 (208.23)**	**1,467.29 (336.36)**	**50.40**	**190.46**	**240.86**

[1] Acres provided in this column considers all surveys to-date (through 2017), including areas that have been subsequently rerouted or dropped (i.e., pipe yards) since surveys were initiated in 2007.
[2] Project includes: right-of-way, temporary extra work area, uncleared storage area, rock storage, pipe yards, aboveground facilities.
[3] Buffer (botanical analysis area) includes area within 30 meters (98 feet) of habitat removal and within 50 feet either side of an existing access road identified with possible road improvements.
[4] Per FWS request (May 2017), PCGP has reinitiated surveys in suitable habitat where survey effort was or would be 10 years old (acres surveyed). Survey efforts began in 2017 and would continue in 2018 and/or 2019 where access is permitted.
[5] Areas not surveyed are either denied access or were not surveyed because of recent modification in Proposed Route that occurred after the flowering season, as well as areas outside of the targeted survey area (i.e., 30-meter analysis area vs. 50-foot targeted survey area on non-federal lands). "Not Habitat" was determined from adjacent survey parcel information, aerial photography, or "drive-by;" no surveys would be necessary and acres are not included.

Note: Surveys have continued in 2018 and the data are currently under review. Most area that remains to be surveyed occurs on private lands; surveys would continue as access becomes available.

Of the 1,467 acres of potential habitat within the botanical analysis area with survey access, 1,227 acres (487 acres within the Pipeline project construction right-of-way) were considered suitable habitat for Gentner's fritillary. Habitat suitability was assessed based on standards from a state-wide Gentner's fritillary habitat analysis protocol (SBS 2001). Habitat found to be "suitable" supported characteristics as detailed in the previous sections (SBS 2008a).

Approximately 241 acres (50 acres within the Pipeline project footprint) of potentially suitable habitat (or unknown habitat status) for this species within the botanical analysis area was denied access by the landowner, or occurs within recent modifications of the Pipeline project. Most of this unsurveyed habitat occurs on non-federal (private) lands, Habitat unsurveyed on federal lands includes an area within a recently proposed reroute and surveys would be initiated in 2018. Since permission to survey on non-federal lands targeted an area of at least 50 feet from the Pipeline project, it is very likely that habitat within the "buffer" (30-meter botanical analysis) area would not be surveyed. PCGP would continue to survey habitat following the 2-year survey protocol where permission is granted. Where survey access has been denied, PCGP would conduct one year of surveys in suitable habitat prior to construction. Until survey data is obtained, for purposes of analysis, a conservative assumption can be made that a similar percent of the unsurveyed area would contain suitable habitat (compared to the areas where surveys have been completed), which means approximately 201 acres within the botanical analysis area (83.6 percent of 241 acres, or 42 acres within the Pipeline right-of-way) could be suitable fritillary habitat.

Survey Results. Surveys for Gentner's fritillary have occurred within suitable habitat in the vicinity of the Pipeline from 2007 through 2018. Surveys are expected to continue to complete second year survey efforts where necessary, as well as initiate surveys in other areas that receive survey permission. Since 2007, Pipeline-specific surveys have identified five sites with Gentner's fritillary, of which three sites have been located in the botanical analysis area (SBS 2008a; SBS 2011; SBS 2013b):

- In 2011, two sites containing three flowering plants and nine *Fritilleria* spp. leaves were located 40 feet apart approximately 21 feet southeast of TEWA 128.01-W near MP 128.1; subsequent surveys for an unrelated BLM Project identified approximately 150 *Fritillaria* spp. leaves (see figure 3.7.2-1).

- In 2013, two flowering plants were documented 70 feet apart near MP 129.1 approximately 54 feet northeast of TEWA 128.96-N, with at least 500 bulb leaves in approximately 0.30 acre, of which some could be Gentner's fritillary (one flowering plant observed again in 2015; ORBIC 2017c; SBS 2015) (see figure 3.7.2-2). This site was observed approximately 1 mile east of the site documented in 2011 near MP 128.1.

- In 2008, one flowering Gentner's fritillary plant (with no leaves) was located near MP 142.10 within 21 feet of proposed TEWA 142.07-N (PCGP modified TEWA 142.07-N to avoid the documented flowering Gentner's fritillary plant). There were 18 additional fritillary species (*Fritillaria* sp.) with leaves located within 150 feet of the flowering site, as well as two other flowering fritillary species (scarlet fritillary [*F. recurva*] and chocolate lily [*F. biflora*]). It is possible that some of the leaves located within this area could be Gentner's fritillary; therefore, a larger area which includes all un-identified *Fritillaria* sp. leaves documented is considered part of the potential *F. gentneri* population area (approximately 0.83 acre) that occurs within TEWA 142.07-N and the construction right-of-way (see figure 3.7.2-3).

- Two additional sites were documented during 2008 surveys along existing roads, including one flowering plant and two *Fritillaria* spp. leaves approximately 0.38 miles north of MP 128.05 near Indian Creek and 50 feet below a four-wheel drive road, and four flowering plants 1.0 mile southwest of MP 128.2 and 100 feet from the existing road, which was verified again in 2010 (ORBIC 2017a). These sites are located along roads that will no longer be used for the Pipeline project.

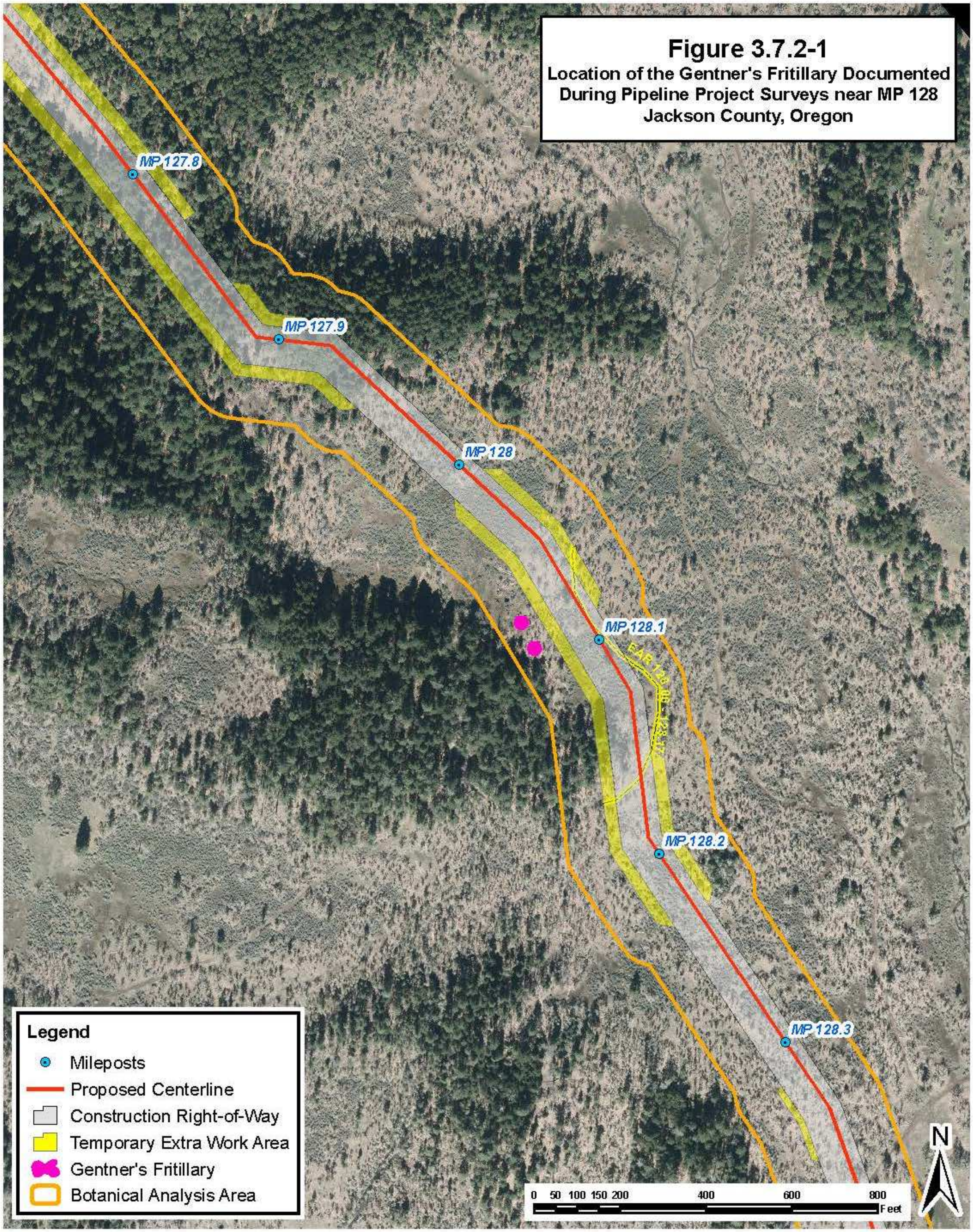

Figure 3.7.2-1
Location of the Gentner's Fritillary Documented During Pipeline Project Surveys near MP 128
Jackson County, Oregon

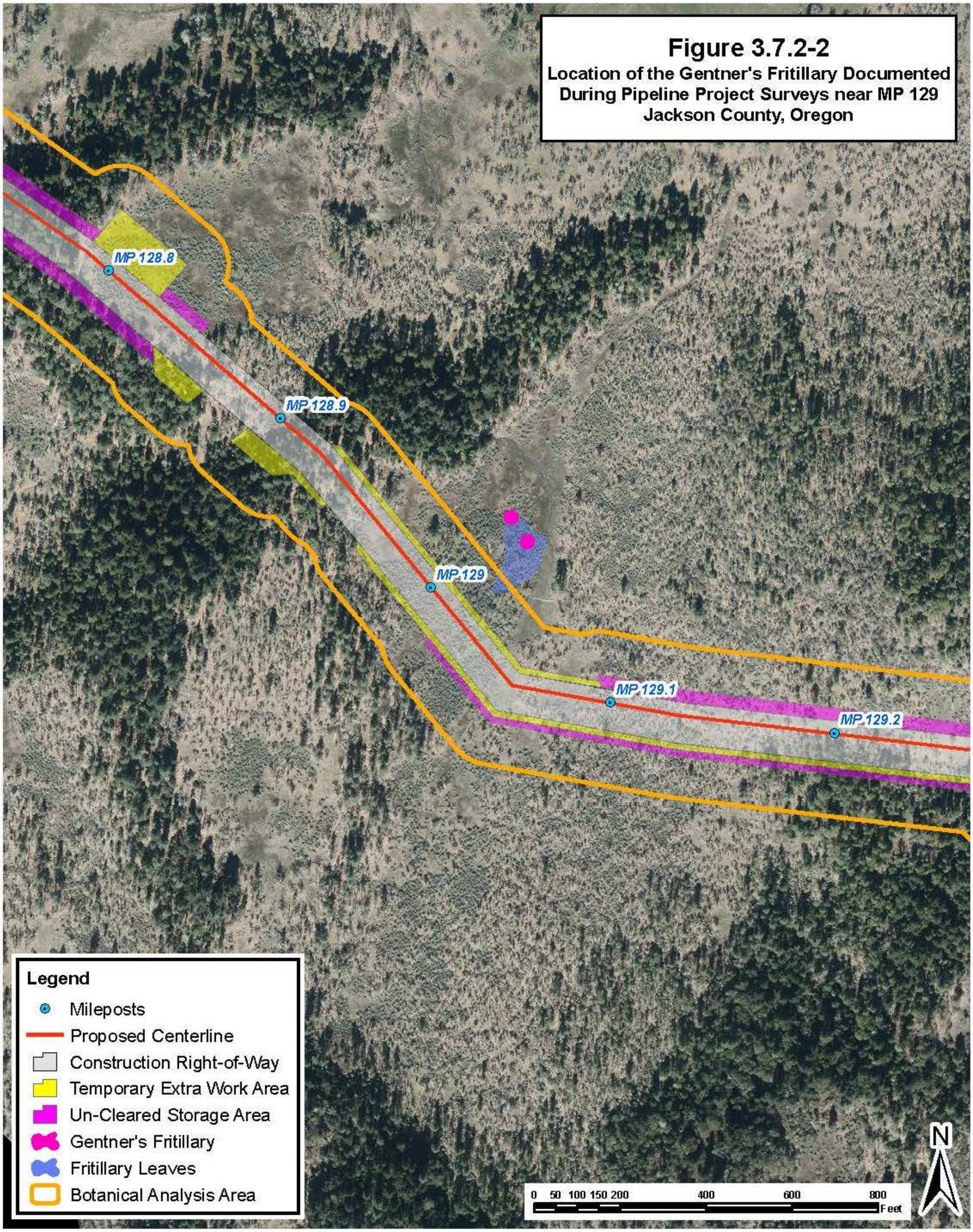
Figure 3.7.2-2
Location of the Gentner's Fritillary Documented During Pipeline Project Surveys near MP 129
Jackson County, Oregon
MP 128.8
MP 128.9
MP 129
MP 129.1
MP 129.2
Legend
Mileposts
Proposed Centerline
Construction Right-of-Way
Temporary Extra Work Area
Un-Cleared Storage Area
Gentner's Fritillary
Fritillary Leaves
Botanical Analysis Area
0 50 100 150 200 400 600 800
Feet
N

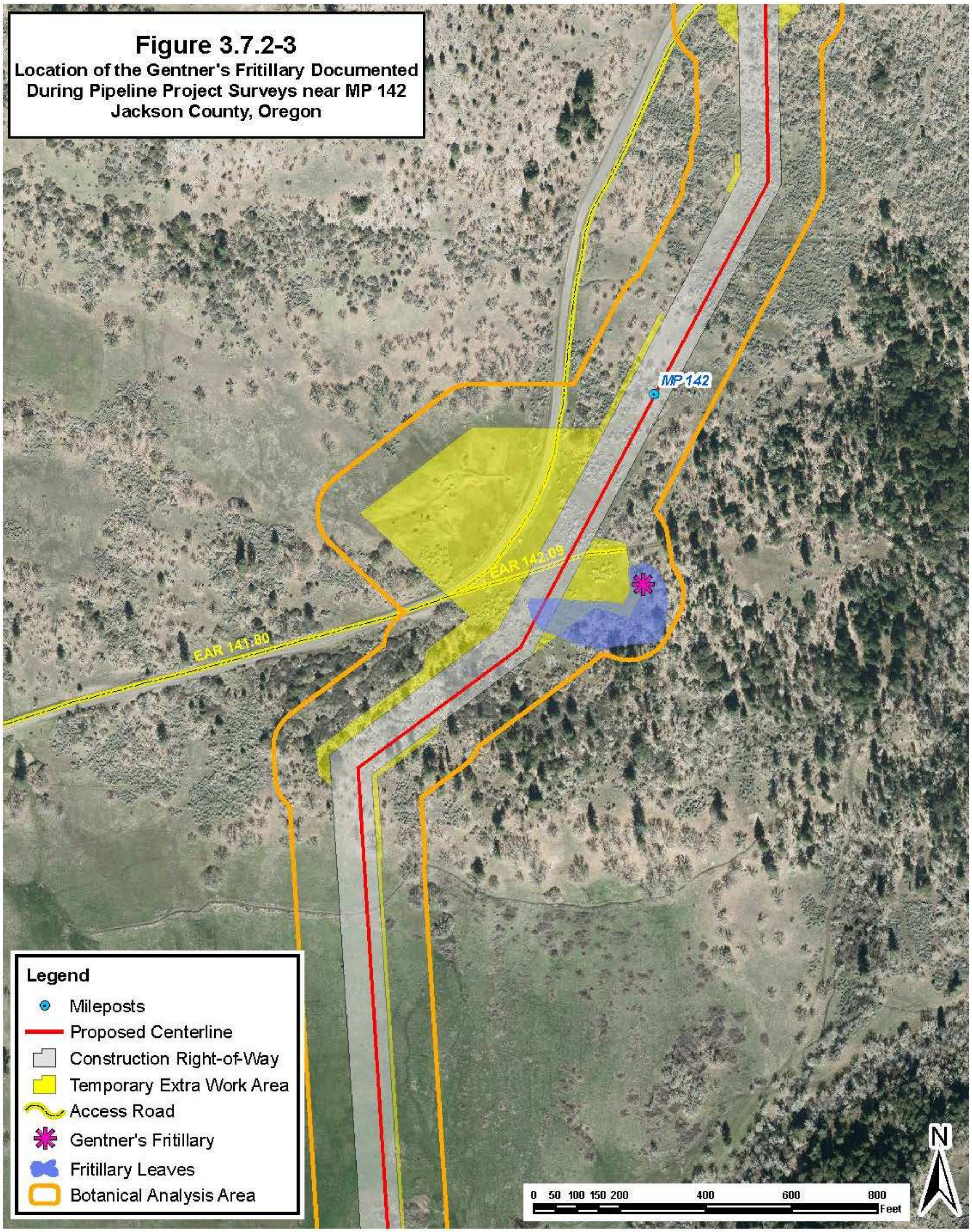
Figure 3.7.2-3
Location of the Gentner's Fritillary Documented During Pipeline Project Surveys near MP 142
Jackson County, Oregon
MP 142
EAR 142.09
EAR 141.80
Legend
Mileposts
Proposed Centerline
Construction Right-of-Way
Temporary Extra Work Area
Access Road
Gentner's Fritillary
Fritillary Leaves
Botanical Analysis Area
0 50 100 150 200 400 600 800
Feet
N

The five sites identified during survey efforts for the Pipeline are 0.4 to 11.2 miles from each other and therefore are not considered a "population center" by the recovery plan definition (four or more locations must occur within 0.3 mile of each other; FWS 2003d). However, BLM and Forest Service have indicated that additional populations have been observed in the Pipeline vicinity during survey efforts for unrelated projects, and, in conjunction with the sites located for the Pipeline project, would be considered a population center.[13]

Critical Habitat

Critical habitat has not been designated for Gentner's fritillary.

3.7.2.3 Effects of the Proposed Action

Direct and Indirect Effects

Five new Gentner's fritillary locations (supporting 11 flowering plants and 679 *Fritillaria* spp. leaves total) were identified during surveys conducted for the Pipeline project, of which three sites (six flowering plants, and 677 *Fritillaria* spp. leaves) occur within the botanical analysis area (see figures 3.7.2-1, 3.7.2-2, and 3.7.2-3). As this species has very low overall population numbers, any loss of individual plants could be considered a substantial impact to the species.

No direct effects are expected at the two sites located within the 30-meter botanical analysis area but are 21 to 54 feet from the Pipeline near MP 128.1 and MP 129.1, respectively (see figures 3.7.2-1 and 3.7.2-2). At the other site near MP 142.1, PCGP removed a portion of TEWA 142.07-N to avoid direct impact to the one flowering Gentner's fritillary plant documented at this site, following recommendations of the Habitat Quality Subtask Group on July 24, 2008; however, several unidentified *Fritillaria* sp. leaves that could be a part of a potential Gentner's fritillary sub-population would be directly affected by construction of the Pipeline (see figure 3.7.2-3 and figure G-3 in appendix V2). Because the site near MP 142.1 consists of a single plant or perhaps a small cluster of plants, it is more vulnerable to extirpation due to even small-scale losses of habitat or plants (FWS 2003d). PCGP has determined that a minor route adjustment of the proposed alignment could be implemented to completely avoid direct effects to the potential Gentner's fritillary sub-population, including the unidentified *Fritilleria* sp. leaves; however, PCGP would need to consult with the landowner to determine if the landowner is agreeable to the revised route. PCGP would conduct additional surveys of this area prior to construction to verify species and/or locate the extent of the potential sub-population and/or additional *Fritilleria* spp. leaves and incorporate additional survey information within a route adjustment prior to construction.

[13] The fritillary sites in section 25 are considered a "population center" because there are four known locations within 0.3 mile of each other, with another three locations within 0.4 mile of the group of four. This cluster of populations is located in the center of Recovery Unit 3, which consists of intersecting circles around a cluster of populations in the Antioch Road area and a cluster of populations in the Cobleigh Road area. The "Indian Creek" cluster and additional sites within 1.5 miles in Section 19, T.34S., R.1E and Section 29, T.34S., R.1E, create a third cluster of populations within RU3. Although fritillary management areas have not been identified in this area, it is assumed that the Indian Creek cluster would be considered for designation as a management area. Hence, the BLM has an interest in protecting and augmenting these populations. Most of these populations were discovered by the BLM during botany clearance surveys conducted in preparation for renewing a grazing allotment permit (not connected with this Pipeline project).

Because Gentner's fritillary does not flower every year and remains dormant underground for one or more years, it is likely that not all plants within areas surveyed for the Pipeline project were documented during the two-year survey effort. Therefore, it is possible that construction activity within identified suitable habitat could directly impact individual plants. Although no direct impacts are expected to occur to identified plants (see discussion above), direct impacts could occur to currently unidentified plants within unsurveyed habitat. However, PCGP intends to conduct additional surveys prior to construction and if plants are documented, direct impacts will be avoided or minimized, where possible following measures outlined in the Gentner's Fritillary Mitigation Plan (see Attachment 3 within the *Federally-listed Plant Conservation Plan*, appendix V2).

Approximately 240.86 acres (table 3.7.2-1) of suitable and potentially suitable habitat (unsurveyed areas) between MPs 113 and 155 would be disturbed by construction of the Pipeline. The construction process could result in indirect impacts to Gentner's fritillary plants and habitat within 30 meters of the Pipeline project, which would include: 1) changes in hydrology and soil characteristics; 2) a potential increase in invasive weeds, which could create additional competition for Gentner's fritillary plants; 3) increased fugitive dust, which could clog stomatal openings in leaves and impede gas exchange, as well as reduce light availability at the leaf surface that could affect plant growth and seed production; and 4) alterations of vegetation cover and species composition, which could impact shading and other interspecific interactions that could negatively impact this species or its ability to re-colonize disturbed areas.

However, the impacted habitat in the analysis area represents a very small percentage of total suitable habitat in the species' range (SBS 2008c); therefore, direct or indirect disturbance to habitats within or adjacent to the Pipeline project is not expected to impede recovery of the species. To control the potential noxious weed invasion, PCGP would implement the procedures outlined in their *Noxious Weed Control Plan* (see appendix N to PCGP's POD). Application of dust abatement measures included in PCGP's Air, Noise and Fugitive Dust Control Plan (see appendix B to PCGP's POD) would minimize the potential for impacts to Gentner's fritillary plants and its habitat during Pipeline construction.

Operation and maintenance of the Pipeline would occur within suitable Gentner's fritillary habitat. Vegetation within the 30-foot operational corridor would be periodically maintained using mowing, cutting, trimming, and herbicides (selectively). Maintenance activities are expected to occur approximately every 3 to 5 years depending on growth rate. However, these activities should not have an adverse effect on Gentner's fritillary because maintenance activities, if necessary, would occur outside the critical growing and flowering season (April through May). If noxious weed infestation occurs within the 50-foot permanent easement, selective use of herbicides or mechanical treatments would be used to control weed within proximity to the species. The Applicant's protection procedures are outlined in the *Noxious Weed Control Plan* (see appendix N to PCGP's POD).

Cumulative Effects

Outside of the areas surveyed for this Proposed Action, it is unknown where Gentner's fritillary occurs on lands not under federal jurisdiction. Therefore, because the extent of this species on non-federal lands is unknown, it is uncertain if there are reasonably foreseeable actions that might occur on these lands within areas currently occupied by this species. As the FWS' authority generally does not extend to listed plants on private or state lands,[14] all federally listed plants located on these lands must be considered at risk of adverse effects from potential developments. Other reasonably foreseeable projects on non-federal lands that could adversely affect this species include residential, commercial, and industrial development, as well as expanding agricultural areas.

PCGP has committed to implementing mitigation measures on private lands.

Critical Habitat

Critical habitat has not been designated for Gentner's fritillary; therefore, no designated critical habitat for this species would be impacted.

3.7.2.4 Conservation Measures

As described for the Applegate's milk-vetch, PCGP has developed a *Federally-listed Plant Conservation Plan* to address how avoidance, minimization, propagation, restoration, and other conservation measures would be applied to protect listed plant species, as well as how potential impacts on un-surveyed lands would be addressed. This plan also contains a Gentner's Fritillary Mitigation Plan that specifically addresses how avoidance and minimization meausres would be implemented for the Gentner's fritillary (see Attachment 3 within the *Federally-listed Plant Conservation Plan*, appendix V2).

To avoid all direct impacts to known Gentner's fritillary flowering plant(s) documented in the Pipeline project, PCGP has modified TEWA 142.07-N (see figure 3.7.2-3 and figure G-3 in appendix V2); all other known Gentner's fritillary plant locations are located outside of the Pipeline project. Additionally, PCGP has identified a reroute that would avoid the unidentified *Fritillaria* sp. leaves located within TEWA 142.07 and the construction right-of-way; however, PCGP would need to consult with the landowner to determine if the landowner is agreeable to the revised route. PCGP would conduct additional surveys near MP 142.1 to verify the presence or absence of *Fritilleria* spp., as well as identify any additional flowering plants or *Fritilleria* spp. leaves that should be considered within the proposed route adjustment prior to construction.

When access to the construction right-of-way is granted, surveys would be conducted in potential habitat (previously surveyed or unsurveyed). Where survey access has been denied, PCGP would conduct at least one year of surveys in suitable habitat prior to construction and would conduct a second year of surveys if possible. Also, PCGP would continue to resurvey areas of suitable habitat where previous Pipeline survey efforts are or will be 10 years old prior to the construction of the Pipeline. FWS would be notified if additional plants are documented. If plants are present, the avoidance/conservation measures included in the Gentner's fritillary mitigation plan would implemented, where feasible (appendix V2). Measures of avoidance may include necking down the construction right-of-way in that area, excluding a portion of an identified TEWA or pipe storage yard, or erecting a protective fence to avoid impact to plants

[14] The ESA does not protect plants outside federal land unless there is a federal nexus. Therefore, activities that occur on private or state lands that could affect listed plants but which do not have federal nexus are not required to consult with the FWS. Plants may not be removed from lands under federal jurisdiction, and activities with a federal nexus must consult with the FWS.

from construction debris. If it is determined that avoidance is not possible, propagation of collected bulblets followed by offsite cultivation for population augmentation could be a viable conservation measure (SBS 2008a). This procedure might include:

- identification and tagging plants for propagation during spring flowering (April in lower elevation, May in higher elevations);
- collection of bulblets during dormant season (late summer to fall-August through November);
- cultivation of bulblets off-site; or
- replanting of grown-out bulbs in subsequent years' dormant season.

Additionally, similar avoidance and conservation measures described above in section 3.7.1.4 for Applegate's milkvetch would be implemented, as described in the Gentner's fritillary mitigation plan (appendix V2), to avoid or minimize effects to Gentner's fritillary plants and habitat.

3.7.2.5 Determination of Effects

Species

The Project may affect Gentner's fritillary because:

- suitable habitat occurs within the botanical analysis area, and
- individual plants have been located within the analysis area during survey efforts.

The Project is **likely to adversely affect** Gentner's fritillary because:

- not all potential suitable habitat within the botanical analysis area was surveyed due to landowner access denial;
- Gentner's fritillary can remain dormant underground for 1 year or longer, does not flower every year, and has been documented to not flower for several years; therefore, it is possible that protocol surveys conducted for the Pipeline did not locate this species; and
- *Fritillaria* spp. leaves were documented within and adjacent to the Pipeline project, and, without flowers, it is nearly impossible to determine if those leaves belong to Gentner's fritillary or another *Fritillaria* species.

Critical Habitat

Critical habitat has not been designated for Gentner's fritillary.

3.7.3 Large-Flowered Woolly Meadowfoam

The large-flowered woolly meadowfoam (*Limnanthes pumila* ssp. *grandiflora*) is an annual plant species in the meadowfoam family (Limanthaceae). It is restricted to the wetter, inner fringes of vernal pools at elevations between 1,220 and 1,540 feet. The plant is found in the Agate Desert in the Rogue River Valley of Jackson County, Oregon (FWS 2002b and 2010c).

3.7.3.1 Species Account and Critical Habitat

Status

The large-flowered woolly meadowfoam was listed as endangered on November 7, 2002 (FWS 2002b). In 2010, FWS (2010c) designated 8 critical habitat units (5,840 acres) for this species in Jackson County, Oregon in the Agate Desert complex.

Threats

A major factor in the FWS 2002 listing of the large-flowered woolly meadowfoam was the present or threatened destruction, modification, or curtailment of its habitat (vernal pools) and range (FWS 2002b). Due to recent rapid population increases in the region, the primary threats to the plant's habitat and range in the Agate Desert (Jackson County, Oregon) are industrial, commercial, and residential development and their residual road and utility construction and maintenance that include mowing, herbicide use, firebreak construction, and hydrologic alteration (mostly for agriculture) (FWS 2011g).

Grazing can have a mixed effect on large-flowered woolly meadowfoam. The effect of grazing on suitable habitat depends on how the grazing is managed. There are various reports showing how grazing practices can positively or negatively affect native plant species' richness (Marty 2005). The Marty (2005) study indicates that wet season grazing resulted in a decrease of native forb species at vernal pool edge habitat, but year-round or off-season grazing improved species' richness through reducing competition with rough/weedy species.

Although disease (e.g., fungal infections), herbivory, and the meadowfoam fly (*Scaptomyza apicalis)* have been identified as potential problems, no data other than casual observations exist to suggest that these factors currently pose a substantial threat to the species (FWS 2012h).

Species Recovery

In November 2012, the FWS (2012h) finalized the *Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems* that identifies nine core areas for protection of vernal pool species in the Rogue Valley that are federally listed or have federal species of concern designation, including the large-flowered woolly meadowfoam. Four Priority 1 core areas are area identified by the FWS that are essential to prevent extinction or irreversible decline of this species, and five Priority 2 core areas are areas identified that are necessary to prevent a significant decline in the species population or habitat quality or some other significant negative impact. The recovery objectives specific to the large-flowered woolly meadowfoam include:

- stabilize and protect populations of the listed species in core areas so further decline in species' status and range are prevented;
- minimize or eliminate the threats that caused the species to be listed, and any other newly identified threats, in order to be able to delist the species;
- conduct research necessary to refine downlisting and recovery criteria;
- ensure long-term conservation; and
- promote natural ecosystem processes and functions by protecting and conserving, in identified core areas, intact vernal pool-mounded prairie complexes and seasonally wet serpentine-derived grassland meadows, sloped mixed-conifer forest openings, and shrub dominated plant communities.

Delisting criteria specific to large-flowered woolly meadowfoam include:

- At least 16 of 18 occurrences for large-flowered woolly meadowfoam (approximately 90 percent of documented/extant occurrences) should be protected from development.
- At least 90 percent of suitable vernal pool habitat acreage within the four Rogue Valley Priority 1 core areas for the species and at least 85 percent of suitable vernal pool habitat acreage within the five Priority 2 core areas for the species has been protected from development. All suitable habitat must include soils and hydrology that support the plant species.
- Develop management plans for each protected core area to guide protection and conservation , including vegetation control such as noxious weed control, monitoring, and maintaining hydrological function.
- Additional species occurrences identified through future site assessments, GIS, other analyses, or status surveys, and that are determined essential to recovery, are protected.
- Seeds from each core area should be collected and stored as insurance against the risk of extirpations and to ensure that genetic lines are preserved. Seed banking is also necessary to complete the reintroductions or introductions that can contribute to meeting recovery criteria.

Life History, Habitat Requirements, and Distribution

The large-flowered woolly meadowfoam is an annual herb endemic to the Agate Desert area in southern Oregon. It grows on the wetter, inner edges of vernal pools mostly in the Rogue River Valley, and is not known from wet meadows. Vernal pool-mounded prairie habitats sustain wet soils needed for growth and flowering, and the shallow pools provide for nutlet dispersal for this species' relatively short life cycle (FWS 2006f). The plant is capable of self-fertilization and self-pollination. Flowering occurs between March and May, with flowers producing nutlets. These nutlets may be dispersed by water, but normally only for short distances; therefore, it is likely that they do not disperse beyond their pool or swale of origin without transportation of mud or substrates containing nutlets (such as on the legs or feet of water birds, or on animal fur).

Large-flowered woolly meadowfoam occupies a limited portion of the Rogue Valley. The plant typically occurs in areas mapped with Agate-Winlo soils (FWS 2012h). There are no major ecological, genetic, or geographic barriers separating extant and historical large-flowered woolly meadowfoam occurrences, apart from agricultural and rural development and road systems. All known populations comprise approximately 177 hectares (440 acres), and are grouped into nine core areas that are separated by at least 1 kilometer (0.7 mile). In the Rogue River Valley, large-flowered woolly meadowfoam is found in the same vernal pool habitats as Cook's lomatium and the vernal pool fairy shrimp.

Population Status

Since listing the large-flowered woolly meadowfoam in 2002, the number of known populations (or occurrences) has increased. At the time of listing in 2002, there were 15 known occurrences of large-flowered woolly meadowfoam. In 2006, a draft recovery plan for listed species of the Rouge Valley vernal pool ecosystem was developed that indicated 22 occurrences were known (FWS 2006f). The most recent five-year review of the species in 2011 noted that 23 occurrences are known (FWS 2011g). Portions of 12 occurrences occur on public lands, within conservation easements, or on lands managed by The Nature Conservancy (FWS 2009e), and thus are protected from development. The population of this species fluctuates annually depending on precipitation and temperature, and so fluctuating populations at the various sites of occurrence have a broad range of approximately 100 to 100,000 (FWS 2006f). In April of 2017, the FWS initiated a 5-Year Status Review (FWS 2017c).

Critical Habitat

Critical habitat was designated in 2010 and included eight critical habitat units in Jackson County totaling 2,363 hectares (5,840 acres; FWS 2010c). The PCEs for large-flowered woolly meadowfoam critical habitat include (FWS 2010c):

1. Vernal pools or ephemeral wetlands and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain large-flowered woolly meadowfoam, growth, and reproduction, between elevations of 1,220 to 1,540 feet, a minimum of 20 acres, and associated with specific dominant native plants.
2. The hydrologically and ecologically functional system of interconnected pools, ephemeral wetlands, or depressions within a matrix of surrounding uplands that together form vernal pool complexes within the greater watershed.
3. Silt, loam, and clay soils that are of alluvial origin, with a 0 to 3 percent slope, primarily classified as Agate-Winlo complex soils, but also including Coker clay, Carney clay, Provig–Agate complex soils, and Winlo very gravelly loam soils.
4. No or negligible presence of competitive, nonnative, invasive plant species.

In the Rogue River Valley, large-flowered meadowfoam is found in the same vernal pool habitats as Cook's lomatium and the vernal pool fairy shrimp, and as a result, most of the critical habitat units designated for large-flowered woolly meadowfoam partially overlap designated habitat for Cook's lomatium and/or vernal pool fairy shrimp. For example, two units designated for the large-flowered woolly meadowfoam in Jackson County are shared by the designated critical habitat for Cook's lomatium (i.e., White City and Whetstone Creek, see below for more details).

3.7.3.2 Environmental Baseline

Analysis Area

For most listed plant species, the botanical analysis area extends to 30 meters (98 feet) each side of the Pipeline project (construction right-of-way, TEWAs, UCSAs, rock source and disposal sites, and proposed storage yards) on lands that have potential habitat for listed plant species. This area generally corresponds to the extent of the area surveyed for sensitive and listed plant species during surveys conducted between 2007 and 2017 (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands), and correlates to a distance that indirect effects to plants would be expected. For the large-flowered woolly meadowfoam, the analysis area was extended 250 feet from the perimeter of four proposed pipe storage areas that are located within the Vernal Pool Complex – Agate Desert, Jackson County, Oregon and shown in figure 3.7.3-1, as well as along the Pipeline right-of-way where Agate-Winlo soil complex occurs. This is a distance within which indirect effects from the Proposed Action could occur to vernal pools supporting this species (FWS 2011h).

Species Presence

Within the vicinity of the Pipeline project, large-flowered woolly meadowfoam is known to occur within the Agate Desert and is associated with Agate-Winlo soils in Jackson County, Oregon. There are multiple records of large-flowered woolly meadowfoam within the Agate Desert southwest of the Pipeline right-of-way (ORBIC 2017c). The closest record to the Pipeline right-of-way is a population with poor viability, last observed in 1982 approximately 3.3 miles southwest of MP 125.3. Other, more distant populations occur 5.8 to 6.9 miles southwest of the Pipeline right-of-way, including, one population of about 400 observed in 1995, another population rated as good or excellent in 2000 with approximately 1,000 plants, and a population discovered in 2008 with about 500 plants scattered across 100 acres. ORBIC (2017c) has reported several other sub-populations of large-flowered woolly meadowfoam (16,200 plants) in the vicinity of proposed pipe storage yards (Burrill Lumber, WC Short, Ave F & 11th St, and Rogue Aggregates), including within the Ken Denman State Game Management Preserve across an existing paved road and east of the Burrill Lumber pipe storage yard (ORBIC 2017b).

Project-Specific Surveys

Habitat Surveyed. Four pipe storage yards have been proposed within the Agate Desert near White City in Jackson County in proximity to known occupied vernal pools and designated large-flowered woolly meadowfoam critical habitat: Burrill Lumber, WC Short, Ave F & 11th St, and Rogue Aggregates (see figure 3.7.3-1). With the exception of Rogue Aggregates, all pipe yards proposed occur on Agate-Winlo complex soils. Although the pipe storage yards are within existing industrial sites, protected vernal pools that may support the large-flowered woolly meadowfoam could be present. Where survey access was permitted, pipe storage yards were evaluated on-site to identify vernal pool habitat, and where vernal pools were observed, surveys for large-flowered woolly meadowfoam occurred (see table 3.6.1-1).

In 2007, SBS identified vernal pool habitat in and near possible pipe storage yards in Jackson County that could provide habitat for the large-flowered woolly meadowfoam, (Cook's lomatium and vernal pool fairy shrimp, discussed in sections 3.7.4 and 3.6.1, respectively). Surveys for the federally-listed plants occurred in the proposed Burrill Lumber pipe yard and Rogue Aggregates pipe yard in 2007; no vernal pools were identified in the two proposed pipe storage yards, although approximately 4.4 acres of high quality suitable vernal pool habitat was observed 850 to 1,165 feet east of Burrill Lumber pipe storage yard where large-flowered woolly meadowfoam was documented (see figure 3.7.3-1 for large-flowered woolly meadowfoam; SBS 2008b). In 2018, habitat north of Burrill Lumber was assessed off-site to determine if possible vernal pools were present within 250 feet of the yard; based on observations from Agate Road and review of aerial photography, no potential vernal pools are located within 250 feet of Burrill Lumber pipe yard. Although Rogue Aggregates pipe yard has been reconfigured since surveys in 2007, portions not included in previous survey efforts for the Pipeline project are not expected to provide suitable habitat for large-flowered woolly meadowfoam because they do not contain suitable soil types.

No surveys have been permitted within Avenue F & 11th Street and WC Short pipe storage yards. Based on aerial photography and off-site observation in April 2018, Avenue F and 11th and WC Short pipe yard do not appear to contain vernal pools: Avenue F and 11th pipe yard is highly disturbed and graded, with railroad and docking faciltities located on the southern edge of the yard, and WC short pipe yard is an existing train yard that would assist moving and off-loading pipe. Although no vernal pools have been observed in Avenue F and 11th pipe yard, there is a long drainage ditch that runs along the northern edge of the pipe yard and paved Avenue F road and extends south along the western edge of the yard; the drainage has very little movement and could be considered low quality vernal pool habitat (approximately 0.46 acre), but because of the existing disturbance at this pipe yard, this habitat is not expected to support large-flowered woolly meadowfoam. No potential vernal pools have been identified in WC Short, and two small exposed drainage ditches (0.02 acre), in an otherwise underground piped drainage system, experience occasional high flow. They are located along an existing access road (Avenue G) within WC Short pipe yard and would not be considered potential vernal pool habitat.

In 2007, a much larger area previously considered for the Burrill Lumber pipe storage yard was also evaluated. High quality suitable vernal pool habitat (approximately 4.4 acres) was observed 850 to 1,165 feet east of the currently proposed Burrill Lumber storage yard where 36 large-flowered woolly meadowfoam were observed (SBS 2008a). Additionally in 2007, two other pipe yards that are no longer included for the proposed Pipeline project were evaluated (11 acres of suitable vernal pool habitat were observed and surveyed south of Ave F & 11th Street pipe yard within Avenue C and 7th Street pipe yard [10.5 acres in seven seasonally saturated pools] and north of Ave F & 11th Street pipe yard within Medford Industrial Park pipe yard [0.55 acre in 20 seasonally saturated pools; see figure 3.7.3-1]). Although suitable vernal pool habitat was present, no plants were observed during species-specific survey efforts (SBS 2008a).

Although out of the expected range of large-flowered woolly meadowfoam, nine vernal pools located in Agate-Winlo soils (approximately 0.2 acre) within and adjacent to the Pipeline project on private lands (MPs 145.3 to 145.40) were surveyed in 2007; no large-flowered woolly meadowfoam were documented (SBS 2008a).

Approximately 190.29 acres within 250 feet of proposed pipe storage yards, including Avenue F & 11th Street and WC Short pipe yards, in Jackson County have not been evaluated on-site for vernal pool habitat; off-site observations identified approximately 0.48 acre of highly modified, low quality vernal pool habitat within 250 feet of proposed pipe. Although 0.48 acre of potential vernal pool habitat has not been surveyed on-site for large-flowered woolly meadowfoam, the area is associated with active industrial sites or previously disturbed industrial areas and is not expected to provide high quality vernal pool habitat for the large-flowered woolly meadowfoam (table 3.6.1-1).

<u>Survey Results</u>. Within the high quality vernal pool habitat east of proposed Burrill Lumber pipe yard, four small patches (36 plants) of large-flowered woolly meadowfoam were found more than 1,530 feet east of the currently proposed pipe storage yard. The site is located on a portion of the property that has not been heavily modified (SBS 2008a; see figure 3.7.3-1). The plants located are suspected to be part of a larger large-flowered woolly meadowfoam population located to the east within critical habitat subunit RV6D. No other large-flowered woolly meadowfoam plants were observed during surveys within vernal pool habitat for the Pipeline project.

Critical Habitat

Within the vicinity of White City, Oregon where four pipe storage yards are proposed, critical habitat units RV6 (6A through 6H) and RV8 have been designated; all units are surrounded by industrial parks and agriculture. Both critical habitat units consist of intact vernal pool-mounded prairie and swale habitats (FWS 2010c). Two of the eight RV6 subunits (i.e., RV6C and RV6D) are near or adjacent to proposed yards: unit RV6C is across an existing paved road from Burrill Lumber pipe storage yard and unit RV6D is 590 feet northeast of Burrill Lumber pipe storage yard. RV8 is over 1.8 miles west of the proposed Rogue Aggregates and the other three pipe storage yards (see figure 3.7.3-1).

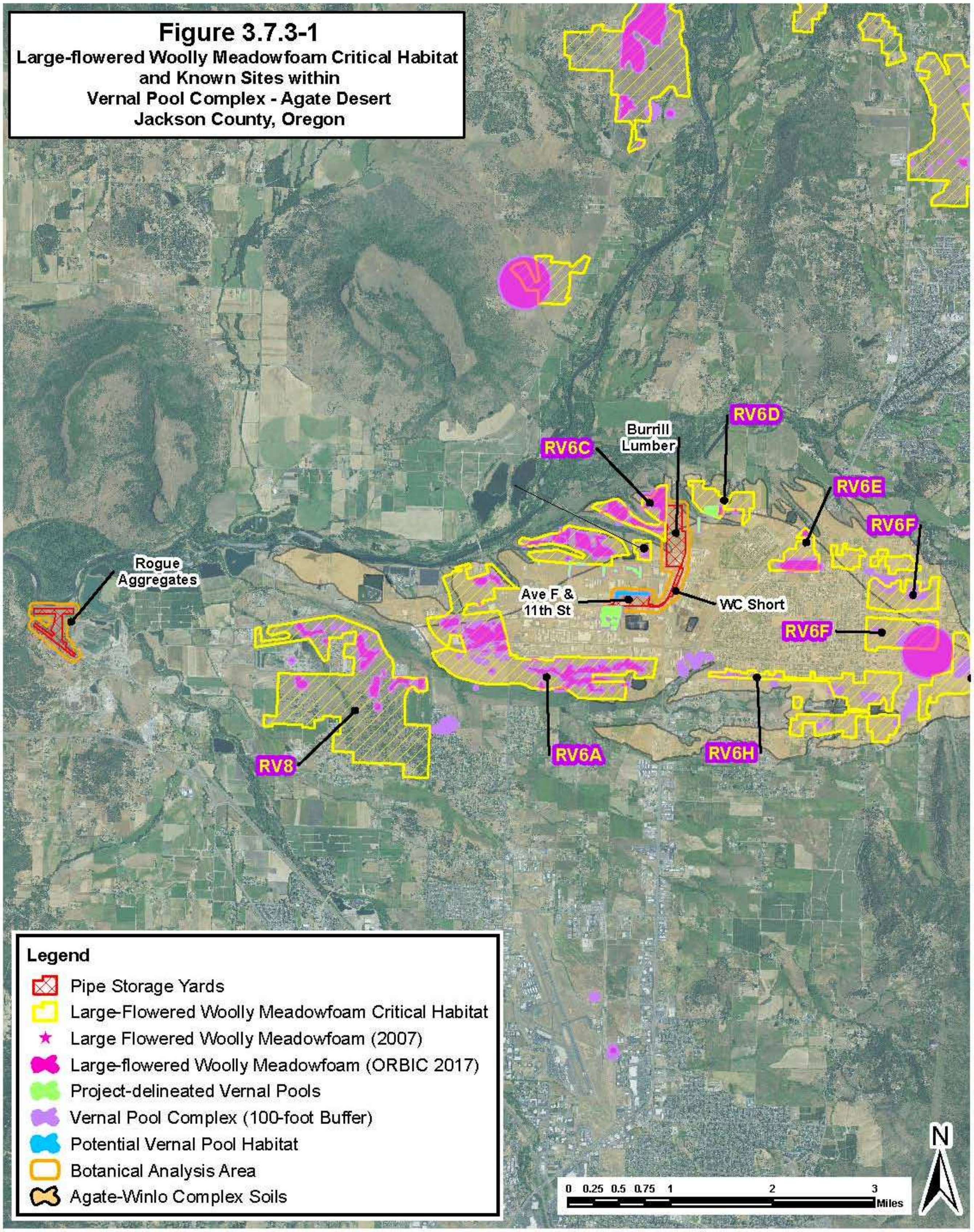
Figure 3.7.3-1
Large-flowered Woolly Meadowfoam Critical Habitat
and Known Sites within
Vernal Pool Complex - Agate Desert
Jackson County, Oregon
RV6D
Burrill
Lumber
RV6C
RV6E
RV6F
Rogue
Aggregates
Ave F &
11th St
WC Short
RV6F
RV8
RV6A
RV6H
Legend
Pipe Storage Yards
Large-Flowered Woolly Meadowfoam Critical Habitat
Large Flowered Woolly Meadowfoam (2007)
Large-flowered Woolly Meadowfoam (ORBIC 2017)
Project-delineated Vernal Pools
Vernal Pool Complex (100-foot Buffer)
Potential Vernal Pool Habitat
Botanical Analysis Area
Agate-Winlo Complex Soils
0 0.25 0.5 0.75 1 2 3
Miles
N

3.7.3.3 Effects of the Proposed Action

Direct and Indirect Effects

Possible direct effects to large-flowered woolly meadowfoam include disturbance to pools from driving on or storing equipment or pipes near or on pools or wetlands associated with this species. Direct effects to the meadowfoam and its habitat could be expected in vernal pools and upland habitat within 100 feet from delineated vernal pool habitat. Because no vernal pool habitat has been documented in surveyed Jackson County proposed pipe storage yards (Burrill Lumber and Rogue Aggregates), and because PCGP has committed to avoiding vernal pool habitats in pipe storage yards by at least 250 feet or would remove a pipe yard from further consideration if vernal pool habitat is documented during future surveys (see Conservation Measures, below), no direct impacts to known large-flowered wooly meadowfoam are anticipated from use of pipe storage yards in Jackson County. Surveys conducted in suitable vernal pool habitat along the construction right-of-way between MPs 145.3 and 145.4 did not locate large-flowered woolly meadowfoam plants; therefore, no direct effects to large-flowered meadowfoam along the construction right-of-way are expected.

Indirect effects to large-flowered woolly meadowfoam and their habitat could occur with increased road use to access the pipe storage yards, as well as pipe storage yard activities, that are adjacent or near suitable or potentially suitable habitat. Although increased road use on paved Agate Road is not expected to increase fugitive dust, pipe yard activities and the associated dust created might impact vernal pool habitat within 250 feet of activities as dust settles, affecting vegetation and vernal pool physical or chemical properties (e.g., pH, water quality, turbidity, sedimentation, temperature). Increased dust levels can negatively impact plants by clogging stomatal openings in the leaves, impeding gas exchange and reducing the ability of plants to take in carbon dioxide. Dust on the leaf surface can also effectively reduce light availability at the leaf surface and thereby reduce plant growth and seed production.

Project use of pipe storage yards adjacent to, or within 250 feet of, suitable or potentially suitable habitat may also indirectly affect the hydrology upon which vernal pools and associated vegetation are dependent (e.g., through potential soil compaction from heavy equipment use). Indirect effects to hydrology could be expected within 250 feet of suitable or potentially suitable vernal pool habitat (see FWS 2011h). Effects could include altering hydrologic processes, such as runoff patterns because of soil compaction, as well as the potential for increased non-native invasive plant species. Any potential compaction that may occur at the yard would likely be insignificant because of the previous industrial use of these areas and associated soil grading. Based on topographic maps, flow patterns in the area are to the northwest, away from the 36 large-flowered woolly meadowfoam plants documented in 2007 and over 1,500 feet east of Burrill Lumber pipe storage yard, and no indirect impact to these plants from hydrologic impact would be anticipated. Additionally, any westerly flow from the Burrill Lumber pipe yard into critical habitat unit RV6C would be intercepted by the raised roadbed of paved, Agate Road.

No other direct or indirect effects to potential vernal pools are expected from use of unsurveyed pipe storage yards in Jackson County, including 0.48 acre of potential vernal pool wetlands (and 15.55 acres of vernal pool complex) identified from off-site observations within or adjacent to Avenue F & 11th Street and WC Short pipe yards (see table 3.6.1-1). Although a drainage has been identified on the north and west edges of Avenue F & 11th Street pipe yard, Pipeline use, if any, would be located farther than 250 feet from the potential vernal pool habitat.

Implementation of conservation measures included in section 3.7.3.4 would minimize impacts to potential suitable vernal pool habitat and large-flowered woolly meadowfoam plants, if present.

Cumulative Effects

Outside of the areas surveyed for the Pipeline, it is unknown where large-flowered woolly meadowfoam occurs on lands not under federal jurisdiction. Therefore, because the extent of this species on these non-federal lands is unknown, it is uncertain if there are reasonably foreseeable actions that might occur on these lands within areas currently occupied by this species. As the FWS's authority generally does not extend to listed plants on private or state lands,[15] all federally listed plants located on these lands must be considered at risk of adverse effects from potential developments. However, populations of large-flowered woolly meadowfoam and their habitats do have the potential to be protected on private and state lands as developments that could potentially affect vernal pool habitat would be required to comply with COE and ODSL requirements, which would limit potential cumulative effects to this species. Additionally, as approximately 98 percent of known large-flowered woolly meadowfoam populations occur in designated critical habitat, these populations may be protected regardless of land ownership. Other reasonably foreseeable projects on non-federal lands that could adversely affect this species include residential, commercial, and industrial development, as well as expanding agricultural areas.

PCGP has committed to implementing mitigation measures for this and other listed plant species regardless of land ownership.

Critical Habitat

One designated critical habitat subunit (RV6C) is located approximately 100 feet west of Burrill Lumber pipe storage yard across existing paved, Agate Road; no direct impacts due to the Pipeline are anticipated because equipment and pipe storage would not occur near or in pools or wetlands located in the critical habitat subunits, nor would traffic to and from the pipe storage yards drive near or in pools within the critical habitat unit. Additionally, plant sites previously located in critical habitat unit RV6C are over 100 feet from the proposed Burrill Lumber storage yard (Friedman 2006; ORBIC 2017c); therefore, no direct impact to those plant sites are expected. Another subunit, RV6D is located approximately 590 feet (at its closest point) northeast of Burrill Lumber pipe storage yard, where survey efforts in 2007 located large-flowered woolly meadowfoam. WC Short, Avenue F and 11th Street, and Rogue Aggregates proposed pipe yards are all over 1,500 feet from the nearest designated critical habitat units (see figure 3.7.3-1); no direct impacts to any designated critical habitat or plants from use of those pipe storage yards would occur.

Indirect effects to the designated critical habitat units in the vicinity of the four pipe storage yards proposed in Jackson County may occur as a result of increased road use to access the pipe storage yards that are adjacent to the critical habitat units (i.e., Agate Road) and use of Burrill Lumber pipe storage yard that is within 100 feet of critical habitat subunit RV6C. Although

[15] The ESA does not protect plants outside federal land unless there is a federal nexus. Therefore, activities that occur on private or state lands that could affect listed plants but which do not have federal nexus are not required to consult with the FWS. Plants may not be removed from lands under federal jurisdiction, and activities with a federal nexus must consult with the FWS.

increased road use on paved Agate Road is not expected to increase fugitive dust, potential dust created from use of the Burrill Lumber pipe yard might impact large-flowered woolly meadowfoam critical habitat as dust settles, affecting associated vegetation and vernal pool physical or chemical properties (e.g., pH, water quality, turbidity, sedimentation, and temperature). PCE 1 specifies that at least 20 acres are essential for intact hydrology, and impact to hydrology within critical habitat subunit RV6C may be expected if actions in the Burrill Lumber pipe storage yard alter hydrology within 250 feet (FWS 2011h). For example, use of the Burrill Lumber yard that includes ground disturbance such as soil compaction by heavy machinery may alter hydrology in vernal pools within critical habitat subunit RV6C, possibly affecting the frequency or amount of water in adjacent vernal pools, thereby altering the hydrology upon which vernal pools and associated vegetation are dependent. However, RV6C is separated from the Burrill Lumber pipe yard by 100 feet and the raised roadbed of Agate Road; therefore, it is highly unlikely that hydrology within RV6C would be impacted by use of the Burrill Lumber pipe storage yard. Additionally, the use of the roads adjacent to the critical habitat units and the pipe storage yards may increase the introduction of non-native, weedy species. PCE 4 specifies that no or negligible presence of competitive nonnative invasive plant species be present for the continued survival and recovery of large-flowered woolly meadowfoam.

Critical habitat unit RV8 is located greater than 1.4 miles from proposed pipe storage yards in Jackson County (see figure 3.7.3-1). The Pipeline project is not expected to directly or indirectly affect this critical habitat unit

Applying the conservation measures identified below, the use/alteration/restoration of pipe storage yards should not result in modifications in the timing, duration, magnitude, or quality of hydrological connections to an off-site vernal pool and/or large-flowered woolly meadowfoam. Additionally, measures taken to minimize the introduction and spread of noxious weeds outlined in the *Integrated Pest Management Plan* (appendix N to the POD) would reduce the risk of spreading or establishing new nonnative weed species.

3.7.3.4 Conservation Measures

PCGP has eliminated from further consideration the following previously proposed pipe storage yards to avoid potential effects to high-quality vernal pool habitat: Avenue C and 7th Street-Elite Cabinet & Door, Medford Industrial Park, and a portion of the previously delineated Burrill Lumber yard that included high quality vernal pool habitat east of the currently proposed yard. To avoid impacts to potential vernal pool habitat, as well as potential large-flowered woolly meadowfoam plants that may occur, although unlikely, along the northern and western edge of Avenue F and 11th Street pipe yard, PCGP would avoid using portions of Avenue F and 11th Street pipe storage yard within 250 feet of potential vernal pool habitat (boundary of indirect effects) or no longer pursue use of the pipe yard.

PCGP would install sedimentation control barriers, as recommended in the Recovery Plan (FWS 2012h) to minimize the potential for offsite mobilization of surface flows or sediment. As described in section 3.6.1.4 for vernal pool fairy shrimp, a silt fence would be erected on the west side of the right-of-way within 250 feet of vernal pools located between MPs 145.27 and 145.44. Additional potential mitigation measures considered for large-flowered woolly meadowfoam, if identified in the area, would include implementation of stormwater measures outlined in the ECRP (see appendix F) to reduce the potential for increased sediment mobilization as well as erosion and dust control measures listed in the ECRP to minimize fugitive dust along the construction right-of-way or within pipe storage yards, and BMPs in the Integrated Pest Management Plan (appendix N to the POD) to control existing noxious weeds and prevent new infestations within and adjacent to occupied and potential habitats.

3.7.3.5 Determination of Effects

Species

The Project **may affect** large-flowered woolly meadowfoam because:

- the Pipeline project occurs in the vicinity of occupied, large-flowered woolly meadowfoam habitat.

The Project is **not likely to adversely affect** large-flowered woolly meadowfoam because:

- surveys of potentially suitable habitat at proposed pipe storage yards in Jackson County and along the proposed Pipeline did not document large-flowered meadowfoam plants;
- PCGP would avoid using portions of proposed pipe storage yards within 250 feet (indirect effect) of these plant species or potentially suitable vernal pool habitat;
- effects to suitable habitat by the proposed action are likely to be insignificant to the point where no meaningful measurement, detection, or evaluation of impact would be possible (i.e., impact would not reach a level where individual plants would be lost);
- sedimentation barriers would be used, as appropriate, to prevent run-off and changes in hydrology;
- conservation measures have been developed to avoid or minimize impacts to future plants identified during surveys prior to construction; and
- construction of the Pipeline is not expected to adversely modify hydrology in nearby suitable habitat areas within 250 feet of proposed pipe storage yards.

Critical Habitat

The Project **may affect** designated critical habitat for large-flowered woolly meadowfoam because:

- the Project occurs adjacent to and nearby large-flowered woolly meadowfoam designated critical habitat.

A **not likely to adversely affect** determination is warranted for large-flowered woolly meadowfoam critical habitat because:

- construction of the Pipeline is not expected to adversely modify designated critical habitat areas within 250 feet of components of the Pipeline (i.e., subunit RV6C); existing features (i.e., paved Agate Road) and proposed conservation measures would provide sufficient protection from adjacent development and weed sources. The Burrill Lumber pipe yard is hydrologically disconnected from RV6D due to topography (flow is away from RV6D) and distance (greater than 590 feet), and is hydrologically isolated from RV6C by the raised Agate Road; and

- no dust-related impacts from use of the Burrill Lumber pipe storage yard would be expected because PCGP would implement measures in the Dust plan (see appendix B of the POD) to minimize potential impacts from fugitive dust.

3.7.4 Cook's Lomatium

Cook's lomatium (*Lomatium cookii*) is a perennial plant of the parsley (Apiaceae) family. It occurs 1) along vernal pools in the Agate Desert area of the Rogue River Valley in Jackson County, Oregon, and 2) in alluvial floodplains within the Illinois River Valley area near Cave Junction in Josephine County, Oregon (FWS 2006f).

3.7.4.1 Species Account and Critical Habitat

Status

Cook's lomatium was listed as endangered on November 7, 2002 (FWS 2002b). In 2010, the FWS designated critical habitat for Cook's lomatium (and concurrently for large-flowered woolly meadowfoam; FWS 2010c).

Threats

A major factor in the FWS 2002 listing of Cook's lomatium was the present or threatened destruction, modification, or curtailment of its habitat (vernal pools) and range. The primary threats to habitat and range are industrial, commercial, and residential development and their associated road and utility construction and maintenance. The FWS also found that competition from introduced grass species and grazing can reduce or eliminate populations (FWS 2002b). In addition, vandalism, in the form of intentional disregard or dismantling of signage or fencing intended to protect certain wetland areas from unauthorized OHV use, and subsequent damage resulting from that use, has resulted in negative effects to habitat.

Grazing can have a mixed effect on Cook's lomatium. The effect of grazing on suitable habitat depends on how the grazing is managed. There are various reports showing how grazing practices can positively or negatively affect native plant species' richness. The Marty (2005) study indicates that wet season grazing resulted in a decrease of native forb species at vernal pool edge habitat, but year-round improved species' richness.

Although disease (e.g., fungal infections) and herbivory have been identified as potential problems, no data other than casual observations exist to suggest that these factors pose a current substantial threat to the species (FWS 2012h). Because of continuing population and development pressures on the limited Cook's lomatium habitat and range, the factors cited in the listing decision remain as significant ongoing threats to the species.

Species Recovery

In November 2012, the FWS (2012h) finalized the *Recovery Plan for Rogue and Illinois Valley Vernal Pool and Wet Meadow Ecosystems* (FWS 2012h). It identifies nine core areas for protection of vernal pool dependent species in the Rogue Valley, including Cook's lomatium. The recovery objectives specific for Cook's lomatium include:

- At least 32 of 36 occurrences for Cook's lomatium (approximately 90 percent of documented/extant occurrences) should be protected from development. For occurrences that have become extirpated, reintroduced or introduced populations may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if the FWS deems them equivalent in their contribution to recovery.

- At least 90 percent of suitable vernal pool habitat acreage within the four Priority 1 core areas for the species and at least 85 percent of suitable vernal pool habitat acreage within the five Priority 2 core areas for the species has been protected from development. All suitable habitat must include soils and hydrology that support the plant species.
- Additional species occurrences identified through future site assessments, GIS, other analyses, or status surveys, and that are determined essential to recovery, are protected.
- Seeds from each core area should be collected and stored as insurance against the risk of extirpations and to ensure that genetic lines are preserved. Seed banking is also necessary to complete the reintroductions or introductions that can contribute to meeting recovery criteria.

Life History, Habitat Requirements, and Distribution

Cook's lomatium is a small perennial in the parsley family. Its range is on seasonally wet soils limited to two areas: 1) along vernal pools in the Agate Desert area of the Rogue River Valley in Jackson County, and 2) in alluvial floodplains within the Illinois River Valley area near Cave Junction in Josephine County (FWS 2006f).

The Jackson County populations occur along the margins and bottoms of vernal pool habitats within the 20,510-acre Agate Desert. Located on the floor of the Rogue River basin north of Medford, the Agate Desert is characterized by shallow, Agate-Winlo complex soils, a relative lack of trees, sparse prairie vegetation, and agates commonly found on the soil surface. Fire may maintain suitable habitat because shrubs compete for sun and space, and a historical fire regime is thought to have prevented such shrubs from encroaching on Cook's lomatium habitat (FWS 2006f). Cook's lomatium plants in the Agate Desert are found on the margins and bottoms of vernal pools with standing water from December to April or May. The plant flowers from late March to May and is pollinated entirely by insects. Each flowering stalk produces either primarily male or female flower clusters (FWS 2006f). In the Rogue River Valley, Cook's lomatium is found in the same vernal pool habitats as the large-flowered woolly meadowfoam and the vernal pool fairy shrimp.

The Josephine County populations occur on seasonally wet soils in the Illinois Valley. The Pipeline project is not located in Josephine County, and this population and habitats are not discussed further.

Population Status

Cook's lomatium occupies 146.5 acres in the Rogue Valley's Agate Desert; an estimated 4,086 acres of potential Cook's lomatium habitat is present within the area. In the Rogue Valley, Cook's lomatium is known from 13 occurrences, of which six are extant, six are unknown in status, and one is extirpated; the Cook's lomatium total population in the Rogue Valley is estimated at 34,000 plants (FWS 2012h).

Critical Habitat

Critical habitat for Cook's lomatium was designated on July 21, 2010, including three critical habitat units in Jackson County, totaling 924 hectares (2,282 acres) (FWS 2010c). As the Pipeline occurs within and adjacent to the Agate Desert complex, this analysis focuses on the Agate Desert geographic area.

When determining areas for critical habitat for the Cook's lomatium in the Agate Desert, FWS focused on the biological or physical PCEs that are essential to the conservation of the species. The PCEs for Cook's lomatium critical habitat include:

1. vernal pools or ephemeral wetlands and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain Cook's lomatium, growth, and reproduction, between elevations of 1,256 to 1,600 feet, a minimum of 20 acres, and associated with specific dominant native plants (FWS 2010c);
2. the hydrologically and ecologically functional system of streams, slopes, and wooded systems that surround and maintain seasonally wet alluvial meadows underlain by relatively undisturbed ultramafic soils within the greater watershed;
3. silt, loam, and clay soils that are of ultramafic and nonultramafic alluvial origin, with a 0 to 40 percent slope, classified as Abegg gravelly loam, Brockman clay loam, Copsey clay, Cornutt–Dubakel complex, Dumps, Eightlar extremely stony clay, Evans loam, Foehlin gravelly loam, Josephine gravelly loam, Kerby loam, Newberg fine sandy loam, Pearsoll–Rock outcrop complex, Pollard loam, Riverwash, Speaker–Josephine gravelly loam, Takilma cobbly loam, or Takilma Variant extremely cobbly loam; and,
4. no or negligible presence of competitive, nonnative, invasive plant species.

Sixteen critical habitat units (CHU) have been designated for the Cook's lomatium; 3 in Jackson County, of which two units (White City and Whetstone Creek) are shared by the designated critical habitat for large-flowered woolly meadowfoam (FWS 2010c).

3.7.4.2 Environmental Baseline

Analysis Area

For most listed plant species, the botanical analysis area extends to 30 meters (98 feet) each side of the Pipeline project (construction right-of-way, TEWAs, UCSAs, rock source and disposal sites, and proposed storage yards) on lands that have potential habitat for listed plant species. This area generally corresponds to the extent of the area surveyed for sensitive and listed plant species during surveys conducted between 2007 and 2017 (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands), and correlates to a distance that indirect effects to plants would be expected. For the Cook's lomatium, the analysis area was extended 250 feet from the perimeter of four proposed pipe storage areas that are located within the Vernal Pool Complex – Agate Desert, Jackson County, Oregon and shown in figure 3.7.4-1, as well as 250 feet from the Pipeline right-of-way in the vicinity of Agate-Winlo soil complex. This is a distance within which indirect effects from the Proposed Action could occur to vernal pools supporting this species (FWS 2011h).

Species Presence

Within the vicinity of the Pipeline project, Cook's lomatium is known to occur within the Agate Desert, and is associated with Agate-Winlo soils in Jackson County, Oregon. Multiple locations of Cook's lomatium have been documented in the Agate Desert, in and around White City, Jackson County; these locations are in proximity to proposed pipe storage yard locations. One population is located 10.3 miles west of the Pipeline route near MP 145.7 (ORBIC 2017c), and several occurrences of Cook's lomatium have been documented 0.5 mile south of the proposed Avenue F & 11th Street, and WC Short yards in the Ken Denman State Game Management Reserve (Hall Tract Unit; Friedman 2006; ORBIC 2017c; see figure 3.7.4-1). Lands between the proposed yards and the Cook's lomatium occurrences are developed with multiple industrial sites on both sides of Antelope Road. No populations of Cook's lomatium were identified by PCGP at any of its proposed facilities; however, some suitable habitat exists near proposed pipe storage yards, as discussed below.

Project-Specific Surveys

Habitat Surveyed. Prior to beginning field surveys in 2007, botanists with SBS conducted a habitat review to identify potential habitat and delineate survey areas for Cook's lomatium within the botanical analysis area, including existing roads identified for access to the construction right-of-way, and associated impact areas like pipe storage yards. Aerial photographs and knowledge of regional landscape and biological features (e.g., soils, geology, topography, elevation, target species habitat, and plant community habitat) were used to determine potential habitat for Cook's lomatium. These same methods were applied to determine areas of suitable habitat in new locations where the proposed right-of-way and related facilities have been relocated or altered since 2007. Habitat found to be "suitable" in the surveys included areas with some of the characteristics detailed in the Life History, Habitat Requirements, and Distribution section under section 3.7.3.1.

Four pipe storage yards have been proposed within the Agate Desert near White City in Jackson County in proximity to known occupied vernal pools and designated Cook's lomatium critical habitat: Burrill Lumber, WC Short, Ave F & 11th St, and Rogue Aggregates (see figure 3.7.4-1). With the exception of Rogue Aggregates, all pipe yards proposed occur on Agate-Winlo complex soils. Although the pipe storage yards are within existing industrial sites, protected vernal pools could be present that may provide potential vernal pool habitat for Cook's lomatium. Where survey access was permitted, habitat within the pipe yards was evaluated to identify suitable vernal pool habitat for Cook's lomatium (see table 3.6.1-1).

In 2007, SBS identified vernal pool habitat in and near possible pipe storage yards in Jackson County that could provide habitat for Cook's lomatium. Surveys for the Cook's lomatium, as well as large-flowered woolly meadowfoam (see section 3.7.3), occurred in the proposed Burrill Lumber pipe yard and Rogue Aggregates pipe yard in 2007; no vernal pools were identified in the two proposed pipe storage yards and no plants were observed. In 2018, habitat north of Burrill Lumber was assessed off-site to determine if possible vernal pools were present within 250 feet of the yard. Based on observations from Agate Road and review of aerial photography, no potential vernal pools are located within 250 feet of the Burrill Lumber pipe yard. Although Rogue Aggregates pipe yard has been reconfigured since surveys in 2007, portions not included in previous survey efforts for the Pipeline project are not expected to provide suitable habitat for Cook's lomatium because they do not contain suitable soil types.

No surveys within Avenue F & 11th Street and WC Short pipe storage yards have been permitted. Based on aerial photography and off-site observation in April 2018, Avenue F and 11th and WC Short pipe yards do not contain vernal pools. Avenue F and 11th pipe yard is highly disturbed and graded, with railroad and docking faciltities located on the southern edge of the yard, and WC short pipe yard is an existing train yard that would assist moving and off-loading pipe. Although no vernal pools have been observed in Avenue F and 11th pipe yard, there is a long drainage ditch that runs along the northern edge of the pipe yard and paved Avenue F road and extends south along the western edge of the yard and could provide habitat for Cook's lomatium. The drainage has very little movement and could be considered low quality vernal pool habitat (approximately 0.46 acre). No potential vernal pools have been identified in WC Short, and two small exposed drainage ditches (0.02 acre), in an otherwise underground piped drainage system, experience occasional high flow. They are located along an existing access road (Avenue G) within WC Short pipe yard and would not provide suitable vernal pool habitat for Cook's lomatium.

In 2007, a much larger area previously considered for the Burrill Lumber pipe storage yard was also evaluated. High quality suitable vernal pool habitat (approximately 4.4 acres) was observed 850 to 1,165 feet east of the currently proposed Burrill Lumber storage yard where 36 large-flowered woolly meadowfoam were documented in 2007; no Cook's lomatium plants were documented (SBS 2008a). Additionally in 2007, two other pipe yards that are no longer included for the proposed Pipeline project were evaluated (11 acres of suitable vernal pool habitat were observed and surveyed south of Ave F & 11th Street pipe yard within Avenue C and 7th Street pipe yard [10.5 acres in seven seasonally saturated pools] and north of Ave F & 11th Street pipe yard within the Medford Industrial Park pipe yard [0.55 acre in 20 seasonally saturated pools; see figure 3.7.4-1]). Although suitable vernal pool habitat was present, no plants were observed (SBS 2008a).

Nine vernal pools (totaling approximately 0.2 acre) within and adjacent to the Pipeline right-of-way on private lands (between MPs 145.3 and 145.40) that occur on Agate-Winlo soils were surveyed in 2007 for presence of vernal pool special status species, including Cook's lomatium; no plants were documented (SBS 2008a).

Approximately 190.29 acres within 250 feet of proposed pipe storage yards, including Avenue F & 11th Street and WC Short pipe yards in Jackson County have not been evaluated on-site for vernal pool habitat; off-site observations identified approximately 0.48 acre of highly modified, low quality vernal pool habitat within 250 feet of proposed pipe. Approximately 0.48 acre of potential vernal pool habitat has not been surveyed on-site for Cook's lomatium; the area is associated with active industrial sites or previously disturbed industrial areas but could provide low quality habitat for Cook's lomatium (table 3.6.1-1).

Survey Results. No populations of Cook's lomatium were identified during Pipeline survey efforts.

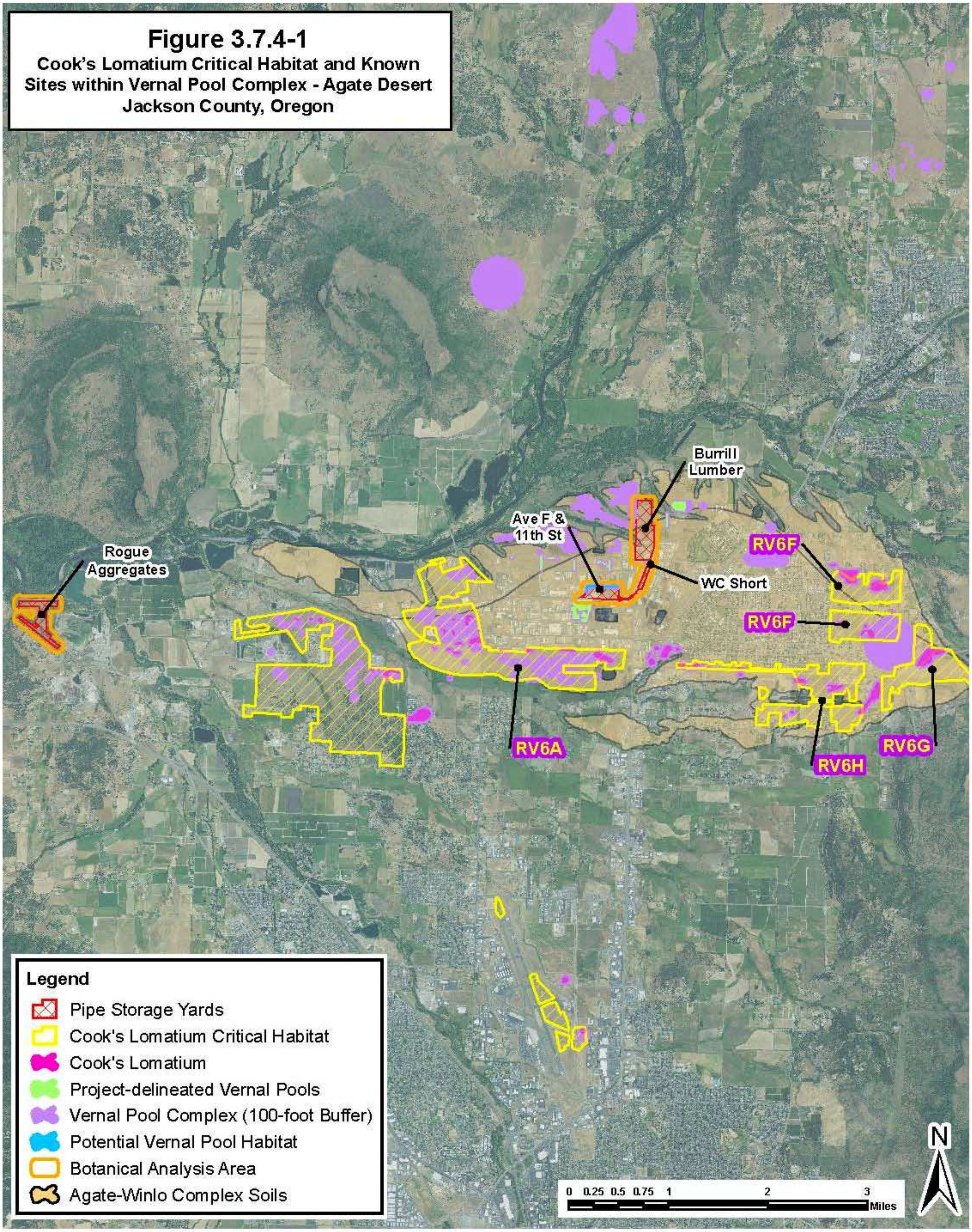
Figure 3.7.4-1
Cook's Lomatium Critical Habitat and Known
Sites within Vernal Pool Complex - Agate Desert
Jackson County, Oregon
Burrill Lumber
Ave F & 11th St
Rogue Aggregates
WC Short
RV6F
RV6F
RV6A
RV6H
RV6G
Legend
Pipe Storage Yards
Cook's Lomatium Critical Habitat
Cook's Lomatium
Project-delineated Vernal Pools
Vernal Pool Complex (100-foot Buffer)
Potential Vernal Pool Habitat
Botanical Analysis Area
Agate-Winlo Complex Soils
0 0.25 0.5 0.75 1 2 3 Miles
N

Critical Habitat

Within the vicinity of White City, Oregon, where four proposed pipe storage yards for the Pipeline project are located, CHUs RV6 and RV8 have been designated (see figure 3.7.4-1). One of the 16 designated critical habitat units for Cook's lomatium (RV6) has two subunits located approximately 0.5 miles south (RV6A) and 0.8 mile southeast (RV6H) of the proposed Avenue F and 11th Street and WC Short pipe storage yards. Another critical habitat unit (RV8) is located approximately 1.8 miles east of Rogue Aggregates pipe yard.

3.7.4.3 Effects of the Proposed Action

Direct and Indirect Effects

Possible direct effects to Cook's lomatium include disturbance to pools from driving through or storing equipment or pipes near or on pools or wetlands associated with this species. Direct effects to Cook's lomatium and its habitat could be expected in vernal pools and upland habitat within 100 feet from delineated vernal pool habitat. Because no vernal pool habitat has been documented in surveyed (onsite) Jackson County proposed pipe storage yards (Burrill Lumber and Rogue Aggregates), and pipe yards have been removed and/or reconfigured in Jackson County to avoid potentially suitable vernal pool habitats, and because PCGP has committed to avoiding vernal pool habitats in pipe storage yards by at least 250 feet or would remove a pipe yard from further consideration if vernal pool habitat is documented during future surveys (i.e., Avenue F and 11th Street pipe yard; see Conservation Measures, below), no direct impacts to Cook's lomatium or its habitat is anticipated. Surveys conducted in suitable vernal pool habitat along the construction right-of-way between MPs 145.3 and 145.4 did not locate Cook's lomatium plants; therefore, no direct effects to Cook's lomatium along the Pipeline right-of-way are expected.

Indirect effects to Cook's lomatium plants and their habitat could occur with increased road use to access the pipe storage yards, as well as pipe storage yard activities, that are adjacent or near suitable or potentially suitable habitat. Although increased road use on paved Agate Road is not expected to increase fugitive dust, pipe yard activities and the associated dust created might impact vernal pool habitat located within 250 feet of activities as dust settles, affecting vegetation and vernal pool physical or chemical properties (e.g., pH, water quality, turbidity, sedimentation, temperature). Use of pipe storage yards adjacent to, or in the vicinity of suitable or potentially suitable habitat, may indirectly affect hydrology (i.e., potential soil compaction by heavy equipment use) upon which vernal pools and associated vegetation are dependent, although this potential effect is highly unlikely. Indirect effects to hydrology could occur if such disturbances to ground and/or soils occurred within 250 feet of suitable or potentially suitable vernal pool habitat (FWS 2011h). Such effects could include altering hydrologic processes, such as runoff patterns as a result of soil compaction, as well as introduction of non-native invasive plant species (PCEs 1 and 4).

No other direct or indirect effects to potential vernal pools are expected from use of unsurveyed pipe storage yards in Jackson County, including 0.48 acre of potential vernal pool wetlands (and 15.55 acres of vernal pool complex) identified from off-site observations within or adjacent to Avenue F & 11th Street and WC Short pipe yards (see table 3.6.1-1). Although a drainage has been identified on the north and west edges of Avenue F & 11th Street pipe yard, Pipeline use, if any, would be located farther than 250 feet from the potential vernal pool habitat.

Implementation of conservation measures included in section 3.7.4.4 would minimize impact to potential suitable vernal pool habitat and Cook's lomatium plants, if present.

Cumulative Effects

Outside of the areas surveyed for the Pipeline, it is unknown where Cook's lomatium occurs on lands not under federal jurisdiction. Therefore, because the extent of this species on these non-federal lands is unknown, it is uncertain if there are reasonably foreseeable actions that might occur on these lands within areas currently occupied by this species. As the FWS's authority generally does not extend to listed plants on private or state lands,[16] all federally listed plants located on these lands must be considered at risk of adverse effects from potential developments. However, populations of Cook's lomatium and their habitats do have the potential to be protected on private and state lands as developments that could potentially affect vernal pool habitat would be required to comply with COE and ODSL requirements, which would limit potential cumulative effects to this species. Other reasonably foreseeable projects on non-federal lands that could adversely affect this species include residential, commercial, and industrial development, as well as expanding agricultural areas.

PCGP has committed to implementing mitigation measures identified for listed plants regardless of land ownership.

Critical Habitat

Critical habitat subunit RV6A is approximately 0.5 mile south of the Avenue F & 11th Street and WC Short proposed pipe storage yards, and critical habitat unit RV8 is more than 1.8 miles from the proposed pipe storage yards in Jackson County. Given the distance separating the pipe storage yards and RV6A and RV8, no direct or indirect impacts from the Pipeline are anticipated since equipment and pipe storage would not occur within 250 feet of pools or wetlands located in the critical habitat subunit, nor would traffic to and from the pipe storage yards drive within 250 feet of vernal pools within the critical habitat unit.

Applying conservation measures identified below, and use/alteration/restoration of pipe storage yards should not result in modifications in the timing, duration, magnitude, or quality of hydrological connections to an off-site vernal pool and/or Cook's lomatium within critical habitat units. Additionally, measures taken to minimize the introduction and spread of noxious weeds outlined in the *Integrated Pest Management Plan* (appendix N to the POD) would ensure that competition from nonnative species in critical habitat units within the vicinity of proposed pipe yards remains negligible.

3.7.4.4 Conservation Measures

PCGP has eliminated from further consideration the following previously proposed pipe storage yards to avoid potential effects to high-quality vernal pool habitat: Avenue C and 7th Street-Elite Cabinet & Door, Medford Industrial Park, and a portion of the previously delineated Burrill

[16] The ESA does not protect plants outside federal land unless there is a federal nexus. Therefore, activities that occur on private or state lands that could affect listed plants but which do not have federal nexus are not required to consult with the FWS. Plants may not be removed from lands under federal jurisdiction, and activities with a federal nexus must consult with the FWS.

Lumber yard that included high quality vernal pool habitat east of the currently proposed yard. To avoid impacts to potential vernal pool habitat, as well as potential Cook's lomatium plants that may occur along the northern and western edge of Avenue F and 11th Street pipe yard, PCGP would avoid using portions of Avenue F and 11th Street pipe storage yard within 250 feet of potential vernal pool habitat (boundary of indirect effects) or no longer pursue use of the pipe yard.

If Cook's lomatium is observed within proximity to the pipe storage yards or the construction corridor, PCGP would insall sedimentation control barriers as recommended in the Recovery Plan (FWS 2012h) to minimize potential impacts to identified Cook's lomatium plants and highly suitable habitat from erosion of sedimentation. As described in section 3.6.1.4 for vernal pool fairy shrimp, a silt fence would be erected on the west side of the right-of-way within 250 feet of vernal pools located between MPs 145.27 and 145.44. Additional mitigation measures considered for Cook's lomatium, if identified in the area during surveys, would include implementation of additional stormwater BMPs outlined in the ECRP (appendix F) to reduce and mitigate the potential for increased sediment mobilization as well as erosion and dust control measures listed in the ECRP and BMPs in the Integrated Pest Management Plan (appendix N to the POD) to control existing noxious weeds and prevent new infestations within and adjacent to occupied and potential habitat.

3.7.4.5 Determination of Effects

Species

The Project **may affect** Cook's lomatium because:

- suitable, occupied habitat occurs within the vicinity of the Pipeline project.

The Project is **not likely to adversely affect** Cook's lomatium because:

- surveys of suitable habitat at proposed pipe storage yards in Jackson County and along the proposed Pipeline did not document Cook's lomatium;
- PCGP would avoid using portions of proposed pipe storage yards within 250 feet (indirect effect) of these, as well as areas with potential vernal pool habitat;
- effects to suitable habitat by the proposed action are likely to be insignificant to the point where no meaningful measurement, detection, or evaluation of impact would be possible (i.e., impact would not reach a level where individual plants would be impacted);
- sedimentation barriers would be used, as appropriate, to prevent run-off and changes in hydrology;
- conservation measures have been developed to avoid or minimize impacts to future plants identified during surveys prior to construction;
- known sites within the vicinity of the project are farther than 0.5 mile from proposed pipe storage yards; and
- unsurveyed habitat is low quality vernal pool habitat located over 0.25 mile from known sites with no apparent hydrologic connectivity.

Critical Habitat

The Project **may affect** designated critical habitat for Cook's lomatium because:

- the Project occurs in the vicinity of Cook's lomatium critical habitat.

The Project would have **no effect** on designated critical habitat for Cook's lomatium because:

- the Pipeline is over 0.5 miles from the nearest critical habitat subunit RV6A; and
- the Pipeline is not expected to adversely modify habitat areas that provide buffer protection from adjacent development and weed sources, continuous non-fragmented habitat, and intact hydrology (PCEs 1 and 4).

3.7.5 Kincaid's Lupine

Kincaid's lupine (*Lupinus oreganus* ssp. *kincaidii*) is a perennial plant species related to the pea (Fabaceae) family. It is known from grassland habitats, mainly in the Willamette Valley and nearby hills, in Oregon, although in Douglas County it occupies sites that are more shaded with tree and shrub canopy (FWS 2006g).

3.7.5.1 Species Account and Critical Habitat

Status

Kincaid's lupine was listed as threatened on January 25, 2000 (FWS 2000c). Approximately 600 acres of critical habitat was designated for this species in 2006 within Oregon and Washington (FWS 2006g).

Threats

The three major threats to Kincaid's lupine populations are habitat loss, competition from non-native plants, and elimination of historical disturbance regimes, such as fire (Wilson et al. 2003; FWS 2010d). The present or threatened destruction, modification, or curtailment of the Kincaid's lupine habitat and range was a major factor for the FWS listing in the final rule. Human alteration of the plant's native prairie in Oregon's Willamette Valley has destroyed over 99 percent of its habitat (FWS 2000c). Remaining prairie habitat is rapidly disappearing because of agricultural practices, development activities, forestry practices, grazing, roadside maintenance, and commercial Christmas tree farming (FWS 2000c). The remaining Kincaid's lupine populations in prairie habitat are relegated to small, isolated patches of habitat. Habitat loss could continue as private lands are developed.

Most prairie sites require frequent disturbances to hold back the natural succession of trees and shrubs. Before settlement by Euro-Americans, the regular occurrence of low-severity fire maintained the open prairie habitats essential to Kincaid's lupine. The loss of a regular disturbance regime has resulted in the decline of prairie habitats through succession by native trees and shrubs, and has allowed the establishment of numerous non-native grasses and forbs. At the time of federal listing, 83 percent of upland prairie Kincaid's lupine sites were estimated to be succeeding to forest (FWS 2000c, 2008e).

In Douglas County, Kincaid's lupine has been found in open woodlands and meadows, often near roads, and associated with Pacific madrone, incense cedar, and Douglas-fir with open canopies (FWS 2008e). Those populations appear to tolerate more shade than populations in the Willamette Valley (BLM et al. 2008). Kincaid's lupine habitat in forested sites is subject to similar alterations from natural succession; fire suppression activities result in increased canopy closure and cover of woody species that contribute to the decline in Kincaid's lupine forested habitat (FWS 2006g).

The Willamette Valley continues to be an important population center for urban, rural, transportation, commercial, and agricultural activities. Aside from changes in fire regimes, other ongoing threats include further habitat loss or fragmentation due to agriculture, development, and forest practices; herbicide use; disease and predation; invasion of prairie habitats by non-native species; inbreeding as a result of isolated and fragmented populations; and habitat vandalism (which is an uncommon occurrence but could further reduce habitat function and destroy individual plants; FWS 2008e, 2010d). Changes in the natural hydrology of a site, such as by ditching or draining a wet prairie can alter the annual duration of soil saturation, which can in turn affect the species composition of the site. Hydrological alterations have been a factor in the reduction of native species in the Willamette Valley (Finley 1995 in FWS 2010d).

Species Recovery

A final recovery plan for the prairie species of western Oregon, including Kincaid's lupine, was published on January 1, 2010, and includes recovery objectives to delist Kincaid's lupine (FWS 2010d). Ten recovery zones were established for Kincaid's lupine, of which Douglas County is considered its own recovery zone. Since the clonal or clumping growth pattern of Kincaid's lupine creates a challenge for estimating and monitoring the number of plants, the recovery plan provides population targets in terms of foliar cover (i.e., the measure of the area occupied by the plants).

Within Douglas County through which the Pipeline will pass, the Douglas County Recovery Zone has a recovery goal of a minimum of two populations covering at least 5,000 square meters (1.25 acres), which are not separated by more than 2.0 miles (FWS 2010d); in 2010, populations were estimated to cover approximately 1.2 acres (FWS 2010e). Additionally, monitoring of these populations should show evidence of reproduction by flowering, seed set, or presence of seedlings, and remain stable or increase in size for a period of at least 15 years. Habitat for Kincaid's lupine populations should be managed to provide high-quality habitat that is protected on lands managed by a government agency or private conservation agreement and is monitored and controlled from threats to the species (FWS 2010d). Recovery actions for Kincaid's lupine include:

- evaluate the status of extant populations;
- manage population sites to minimize woody plant succession and reduce the threat of competition from nonnative plants, including mowing in late summer (August or September) after the plants have become dormant, and elimination of invasive species with careful and appropriate application of herbicides or mechanical control methods;
- restore connectivity among populations, establishing subpopulations within 2 miles of each other;
- augment or reintroduce populations and restore habitat to achieve population targets;
- monitor populations and trends;
- monitor prairie quality at all population sites; and
- collect and bank seeds.

Life History, Habitat Requirements, and Distribution

Kincaid's lupine is a long-lived perennial herb inhabiting native prairies and foothills (FWS 2000c). Prior to Euro-American settlement, Kincaid's lupine was likely well-distributed throughout the prairies of western Oregon and southwestern Washington from Lewis County, Washington, in the north, to the foothills of Douglas County, Oregon, in the south. Today, fragmentation, degradation, and elimination of natural prairie habitat has resulted in existing populations that are widely separated by expanses of unsuitable habitat (FWS 2008e). Most of the known extant populations are found in Oregon's Willamette Valley (FWS 2006g).

In Douglas County, Kincaid's lupine appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80 percent. Tree and shrub species dominating occupied sites include Douglas-fir, California black oak, Pacific madrone, ponderosa pine, incense cedar, hairy manzanita, and poison oak (FWS 2006g).

Kincaid's lupine reproduces sexually and asexually with production of rhizomes (horizontal stems) that can produce clumps of cloned plants. Individual clones can be several centuries old (FWS 2005g; Kaye 2008) and can become quite large with age, producing many flowering stems. Excavations and morphological patterns suggest that plants 33 feet or more apart can be interconnected by below-ground stems, and such clones can exceed 66 feet across. Because of vegetative (clonal) growth pattern, it is difficult to distinguish individuals (Wilson et al. 2003); counting individual "plants" and monitoring the size of populations is challenging. Instead, monitoring agencies have used a grid pattern and counted stems or leaves to assess density rather than attempt to count "individuals."

Flowering typically ranges from April through June. Pollinators include small native bumblebees, solitary bees, and occasionally European honey bees. Insect pollination appears to be critical for successful seed production. Seeds are dispersed from fruits that open explosively upon drying (FWS 2006g). Seeds of the genus *Lupinus* could lie dormant for many years because of their relative impermeability, with noted similar longevity to Scotch broom that could remain viable in the ground for up to 60 years (Grigore and Tramer 1996; CPOP 2014; JCNWCB 2014). Lupine seeds will germinate under increasing humidity or when the seed coat is cracked by pressure or temperature fluctuations (Grigore and Tramer 1996). Kincaid's lupine is also a host plant for the endangered Fender's blue butterfly (FWS 2008e). Fire is necessary to maintain and sustain habitat for the Fender's blue butterfly (FWS 2003). Also, fire clears shading vegetation, especially from invasive species, and converts soil phosphorous into a form more usable by plants. Kincaid's lupine may respond positively to fire (Wilson and Clark 1997) and fire may lead to increased numbers of pollinators which have a positive effect (FWS 2003).

Population Status

Most of the known extant populations are found in Oregon's Willamette Valley. At the time of listing, approximately 91 percent of the occupied sites (i.e., 51 of 54 sites) were on private lands and therefore were considered to be at a higher risk of extirpation (FWS 2008e). As of the 2010 five-year review, Kincaid's lupine is known to occur within about 164 sites, comprising about 246 hectares (608 acres; FWS 2010g). Another five-year review was initiated in February 2016 that will provide additional information on population status (FWS 2016f).

Critical Habitat

Almost 600 acres of critical habitat were designated on November 30, 2006, in Benton, Lane, Polk, and Yamhill Counties, Oregon, and Lewis County, Washington (FWS 2006g). The designation did not include Douglas County where conservation agreements were established to formally document the intent to protect, conserve, and contribute to the recovery by implementing recovery actions for Kincaid's lupine and its habitat (see further discussion below).

The PCEs of critical habitat are: 1) the habitat components that provide early seral upland prairie and oak savanna habitat with a mosaic of low growing grasses, forbs, and spaces to establish seedlings or new vegetative growth, with an absence of dense canopy vegetation providing sunlight for individual and population growth and reproduction; and 2) the presence of insect pollinators with available corridors between lupine patches to allow unrestricted movement of pollinators (FWS 2006g).

Other Conservation Agreements and Plans. In 2006, the BLM Roseburg District, Umpqua National Forest, and FWS completed a programmatic conservation agreement for Kincaid's lupine in Douglas County, which specifies the following goals (BLM et al. 2006):

1. Maintain stable populations by protecting and restoring habitats.
2. Reduce threats to the species on BLM and NFS lands.
3. Promote larger functioning meta-populations, with increased population size and genetic diversity.
4. Meet the recovery criteria in the Recovery Outline for the species (FWS 2006g).

Also in 2006, three private timber companies in Douglas County (Lone Rock Timber Management Company, Roseburg Forest Products, and Seneca Jones Timber Company) signed a voluntary conservation agreement. This *Voluntary Agreement for Kincaid's Lupine (*Lupinus Sulphureus *spp.* kincaidii*) in Douglas County* (Lone Rock Timber Management Company et al. 2006) includes reporting guidelines and an agreement for road maintenance and minimizing disturbance along roads. The objective of the Voluntary Agreement is "to promote functioning meta-populations," including coordinating propagation activities for establishing new sites and extending known populations.

In March 2008, a management plan for Kincaid's lupine in Douglas County was developed between the BLM's Roseburg District, the Umpqua National Forest, and the FWS addressing the populations and habitat of Kincaid's lupine on BLM and NFS lands in Douglas County (BLM et al. 2008). Kincaid's lupine occurs on 14 sites within Douglas County, of which 9 are on federally managed lands (8 on BLM land [Roseburg District] and 1 on the Umpqua National Forest; BLM et al. 2008).

3.7.5.2 Environmental Baseline

Analysis Area

The botanical analysis area extends to 30 meters (98 feet) each side of the Pipeline project (construction right-of-way, TEWAs, UCSAs, rock source and disposal sites, and proposed storage yards) on lands that have potential habitat for listed plant species. This area generally corresponds to the extent of the area surveyed for sensitive and listed plant species during surveys conducted between 2007 and 2017 (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands), and correlates to a distance that indirect effects to plants would be expected. Portions of the botanical analysis area that coincide with Kincaid's lupine are included in figures 3.7.5-1, 3.7.5-2, and 3.7.5-3.

Species Presence

The Pipeline is located within known or historic Kincaid's lupine range between MPs 46.8 and 99.3. Records obtained from ORBIC (2017c) indicate that Kincaid's lupine had been previously located at 11 sites within 2.5 miles of the Pipeline. The closest sites are: 1) 10 clumps located 1.5 miles north of MP 56.0 in 1999 within a 200 square-foot area; 2) 100 to 1,000 plants located 1.5 miles southeast of MP 59.6 in 2005; 3) 100 to 1,000 plants located 2.0 miles northeast of MP 86 in 1990; 4) 400 to 4,000 plants within four sites occupying approximately 3 acres located 2.2 miles southwest of MP 96.0 in 2003; and 5) about 100 to 200 plants in one acre located in 1992 approximately 1.5 miles east of MP 98.9. Herbarium records indicate that one extinct population (1979) occurred near the 1992 documented site, approximately 1.7 miles east of MP 98.9 and 0.25 mile from the other 1992 population. Botanical surveys conducted by PCGP in 2007-2008 located three new populations of Kincaid's lupine along the Pipeline route, as discussed below.

Project-Specific Kincaid's Lupine Survey

Habitat Surveyed. Prior to beginning field surveys in 2007, botanists with SBS conducted a habitat review to identify potential habitat and delineate survey areas for Kincaid's lupine within the botanical analysis area from MPs 46.8 to 111.0, including existing roads identified for access to the construction right-of-way. Aerial photographs and knowledge of regional landscape and biological features (soils, geology, topography, elevation, target species habitat, and plant community habitat) were used to determine potential habitat for Kincaid's lupine. These same methods were applied to determine areas of suitable habitat in new locations where the proposed right-of-way has been relocated since 2007.

Surveys were conducted for this species where survey permission was granted within the vicinity of the Pipeline project (within at least 50 or 100 feet of the Pipeline project on non-federal and federal lands, respectively and where permitted) and along proposed access roads (within at least 50 feet of access roads where road improvements are proposed and surveys permitted). Most surveys were conducted in 2007 and 2008, but additional surveys have been conducted since 2008 in areas of reroutes, minor route adjustments, and areas with granted survey permission. Areas where Kincaid's lupine were documented during previous Pipeline survey efforts were also resurveyed in 2016 and/or 2017. Surveys have continued in 2018 and data are currently under review.

Overall, 2,840.88 acres have been surveyed by PCGP from 2007 through 2017 for Kincaid's lupine within the vicinity of the proposed Pipeline, including previously proposed routes and project components, alternate routes, and along access roads that are no longer considered for the Pipeline project. Within the 30-meter botanical analysis area, approximately 2,674.24 acres, generally between MPs 46 and 99.3, have been identified as potential suitable habitat (see table 3.7.5-1). The potential suitable habitat includes both meadow (typically non-native pasture) and forested upland Kincaid's lupine habitats. Of this habitat, access was granted to 1,682.62 acres (842.85 acres within the Pipeline project), including potential habitat within 50 feet of access roads where road improvements have been proposed. Table 3.7.5-1 provides a summary of potential suitable Kincaid's lupine habitat within the botanical analysis area.

Of the 1,682.62 acres of potential habitat with survey access, 1,273.77 acres (661.56 acres within the Pipeline project) were considered suitable habitat for Kincaid's lupine. Habitat suitability was qualitatively assessed based on Kincaid's lupine habitat analysis conducted in Oregon by SBS in 2001. Habitat found to be "suitable" in the surveys included areas with some of the characteristics detailed in the Life History, Habitat Requirements, and Distribution section above.

Approximately 991.62 acres (448.67 acres within the Pipeline project) of potentially suitable habitat for this species within the botanical analysis area was denied access by the landowner or occurs within recent modifications of the Pipeline project (the majority of this habitat occurs on non-federal lands; see table 3.7.5-1). PCGP would continue to survey habitat where permission is granted. Where survey access is denied, PCGP would conduct surveys in suitable habitat within the Pipeline project footprint prior to construction. For purposes of analysis, until surveys are conducted, a conservative assumption can be made that a similar percent of the unsurveyed area could contain suitable habitat. Based on this assumption, approximately 730 acres of habitat within the botanical analysis area (73.6 percent of 992 acres, or 330 acres within the Pipeline right-of-way) could contain suitable for Kincaid's lupine.

TABLE 3.7.5-1

Summary of Potential Suitable Kincaid's Lupine Habitat within the Right-of-Way (ROW) and Botanical Analysis Area

General Landowner	Suitable Habitat Status	Total Acres Surveyed [1] (2007-2017)	Acres Surveyed			Acres Not Surveyed [4]		
			Project [2]	**Buffer [3]**	**Total**	**Project [2]**	**Buffer [3]**	**Total**
MPs 46.8 – 99.3 (2,916 acres within botanical analysis area)								
Federal	Suitable Habitat	544.27	174.98	162.00	336.99	31.75	42.80	74.56
	Not Habitat	360.52	84.17	130.77	214.94	N/A	N/A	N/A
	Unknown	N/A	N/A	N/A	N/A	0.02	0.14	0.16
	Total	*904.79*	*259.15*	*292.77*	*551.93*	*31.77*	*42.94*	*74.71*
Non-Federal	Suitable Habitat	1,547.10	486.58	450.20	936.78	184.32	211.96	396.27
	Not Habitat	388.99	97.13	96.78	193.91	N/A	N/A	N/A
	Unknown	N/A	N/A	N/A	N/A	232.59	288.05	520.64
	Total	*1,936.09*	*583.70*	*546.99*	*1,130.69*	*416.90*	*500.01*	*916.91*
Total	Suitable Habitat	2,091.37	661.56	612.20	1,273.77	216.07	254.76	470.83
	Not Habitat	749.51	181.30	227.55	408.85	0.00	0.00	0.00
	Unknown	0.00	0.00	0.00	0.00	232.61	288.19	520.80
	Total	**2,840.88**	**842.85**	**839.76**	**1,682.62**	**448.67**	**542.95**	**991.62**

[1] Acres provided in this column considers all surveys to-date (through 2017), including areas that have been subsequently rerouted or dropped (i.e., pipe yards) since surveys were initiated in 2007.
[2] Project includes: right-of-way, temporary extra work area, uncleared storage area, rock storage, pipe yards, aboveground facilities.
[3] Buffer (botanical analysis area) includes area within 30 meters (98 feet) of habitat removal and within 50 feet either side of an existing access road identified with possible road improvements.
[4] Areas not surveyed are either denied access or were not surveyed because of recent modification in Proposed Route that occurred after the flowering season, as well as areas outside of the targeted survey area (i.e., 30-meter analysis area vs. 50-foot targeted survey area on non-federal lands). "Not Habitat" was determined from adjacent survey parcel information, aerial photography, or "drive-by;" no surveys would be necessary and acres are not included.

Note: Surveys have continued in 2018 and the data are currently under review. Most area that remains to be surveyed occurs on private lands; surveys would continue as access becomes available.

Survey Results. Surveys for the Pipeline located three populations (approximately 1,330 plants) in 2007 (see table 3.7.5-2): two in western and one in eastern Douglas County (also see figures 3.7.5-1, 3.7.5-2, and 3.7.5-3). Two of the sites (MPs 57.84 through 57.92 and MP 59.60) are unique in Douglas County in that they occupy pasture / meadow habitat rather than forested habitats and may preserve high value genetic information and diversity.

TABLE 3.7.5-2

Summary of Kincaid's Lupine Locations

Milepost	Year Located	Number of Subpopulations	Number of Plants	Site Description
57.84-57.92	2007	7	199	Along centerline near MP 57.9; in the right-of-way and continuing south of the right-of-way at MP 57.85 - 57.90
59.6	2007	2	48	Outside of the construction zone and 30 meter analysis area.
96.48-96.9 [1]	2007	28	1,083	In the right-of-way and in access roads south of the right-of-way

[1] All plants in right-of-way obliterated from road construction and slash piles, only a few plants alongside access road observed (see discussion below).

Population at MPs 57.84-57.92. The first occupied site in western Douglas County was located along the right-of-way as proposed in 2007 between MPs 57.84 and 57.92 on private land (figure 3.7.5-1). This site was approximately 2.1 miles from a known site 1.5 miles northeast of MP 56.0, and approximately 1.6 miles southwest of the second site located during surveys in 2007 near MP 59.60. Approximately 199 plants were found at this site within seven subpopulations covering approximately 0.6 acre of area scattered within an approximately 4-acre area in pasture habitat. Subpopulations or patches ranged in size from 1 to 54 plants and are anywhere from 20 feet to 177 feet from each other (SBS 2008a). Plant counts were made by considering all stems in close proximity as one plant. Six of the seven patches were within 33 feet of each other and were assumed to be interconnected by below-ground stems; sub-population 7 was 150 to 190 feet from the other documented patches and was assumed to not be interconnected. Sub-populations were located approximately 2 feet south of the right-of-way (sub-population 7) and 3 to 438 feet north of the right-of-way (sub-populations 1 through 6).

This site was revisited in 2017 and the site appears to be stable or slightly increasing despite the removal of oaks along the fence line and continued grazing. One plant south of the right-of-way (sub-population 7) was not relocated in 2017 (SBS 2017a).

Population at MP 59.6. A second site was located on private land approximately 300 feet north of MP 59.60 and approximately 67 feet and 222 feet to the north and west of TEWA 59.30-N (figure 3.7.5-2). McNabb Creek Road, an identified existing access road (EAR 59.62) is approximately 40 and 85 feet to the south and west of this occurrence. Approximately 48 plants within two clumps or subpopulations (clonal groups) were documented covering approximately 0.5 acre scattered in a two-acre area on a flat grazed pasture (SBS 2008a). This site was also revisited in 2017. The two clumps of plants have migrated slightly farther from the Pipeline project, possibly as a response to grazing, but appear to be stable or slightly increasing in size (SBS 2017a).

Population at MPs 96.48-96.9. A third Kincaid's lupine site was found between MPs 96.5 and 96.9 and on proposed access roads south of MPs 96.7 to 96.9 during 2007 Pipeline survey efforts (figure 3.7.5-3); however, in late July 2015, the Stouts Creek fire burned through this population with a high intensity (all trees were killed and the ground scorched). The population was documented on private timberland two miles south of the South Umpqua River on a ridgeline east of Stouts Creek and was considered an important element in the recognized Stouts Creek-Callahan Ridge meta-population since it occurs in a central location between these populations thus forming an important genetic link. The plants were all located on loam soils in a young mid-seral mixed conifer and hardwood forest. Plants were documented within canopy gaps and, less regularly, under closed canopy (mostly under ponderosa pine trees) and in openings along four-wheel drive roads. Approximately 1,083 plants were located within 28 subpopulations or patches scattered within a 20-acre area. In all, plants occurred on an approximately 0.6-acre area (with approximately 29 percent cover). The 28 patches ranged in size from one plant to 258 plants in a 0.4-acre area and were documented within and adjacent to the Pipeline right-of-way and proposed access roads (see figure 3.7.5-3).

The area burned in 2015 was subsequently logged using ground-based equipment, roads were widened, and new roads built; large piles of slash from logging activities remain on site (SBS 2016). SBS (2016) revisited the site in June 2016 to determine the impact of the fire on the Kincaid's lupine population (MPs 96.5 through 96.9); all 28 sub-populations documented in 2007 were relocated and examined for re-sprouting lupine. Only two of the original 28 sites (subpopulations 8 and 16) had Kincaid's lupine growing (64 plants); subpopulation 8 is located 55 to 70 feet from proposed access road EAR 96.33 and 95 feet south of TEWA 96.25, and subpopulation 16 is located 20 feet from proposed access road EAR 96.33 and 395 feet south of TEWA 96.66-W. Proposed access road EAR 96.33 has been significantly widened since Stouts Creek fire. Many of the sites visited in 2016 suffered physical disturbance from heavy equipment, and several of the sites are under large slash piles. All sites that had been in or adjacent to proposed access roads were obliterated by the significantly widened roads. Eleven of the sites were relatively undisturbed, but no plants were present.

Although fire is a recommended method to manage habitat for Kincaid's lupine in prairie habitat, wildlfires have also been identified as a threat to Kincaid's lupine, especially if the fire destroys lupine plants before they senesce by mid-August and set seed for the next growing season (FWS 2006g). FWS (2008f) recommends prescribed burning in the late summer and early fall (September or October), after plants have set seed and senesced. Since the fire in 2015 occurred in late July/early August, it is possible plants in this population could have set seed. Lupine seedlings have the potential to return to this area, especially since legume seeds are known to be long-lived (Grigore and Tramer 1996; CPOP 2014), and Kincaid's lupine has evolved in a landscape with periodic wildfire, such that increased temperatures from the fire could have cracked the seed coat germinating previously dormant seeds (Grigore and Tramer 1996). PCGP will continue to monitor previous plant locations, as well as conduct full pre-construction surveys in the Pipeline project area between MPs 96.48 and 96.9.

Critical Habitat

The proposed action would not affect any of the PCEs identified because no critical habitat for Kincaid's lupine is present within the analysis area.

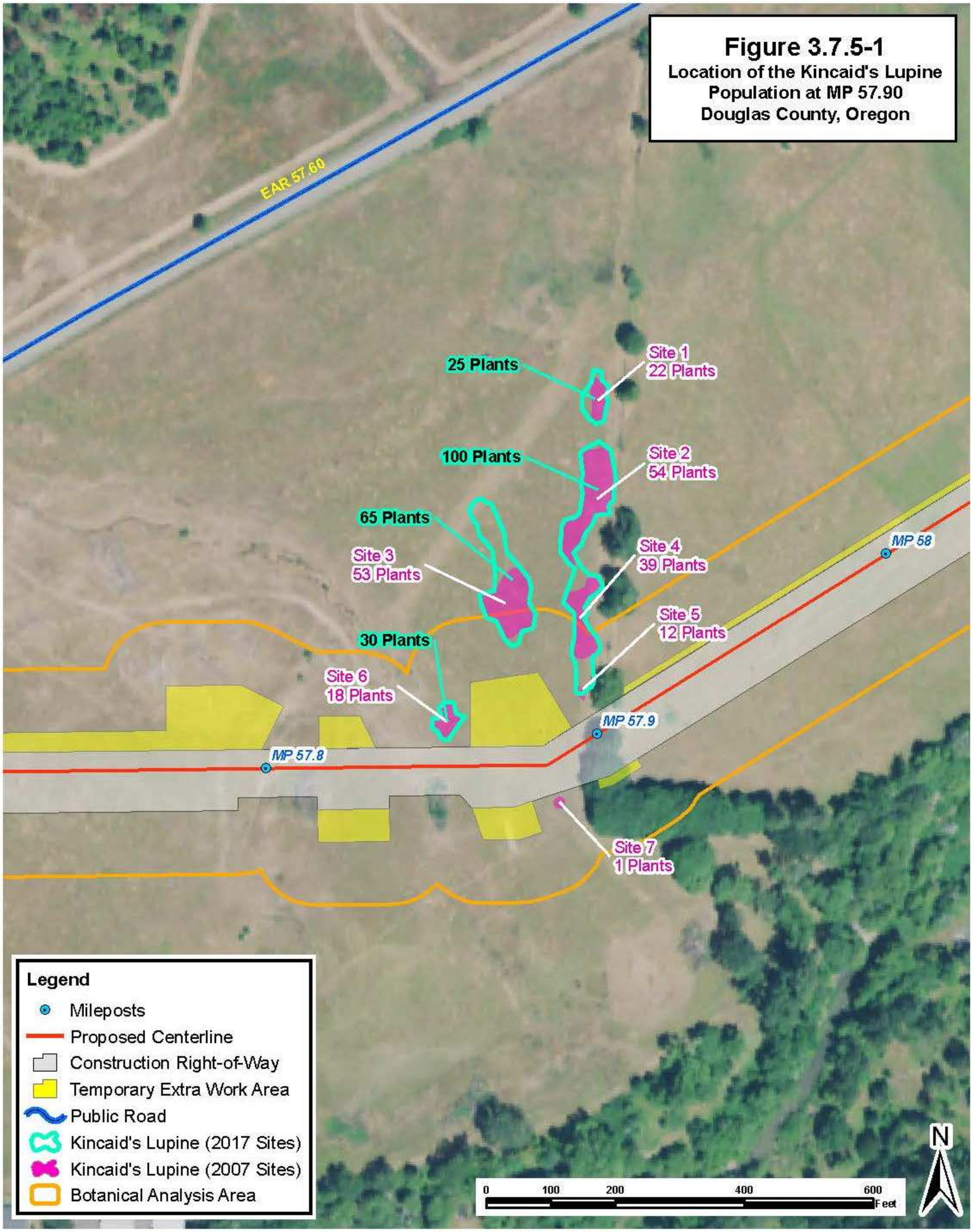

Figure 3.7.5-1
Location of the Kincaid's Lupine
Population at MP 57.90
Douglas County, Oregon
EAR 57.60
25 Plants
Site 1
22 Plants
100 Plants
Site 2
54 Plants
65 Plants
Site 3
53 Plants
Site 4
39 Plants
Site 5
12 Plants
30 Plants
Site 6
18 Plants
MP 58
MP 57.9
MP 57.8
Site 7
1 Plants
Legend
Mileposts
Proposed Centerline
Construction Right-of-Way
Temporary Extra Work Area
Public Road
Kincaid's Lupine (2017 Sites)
Kincaid's Lupine (2007 Sites)
Botanical Analysis Area
0
100
200
400
600
Feet
N

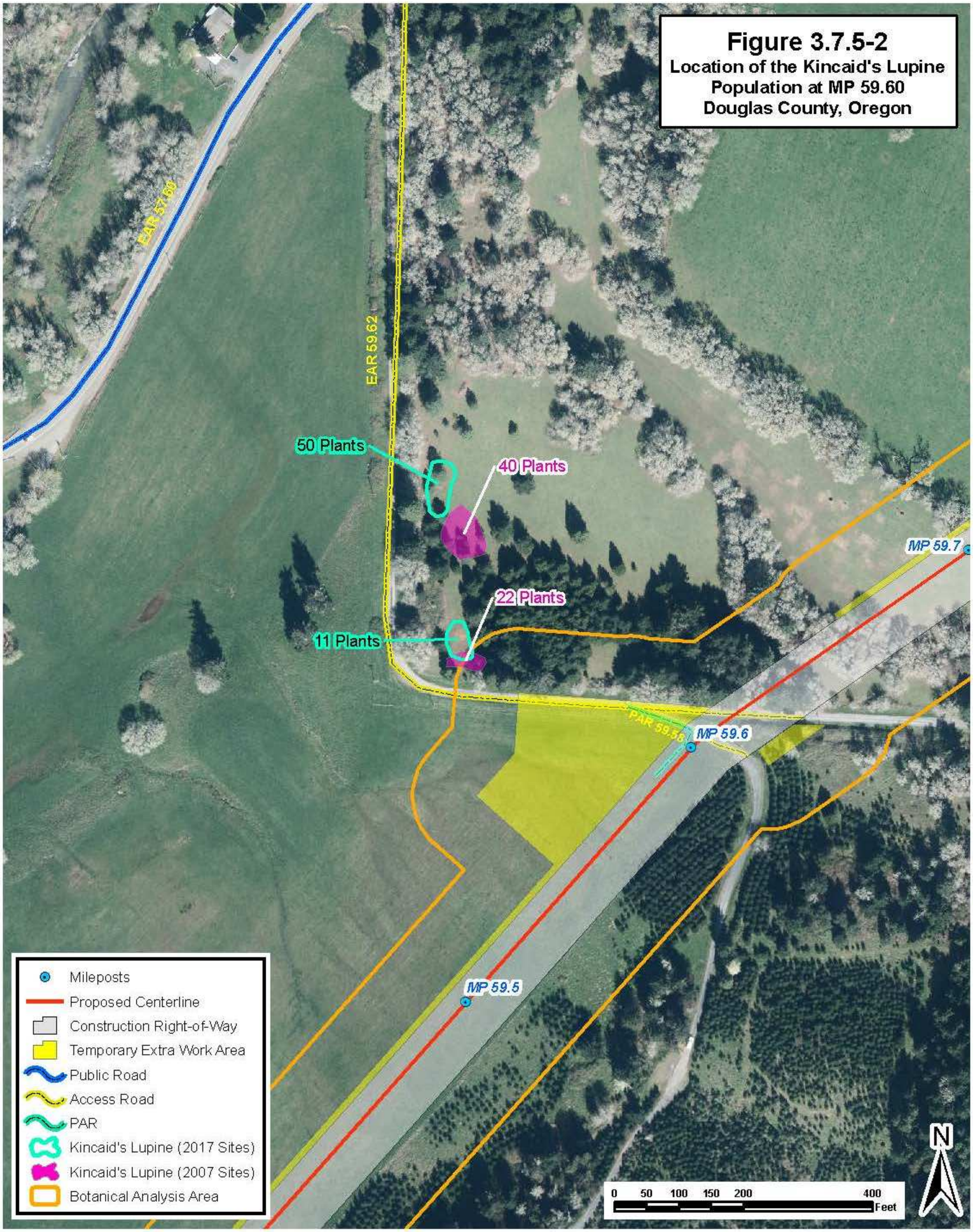
Figure 3.7.5-2
Location of the Kincaid's Lupine
Population at MP 59.60
Douglas County, Oregon
EAR 57.60
EAR 59.62
50 Plants
40 Plants
22 Plants
11 Plants
MP 59.7
PAR 59.58
MP 59.6
MP 59.5
Mileposts
Proposed Centerline
Construction Right-of-Way
Temporary Extra Work Area
Public Road
Access Road
PAR
Kincaid's Lupine (2017 Sites)
Kincaid's Lupine (2007 Sites)
Botanical Analysis Area
0 50 100 150 200 400
Feet
N

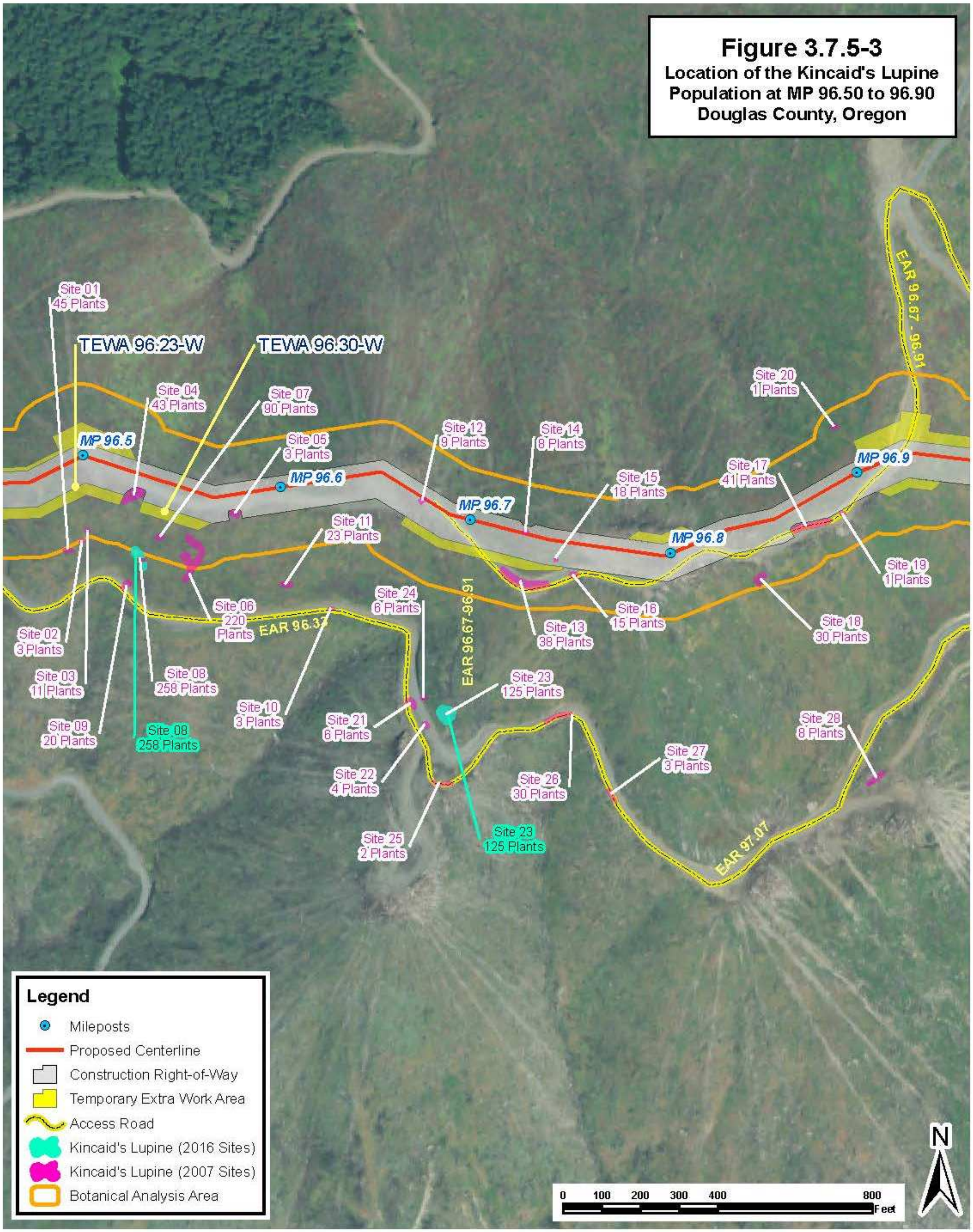
Figure 3.7.5-3
Location of the Kincaid's Lupine Population at MP 96.50 to 96.90 Douglas County, Oregon
Site 01 45 Plants
TEWA 96.23-W
TEWA 96.30-W
Site 04 43 Plants
Site 07 90 Plants
Site 05 3 Plants
Site 12 9 Plants
Site 14 8 Plants
Site 15 18 Plants
Site 17 41 Plants
Site 20 1 Plants
EAR 96.67 - 96.91
MP 96.5
MP 96.6
MP 96.7
MP 96.8
MP 96.9
Site 11 23 Plants
Site 19 1 Plants
Site 06 220 Plants
EAR 96.33
Site 24 6 Plants
EAR 96.67-96.91
Site 13 38 Plants
Site 16 15 Plants
Site 18 30 Plants
Site 02 3 Plants
Site 03 11 Plants
Site 08 258 Plants
Site 09 20 Plants
Site 08 258 Plants
Site 10 3 Plants
Site 23 125 Plants
Site 21 6 Plants
Site 22 4 Plants
Site 25 2 Plants
Site 23 125 Plants
Site 26 30 Plants
Site 27 3 Plants
Site 28 8 Plants
EAR 97.07
Legend
Mileposts
Proposed Centerline
Construction Right-of-Way
Temporary Extra Work Area
Access Road
Kincaid's Lupine (2016 Sites)
Kincaid's Lupine (2007 Sites)
Botanical Analysis Area
0 100 200 300 400 800 Feet
N

3.7.5.3 Effects of the Proposed Action

Direct and Indirect Effects

The report published on the biology of Kincaid's lupine (Wilson et al. 2003) indicates that Kincaid's lupine spreads extensively by physiologically-interdependent clones interspersed across large distances in the population, making it challenging to distinguish genetically distinct individual plants. Any estimates of number of individuals impacted by the proposed action are subject to broad margins of error. Because even broadly separated clones share resources through caudices, removal of stems from the occurrence may impact other connected clones, potentially increasing the number of plants impacted. There is no data to date regarding the short or long-term survivability of individuals when separated from the remainder of clone. Therefore, removing any individuals from small populations like those documented during survey efforts could decrease potential survival and decrease the ability for this species to readily colonize available habitats.

An important related concern is that these populations may consist of substantially fewer genetically distinct plants than estimated due to clonal growth. Kincaid's lupine depends on sexual reproduction to replace individual plants that may succumb to numerous threats to augment populations and to spread into suitable habitat. Such out-crossing plants require a large number of genetically distinct individuals as well as adequate pollinators to maintain genetic diversity and avoid negative effects of inbreeding depression, which may already be impacting these small remnant populations.

The three new populations of Kincaid's lupine identified during surveys in 2007 on private lands at MPs 57.84 through 57.92, 59.60, and 96.48 through 96.9 are too small to meet the minimum viable population size specified in the FWS recovery plan (either by estimated number of plants or by density within a coverage area). The newly found populations, however, may be contributing to other known meta-populations and recovery plan objectives, and removal of these plants may contribute negatively toward recovery of the species.

The population at MP 57.9 totals 0.6 acre within a four-acre area (15 percent cover) and the population at MP 59.6 is approximately 0.5 acre within a two-acre area (25 percent cover). Total cover at these population locations is high due to the vigor and age of the plants. These sites are approximately 2.1 to 2.7 miles from an extant site with plants of low vigor near Ten Mile, but far from other known sites, so are unlikely to be part of an eventual meta-population for meeting Recovery Plan goals (FWS 2008e). They do, however, contribute significantly to the "additional" population goals. These sites are unique for Douglas County in that they occupy Valley-Floor pasture/meadow habitats similar to Willamette Valley populations. As a result, plants identified during survey efforts may be preserving high value genetic information and diversity.

Prior to the 2015 Stouts Creek fire, the population near MP 95.6 was considered an important element in the recognized Stouts Creek-Callahan Ridge meta-population. It is approximately 2.5 miles east/northeast of the large known population cluster on BLM and Roseburg Timber lands at Stouts Creek, and approximately 2.7 miles west/northwest from the population on Forest Service and private land at Callahan Ridge, and approximately 3.7 miles from the population at Callahan Meadows. It occurs in a central location between these populations thus forming an important genetic link and increases the possibility of developing a successful South Umpqua "meta-population" to further achieve recovery goals. The population consisted of 28 patches within an area of 20 acres, occurring in transitory and natural openings in 45-year-old forest. The total cumulative area of the patches documented is approximately 0.57 acre (2.9 percent total cover), with the largest patch covering 0.09 acre. However, the combination of high intensity fire followed by physical disturbance to soils may preclude re-establishment of Kincaid's lupine at these sites.

Direct Impacts

During a previous iteration of the Pipeline project, PCGP met with several members of the Habitat Quality Subtask Group, to discuss impacts to documented plants and get recommendations on how to avoid or minimize impacts. In response to recommendations, PCGP rerouted the Pipeline near the population at MPs 57.84-57.92 south of six of the seven patches documented (see figure 3.7.5-1 and figure K-1 in appendix V2), completely avoiding all aboveground documented Kincaid's lupine patches. Subpopulation 7 (one plant, near MP 57.84) which was located south of the proposed Pipeline route is most likely not a part or clone of the other plants and should not be affected by dissecting below-ground stems. Additionally, surveys in 2017 did not relocate this plant. Therefore, no direct impacts to the subpopulations that are or were located at this site are expected.

No direct effects are expected at the second population near MP 59.60 documented north of TEWA 59.30-N, because the site is at least 67 feet from the Pipeline. Furthermore, direct impacts from use of the existing access road are also not expected (figure 3.7.5-2 and figure K-2 in appendix V2).

The third population between MPs 96.5 and 96.9 had an estimated 1,083 plants located within 28 subpopulations. As the proposed Pipeline route is located on a narrow ridgeline, there were no feasible routing alternatives to completely avoid this documented population. Therefore, to minimize impacts to this population, PCGP modified the construction right-of-way and TEWA 96.66-W to avoid impacts to 61 plants and partially avoid plants within a fourth subpopulation by narrowing the construction right-of-way (see figure 3.7.5-3). After modifications and prior to the 2015 Stouts Creek fire, approximately 35 plants (within three patches) were located within the proposed Pipeline project. When this population was revisited in 2016 after the Stouts Creek fire and subsequent salvage logging and road widening, no viable plants were located in the Pipeline right-of-way or within proposed access roads. Although no plants were relocated along the construction right-of-way in 2016, it is possible that construction of the Pipeline project and use of access roads could affect this population if plants resprout in this area. Because legume seeds are known to be long-lived, the lupine plants previously documented may have set seeds prior to the late July 2015 fire, and plants can be interconnected by underground stems up to 33 feet apart (FWS 2006g). Additional surveys would be conducted within this area prior to construction to determine the presence or absence of Kincaid's lupine plants. If plants or seedlings are located within the construction right-of-way, similar measures taken to avoid the plants previously within this milepost range would be applied to minimize impacts (see Attachment 1 within the *Federally-listed Plant Conservation Plan*, appendix V2).

Not all suitable habitats have been surveyed to date, indicating that additional Kincaid's lupine plants may be located within areas where direct impacts could occur. However, PCGP would implement the mitigation measures with respect to any identified populations that might be impacted by the Pipeline. The mitigation measures are described below in the "Conservation Measures" subsection and in the species-specific mitigation plan, appendix V2).

Indirect Impacts

Changes in the natural hydrology of a site can alter the annual duration of soil saturation, which in turn affects the species composition of the site. The potential for soil compaction along the construction right-of-way could occur from heavy equipment use and repeated vehicle traffic. Soil compaction can alter soil hydrologic conductivities, decreasing soil infiltration rates and available water contents, and increase runoff rates, or concentrate surface waters (such as along a settled trenchline). PCGP's ECRP (see appendix F describes the mitigation measures that would be implemented during restoration to alleviate potential soil compaction along the right-of-way to ensure revegetation success and to minimize any potential effects to Kincaid's lupine. Construction of the Pipeline in Kincaid's lupine meadow habitats could cause an increase in weedy grasses and forbs. In Kincaid's lupine forested habitat, a decrease in overstory canopy cover and subsequent shift to early seral vegetation associated with logging is expected with construction of the Pipeline. A reduction in canopy cover alone (i.e., without the ground disturbance associated with logging activities) could result in an improvement to forested Kincaid's lupine habitat. Kincaid's lupine is very sensitive to habitat loss, competition from nonnative plants, and elimination of historical disturbance regimes (and resulting competition from increased vegetation cover), all of which have contributed to the decline of Kincaid's lupine populations (FWS 2006g). Indirect impacts to documented patches of lupine are also possible from heavy dust created during construction activities and use of existing access roads and sub-surface disturbance to underground stems.

Cumulative Effects

Outside of the areas surveyed for this Project, it is unknown where Kincaid's lupine occurs on lands not under federal jurisdiction. Therefore, because the extent of this species on these non-federal lands is unknown, it is uncertain if there are reasonably foreseeable actions that might occur on these lands within areas currently occupied by this species. As the FWS's authority generally does not extend to listed plants on private or state lands,[17] all federally listed plants located on these lands must be considered at risk of adverse effects from potential developments. Other reasonably foreseeable projects on non-federal lands that could adversely affect this species include residential, commercial, and industrial development, as well as expanding agricultural areas.

PCGP has committed to implementing mitigation measures to address potential impacts to Kincaid's lupine regardless of land ownership.

Critical Habitat

Critical habitat has not been designated for Kincaid's lupine within the Project area; therefore, no designated critical habitat for this species would be impacted.

[17] The ESA does not protect plants outside federal land unless there is a federal nexus. Therefore, activities that occur on private or state lands that could affect listed plants but which do not have federal nexus are not required to consult with the FWS. Plants may not be removed from lands under federal jurisdiction, and activities with a federal nexus must consult with the FWS.

3.7.5.4 Conservation Measures

As described for the Applegate's milk-vetch, PCGP has developed a *Federally-listed Plant Conservation Plan* to address how avoidance, minimization, propagation, restoration, and other conservation measures would be applied to protect listed plant species, as well as how potential impacts on un-surveyed lands would be addressed. This plan also contains a Kincaid's Lupine Mitigation Plan that specifically addresses how mitigation would be implemented for the Kincaid's lupine (see Attachment 1 within the *Federally-listed Plant Conservation Plan*, appendix V2).

Because the removal of any Kincaid's lupine plants may hinder the recovery and eventual downlisting of the species, PCGP has avoided or minimized impacts to the populations of Kincaid's lupine that were located during survey efforts near MPs 57.84 to 57.92 and 96.5 to 96.9, as described in the Kincaid's mitigation plan (appendix V2). These measures included altering the proposed route, removing or minimizing proposed TEWAs, and/or minimizing the construction right-of-way (see figures 3.7.5-1, 3.7.5-2, and 3.7.5-3, as well as figures K-1, K-2, and K-3 in appendix V2). PCGP would conduct additional surveys within the Stouts Creek fire area (MP 96.5 to 96.9) to determine the presence or absence of Kincaid's lupine plants prior to ground-disturbing activities. If subsequent surveys continue to document the absence of these plants within the Pipeline right-of-way, PCGP would revert back to the previous disturbance footprint (i.e., remove neck-downs within the construction right-of-way and TEWAs that are called out in Figure K-3). If plants are located within the construction right-of-way, measures similar to those previously incorporated into the Pipeline project (see figure 3.7.5-3 and figure K-3 in appendix V2), would be implemented to minimize or avoid effects to observed plants, where necessary.

Persisting subpopulations at population MPs 96.5 to 96.9 identified along the existing access roads would be flagged by a qualified botanist prior to Pipeline activities in the area and PCGP's EIs would clearly fence the road edges adjacent to these subpopulations to minimize potential disturbance from road use and possible maintenance activities.

When access to the construction right-of-way is granted, surveys would be conducted in potential habitat (previously surveyed or unsurveyed). FWS would be notified of survey results. If plants are present, the avoidance/conservation measures included in the Kincaid's lupine mitigation plan would be implemented, where feasible. Measures of avoidance may include minor alignment reroutes, necking down the construction right-of-way in that area, excluding a portion of an identified temporary extra work area or pipe storage yard, or erecting a protective fence to avoid impacts to plants from construction debris (similar to actions taken or proposed at the previously identified Kincaid's lupine sites documented within the Pipeline project area).

If any Kincaid's lupine plants are observed within the construction area, seed collection would be completed prior to construction, after the plants have floweredand the seeds have developed and matured. Research has suggested that using pre-scarified seeds to establish Kincaid's lupine is more successful than salvaging and transplant efforts (Gisler 2004); direct seeding with pre-scarified seeds resulted in a 68 percent survival through the first growing season, versus only 5 percent of 150 seedlings sown. The collected seed would either be provided to a certified repository (i.e., The Berry Botanic Garden) or would be replanted within or adjacent to the construction right-of-way during restoration efforts on suitable BLM lands where future protection can be managed or on private lands where a conservation easement has been acquired. If planting is to occur on the construction right-of-way, it would occur outside the 30-foot maintained easement.

Additional mitigation measures for impacts to individual Kincaid's lupine plants would include application of measures included in the Integrated Pest Management Plan (appendix N to the POD) to control existing noxious weeds and prevent new infestations within and adjacent to occupied and potential habitats. Competition with invasive species (e.g., Himalayan blackberry, oxeye daisy, grasses, Scotch broom) have been the biggest threat to maintaining or reestablishing Kincaid's lupine in some locations (Thorpe and Massatti 2008; Thorpe et al. 2009); therefore, control of these invasive species could have a beneficial impact on Kincaid's lupine. Other measures could include planting native forbs and shrubs adjacent to Kincaid's lupine populations to encourage a variety of pollinating insects. Controlling canopy cover in occupied or potential wood habitats could also stimulate growth of existing clones if shading is judged to be a limiting factor.

It is possible that clones of Kincaid's lupine could become established within the construction right-of-way where rerouted near MPs 57.84 to 57.92, or could resprout within the Stouts Creek Fire area near MPs 96.5 to 96.9. PCGP has agreed to monitor revegetation success in the areas of the restored Kincaid's lupine populations (between MPs 57.84 to 57.92 and MPs 96.5 to 96.9) annually for five years after completion of construction. Monitoring would include inspection between those mileposts for any new growths of Kincaid's lupine. If any are found, only mowing to comply with DOT requirements would be conducted. The five-year monitoring period is longer than FERC's three-year monitoring period requirement for sensitive areas such as wetlands (see section VI.D.3. of FERC's *Procedures*).

3.7.5.5 Determination of Effects

Species

The Project **may affect** Kincaid's lupine because:

- suitable habitat is present within the analysis area; and
- individual plants have been located within the analysis area during survey efforts.

The Project is l**ikely to adversely affect** Kincaid's lupine because:

- surface disturbance and excavation would occur within potentially suitable habitats, which may contain un-identified plants, or may be able to support this species in the near future;
- indirect impacts are expected to documented or suspected plants outside of the construction right-of-way (within 30 meters) and along proposed access roads;
- trenching activities associated with the proposed Pipeline could impact below-ground stems and the expected impact to extant plants is unknown; and
- potential suitable habitat has not been surveyed due to landowner access denial.

Critical Habitat

A **no effect** determination is warranted for Kincaid's lupine because:

- the Pipeline does not occur within designated Kincaid's lupine critical habitat.

3.7.6 Rough Popcornflower

The rough popcornflower (*Plagiobothrys hirtus*) is an annual herb in the borage (Boraginaecae) family. It is found in wetlands in the Umpqua River valley in Douglas County, Oregon (FWS 2000d).

3.7.6.1 Species Account and Critical Habitat

Status

The rough popcornflower was listed as endangered on January 25, 2000 (FWS 2000d). There has been no critical habitat designated for this species.

Threats

FWS listed the rough popcornflower as threatened based on the destruction, modification, or curtailment of its wetland habitat and range. At that time, the species was limited to 17 small isolated habitat patches. Areas supporting the rough popcornflower were threatened by hydrological alterations (including ditching and wetland fill), livestock grazing, agricultural land conversion, non-native vegetation invasion, forest succession and canopy cover, as well as residential and commercial development.

Predation and other natural or manmade factors are also threats identified in the endangered status ruling. These factors include herbicide and pesticide use, chemical spills and runoff from roads, roadside maintenance, habitat vandalism, and grazing. Overgrazing likely contributed to declining numbers throughout its historical range, with livestock grazing in spring and summer months causing the most damage. When flowers and seed heads are grazed, the reproductive output for the year is destroyed; however, FWS noted in its listing decision that grazing in the fall, during the plant's dormant stage, can be a benefit to the species by reducing the growth of weedy competitors (FWS 2000d). The small, isolated populations also make the species vulnerable to disease outbreaks, weak genetic viability, adverse pollinator activity, and random environmental events.

Since the publication of the final rule for rough popcornflower, the potential for further development in the plant's habitat remains the most urgent threat. Habitat destruction and fragmentation from residential, commercial, and agricultural development continues as the area around Sutherlin, Oregon expands. Competitive exclusion by other wetland vegetation is another major threat to the plant. Other ongoing threats include forest succession, overgrazing by livestock, chemical spills and fire along roadsides, herbicide use, wetland infill, and the intentional destruction of suitable habitat and plants (FWS 2003f).

Species Recovery

A recovery plan was developed in 2003 (FWS 2003f), which created three recovery units to ensure that the rough popcornflower was conserved throughout its range in the North Umpqua system. The recovery plan identified that nine reserves, each containing a minimum of 5,000 plants, should be distributed across the three recovery units of Calapooya Creek, Sutherlin Creek, and Yoncalla Creek (FWS 2003f). The objective of the recovery plan is to reduce threats and increase population viability until the rough popcornflower can be downlisted. The recommended steps are as follows:

- Conserve and manage a minimum of nine reserves within three recovery units.
- Practice ex-situ conservation.
- Research factors that threaten the recovery of the species.
- Provide outreach services for owners of reserve populations and the general public.

All the recovery units identified in the recovery plan occur more than 17.5 miles north of the Pipeline right-of-way and more than 4 miles north of the nearest proposed pipe storage yard.

Life History, Habitat Requirements, and Distribution

The rough popcornflower is currently found in seasonal wet meadows or wet prairies in poorly drained clay or silty clay loam soils at elevations ranging from 100 to 900 feet. Deep, poorly drained soils provide a high-to-surface-level water table from November to May, when rough popcornflowers' seedlings germinate and overwinter as submerged rosettes. In these areas, the rough popcornflower is often observed in the deeper sections of shallow meadow pools that lack significant shade and is associated with typical marshland sedge and grasses (FWS 2003f).

Rough popcornflower generally blooms from June through July. Rough popcornflower grows in scattered groups and reproduces largely by insect-aided cross-pollination and partially by self-pollination (FWS 2008g). The herbaceous plant occurs near the towns of Sutherlin and Yoncalla, mostly on private lands in the Umpqua River drainage (FWS 2003f).

Population Status

As of 2010, there were 14 extant populations of rough popcornflower, distributed from Yoncalla Creek near Rice Hill, south to Sutherlin Creek near Wilbur, of which five populations have been introduced (FWS 2010g). Six populations are considered protected and have a documented occupancy of at least 5,000 plants (FWS 2010g). Populations range from 75 plants to more than 35,000 plants (FWS 2010g).

Critical Habitat

Critical habitat has not been designated for the rough popcornflower.

3.7.6.2 Environmental Baseline

Analysis Area

The botanical analysis area extends to 30 meters (98 feet) each side of the Pipeline project (construction right-of-way, TEWAs, UCSAs, rock source and disposal sites, and proposed storage yards) on lands that have potential habitat for listed plant species. This area generally corresponds to the extent of the area surveyed for sensitive and listed plant species during surveys conducted between 2007 and 2017 (at least 100 feet from habitat removal on federal lands and at least 50 feet from habitat removal on non-federal, private lands), and correlates to a distance that indirect effects to plants would be expected.

Species Presence

This species has only been documented in northern Douglas County. The nearest occupied habitats to the Pipeline are along Sutherlin Creek, which is within the Lower North Umpqua River watershed (HUC 171003011), and extend from inside the city of Sutherlin to the south approximately four miles. ORBIC (2017b) reported this plant within multiple sub-populations approximately 1.7 miles north of the proposed Winchester pipe storage yard where 62,765 plants were documented in 2016. The closest rough popcornflower occurrence to the Pipeline right-of-way is approximately 17.5 miles north of MP 68 (ORBIC 2017c).

Project-Specific Rough Popcornflower Survey

Habitat Surveyed. Prior to beginning field surveys in 2007 for the Pipeline, botanists with SBS conducted a habitat review to identify potential habitat and delineate survey areas for rough popcornflower within the botanical analysis area from MPs 51.7 through 67, including existing roads identified for access to the construction right-of-way. Aerial photographs and knowledge of regional landscape and biological features (soils, geology, topography, elevation, target species habitat, and plant community habitat) were used to determine potential habitat for rough popcornflower. The same methods were used to determine potential suitable habitat coinciding with new realignments of the project corridor since 2007.

Overall, 12.89 acres have been surveyed by PCGP from 2007 through 2017 for rough popcornflower within the vicinity of the proposed Pipeline, including previously proposed routes and project components, alternate routes considered, and along access roads that are no longer considered for the Pipeline project. Surveys have continued in 2018 and the data are currently under review. Within the 30-meter botanical analysis area of the Proposed Action where survey permission was granted, approximately 2.79 acres (1.07 acres within the Pipeline project) had been identified as suitable habitat and 6.43 acres were determined not to be suitable habitat for the rough popcornflower (see table 3.7.6-1). Habitat found to be "suitable" in the surveys included areas with some of the characteristics detailed in the Life History, Habitat Requirements, and Distribution section above. Table 3.7.6-1 provides a summary of potential suitable rough popcornflower habitat and survey status within the botanical analysis area.

TABLE 3.7.6-1

Summary of Potential Suitable Rough Popcornflower within the Right-of-Way and Botanical Analysis Area

General Landowner	Suitable Habitat Status	Total Acres Surveyed [1] (2007-2017)	Acres Surveyed			Acres Not Surveyed [4]		
			Project [2]	Buffer [3]	Total	Project [2]	Buffer [3]	Total
MPs 51.7 – 67.0 (109 acres within botanical analysis area)								
Federal	Suitable Habitat	0			0			0
	Not Habitat	0			0	N/A	N/A	0
	Unknown	0			0			0
	Total	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Non-Federal	Suitable Habitat	5.03	1.07	1.73	2.79	0	0.01	0.01
	Not Habitat	7.86	2.00	4.43	6.43	N/A	N/A	N/A
	Unknown	0	0	0	0	82.63	17.18	99.81

	Total	*12.89*	*3.07*	*6.16*	*9.23*	*82.63*	*17.19*	*99.83*
Total	Suitable Habitat	5.03	1.07	1.73	2.79	0	0.01	0.01
	Not Habitat	7.86	2.00	4.43	6.43	N/A	N/A	N/A
	Unknown	0	0	0	0	82.63	17.18	99.81
	Total	**12.89**	**3.07**	**6.16**	**9.23**	**82.63**	**17.19**	**99.83**

[1] Acres provided in this column considers all surveys to-date (through 2017), including areas that have been subsequently rerouted or dropped (i.e., pipe yards) since surveys were initiated in 2007.
[2] Project includes: right-of-way, temporary extra work areae, uncleared storage area, rock storage, pipe yards, aboveground facilities.
[3] Buffer (botanical analysis area) includes area within 30 meters (98 feet) of habitat removal and within 50 feet either side of an existing access road identified with possible road improvements.
[4] Areas not surveyed are either denied access or were not surveyed because of recent modification in Proposed Route that occurred after the flowering season, as well as areas outside of the targeted survey area (i.e., 30-meter analysis area vs. 50-foot targeted survey area on non-federal lands). "Not Habitat" was determined from adjacent survey parcel information, aerial photography, or "drive-by;" no surveys would be necessary and acres are not included.

Note: Surveys have continued in 2018 and the data are currently under review. Most area that remains to be surveyed occur within Winchester pipe storage yard; surveys would continue as access becomes available.

Access to approximately 99.83 acres (82.63 acres within the Pipeline project) of potentially suitable habitat for this species has not been granted within the botanical analysis area, of which the majority of acres (93.16 acres) are associated with the proposed Winchester pipe storage yard and buffer. PCGP would continue to survey habitat where permission is granted. Where survey access has been denied, PCGP would conduct surveys in suitable habitat within the Pipeline project prior to construction.

Survey Results. No rough popcornflower individuals were located during surveys conducted during Pipeline survey efforts.

Critical Habitat

Critical habitat has not been designated for this species.

3.7.6.3 Effects of the Proposed Action

Direct and Indirect Effects

Surveys conducted within potential suitable rough popcornflower habitat along the Pipeline right-of-way did not locate any plants. Additional habitat has been identified in the vicinity of the Pipeline right-of-way where surveys have not been permitted; however, given that the nearest known occurrence of rough popcornflower is over 17 miles north of the Pipeline route, it is unlikely that rough popcornflower plants would be documented along the right-of-way. Potential wetland habitat for the species may be present at the proposed Winchester pipe storage yard, which is located 1.7 miles south of documented occurrences. If PCGP determines that it would use this pipe storage yard during construction of the Pipeline, surveys for rough popcorn flower would be conducted. If plants are documented, PCGP would either not use the pipe storage yard or, if the yard is necessary, not use that portion of the yard where plants are documented. However, due to the current use of this pipe yard and adjacent highway, any plants found adjacent to these areas would likely already be experiencing indirect impacts.

Based on the information presented above, direct impacts to this species are unlikely to occur (i.e., the project is unlikely to occur in areas occupied by rough popcornflower). Indirect impacts could, however, occur if this plant is located within or adjacent to Winchester pipe storage yard or the unsurveyed portion of the Pipeline through dust generated via use of the area, changes in runoff and hydrology, or through the spread/establishment of weeds.

Cumulative Effects

Outside of the areas surveyed for this Project, it is unknown where rough popcornflower occurs on lands not under federal jurisdiction. Therefore, because the extent of this species on these non-federal lands is unknown, it is uncertain if there are reasonably foreseeable actions that might occur on these lands within areas currently occupied by this species. As the FWS's authority generally does not extend to listed plants on private or state lands,[18] all federally listed plants located on these lands must be considered at risk of adverse effects from potential developments. Other reasonably foreseeable projects on non-federal lands that could adversely affect this species include residential, commercial, and industrial development, as well as expanding agricultural areas.

PCGP has committed to implementing appropriate mitigation measures for any listed plants, regardless of land ownership.

3.7.6.4 Conservation Measures

It is possible that rough popcornflower plants could be present in Winchester pipe storage yard, considering distance to recently documented plants along Highway 99 (ORBIC 2017c) and the potential for suitable wetland habitat on the eastern edge of the proposed yard. If plants are documented in the Winchester pipe storage yard, PCGP would either not use the pipe storage yard or, if the yard is necessary, not use that portion of the yard where plants are documented. Additionally, mitigation measures included in the *Federally-Listed Plant Conservation Plan* (appendix V2) would further minimize impacts to rough popcornflower plants if documented during preconstruction surveys.

3.7.6.5 Determination of Effects

Species

The Project **may affect** rough popcornflower because:

- populations occur in the vicinity of one proposed pipe storage yard; and
- potential suitable habitat might be present within the 30-meter botanical analysis area.

The Project is **not likely to adversely affect** rough popcornflower because:

- surveys for the Pipeline project have not documented rough popcornflower, where survey permission has been granted;

[18] The ESA does not protect plants outside federal land unless there is a federal nexus. Therefore, activities that occur on private or state lands that could affect listed plants but which do not have federal nexus are not required to consult with the FWS. Plants may not be removed from lands under federal jurisdiction, and activities with a federal nexus must consult with the FWS.

- surveys in potentially suitable habitat identified within Winchester pipe storage yard or within potential habitat identified within the botanical analysis area along the right-of-way would occur prior to ground disturbing activities; if plants are identified, conservation measures developed to avoid or minimize impacts to future plants would be applied;
- consultation with the FWS would be reinitiated if this species is found to be present in the area and impacts cannot be avoided.

Critical Habitat

Critical habitat has not been designated for rough popcornflower.

4.0 ESSENTIAL FISH HABITAT

The Sustainable Fisheries Act of 1996 amended the MSA and requires federal agencies, in part, to consult with NMFS about activities that may adversely affect EFH (NMFS 1997a). The MSA established guidelines for Regional Fishery Management Councils to identify and describe EFH in FMPs to responsibly manage exploited fish and invertebrate species in federal waters. The PFMC has developed four FMPs that address EFH for managed species in the project area (PFMC 2004, 1998, and 1999).

The MSA describes EFH as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (NMFS 1997a). The MSA provides these additional definitions:

- "Waters" include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate;
- "Substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities;
- "Necessary" means the habitat required to support a sustainable fishery and the managed species contribution to a healthy ecosystem; and
- "Spawning, breeding, feeding, or growth to maturity" covers the full life cycle of a species.

One purpose of this EFH assessment is to determine whether, and to what degree, Project actions would adversely affect any of the EFH within the analysis areas. NMFS (2015d) defines a project action that will adversely affect EFH as:

> *any impact that reduces quality and/or quantity of EFH. This includes direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to species and their habitat, and other ecosystem components, or reduction of the quality and/or quantity of EFH. Adverse effects may result from actions occurring within EFH or outside of EFH.*

There are three general analysis areas in which Project effects to EFH are assessed:

- marine: the marine waters extending from the mainland marine coastline (excluding Coos Bay), out to 15 nmi that may be affected by LNG carriers or other project actions;
- estuarine: the waters of Coos Bay; and
- riverine: freshwater areas that may be affected by project actions in fifth-field watersheds currently containing EFH species.

The Pacific Fishery Management Council (PFMC) has developed four Fishery Management Plans (FMPs) that address Essential Fish Habitat (EFH) for managed species in the Project action area. There are four federal FMPs and associated EFH that coincide with these analysis areas. They include highly migratory species, coastal pelagic species, groundfish, and Pacific Coast salmon. Within these analysis areas, EFH has been designated for two salmonid species, five pelagic species, 70 groundfish species, and over a dozen highly migratory species as described below.

EFH has been defined by the PFMC out to the limits of the United States Exclusive Economic Zone (EEZ). Marine traffic associated with construction and operation of the LNG Terminal may affect EFH beyond the marine analysis area (that is, beyond the limits of the OCS out to the limits of the EEZ). For example, vessel traffic would generate localized noise, and impacts on water quality may occur due to discharge of ballast water, intake and discharge of cooling water, or accidental spills of pollutants at sea. However, Coos Bay and the waters offshore out to the limits of the EEZ currently provide deepwater access for maritime commerce, and support high levels of deep draft vessel traffic. Any impacts due to the incremental increase in marine vessel traffic during construction and operation of the Project would not have a significant adverse effect on EFH outside of the marine analysis area of the Project action area. As a result, the analysis of potential adverse effects to EFH coincides with the Project action area under the ESA, and the EFH Assessment has been incorporated into the APDBA. 50 CFR § 600.920(e)(3).

See section 1.0 of this BA for a description of the Project, including a description of the proposed facilities (section 1.2) and proposed conservation measures (section 1.3). Section 3.5 analyzes the effects of the Project on ESA listed fish species and supplies most of the analysis provided in this EFH as it addresses effects to fish species and their habitat in all three analysis areas defined above.

The following discussion focuses on the potential effects to habitats for groups of species, not individual species. Table 4.0.0-1 provides a summary of the EFH habitat description, Project actions that may contribute to adverse effects to EFH, and overall determination of adverse effects for each EFH group.

TABLE 4.0.0-1

Potential Impacts to EFH due to Construction and Operations

EFH	Description of EFH a/	Potential Impacts	Determination of Effects
Highly Migratory Species	EFH is defined by temperature ranges, salinity, oxygen levels, currents, shelf edges, and sea mounts. Based on species characteristics, the closest EFH would be beyond the 40-fathom depth off of Coos Bay. b/	• Accidental spills of hazardous substances	Minimal adverse effects or negligible effects to highly migratory species EFH
Coastal Pelagic Species	All marine and estuarine waters from the coast to the limits of the EEZ and above the thermocline where sea surface temperatures range between 50°F and 79°F	• Accidental spills of hazardous substances • Dredging of 62.7 acres of estuarine habitat in Coos Bay • Installation of two HDDs across Coos Bay • • Potential impingement or entrainment of small fish, food and larval organisms from dredging and LNG carrier cooling water intake	Habitat effects minimal; Significant adverse effects to coastal pelagic species unlikely (northern anchovy, Pacific sardine) EFH
Groundfish	All waters from the extent of the high tide line (and parts of estuaries) to	• Accidental spills of hazardous substances	Habitat effects minimal; Significant adverse

	offshore to the 3,500-meter (1,914-fathom) depth.	• Dredging of 62.7 acres of estuarine habitat in Coos Bay • Short-term water quality degradation should a low-probability inadvertent return occur during installation of two HDDs across Coos Bay • Potential impingement or entrainment of small fish, food, and larval organisms •	effects to multiple groundfish species unlikely (e.g., rockfish, English sole, starry flounder) EFH
Pacific Coast Salmon	All streams, lakes, ponds, wetlands, and other waterbodies currently and historically accessible to salmon. Estuaries and marine areas extending to the EEZ and beyond.	• Accidental spills of hazardous substances • Dredging of 62.7 acres of estuarine habitat in Coos Bay • Installation of two HDDs across Coos Bay • Periodic channel dredging and disposal • Short-term increase in noise associated with land based pile driving at the MOF and in-water pile driving at various temporary construction activities • Potential impingement or entrainment of small fish, food and larval organisms • Fish salvage during stream crossings • Short-term loss of nearshore cover, prey species, and long-term loss of sources of large woody debris recruitment from riparian vegetation removal • Elevated suspended sediment at pipeline stream crossings • Diverted open-cut across South Umpqua River, installation of HDD across Coos River and Rogue River	Isolated and localised adverse effects to Pacific coastal salmon species (coho and Chinook salmon) EFH

a/ PFMC (2006; updated version July 24, 2006)
b/ PFMC (2007)

4.1 ESSENTIAL FISH HABITAT DEFINITION

As noted, there are four FMP fish habitat groups. The characteristics of each of the habitats and associated species relative to Project analysis areas are summarized below.

4.1.1 Highly Migratory Species

Highly migratory species are species that only occur within the marine analysis area since they migrate considerable distances across oceans to feed and reproduce. Highly migratory species defined by the PFMC include tunas (five species), sharks (five species), billfish/swordfish (two species), and the dorado (also called dolphinfish or mahi-mahi). However, highly migratory species and their various life stages are not uniformly distributed within the marine analysis area. Species' life cycles included in table 4.1.1-1 have been separated by their distributions in the EEZ north of 37°N latitude (north of Monterey Bay, California). The earliest life stages for most highly migratory species on the U.S. West Coast occur south of Monterey Bay, outside the marine analysis area. Based on their distribution in mostly warmer waters and usually well outside the coastal area habitat that is typical of the marine area near Coos Bay, none of these fish are likely to be present in the immediate marine waters near the entrance to Coos Bay.

TABLE 4.1.1-1

Highly Migratory Fish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Marine Analysis Area

		Distribution within the EEZ Analysis Area North of 37°N Latitude				
Common Name/ ***Scientific Name***	**Life Cycle and Habitat Associations a/**	**Eggs**	**Larvae**	**Neonate-Early Juvenile b/**	**Late Juvenile - Sub-adults b/**	**Adult**
Common thresher shark *Alopias vulpinus*	Epipelagic, neritic, and oceanic waters off beaches, in shallow bays, open coast bays and offshore, in near surface waters. Feeds primarily on northern anchovy, Pacific hake, Pacific mackerel, and sardine.					X
Bigeye thresher shark *Alopias superciliosus*	Coastal and oceanic waters in epi- and mesopelagic zones. Little known of diet; presumably feeds on pelagic fish and squids.					X
Blue shark *Prionace glauca*	Epipelagic and oceanic waters. Feeds on northern anchovy, Pacific hake, squid, spiny dogfish, herring, and flatfish.			X	X	X
Shortfin mako shark *Isurus oxyrinchus*	Oceanic and epipelagic waters. Reportedly feed on mackerel, sardine, bonito, anchovy, tuna, other sharks, swordfish, and squid.			X	X	X
Albacore *Thunnus alalunga*	Oceanic, epipelagic waters. Feed opportunistically. Younger fish may aggregate in vicinity of upwelling fronts to feed.			X		X
Northern bluefin tuna *Thunnus thynnus*	Juvenile-oceanic, epipelagic waters. Major part of diet is northern anchovy.			X		
Skipjack tuna *Katsuwonus pelamis*	Adult-oceanic, epipelagic waters. Major part of diet are pelagic red crab and northern anchovy.					X
Broadbill swordfish *Xiphias gladius*	Oceanic, epipelagic, and mesopelagic waters. Food species not documented.			X		X

a/ PFMC 2007.
b/ All juvenile life stages are combined for species other than sharks.

4.1.2 Coastal Pelagic Species

Coastal pelagic species include four fin fish—northern anchovy, Pacific sardine, Pacific (chub) mackerel, and jack mackerel—and the invertebrate market squid. Coastal pelagic species occur from the ocean surface to depths of 1,000 meters (547 fathoms within the marine analysis area, but the distributions of several species tend to be in relatively shallow water closer to shore, including the estuarine analysis area). These species are not associated with the seafloor or bottom substrates. EFH for coastal pelagic species also includes portions of the water column where sea surface temperatures range between 50°F (near the United States/Mexico maritime boundary) and 79°F (seasonally and annually variable) (PFMC 2006).

All life stages for each of the coastal pelagic species are expected to occur within the marine analysis area, and the adults of most species are expected within the estuarine analysis area (table 4.1.2-1). Northern anchovies are the only coastal pelagic species for which all life stages are likely to utilize the estuarine analysis area (table 4.1.2-1), although some life stages of Pacific sardine and Pacific mackerel may be present. In Coos Bay, these are not resident species, but are primarily present in the summer months. During the summer, the estuary may be utilized as a forage area for juveniles and adults, and as a nursery area for larvae and juveniles for some of the species.

Within the Coos Bay estuary, northern anchovies are expected to be transient users of eelgrass (Phillips 1984). Eelgrass provides indirect benefits to these species by contributing to productivity in the estuary, and eelgrass drift may provide cover for coastal pelagic species (Nightingale and Simenstad 2001).

TABLE 4.1.2-1

Coastal Pelagic Fish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

		Distribution within Estuarine Analysis Area				**Distribution within Marine Analysis Area**			
Common Name ***Scientific Name***	**Life Cycle and Habitat Associations a/**	**Eggs**	**Larvae**	**Juvenile**	**Adult**	**Eggs**	**Larvae**	**Juvenile**	**Adult**
Pacific sardine *Sardinops sagax*	Pelagic commercially harvested schooling fish that inhabits coastal subtropical and temperate waters. Occurs in estuaries, but more commonly near shore and offshore. Highly mobile, moving seasonally along the coast. More abundant in Oregon during the summer and warm water years. Spawning occurs year-round (spatially and seasonally dependent on temperature) in loosely aggregated schools in the upper 50 yards of the water column, generally 30-90 miles offshore. Major prey species for commercially valuable and endangered fish species.			?	X	X	X	X	X
Northern anchovy *Engraulis mordax*	Often in schools near the surface. Spawning occurs every month, especially in late winter and early spring (February–April). Overwinter in mixed layer temperatures. Nearshore habitats support most of the juvenile population. Eat phytoplankton or zooplankton by either filter-feeding or biting. Considered a valuable source of food for endangered fish and bird species.	X	X	X	X	X	X	X	X
Pacific (chub) mackerel *Scomber japonicus*	Pelagic for all life stages. Adults commonly found in shallow banks with increased abundance from July to November. Spawning peaks April through July in California.			?	?	X	X	X	X
Jack Mackerel *Trachurus symmetricus*	Pelagic schooling fish that range widely. Diet on large zooplankton, juvenile squid, and anchovy. They are more available on offshore banks in late spring, summer and early fall than during the remainder of the year. Much of their range lies outside the 200 mile EEZ.				X	X	X	X	X
Market Squid *Loligo opalescens*	Prefer oceanic salinities and rarely found in bays, estuaries, or near river mouths. Spawning occurs year-round. They are important as forage foods for many species.		X	X	X	X	X	X	X

a/ PFMC 2007

4.1.3 Groundfish Species

There are over 80 species of groundfish, most of which live at or near the ocean bottom, that are managed under the Pacific Coast Groundfish FMP (PFMC 2008). Many groundfish species occur within the marine and estuarine analysis areas. This FMP includes EFH within the waters and substrates at "depths less than or equal to 3,500 m (1,914 fm) to mean higher high water level (MHHW) or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow" (PFMC 2005). Species and their likely life stage distributions in the Project analysis areas are summarized in table 4.1.3-1 (at the end of this section). This distribution is based on mapped habitat suitability probabilities for spatial occurrences by different life stages (Appendix B-4 in PFMC 2006). Although many groundfish species have the potential to be in the estuary based on the PFMC habitat maps, only 19 species are considered to be more than "unlikely" in the estuarine analysis area. Based on sampling within Coos Bay estuary, at least 16 groundfish species are known to be present (see JCEP's Resource Report 3, appendix E.3; Wagoner et al. 1990).

Most groundfish species are not residents of Coos Bay but utilize the bay primarily in the spring and summer months. During spring and summer, the estuary may be utilized as a forage area for juveniles and adults, and as a nursery area for larvae and juveniles. For example, starry flounder spawn near river mouths and sloughs. Juvenile starry flounder are found exclusively in estuaries. Sampling in upper Coos Bay from 1979 to 1990 showed that young-of-the-year flounder are present at least in the spring and summer months (Wagoner et al. 1990). Flounder and sole are found in sandy or muddy substrate, and juveniles are found in shallow water near rivers and in estuaries in eelgrass beds. Adults generally are found in deeper waters in the winter and migrate to shallower water in the spring. Juvenile English sole depend heavily on intertidal areas, estuaries, and shallow nearshore waters for food and shelter.

The black rockfish is the only member of the rockfish family that is consistently caught in the Coos Bay recreational fishery. Other species caught include copper, blue, grass, and canary rockfish, as well as bocaccio (Wagoner et al. 1990). Rockfish occur in the lower areas of Coos Bay, mainly during the late spring and summer months (Wagoner et al. 1990). Black rockfish are not known to spawn in estuaries. Rockfish recruit to seagrass beds in shallow, soft bottom embayments (Love et al. 1991). Johnson et al. (2003) reported that juveniles of many commercially important species utilize eelgrass habitat in Southeastern Alaska. Rockfish juveniles settle into shallow, vegetated habitats for rearing. Vegetated habitats (eelgrass and kelp) provide refuge from predators and access to prey. Juvenile rockfish may also be closely associated with seagrass drift for both feeding and refugia while they move between pelagic and near shore habitat (Nightingale and Simenstad 2001).

Rockfish have not been observed by ODFW while seining in or near the immediate Project slip area, indicating that this area is not likely utilized by rockfish (ODFW 2006a). Black rockfish and cabezon, however, were the most abundant juvenile rockfish species captured elsewhere within Coos Bay (near the entrance), between June 2003 and December 2005 (Schlosser and Bloeser 2006). Trap sites were located in eelgrass beds, along dock pilings, and in sandy bottom habitat near the entrance to Coos Bay. Juvenile chillipepper, copper, grass, yellowtail, and kelp greenling were also captured near the Coos Bay entrance.

Lingcod begin life in near-surface marine waters and estuarine areas. Juvenile lingcod primarily use estuaries, entering to feed, while adults are usually found in marine waters that are 100 to 150 meters deep. Lingcod lay eggs in rocky, marine subtidal areas. Larvae are found in the near-surface marine waters and estuarine areas. In this life stage, lingcod feed primarily on copepods, eggs, and other crustaceans. As lingcod mature, they are commonly found in shallow, inter-tidal areas of bays near algae and seagrass beds.

TABLE 4.1.3-1

Groundfish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

Common Name Scientific Name	Life Cycle and Habitat Associations a/	Distribution within Estuarine Analysis Area b/				Distribution within EEZ Analysis Area b/			
		Eggs c/	Larvae c/	Juvenile c/	Adult c/	Eggs c/	Larvae c/	Juvenile c/	Adult c/
Soupfin shark *Galeorhinus galeus*	Coastal-pelagic species associated with the bottom, inhabiting bays, muddy shallows and offshore up to 225 fathoms (fm). Adult males occur in deeper waters and females usually at less than 30 fm. From dense shoals, migrating north in the summer and south in the winter. Mating occurs in the spring.			L	M			H	H
Spiny dogfish *Squalus acanthias*	An inner shelf-mesobenthal species with a depth range of 0 to 677 fm. Common in inland seas and shallow bays. Seasonal migrations occur within preferred temperature range.			L	H			H	H
Leopard shark *Triakis semifasciata*	Inhabits enclosed muddy bays, flat sandy areas, mud flats, sandy and muddy bottoms strewn with rock near reefs and kelp beds. Common in littoral waters and around jetties and piers. Pupping and feeding/rearing grounds in estuaries and shallow coast waters. Found at depths up to 50 fm, common at 0 to 2 fm.			H	H			H	H
Big skate *Raja binoculata*	Inhabits inner and outer shelf areas, particularly on soft bottom sediments. Either associated with silty sediment, or with sediment consisting of a mixture of mud, sand, gravel, and cobble. Found at depths up to 55 fm.	U		U	U	H		H	H
California skate *Raja inornata*	Usually occur in habitats with muddy bottoms. Juveniles are associated with soft bottom sediments. Common in inshore waters and shallow bays; sometimes in deep water.	H		U	H	H		H	H
Longnose skate *Raja rhina*	Occurs on the bottom inner and outer shelf areas, usually less than about 175 fathoms deep. Juveniles and adults are associated with soft bottom sediments with combinations of mud and cobble near high relief structures.	L		U	U	H		H	H
Pacific cod *Gadus macrocephalus*	Adults and juveniles prefer mud, sand, and clay. Usually found near bottom, with a wide depth range of 7 to 300 fm. Spawning occurs from the late fall to early spring. Larvae and small juveniles are pelagic, large juveniles and adults are parademersal.	L	U	U	U	H	H	M	L
Pacific grenadier (rattail) *Coryphaenoides acrolepis*	Commercial species that inhabits the continental slope. Highest densities occur on the sandy bottoms of abyssal plains. Migrations have not been documented, but larger fish are found in deeper water. Larvae are pelagic.	H	H	U	U	H	H	L	H
Pacific whiting (hake) *Merluccius productus*	Inhabits euhaline waters of the continental shelf. Juveniles reside in shallow coastal waters, bays, and inland seas and move deeper as they get older. Highly migratory. Spawns from December through March, perhaps more than once per season.	U		U	L	H		U	H
Spotted ratfish *Hydrolagus colliei*	Found near the bottom, from close inshore to about 500 fm. Abundant in cold waters at moderate depths. Feed on mollusks, crustaceans and fish; also echinoderms and worms. Fishers are reputed to fear the jaws of the ratfish more than they do the dorsal spine.	U		U	U	H		H	H

TABLE 4.1.3-1

Groundfish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

		Distribution within Estuarine Analysis Area b/				Distribution within EEZ Analysis Area b/			
Common Name **Scientific Name**	**Life Cycle and Habitat Associations a/**	**Eggs c/**	**Larvae c/**	**Juvenile c/**	**Adult c/**	**Eggs c/**	**Larvae c/**	**Juvenile c/**	**Adult c/**
Rougheye rockfish *Sebastes aleutianus*	Usually found on the bottom in deep, offshore waters with soft substrata, frequenting boulders and at slopes greater than 20 degrees. Depths range from 14 to 478 fm.			U	U			H	L
Pacific Ocean Perch *Sebastes alutus*	This commercially important schooling fish is abundant offshore, often found along submarine canyons, depressions, pinnacles, and seamounts. Depth ranges from surface to 451 fm (most occur in 80 to 200 fm).		U	U	U		H	H	M
Kelp rockfish *Sebastes atrovirens*	Inhabiting shallow waters, adults are primarily residential in kelp forests and on the bottom near rocky areas and are considered parademersal. Common at depths of 5 to 7 fm, but found up to 25 fm with a distribution mostly off the coast of California.				U				H
Aurora rockfish *Sebastes aurora*	Adults and juveniles are found in soft- and hard- bottom habitats on the continental slope/basin. Distribution ranges from Vancouver Island, British Columbia to Cedros Island, Baja California. Depth ranges from 68 to 420 fm.		U	U	U		H	H	H
Redbanded rockfish *Sebastes babcocki*	Thought to associate with both soft substrata and hard-bottom substrata, and in crevices between boulders. This deepwater species has been caught in the 50 to 342 fm range and is found from Amchitka Island, Alaska to San Diego, California.				U				H
Silvergray rockfish *Sebastes brevispinis*	Inhabits the outer shelf-mesobenthal zone on a variety of rocky-bottom habitats. Found at the surface to 205 fm, from the Bering Sea to Baja California.				U				L
Shortraker rockfish *Sebastes borealiz*	Deepwater species inhabiting the middle shelf to the mesobenthal slope and common on the bottom from 100 to 478 fm. Distribution from the Aleutian Islands and down to Point Conception, California				U				H
Gopher rockfish *Sebastes carnatus*	These are shallow-water benthic fish that inhabit rocky reefs, kelp beds, and sandy areas near reefs. Common depth from surface to 9 fm and mostly limited to the California coast.		U	U	U		H	H	H
Copper rockfish *Sebastes caurinus*	Occur in nearshore waters, from the surface to 100 fm. Found on or near natural rocky reefs, boulder fields, artificial reefs, oil platforms and rockpiles; usually directly on the bottom with reefs or kelp bed areas. May move inshore to release their young.				U				H
Greenspotted rockfish *Sebastes chlorostictus*	Associated with soft-bottom habitats and also with rock outcrops, reefs, caves, and crevices. Range is from Washington to Baja California with depths 27-150 fm			U	U			H	L
Black and yellow rockfish *Sebastes chrysomelas*	Inhabits holes and crevices in rocky areas. Found in intertidal areas and depths to 20 fm.		U	U	U		H	M	M
Starry rockfish *Sebastes constellatus*	Usually found on reefs. Viviparous, with planktonic larvae and pelagic juvenlies. Limited distribution along the California coast from north of San Franciscon to Baja. Depth ranges from 13 – 150 fm.			U	U			U	M
Darkblotched rockfish *Sebastes crameri*	Adults are associated with muddy areas near cobble or boulders. Found at depths of 14 to 328 fm from the Bering Sea to Catalina Island, California.		U	U	U		H	H	H

TABLE 4.1.3-1

Groundfish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

		Distribution within Estuarine Analysis Area b/				**Distribution within EEZ Analysis Area b/**			
Common Name Scientific Name	**Life Cycle and Habitat Associations a/**	**Eggs c/**	**Larvae c/**	**Juvenile c/**	**Adult c/**	**Eggs c/**	**Larvae c/**	**Juvenile c/**	**Adult c/**
Splitnose rockfish *Sebastes diploproa*	Associated with offshore mud habitats near isolated rock cobble and boulder fields. Most common at 50 to 250 fm. Young occur in shallow water, often at the surface under drifting kelp, algae, and seagrass. Emigration from surface waters occurs primarily in May and June.		H	U	U		H	H	H
Greenstriped rockfish *Sebastes elongatus*	Prefers a mixture of mud and rock bottom and found at depths of 14 to 232 fm. Distribution from Alaska to Baja California.			U	U			H	H
Widow rockfish *Sebastes entomelas*	All life stages are pelagic, but older juveniles and adults are associated with hard bottoms among rocks. This important commercial fish ranges from near Kodiak Island, Alaska to Todos Santos Bay in Baja California; from surface to 300 fm.			U	U			H	M
Pink rockfish *Sebastes eos*	Demersal, inhabiting rocky bottoms in isolated areas from Southern Oregon to Central Baja California. Depth range from 40 to 200 fm.				U				H
Yellowtail rockfish *Sebastes flavidus*	They are considered a middle shelf-mesobenthal species most common near the bottom. This schooling rockfish has a range from Unalaska Island, Alaska to San Diego, California and is found from the surface down to 300 fm.			U	U			H	H
Chilipepper rockfish *Sebastes goodei*	Most commonly associated with deep, high-relief rocky areas and along cliffs. A commercially important species in California found at the surface to 232 fm.			U	U			H	H
Rosethorn rockfish *Sebastes helvomaculatus*	Adults are mostly found in muddy areas adjacent to boulders, cobble, or rock. Depth range from 40 to 300 fm. Limited distribution from Alaska to Baja California.				U				L
Squarespot *rockfish* *Sebastes hopkinsi*	They are reef-associated, in areas with cobble and have a depth range of 2 to 120 fm.			U	U			H	H
Shortbelly rockfish *Sebastes jordani*	Can be found in large schools, offshore and off smooth bottom areas near the shelf break and sharp drop-offs. Depths of 0 to 191 fm.				U				H
Cowcod *Sebastes levi*	Adults are primarily found over high-relief rocky areas. Juveniles prefer soft bottom habitats and those consisting of low-relief rocks. Mostly found off California at depths of 11 to 200 fm.			U	U			H	L-M
Quillback rockfish *Sebastes maliger*	A common, shallow-water benthic species, from subtidal depths to 150 fm. Young occur along shores and adults usually in deeper waters.			U				H	
Black rockfish *Sebastes melanops*	Adults inhabit midwater and surface areas over-high relief rocky reefs, in and around kelp beds, boulder fields, pinnacles, and artificial reefs. Larvae and young juveniles are pelagic.			M	U			H	H
Blackgill rockfish *Sebastes melanostomus*	An aggregate species, usually inhabiting deep rocky-or hard-bottom habitats along steep drop-offs. Larvae inhabit the upper mixed layer of water, juveniles are pelagic (associated with flat bottoms) and migrate shoreward. Spawn from January to June.		U	U	U		H	H	H

TABLE 4.1.3-1

Groundfish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

Common Name Scientific Name	Life Cycle and Habitat Associations a/	Distribution within Estuarine Analysis Area b/				Distribution within EEZ Analysis Area b/			
		Eggs c/	Larvae c/	Juvenile c/	Adult c/	Eggs c/	Larvae c/	Juvenile c/	Adult c/
Vermilion rockfish *Sebastes miniatus*	Found over rocks, along drop-offs, and over hard bottom. Adults inhabit rocky reefs at depths of 8 to 150 fm. Larvae are pelagic and found near the surface for three to four months, and are frequently associated with algae.				U				H
Blue rockfish *Sebastes mystinus*	Strong affinity for kelp forests. Adults inhabit midwater and surface areas around high relief rocky areas, within and round the kelp colony, and around artificial reefs. Common depth range of 33 to 167 fm. Larvae and early stage juveniles are pelagic, and older individuals are semi-demersal or demersal.		L	U	U		H	H	H
China rockfish *Sebastes nebulosus*	Occur both inshore and along the open coast from 1 to 75 fm. Most Juveniles are pelagic, but adults are sedentary, associated with rocky reefs or cobble. They are residential and associated the bottom, crevices, and kelp beds.			U	U			H	H
Tiger rockfish *Sebastes nigrocinctus*	Found at depths of 5 to 150 fm. Juveniles are pelagic, common near water surface with algae mats and plants. Adults are semi-demersal. Often found in caves, off cliffs, and on floors. Solitary, may be territorial.				U				H
Speckled rockfish *Sebastes ovalis*	They occur in midwater over rocks and are also found near the bottom on reefs and among boulders. Depths range from 17 to 200 fm.			U	U			H	H
Bocaccio *Sebastes paucispinis*	Benthic juveniles and adults are found around vertical relief; over sand-mud bottoms with little relief; and in areas with mixtures of rocks and boulders, rock ridges, and rocks and boulders among mud. Most common at depths of 40 to 175 fm. Larvae and small juveniles are pelagic; large juveniles and adults are semi-demersal.		L	U	U		H	H	M
Canary rockfish *Sebastes pinniger*	Most abundant above hard bottoms, usually 50 to 110 fm. In its southern range, it is a reef associated species. Larvae and juveniles are pelagic. Young of the year can be found in tide pools, and can be associated with artificial reefs and interfaces between mud and rock. Juveniles descend deeper as they mature. Capable of large latitudinal movements.			U	U			H	H
Redstripe rockfish *Sebastes prorigger*	Generally found off the bottom over both high- and low-relief rocky areas. Depths range from 7 to 232 fm (most common at 70 to 150 fm).				U				H
Grass rockfish *Sebastes rastrelliger*	Common in nearshore rocky areas, along jetties, and in kelp and eelgrass. Residential species at shallow depths.			U	U			H	H
Yellowmouth rockfish *Sebastes reedi*	Found over rough bottoms from the Northern Gulf of Alaska to the south of Crescent City, California, with a depth range from 75 to 200 fm. More common at 100 to 200 fm.			U	U			H	M
Rosy rockfish *Sebastes rosaceus*	These fish are solitary bottom-dwellers found over hard, high-relief areas and at low-relief spots among rocks and sand. Depths range from 27 to 150 fm.			U	U			H	H
Yelloweye rockfish *Sebastes ruberrimus*	Inhabits rocky reefs and boulder fields from Prince William Sound, Alaska to Ensenada, Baja California. An important commercial species ranging from 8 to 300 fm.			U	U			H	H

TABLE 4.1.3-1

Groundfish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

Common Name Scientific Name	Life Cycle and Habitat Associations a/	Distribution within Estuarine Analysis Area b/				Distribution within EEZ Analysis Area b/			
		Eggs c/	Larvae c/	Juvenile c/	Adult c/	Eggs c/	Larvae c/	Juvenile c/	Adult c/
Flag rockfish *Sebastes rubrivinctus*	These demersal fish inhabit rocky areas and have a depth range of 0 to 302 meters.			U	U			M	H
Bank rockfish *Sebastes rufus*	Juveniles are parademersal and prefer mixed mud and rock habitats. Adults can be found on rocky reefs, among boulder fields, cobble, and mixed mud-rock bottoms. Depths range from 17 to 135 fm.			U	U			H	L
Stripetail rockfish *Sebastes saxicola*	A dominant soft-bottom fish. Pelagic juveniles, with a narrow depth range of 27 to 30 fm, are associated with sandy bottoms. Adult depth ranges from 5 to 299 fm (most common 80-150 fm).			U	U			H	H
Sharpchin rockfish *Sebastes zacentrus*	An outer shelf-mesobenthal species preferring mud and cobble and mud and boulder substrata. Found at depths from 14 to 260 fm.		U	U	U		H	H	M
Shortspine thornyhead *Sebastolobus alascanus*	Juveniles occupy shallower waters than adults, usually over muddy bottoms near rocks. Adults are found on muddy bottoms and bottoms with mud and cobble/boulder mixes. A deepwater species, found at 10 to 833 fm.			U	U			H	H
Longspine thornyhead *Sebastolobus altivelis*	Juvenile and adults are demersal and occupy the sediment surface, preferably sand or mud. A deepwater species, found often at 110 to 960 fm.			U	U			H	H
Cabezon *Scorpaenichthys marmoratus*	Most abundant in estuaries where all life stages may be present. Found intertidally or in shallow subtidal areas in a variety of habitats, often in the vicinity of kelp beds, jetties, oil platforms, isolated rocky reefs or pinnacles, and shallow tide pools. Mostly utilize rocky bottoms and cobble substrata.				U				H
Sablefish *Anoplopoma fimbria*	Inner shelf-bathybenthal commercial species. Eggs, larvae, and young juveniles are pelagic. Older-juveniles and adults are benthopelagic on soft bottoms, commonly with mud and sea urchins. Often migratory, wide-ranging depths from 170 fm to 1,000 fm. Spawning occurs in the late fall and early winter in waters at depths >167 fm.	L	U	U	U	H	H	H	H
Lingcod *Ophiodon elongatus*	Occupy the estuarine-mesobenthic zone, from intertidal areas to 266 fm. Mostly inhabit slopes of submerged banks with seaweed, kelp and eelgrass beds. Spawning occurs from December through April, 2-5 fm below mean lower low water over rocky reefs in areas with a swift current.	H	U	U	U	H	H	H	H
Finescale codling (mora) *Antimora microlepis*	Inhabits the lower regions of the continental slope between 437 fm and 980 fm. Whether or not the species migrates extensively or uses the North American west coast slopes only as feeding areas is not known.				U				H
Kelp greenling *Hexagrammos decagrammus*	High affinity for rocky banks near dense algae or kelp beds, or in kelp beds. Larvae and small juveniles are pelagic, adults are demersal (but not usually below 11 fm). Juveniles associated with rocky reefs and microalgae. Newly hatched larvae move out of estuaries or shallow nearshore areas into open water. Spawning occurs in the fall.		M		U		H		M

TABLE 4.1.3-1

Groundfish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

Common Name Scientific Name	Life Cycle and Habitat Associations a/	Distribution within Estuarine Analysis Area b/				Distribution within EEZ Analysis Area b/			
		Eggs c/	**Larvae c/**	**Juvenile c/**	**Adult c/**	**Eggs c/**	**Larvae c/**	**Juvenile c/**	**Adult c/**
Pacific sanddab *Citharichthys sordidus*	Inhabit s inner continental shelf along the West Coast. Most abundant in 20 to 50 fm. Small juveniles prefer silty sand substrata and adults prefer sand and coarser sediments and low-relief rock bottoms. Spawning occurs late winter through summer.				U				H
Arrowtooth flounder *Atheresthes stomias*	Eggs and larvae are pelagic and juveniles and adults are demersal. Juveniles and adults are usually found on sand or sandy gravelly substrata, but occasionally over rock-relief sponge bottoms. Migrate from shallow-water summer feeding grounds on the continental shelf to deep-water spawning grounds over the continental shelf. Spawning occurs in the winter.	H	H	U	U	H	H	H	H
Petrale Sole *Eopsetta jordani*	Juveniles and adults are demersal. Adults migrate seasonally between deep-water winter spawning areas to shallower, spring feeding grounds. Found on sand and mud bottoms from 10 to 300 fm. Most abundant at 30 to 70 fm from April through October and at 150 to 250 fm during winter.			U	U			H	H
Rex sole *Glyptocephalus zachirus*	Abundant on sandy, muddy, and gravely bottoms. Also in complexes of mud and boulders. Cold temperate, upper-slope, outer-shelf flatfish with pelagic eggs and larvae. Move inshore in summer and offshore for spawning in winter and early spring.			U	U			H	H
Flathead sole *Hippoglossoides elassodon*	These sole inhabit soft, silty or muddy bottoms from 0 to 575 fm (common 55 to 135 fm). They can also be associated with mud mixed with gravel or sand.			U	U			L	L
Dover sole *Microstomus pacificus*	Innershelf-mesobenthal commercially caught species, mostly in waters <273 fm. Adults and juveniles have high affinity for soft bottoms of fine mud and sand. Commonly associated with mud and sea urchins. Eggs are epipelagic, larvae are epi-mesopelagic, and juveniles and adults are demersal. Spawning occurs in the spring near the bottom of the water. Females and juveniles migrate offshore to deeper waters in the fall.			U	U			H	H
English sole *Parophrys vetulus*	Shallow-water, soft-bottom, marine and estuarine environments. Spawning occurs in winter to early spring over soft-bottom mud strata, depths of 27-38 fm. Eggs and larvae are pelagic and adults are demersal		M	L	L		H	H	H
Starry flounder *Platichthys stellatus*	Occur in the inner continental shelf and shallow sublittoral communities. Older individuals occur from 75 miles upstream to the outer continental shelf. Juveniles prefer sandy to muddy substrata. Spawning occurs in late winter-early spring in estuaries or sheltered inshore bays with less than 25 fm.	L		U	L	H		H	H
Rock sole *Pleuronectes bilineatus*	Juveniles and adults are demersal and found primarily in shallow water bays and over the continental shelf on rocky, pebbly, or sandy bottoms form 0 to 200 fm. Most are caught in 20 to 40 fm.				U				H
Curlfin sole *Pleuronichthys decurrens*	Curlfin are found on soft bottoms from 4 to 291 fm, but usually are found in shallower waters.				U				H

TABLE 4.1.3-1

Groundfish Species Managed by the Pacific Fishery Management Council for which Essential Fish Habitat Has Been Identified and May Occur Within the Proposed Action Estuarine Analysis Area and Marine Analysis Area

		Distribution within Estuarine Analysis Area b/				Distribution within EEZ Analysis Area b/			
Common Name **Scientific Name**	**Life Cycle and Habitat Associations a/**	**Eggs c/**	**Larvae c/**	**Juvenile c/**	**Adult c/**	**Eggs c/**	**Larvae c/**	**Juvenile c/**	**Adult c/**
Sand sole *Psettichthys melanostictus*	High affinity to shallow waters with sandy/muddy substrate. Spawning occurs in winter and spring near shore. Larvae and small juveniles are pelagic and transported to estuaries by tidal current.		M	U	U		H	H	H

a/ Life Cycle and Habitat Association: Froese and Pauly 2008; ODFW 2008; NMFS 2005d; PFMC 2005; PFMC 2004; Orr et al. 1998; PFMC 1998; Kostow 1995.
b/ Life Stages Distribution: Ground Fish Species' Distribution based on Habitat Suitability Probability Maps, Appendix B-4 (PFMC 2005); McCain et al. 2005.
c/ "U" indicates unlikely occurrence; "L" –Low probability; "M"—Moderate probability; "H"—High probability; " " indicates no PFMC distribution data available.
d/ X=collected in samples or assumed to be present based on known habitat use (Source: Hinton and Emmett 1994)

4.1.4 Pacific Salmon Species

EFH for Pacific salmon species includes nearshore marine water and waters extending out 200 nmi to the EEZ boundary off the coasts of Washington, Oregon, and in California north of Point Conception. It also includes inland estuaries and freshwater streams, lakes, ponds, and other waterbodies that were historically accessible to salmon. EFH excludes habitats upstream from longstanding impassible barriers (waterfalls) and upstream from impassible barriers (dams) identified by PFMC (1999). Pacific salmon species with EFH in the marine, estuarine, and riverine project analysis areas include Chinook and coho salmon. This includes two ESA-listed coho salmon ESUs in portions of the analysis area as described below.

EFH for Chinook and coho salmon has been designated within the following watersheds that coincide with the proposed action riverine analysis areas: South Umpqua River (HUC 17100302), Coos River (HUC 17100304), Coquille River (HUC 17100305), and Upper Rogue River (HUC 17100307). EFH for Chinook salmon and coho salmon is also present in the Upper Klamath River (HUC 18010206) in California and Oregon, but construction of multiple dams on the mainstem Klamath River has made upstream areas impassible to anadromous fish (Hamilton et al. 2005). Habitats within the project area upstream from the Iron Gate Dam are not currently accessible to coho or Chinook salmon, but the Oregon Fish and Game Commission in July 2008 authorized the study of reintroduction of anadromous fish into the Klamath River system in Oregon. As of 2014, no action has been taken to actually remove these dams or transport fish upstream past the dams, so no further assessment of potential EFH effects in the Upper Klamath River watershed is provided in this BA.

Coho salmon within the riverine analysis area of the Upper Rogue River (HUC 17100307) watershed are within the SONCC coho salmon ESU, and their threatened status, environmental baseline, Project effects, and determination of effects under the ESA (species effects and effects to designated critical habitat) were addressed earlier in this BA in section 3.5.3. Likewise, section 3.5.4 evaluates coho salmon within the South Umpqua River (HUC 17100302), Coos River (HUC 17100304), and Coquille River (HUC 17100305) watersheds theat are within the Oregon Coast ESU, which are listed as threatened and with designated critical habitat under the ESA.

EFH for coho salmon of both listed ESUs is present within the riverine and marine analysis areas. The listed Oregon Coast coho salmon ESU is also present in the estuarine analysis area of Coos Bay.

Figure 4.1.4-1 shows the specific timing of life history phases for fall-run Chinook salmon within the estuarine and riverine analysis areas. Spawning does not occur within the Coos Bay estuary or the analysis area included for the Coos River. Spawning does occur within the Coquille River and tributaries, in the Rogue River mainstem and tributaries, and in the South Umpqua River mainstem and tributaries.

Specific timing and life history phases of the ESA-listed coho salmon are presented the main BA sections 3.5.3 (SONCC coho) and 3.5.4 (Oregon Coast coho) shown in (figures 3.5.3-1 and 3.5.4-1). Whereas adult coho in the SONCC ESU and Oregon Coast ESU begin upstream migrations in September, fall Chinook salmon in some watersheds begin as early as mid-July (Coos River and Coquille River) or early August. Similar to coho, fall Chinook salmon in the South Umpqua River begin upstream migrations in early September. Spawning in the South Umpqua mainstem begins as early as mid-September, but begins in October within tributaries to the South Umpqua. Fall Chinook salmon spawning in the Rogue River mainstem and tributaries also begins in October (see figure 4.1.4-1).

Life Stage/Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coos Bay Estuary and Coos River to the Confluence of Millicoma - South Fork Coos River												
Upstream Adult Migration												
Adult Holding												
Juvenile Rearing												
Juvenile Out-Migration												
Coquille River and Tributaries												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												
Rogue River Mainstem												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												
Rogue River Tributaries from Marial to Lost Creek												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												
South Umpqua River Mainstem												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												
South Umpqua River Tributaries												
Upstream Adult Migration												
Adult Spawning												
Adult Holding												
Incubation-Fry Emergence												
Juvenile Rearing												
Juvenile Out-Migration												

Key:
- period of peak use.
- period of lesser level.
- period of known presence with uniform or unknown level of use.

Source: ODFW 2008.

Figure 4.1.4-1 Approximate Timing of Fall Chinook Salmon Use of Streams and Estuaries in the Pipeline Project Area

Figure 4.1.4-2 shows the specific timing of life history phases for spring-run Chinook salmon within the riverine analysis areas. No life-phase timing of spring Chinook salmon is reported for the Coos Bay estuary or Coos River. Spawning does occur in the Coquille River and tributaries from September through mid-November. Spawning also occurs within the Rogue River mainstem and tributaries in October and November, as well as in the South Umpqua River mainstem from mid-September through January and in its tributaries from October through mid-January (see figure 4.1.4-2).

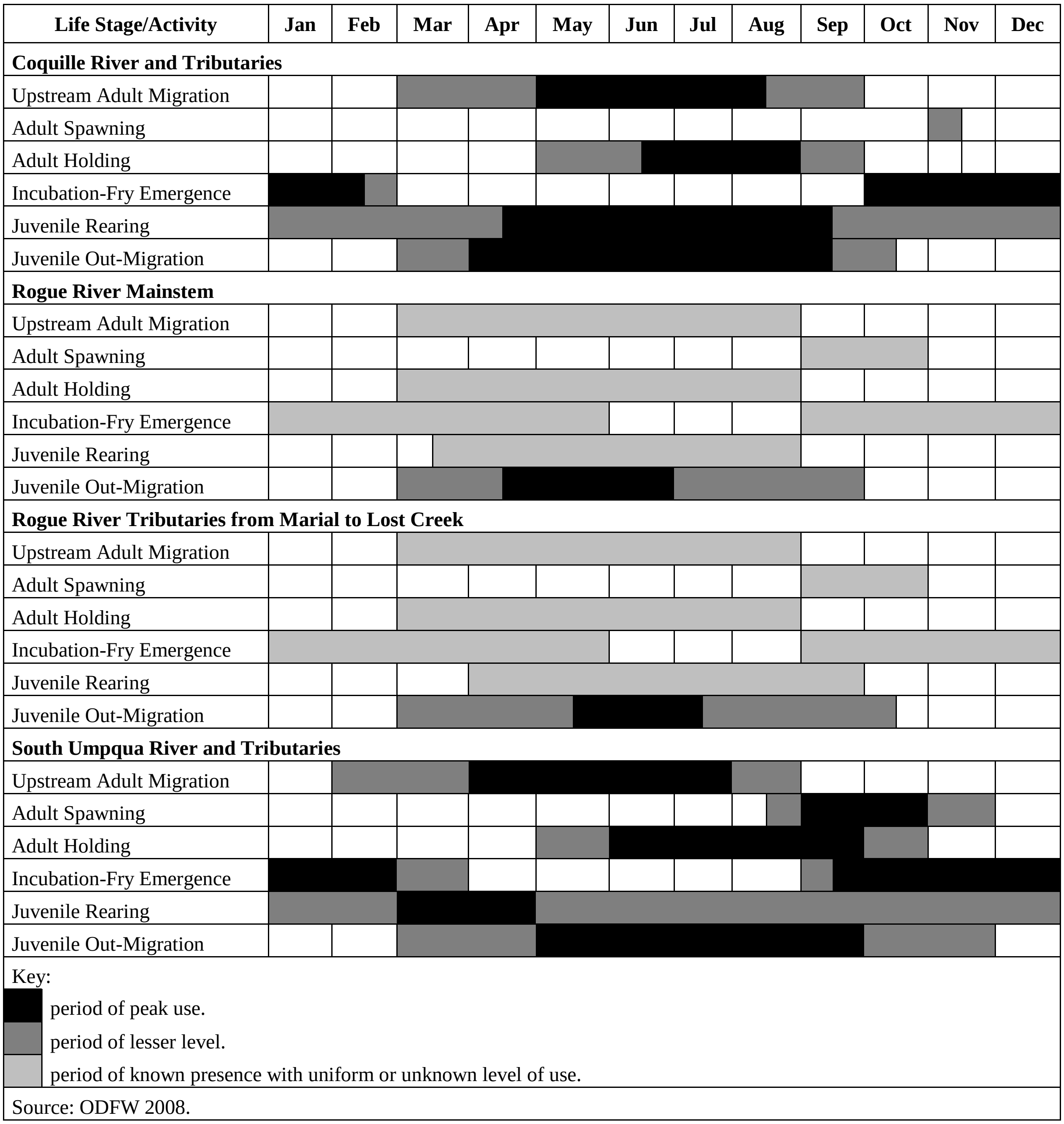

Figure 4.1.4-2 Approximate Timing of Spring Chinook Salmon Use of Streams in the Pipeline Project Area

4.2 ANALYSIS OF EFFECTS

Most of the Project effects to fish and their habitats are described in detail in BA effects discussions for the ESA listed fish species including green sturgeon (section 3.5.1.3), eulachon (section 3.5.2.3), SONCC coho salmon (section 3.5.3.3), and Oregon Coast coho salmon (section 3.5.4.3). While effects analyzed were specific to these species, the details of the type of effects are mostly comparable to other fish habitat groups in the same environment.

Since the four EFH fish management groups would have effects that are similar or the same across the three analysis areas (marine, estuarine, and riverine) in type and magnitude, the discussion below will focus on the level of specific effects within each analysis area. Where effects would be unique to each management group, these effects are called out.

4.2.1 Marine Analysis Area

The marine analysis area includes EFH for all four FMP fish groups and is the only analysis area where highly migratory species may be present. With the possible exception of adult common thresher shark, highly migratory species are likely to be absent from the marine environment near the entrance to Coos Bay. Project actions in this area that have the potential to affect these FMP groups are associated with underwater noise and potential fuel, gas, or oil spills from LNG carriers in transit to and from the LNG Terminal. A more detailed discussion of direct, indirect, and cumulative effects of the Project on fish and their associated habitat requirements in the marine analysis area is included in section 3.5.

4.2.1.1 Acoustic Effects

Underwater noise produced by LNG carriers transiting the marine analysis area may affect fish of all four FMP groups. Some of the LNG carriers that would call on the LNG Terminal generate more noise than the LNG carriers built in 2003 with 138,028 m^3 capacity that produced sound levels (with one standard error) of 182 ± 2 dB re: 1 µPa @ 1 meter as reported by Hatch et al. (2008). Hatch noted that LNG carriers produced nearly the highest noise level of any type of major vessel monitored.

State agencies in Washington, Oregon, and California along with federal agencies have developed interim noise exposure threshold criteria for pile-driving effects on fish (WSDOT 2011a; Fisheries Hydroacoustic Working Group 2008; Popper et al. 2006). These threshold criteria are considered levels below which injury effects would not occur to fish from in water noise. These thresholds should thus be suitable for all forms of in-water noise. Interim noise exposure threshold criteria for pile driving effects on fish include: 1) a cumulative sound exposure level (SEL_{cum}) of 187 dB re 1 μPa^2 s for fishes weighing more than two grams, 2) a SEL_{cum} of 183 dB re 1 μPa^2 s for fishes less than two grams, and 3) a single-strike peak level (SPL_{peak}) of 206 dB re 1 µPa for all sizes of fishes (WSDOT 2011a). As described by Hatch et al. (2008), LNG carriers built in 2003 produced sound levels (with one standard error) of 182 ± 2 dB re: 1 µPa @ 1 meter that attenuated to 160 dB at 35 ± 11 meters and to 120 dB at 16,185 ± 5,359 meters.

In-water noise values generated by LNG carriers transiting the marine analysis area for the proposed project would attenuate to levels below the effect thresholds noted above a few meters from a vessel's hull and, therefore, would not cause direct harm to fish. Very small fish within 1 meter (3 feet) of an LNG carrier hull that are exposed to LNG carrier noise for extended periods, however, could be adversely affected. Since most fish can easily avoid LNG carriers in transit, noise exposure typically would be very brief, further reducing the potential for adverse effects. Therefore, underwater noise generated by LNG carriers transiting the marine analysis area is not expected to adversely affect EFH of the four FMP groups.

4.2.1.2 Fuel or Oil Spills at Sea

The LNG carriers use either a steam or duel fuel diesel electric propulsion system that is primarily fueled by natural boil-off gas. Fuel (e.g., diesel) used for back-up generation for LNG carrier propulsion and oil or hydraulic fluids used for mechanical equipment could possibly leak or be spilled while the carriers are in transit. A maximum of 120 LNG carriers per year would traverse the marine analysis area to call at the LNG Terminal. The low volumes of petroleum oils and fuel on LNG carriers greatly reduces the risk of impacts on the marine environment from petroleum spills. The Federal Water Pollution Control Act, as amended by the CWA (33 U.S.C. 1251–1387), prohibits the discharge of oil upon the navigable waters of the United States. Also, LNG carriers calling on the LNG Terminal would be required by the Coast Guard to have a vessel response plan in order to be adequately prepared for accidental spills. As reported by Pacific States/British Columbia annual reports (2002), the number of oil spills reported from fishing, recreational and other harbor marine vessels in Oregon ranged from about 9 to 65 per year, which is fairly infrequent considering that thousands of marine vessels, both recreational and commercial utilize Oregon coastal marine waters. As a result, accidental spills or release of fuel, lubricants, or hydraulic fluids within the marine analysis area are not expected to adversely affect any EFH of the four FMP groups.

4.2.2 Estuarine Analysis Area

The estuarine analysis area of Coos Bay includes habitat and fish from the coastal pelagic, groundfish, and Pacific salmon FMP groups. Effects to EFH in this area would be associated with LNG carrier transit into and out of the bay; slip, access channel, Navigation Reliability Improvements, and associated upland facility construction and operation; HDD installation under the Coos Bay estuary; and LNG carrier water intake and discharge while at the loading dock. A summary of marine and estuarine habitat areas temporarily and permanently affected by construction and operation of the LNG Terminal is presented in tables 2.3-1 and 2.3-2 of JCEP's Resource Report 2. Additional detailed discussion of direct, indirect, and cumulative effects of the Project on fish and associated habitats in the estuarine analysis area is included in section 3.5.

4.2.2.1 Turbidity Effects from Dredging in Coos Bay

Resuspension of sediments and temporary increases in turbidity above Coos Bay background levels would occur while installing and removing the temporary earthen berm at the LNG Terminal slip and while dredging the access channel and Navigation Reliability Improvements.

Turbidity increases would be limited to the time required to complete each of the respective Project components within the ODFW in-water work window (October 1 to February 15) and would be subject to water quality compliance standards.

Construction of the LNG Terminal slip would require excavation and dredging of Coos Bay's shoreline near Jordan Cove. Excavation of the slip would be primarily conducted in isolation from the waters of Coos Bay by leaving a temporary earthen berm in place at the mouth of the slip during excavation. Release of turbid waters into the bay would be essentially prevented during excavation of the slip, except during a short period when the earthen berm is removed to connect the slip to the access channel and Federal Navigation Channel (FNC). Details on dredging quantities and methods, sedimentation and turbidity levels, and other Project related effects on fish habitat are described in section 3.5.1.3 and in JCEP's Resource Reports 2, 3, and 7.

The effects of temporary siltation and sedimentation on EFH from removing the earthen berm at the mouth of the Terminal slip and while dredging the access channel would be similar to those that would result from maintenance dredging of the Coos Bay FNC by the USACE. The quantity of dredge material from the maintenance of the FNC averages about 900,000 cubic yards (cy) per year. In comparison, JCEP would dredge a total of about 1.8 million cy (mcy): 0.5 mcy when removing the earthen berm and 1.3 mcy when dredging the access channel to a design depth of minus 45 feet (NAVD88) plus 1.7 feet for advanced maintenance dredging and 2 feet for allowable overdepth. Dredging methods would include cutterhead suction dredge, clam shell dredge, and/or mechanical excavation with backhoe.

Turbidity was modeled for the capital (i.e., new construction) dredging operations based on the anticipated geotechnical and environmental conditions for this project using the COE's DREDGE model and two dimensional numerical model Mike21 (see discussion in section 3.5.1.3, green sturgeon). Increases in turbidity in the bay due to construction-related dredging would be for a short period of time (4-6 months) affecting a restricted area. Modelling at the access channel has demonstrated the maximum turbidity plume extent, defined by the simulated 10 NTU above background contour, to be approximately 780 and 750 feet when using a cutter suction and clamshell dredges respectively. (Moffatt & Nichol 2017c). When dredging the access channel, the turbidity plume would be primarily elongated in an upstream or downstream direction, depending on the tidal cycle. To a more limited extent, the plume also would extend laterally from dredging sites. As dredging operations approach the FNC (where water velocities are greater), the turbidity plume would extend farther downstream (during an outgoing tide) or upstream (during an incoming tide) than it would near the mouth of the terminal slip where water currents are lower.

To minimize the generation of TSS and turbidity during dredging, operational and environmental controls would be employed to assure compliance with water quality criteria stipulated in the CWA Section 401 Certification issued by ODEQ. Such controls may include ceasing dredging, decreasing cutterhead speed, increasing the suction flow rate and using different size or type of dredge (e.g., use of a cutter suction dredge or closed clamshell bucket to minimize turbidity generation), lowering the crest elevation, and/or avoiding sediment stockpiling during peak ebb conditions (Moffatt & Nichol 2017o). In addition, containment systems on scows and/or barges used to transport material from the eelgrass mitigation site, or other dredge locations, will minimize the release of turbid decant water back into the bay. All dredging activities that are not isolated from Coos Bay will be conducted during the in-water work window that will extend from October 1st to February 15th to limit potential impacts to sensitive life stages of fish.

A Turbidity Monitoring and Management Plan (TMMP) will be prepared during final design. The TMMP will be finalized after the means and methods of dredge operations are confirmed by the selected contractor. The primary goal of the TMMP will be to manage proposed dredging operations for the Project consistent with DEQ water quality standards and permit requirements. Provisions of the DEQ-approved TMMP will be followed during all dredging activities.

Juvenile life stages of coho and Chinook salmon would be less common in Coos Bay during the fall and winter in-water work window. Exposure to sedimentation and turbidity from dredging, therefore, would be minimal. Adult coho and Chinook salmon, however, migrate into the estuary in the fall and early winter concurrent with in-water construction and maintenance activities (see life history figures 4.1.4-1 and 4.1.4-2 above for Chinook salmon and figure 3.5.3-1 for SONCC coho and figure 3.5.4-1 for Oregon Coast coho salmon). Smaller fish, with a limited swimming ability, would be less able to avoid turbid waters within about 200 feet of dredging operations. Turbidity exposure to adult or juvenile fish would be short-term and localized and may be mitigated to an immeasurable extent as fish avoid underwater noise generated near dredging areas.

Benthic and epibenthic biota would be directly and indirectly affected by dredging, sedimentation, turbidity, and from other in-water construction activities. Construction of the MOF, slip, and access channel would result in the long-term loss of intertidal to shallow subtidal, salt marsh, and eelgrass habitats as described in greater detail in section 3.1.4.2 of JCEP's Resource Report 3. Temporary impacts to deep subtidal habitats would result from dredging the Navigation Reliability Improvements.

While both long- and short-term losses of such habitat from dredging would adversely affect EFH for the three FMP groups, such impacts would be minor relative to the overall availability of EFH in Coos Bay. EFH disturbed by dredging the Navigation Reliability Improvement sites, access channel and the earth berm at the Slip entrance, would recover to a limited extent within a month to a year subject to future disturbance (Newcombeand Jensen 1998, Swartz et al. 1980, as cited in Wilber and Clarke 2007). The Eelgrass Mitigation Site, although requiring several years to develop, would eventually improve the ecological function of the existing eelgrass community and contribute to a long-term increase in EFH for all three FMP groups.

In summary, capital dredging may adversely affect EFH for juvenile and adult fish from the three FMP groups. This is based on the predicted levels of turbidity from dredging in Coos Bay relative to background levels, the short-term, localized, but ongoing exposure of fish to such conditions during the possible four in-water work windows.. Maintenance dredging plans are subject to subsequent regulatory consultations and permit approvals associated with the Project operations phase.

4.2.2.2 Turbidity Effects from Temporary In-water Construction

In-water construction activities are expected to temporarily increase concentrations of sediment and turbidity. Such increases would be localized and limited to the time required to complete each of the following Project components within the ODFW in-water work window:

- Temporary Material Barge Berth (TMBB),
- Material Offloading Facility (MOF),
- Pile Dike Rock Apron
- Trans Pacific Parkway/US-101 Intersection Widening,

- APCO Site access bridge construction,
- replacement of anchoring systems for existing meteorological ocean data collection buoys as well as addition of anchoring systems for two new buoys,
- establishment of hydraulic connections to the Kentuck Project for estuarine habitat mitigation, and
- creation of the Eelgrass Mitigation site.

Benthic and epibenthic biota would be directly and indirectly affected by sedimentation, turbidity, excavating the TMBB, fill associated with the MOF, and from other in-water construction activities. Construction of the MOF and Pile Dike Rock Apron would result in the long-term loss of intertidal to shallow subtidal, salt marsh, and eelgrass habitats as described in greater detail in section 3.1.4.2 of JCEP's Resource Report 3 for the MOF. Temporary impacts to intertidal and deep subtidal habitats, including eelgrass communities, also would result from in-water construction including the work bridge piling for the APCO Site access bridge, the Eelgrass Mitigation Temporary Dredge Line, the Kentuck Project, and the APCO 2 Temporary Dredge Transfer Line.

While both long- and short-term losses of such habitat would adversely affect EFH for the three FMP groups, such impacts would be minor relative to the overall availability of EFH in Coos Bay. The Eelgrass Mitigation Site, although requiring several years to develop, would eventually result in a long-term increase in habitat that would benefit EFH for all three FMP groups.

4.2.2.3 Turbidity Effects – LNG Carriers in the Waterway

Propwash from propellers of LNG carriers and tug boats, as well as ship wakes (waves) breaking on shore, may cause an increase in shoreline erosion and turbidity over existing conditions. Depending on the intensity of such wave energy and bottom scour, eroded materials could be re-suspended within the water column resulting in disturbance, displacement, and injury to nearshore fish and benthic communities. Potential effects to the abundance, diversity, and health of benthic biota could alter food availability and feeding conditions for foraging and migrating fish species. Depending on the magnitude of vessel-generated waves and the location and character of the shoreline they encounter, potential fish stranding also could result from certain vessels in transit in Coos Bay (see section 4.2.2.5).

To address such concerns, potential wake effects of LNG carriers and tugs, with up to 120 inbound and 120 outbound trips per year, were evaluated through model studies by JCEP (see section 3.5.1.3). The model results indicated LNG carrier transit would contribute to existing shoreline erosion caused by wind and existing vessel traffic, however, the magnitude would be small and much less than what naturally occurs from wind-generated waves. The height of waves along the shoreline were predicted to range from 0.6 to 0.8 feet for outbound tugs periodically traveling at high speeds (up to 10 knots) to meet incoming LNG carriers. Wave heights associated with typically slower LNG carrier-tug transits were predicted to be lower at 0.2 to 0.6 feet. Therefore, project-related wakes and shoreline erosion would likely be within the range of the natural annual variability of wind waves that have heights ranging from 0.5 to 3 feet (Moffatt & Nichol 2017d).

Modeled propeller-generated bottom disturbance from LNG carrier passages indicated some increases in bed disturbance within 0.25 to 0.5 mile of the slip along a narrow band (about 80 feet wide) in the deep mid-channel where coarse sediments occur. This would result in a limited amount of turbidity that would be localized and within the range of seasonal background levels in Coos Bay. Modeled tugboat operations indicated some bottom disturbance also would be likely during docking. The extent of bottom disturbance in the access channel would be limited to a depth of nearly 0.5 feet below the bed surface over a small area of about 100 by 50 feet. In most cases, the actual disturbance would likely be much less than this because of the conservative assumptions used in the model, including a lack of slope protection. Slope protection is planned for the north side and sections of the east side of the slip, reducing potential bottom scour. Again, elevated suspended sediment and turbidity levels during LNG carrier docking are expected to be localized resulting in short-term effects to benthic communities and fish habitat in the docking area. Overall, while the magnitude, extent, and frequency of propeller scour, suspended sediment, and turbidity resulting from Project-related wave energy and propwash, may be minor, it may adversely affect EFH for the three FMP groups.

4.2.2.4 Turbidity Effects – Pipeline Construction with HDD

Coos Bay would be crossed by two HDDs, one from MP 0.28 to MP 1.00 (West HDD), the other from MP 1.46 to MP 3.02 (East HDD). The Coos River (a tributary to the estuary) would also be crossed using HDD at MP 11.13. At that location, the Coos River is under tidal influence.

Drilling requires use of a drilling mud for lubrication of the bit and removal of cuttings. A non-toxic, biodegradable bentonite clay mixture makes up drilling mud. Because the drilling mud is under pressure during drilling, if the bit encounters substrate fractures or channels, it is possible for bentonite to escape from the hole (termed a “inadvertent return”). Bentonite can escape to the surface through fractures in the drilled substrate. Benthic organisms, which coho salmon would feed on, could also be affected by burial. However, bentonite is more likely to stay in suspension than settle if compared to common bottom sediment; therefore, in flowing water areas, effects to benthic organisms from burial from inadvertent return are likely to be low.

The horizontal crossing length of the West HDD would span 5,192 feet, extending from the North Spit to the southeast, crossing the Coos Bay navigation channel and terminating at North Point in North Bend, Oregon. The HDD profile would pass approximately 158 feet below the railroad trestle bridge and approximately 138 feet below the deepest part of the navigation channel. The depth and the locations of the railroad trestle foundations are unknown at this time (GeoEngineers 2017a). The feasibility analysis for the West HDD anticipates a relatively low risk of hydraulic fracture and drilling fluid surface releases occurring during construction due to geologic conditions along the drill path. However, there is a risk of hydraulic fracture and drilling fluid surface release within about 150 feet of either end of the HDD due to the anticipated loose sand and decreased depth of cover during drilling operations.

The horizontal crossing length of the East HDD would span 8,972 feet extending from North Point in North Bend, Oregon eastward across Coos Bay and ending at the mouth of Kentuck Slough. Surface conditions at North Point at the west end of the HDD consist of a relatively flat ground surface covered with fill stockpiles. The east end of the HDD would be located within a flat grass vegetated area in Kentuck Slough Valley. The proposed depth of the pipeline would be 210 feet below ground surface. The risk can be reduced by reaming the hole from both ends of the crossing. In general, GeoEngineers (2017a) expects the risk of drill hole instability along the HDD drill paths to be relatively low. Minor hole instabilities may be encountered within the very loose to loose soils expected along the upper portions of the HDD profile at the east end near Kentuck Slough, but that condition would not jeopardize the successful installation of the product pipe.

For construction using HDD across the Coos River (GeoEngineers 2017b), the design length of the Coos River HDD crossing would be approximately 1,602 feet. The proposed entry point would be located approximately 500 feet from the north bank of the Coos River and the exit point approximately 630 feet from the south bank. The entry and exit points would allow for adequate depth beneath the Coos River. The preliminary design provides a minimum of 50.3 feet of cover below the Coos River. GeoEngineers' evaluation determined that the construction of the Coos River HDD crossing is likely feasible. GeoEngineers opined that there is a relatively high risk of hydraulic fracture and drilling fluid surface releases along the first 500 feet and last 300 feet of the HDD, respectively. However, the risk of drilling fluid surface release to the Coos River would be relatively low.The locations where any inadvertent return may occur in the Coos River would be affected less because of the dilution factor of the large volume of water from any spill. PCGP's *Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations* (see appendix D) describes how the drilling operations would be conducted and monitored to minimize the potential for inadvertent drilling mud releases. The HDD Contingency Plan also includes procedures for cleanup of drilling mud releases. If significant concentrations are found during monitoring as a result of a release, possible corrective measures would be taken as described for Oregon Coast Coho in section 3.5.4.3 (Direct and Indirect Effects – Estuarine Analysis Area).

4.2.2.5 Construction Runoff and Stormwater Discharge from LNG Terminal

The type of effects to EFH from upland facility stormwater discharge during construction and operation are described in detail in sections 3.5.1.3 and 3.5.4.3. During construction, impacts on marine resources could result from the clearing of vegetation at the terminal, erosion and sediment runoff, and potential hazardous substance spills. While no streams are present in the upland portion of the LNG Terminal, the removal of existing vegetation could modify the character and amount of water runoff into the bay. JCEP would prevent uncontrolled releases of sediment runoff during construction by implementing the erosion control and revegetation measures described in JCEP's ESCP. Additionally, accidental spills of hazardous materials (e.g., equipment fuel, oils, and paints) during construction could have effects on aquatic resources in the bay. JCEP prepared a draft site-specific SPCCP to control accidental releases of hazardous materials and manage potential adverse effects to EFH and fish species in Coos Bay.

Stormwater discharge has the potential to contain chemicals toxic to EFH species present in the Coos Bay estuary and nearshore ocean, excluding highly migratory species. The applicant's NPDES permit would require monitoring of discharges to ensure they do not modify state water quality standards of the receiving water. The 1200-C stormwater permit application states, "The permit registrant must not cause a violation of instream water quality standards" (ODEQ 2007).

Since the water quality standards are designed to protect aquatic resources, including EFH species, the applicants are to ensure the standards are not exceeded, and therefore do not cause adverse harm to aquatic resources. Thus, compliance monitoring to ensure all terms and conditions of the permit issued by the state also would ensure that aquatic resources are protected. However, it is known that stormwater runoff can result in chemical concentrations at the point of discharge that are in excess of EPA water quality criteria (WDOE 2009). The general characteristics of the stormwater management system is described below.

The proposed stormwater management system is designed to direct flows that do not come into contact with any equipment containing potential contaminants (grease or lubrication oil) to designated areas for treatment.. Treatment of runoff from areas that have low potential for oil or grease contamination will generally consist of on-site infiltration to treat for suspended solids. Cartridge filter vaults may also be used in some locations. Stormwater collected in areas that are potentially contaminated with oil or grease will be pumped or will flow to the oily water system. Primarily, these localized drains are located around equipment to contain grease and/or lubrication oil. Water and oil from the collection sump would overflow to the oily waste separator package equipped with plate type separation devices to remove any oil and grease washed down from the facility equipment. Recovered oil and grease would be held in the sump and periodically pumped directly to storage drums for disposal. The oily water system will flow to the oily water separator package(s) before being treated and discharged to the IWWP and ocean outfall. The facility will be designed to provide drainage of surface water to designated areas for disposal in accordance with 49 CFR § 193.2159. Stormwater collection and treatment facilities will be designed to meet regulatory requirements from the National Marine Fisheries Service ("NMFS") and ODEQ.

The proposed oil and grease treatment system is designed to limit discharges of oil and grease and would ultimately need approval from the State to obtain the NPDES permit. The treatment system function is an additional level of protection for inadvertent spills that come into contact with stormwater. The facility is not designed to intentionally mix oil and grease with stormwater and there are no continuous discharges of oil and grease from the LNG Terminal. Discharges from the LNG Terminal that could contain oil and grease would only occur during stormwater events. The following is a description of stormwater management systems for specific Project components.

Stormwater Management at LNG Terminal Site

The stormwater management plan has been prepared to address stormwater system design, which would require approval from ODEQ (see Storm Water Management Plan appended to JCEP's Resource Report 2). Impervious surfaces associated with the LNG Terminal site include concrete at operational laydown areas, vehicle offloading areas, secondary containment areas, and working areas for operational maintenance. General surfacing in other areas where operational maintenance access would potentially be required would be dense-graded aggregate. In the areas of the Administration building and the Southwest Oregon Regional Safety Center (SORSC) building, finished surfaces would consist of asphalt for the parking lots and concrete for the helipad. The gas metering station would be surfaced with dense-graded aggregate. Runoff would be separated into either the stormwater system or the oily waste system. Stormwater with a high potential to encounter oil and grease pollution would be contained via curbs or other means and routed to an oil/water separator prior to being conveyed to the

Industrial Wastewater Pipeline (IWWP) according to the applicable the NPDES permit requirements. For areas of the site where stormwater has a low potential to encounter oil and grease pollution, the first flush of stormwater would be treated onsite by either infiltration facilities, flow-through type cartridge filter devices, or vegetated side slopes. Infiltration facilities would provide treatment for the majority of the stormwater falling on the site. The facilities would be designed to capture and infiltrate all stormwater for 100% of the 2-year, 24-hour storm. Overflows from the infiltration facilities would be routed to pipe outfalls in the slip and Coos Bay. For locations that are not feasible to infiltrate, stormwater would be routed to cartridge filter devices, where the treated effluent would be discharged to Coos Bay through an NPDES permitted outfall. Stormwater from access roads to the site would flow through vegetated side slopes or ditches for treatment prior to being discharged to natural grade.

Industrial wastewater would be conveyed to the Port's existing ocean outfall, pursuant to the NPDES permit issued by the ODEQ. Stormwater collection and treatment facilities would be designed in consultation with NMFS and the ODEQ.

During construction, spills or leaks of hazardous liquids such as fuel or oil associated with construction equipment have the potential to reach surface waters including Coos Bay. Potential adverse effects from a fuel spill would likely be short-term and localized, affecting EFH species within the estuarine analysis area. Petroleum-based contaminants such as fuel, oil, and some hydraulic fluids contain polycyclic aromatic hydrocarbons (PAHs) which can be acutely toxic to the aquatic environment for fishes, and can also cause lethal and sublethal effects to aquatic organisms (Breteler et al. 1985). Potential impacts from such spills would be avoided or greatly reduced by regulating storage and refueling activities, and by immediately implementing cleanup should a spill or leak occur. To avoid and control the potential contamination of surface water, the preliminary SPCCP prepared for the construction phase; describes the measures that would prevent and minimize the potential for accidental releases of hazardous materials and to establish protocols concerning containment, remediation and reporting of any releases that occur. The SPCCP would be included as part of the NPDES permit.

Operation of the LNG Terminal would not require or produce large quantities of hazardous materials. Solvents and paints would be used during normal maintenance activities and would be stored in specialized containers with secondary containment to prevent spills. Within the LNG Terminal would be a system of curbs, drains, and basins that contain and collect accidental spills or leaks thus preventing releases into Coos Bay that otherwise could impact water quality and reduce feeding opportunities for aquatic species within the estuarine analysis area. Operations at the LNG Terminal would comply with the SPCCP to minimize the potential for accidental releases of hazardous materials and to establish proper protocols concerning minimization, containment, remediation, and reporting should releases occur. The SPCCP would meet the requirements of 40 CFR Part 112.

In the event of a spill, any hazardous materials from the concrete containment basins would be collected and trucked offsite to appropriate disposal areas. In the unlikely event of an accidental LNG spill, no effects on EFH are anticipated since LNG is not toxic, is not soluble in water, and, if spilled on water, would vaporize and rise when exposed to the warmer atmosphere.

During operations, LNG carriers calling on the LNG Terminal could have accidental releases of fuels or other contaminants commonly used on ships. There is no planned bunkering (loading of fuel oils) for the LNG carriers and these products are kept in relatively small quantities on ships. Therefore, such spills would be limited to small inadvertent spills of petroleum-based fuels and lubricants from equipment onboard that would be managed according to the carrier's oil spill response plan. Depending on the timing, weather conditions, and the efficiency of the response and cleanup, localized adverse impacts may still occur depending on the proximity to aquatic habitat.

Stormwater Management at Trans Pacific Parkway/US-101 Intersection Widening

Stormwater generated as a result of new impervious area at the Trans Pacific Parkway/US-101 Intersection Widening would be collected and conveyed to treatment facilities to provide treatment for 100% of the 2-year storm event. Drainage curbs would be installed near the edge of pavement along the northwest side of the roadway. These drainage curbs would collect and convey flow from the road crown to water quality treatment facilities. The water quality facilities would provide treatment for the design flow volume and bypass higher flows before discharging the runoff into Coos Bay.

Stormwater Management at Kentuck Project Site

Roadway improvements associated with the Kentuck Project, which include elevating and re-paving of East Bay Drive and Golf Course Lane, would result in the addition of new impervious area. The stormwater facilities at the Kentuck Project site would be designed to provide treatment for 100% of the 2-year storm event wherever feasible.

East Bay Drive would sheet flow stormwater runoff to roadside drainage curbs. Once along the curb, water would flow toward cartridge filters which would treat water before discharging the runoff onto rip-rap road base adjacent to the receiving waters in Kentuck Inlet.

Along most of Golf Course Lane, surface water ditches and flow-through bio-infiltration conveyance systems are proposed. In these areas, collected flow that does not fully infiltrate into the underlying well-draining soils would be conveyed to an outfall into the Kentuck Slough. At the north end of Golf Course Road, runoff would be collected in drainage curbs and conveyed to cartridge filters before discharging to Kentuck Slough.

Stormwater Management at Temporary Construction Facilities

Construction laydown areas would be surfaced to a large extent with larger, open-graded aggregate that would allow infiltration; therefore, stormwater from these areas would be self-contained and would infiltrate without the need for outfalls. Impervious surface would not be added at the Pony Village and Myrtlewood Offsite Park & Rides for the JCEP Project Area. Stormwater treatment for temporary facilities is described further in JCEP's Resource Report 2 and the ESCP appended to JCEP's Resource Report 7.

Stormwater Management at APCO Sites

APCO Site 1 (East) would be surfaced with dense-graded gravel and would have existing drainage patterns would be preserved to the maximum extent practical. Stormwater would be treated primarily by vegetated swales and filter strips. Fill placed on APCO Site 2 (West) would be surfaced with native vegetation. Additional storm water controls would be added if necessary. The bridge connecting APCO Site 1 and 2 is in preliminary design. All stormwater run-off from the bridge would be treated prior to discharge to Coos Bay.

As a result of the stormwater management system that would be implemented during Project construction and operation, stormwater runoff and discharges may affect EFH or coastal pelagic, groundfish, and Pacific salmon species under the three FMP groups.

4.2.2.6 Stranding from Ship Wakes

Fish stranding can occur when fish, particularly those with a weak swimming ability, become displaced from shallow waters onto shore by waves generated by the wakes of passing vessels. A description of how fish stranding occurs, various causal factors, and locations in Coos Bay identified as having a potential risk of fish stranding are described in sections 3.5.1.3 and 3.5.4.3. Detailed fish stranding studies involving juvenile salmon and other fish species have been conducted in the Lower Columbia River and provide the primary basis for the following analysis.

Fish stranding typically results in mortality unless subsequent waves return the fish to the water after stranding occurs. A series of interlinked factors act together to produce stranding during vessel passages. These factors may include water surface elevations, with low tides more likely to result in strandings than high tides; beach slope, with strandings more likely on low gradients than high; wake characteristics influenced by vessel speed, size, hull geometry, and depth underwater (draft); and biological factors, such as numbers of small fish with weak swimming ability near the shoreline that tend to be more susceptible to stranding (see section 3.5.4.3).

In the Lower Columbia River, ship wakes produced by deep-draft vessels traveling at speeds greater than the estimates for LNG carriers to be used in the Coos Bay estuary have been observed to cause occasional stranding of juvenile salmon (Pearson et al. 2006). When stranding occurred, however, none was observed as a result of vessels traveling at speeds under 9 knots (10.4 mph). Pearson et al. (2006) also found that salmon larger than 90 mm were generally not susceptible to stranding. The hull geometry of the LNG carriers is such that bow wakes are minimized, especially at the slower speeds of four to six knots that would be typical along most of the transit route through Coos Bay. Therefore, the LNG carriers would be traveling at speeds less than that observed by Pearson et al. (2006) that caused stranding. In models and research conducted by JCEP, wave heights produced by LNG carrier traffic would be less than background levels from existing Coos Bay vessel traffic. Overall, vessel-generated waves would contribute a small proportion of the total waves that occur in the bay when waves caused by natural winds are considered (see models described in section 3.5.1.3). In addition, the LNG carriers would be arriving and leaving the bay at high tide when gently sloping beaches are mostly submerged and less likely to contribute to fish stranding risk.

While more species and life stages would be present year-round in Coos Bay for groundfish than coastal pelagic species, their susceptibility to stranding and loss from vessel wake should not be markedly different for either FMP group than those described below for salmon. Considering that LNG carriers and accompanying tugs would enter and leave the bay at high slack tide and would typically travel at low speeds of 6 knots (6.9 mph) generating wave heights within the normal range of background conditions, Project-related vessel wakes are not expected to adversely affect EFH for the coastal pelagic and groundfish FMPs.

The assessment of potential effects of stranding from Project-related vessel wakes was described for coho salmon in section 3.5.4.3. Based on that analysis, vessel wakes are not expected to adversely affect Pacific salmon EFH in Coos Bay that support both coho and juvenile Chinook salmon. While age 0 Chinook salmon tend to be more susceptible to stranding, partly because of their apparent nearshore distribution, proposed vessel traffic procedures for LNG carriers in Coos Bay that include low travel speeds only at high tide have been found to reduce the stranding loss of even age 0 Chinook salmon in the lower Columbia River to insignificant levels (Hinton and Emmett 1994). The outer mile of the channel, where vessel speed would be the highest, would appear to be a region of greatest potential stranding from large waves generated by vessels. However, the area is also a region of naturally higher waves due to its proximity to the ocean (Wagoner et al. 1990), so ship wake is likely to have a much lower effect than natural conditions relative to frequency and magnitude of shore waves.

Also, although data for Coos Bay are not specifically available, radio-tagging studies of juvenile salmonids in the Columbia River suggest that even age 0 Chinook salmon tended to be more commonly offshore when they are approaching the marine environment near the mouth of the Columbia River (Carter et al. 2009). If this behavior should occur in Coos Bay, it would further reduce the risk of age 0 Chinook salmon from potential stranding by vessel wakes. Overall stranding potential is higher for age 0 Chinook salmon in Coos Bay from vessel wakes than for larger Chinook or coho salmon. Available information suggests stranding of all juvenile salmonids would not be substantial. Project-related vessel wakes, therefore, are not expected to adversely affect Pacific salmon EFH.

4.2.2.7 Ballast Water Exchanges and Exotic, Invasive Species

As described in further detail in section 2.2.6.1.7.1 of JCEP's Resource Report 2 and section 3.1.4.11 in Resource Report 3, LNG carriers must discharge ballast water into the terminal slip when taking on cargo. Each LNG carrier would discharge approximately 9.2 million gallons of ballast water during the loading cycle, which would occur about 120 times per year. While no wastewater would be discharged to the slip, ballast water exchanges (BWEs) could introduce exotic, non-native species into Coos Bay. Should this occur, such organisms may threaten to outcompete and exclude native species thereby affecting the overall health of the estuarine ecosystem. Potential adverse effects of BWEs to the EFH of all three FMP groups would be mitigated by federal mandates that regulate how and where vessels must conduct a BWE before entering U.S. ports. Enforced by the U.S.C.G., these protocols require complete exchange of ballast water in the open sea at least 200 miles from U.S. waters and have been reported to reduce the introduction of exotic and invasive organisms by 88 to 99 percent (NRC 2011). An additional requirement for many marine vessels (depending on size and when constructed) was implemented beginning in 2013. It requires regulated vessels from foreign ports to also treat ballast water, rather than just exchange it with ambient seawater, and to "flush" potential invasive organisms to further reduce the risk of invasive species being discharged at U.S. ports (see section 3.5.1.3 for details of these regulations). Compliance with these regulations by LNG carriers transiting to and from the LNG Terminal, therefore, should effectively reduce risks of introducing exotic, invasive species to the Coos Bay ecosystem.

Ballast water discharges also could affect certain estuarine water quality parameters on a local basis near the point of discharge. For example, salinity could be increased and dissolved oxygen could be reduced as a result of the periodic influx of seawater at the LNG Terminal. While 9.2

million gallons of ballast water would be typically discharged from each LNG carrier, this represents only 0.3 percent of the water passing by the LNG Terminal and only 2.4 percent of the total volume of 374 million gallons in the slip. Relative to the total water volume of Coos Bay, the net change in salinity would be extremely small and discountable. Potential net effects on other water quality parameters, including dissolved oxygen and pH, also would not be notable as described in further detail in section 2.2.6.1.7.1 of JCEP's Resource Report 2 and section 3.1.4.11 in Resource Report 3. Therefore, BWEs may affect but would not adversely affect EFH for the three FMP groups.

4.2.2.8 Entrainment and Impingement

Dredging

During dredging operations, small fish, larvae, fish eggs, and benthic prey species could be entrained. Larger fish with greater swimming ability would be able to actively avoid areas where disturbance from dredging operations occurs. In a review of many maintenance dredge studies through 1998, Reine et al. (1998) concluded that "much of the available evidence suggests that entrainment is not a significant problem for many species of fish and shellfish in many bodies of water that require periodic dredging."

Dredging could affect certain bottom-dwelling fishes, such as Pacific sand lance (*Ammodytes personatus*) which frequently inhabit sands and fine-grain sediments for rest and predator avoidance. Sand lance are an important prey species for many marine mammals, birds, and fishes including marbled murrelet and Pacific salmon. While sand lance could be subject to mortality or injury from proposed dredging, the timing and extent of their presence in lower Coos Bay at the NRI sites has not been confirmed.

Therefore, while entrainment of fish, shellfish, and other benthic species from dredging would be minor, it may adversely affect EFH for the coastal pelagic, groundfish, or Pacific salmon FMP groups. Direct or indirect impacts would be minimized by limiting work to the in-water work window (October 1 to February 15) and by maintaining the dredge cutterhead near the bottom.

Entrainment and Impingement through Vessel Cooling Water Intake at the Terminal Dock

During operation of the LNG Terminal, carriers at the export terminal slip may entrain fish and other marine organisms through the intake of cooling water, which is needed for vessel power plant operations. The potential effects to EFH for three of the FMP fish groups are twofold. The first is direct entrainment or impingement of individuals of these groups, and the second is the entrainment or impingement of pelagic food organisms that these groups feed upon (see section 3.5.4.3 Effects of Proposed Action regarding further details on entrainment and impingement of fish and related food organisms from LNG carrier cooling water intake systems at the Terminal dock).

For purposes of this analysis, typical cooling water flow rates were estimated at 3,200 m^3/hr (845,376 gallons per hour or 14,000 gpm) for 160,000 – 170,000 m^3 carriers with dual fuel diesel electric propulsion. This would result in a total of approximately 22 million gallons of cooling water being recirculated to the slip over a 26-hour loading cycle of LNG cargo. Cooling water flow rates would be 11,000 m^3/hr (2.9 million gallons per hour or 48,430 gallons per minute [gpm]) for 148,000 m^3 carriers with steam turbine propulsion systems. For a 148,000 m^3 carrier, this would total approximately 69.7 million gallons of water being recirvulated during the 24-hour loading cycle of LNG cargo..

The intake ports for engine cooling water would be through the ship's sea chests. A typical LNG carrier has two sea chests. The lower unit is usually located just above the keel of the ship, approximately 10 meters (33 feet) below the water line. It is approximately 3.5 to 4.2 square meters (37.7 to 45.2 square feet) covered by a screen with 4.5 mm (0.18 inch) wide bars, spaced every 24 mm (0.94 inch). The estimated velocity at the opening of the cooling water intake for a steam propulsion system ranges from 2.2 to 4.4 feet per second (ft/sec) (0.66 to 1.3 meters/second), depending on the intake rate of cooling water used. The estimated velocity at the opening of the cooling water intake for a dual propulsion system is approximately 1.3 ft/sec (0.39 meters/second), depending on the intake rate of cooling water used. No additional screening system other than that already employed on the LNG carriers is proposed for water intakes.

NMFS recommends that the approach velocity for screening systems operating where salmonid fry less than 60 mm in length are present should not exceed 0.33 ft/ sec (0.11 meter per second) or 0.8 ft/sec (0.26 meter/second) for larger juvenile salmonids in tidal systems (NMFS 1997c). These guidelines also include other requirements such as sweeping velocity and type and size of openings that are not present on these screens. Based on the anticipated range of velocities at the opening of the cooling water intake, which could reach a maximum of 1.44 ft/sec (0.44 meter/second), fish ranging in size from fry to possibly larger juvenile salmonids (including coho and Chinook salmon) may be entrained or impinged at cooling water intakes if they swim near the intake screens.

In the case of coho salmon, it is anticipated that few in the vicinity of the cooling water intake would be as small as 60 mm (2.4 inches) and subject to potential entrainment or impingement since most coho outmigrate at age 1+ and likely would be greater than 120 mm (4.7 inches) with a strong swimming ability. Similarly, age 1+ Chinook salmon would be of comparable size and swimming ability as coho salmon which also would allow them to be less susceptible to potential entrainment or impingement. Age 0 Chinook, however, which may be present in the Coos Bay estuary during summer, would be more susceptible to entrainment and impingement due to their smaller size. If present in the Terminal slip, many of the juvenile coho and Chinook salmon would, therefore, have sufficient swimming ability to actively avoid being entrained or impinged at cooling water intakes of berthed LNG carriers. Also, since the LNG Terminal slip would be excavated from upland habitat that extends landward from the main channel of Coos Bay, this may reduce the distribution of juvenile salmon in the vicinity of the water intakes of LNG carriers while berthed at the terminal dock. Salmon distribution patterns in Coos Bay are unknown, making it speculative to predict potential losses of fish to cooling water intake entrainment. Studies on the Columbia River, however, found that coho salmon and even smaller Chinook salmon occupied offshore portions of the river channel where the current is greater as they approached the ocean. Should distribution patterns for outmigrating coho and Chinook salmon in Coos Bay also occur primarily in the main channel, this would tend to minimize their potential exposure to cooling water intake entrainment.

Given the LNG carrier water intake and velocity characteristics as previously described, entrainment and impingement would primarily affect zooplankton, larval life stages, and small juvenile fish, since larger organisms could more actively avoid entrainment. Of the EFH species that inhabit Coos Bay, species with planktonic/pelagic eggs and larval life stages include the groundfish species English sole, rex sole, sand sole, starry flounder, lingcod, cabezon, and possibly bocaccio. A recent study found less diverse species near the mouth of the proposed slip (Shanks et al. 2011), but other larval or juvenile fish, including English sole, buffalo sculpin, anchovy, and pipefish, were found to be more abundant. A total of nine fish species were captured near the proposed slip site by Shanks et al. (2011).

Miller and Shanks (2005) collected a total of 35 species of ichthyoplankton in Coos Bay, the most abundant of which were pinpoint gunnel, northern anchovy, rosylip sculpin, Pacific sardine, and surf smelt. These five species consistently comprised more than 70 percent of the total catch. All of these are small, abundant, forage species, and two, sardine and anchovy, are coastal pelagic species. Miller and Shanks (2005) found that at both ocean-dominated and up-estuary sites in Coos Bay, the majority of the catch occurred from October 1 to May 31, although the seasonal difference was less marked within the estuary than it was at the estuary mouth. It can be expected that large numbers of these life stages, which are widely dispersed within the estuary, would be entrained during seasonal periods of high abundance. As noted above, both coho and Chinook salmon juveniles would be present in Coos Bay primarily in late spring and summer.

Should juvenile or larval fish and invertebrates that are small and unable to avoid entrainment occur in the slip area near the LNG carrier's intake screens, it is expected that a high portion would be entrained or impinged, resulting in their mortality. Their loss to the Coos Bay system would diminish their availability as a food source for coastal pelagic, groundfish, or salmon species.

The loss of these organisms from entrainment can be considered in the context of losses from natural mortality in the bay environment. Instantaneous natural mortality rate (per day) can be defined by the function: $M = \ln (N_0/N_t)/-t$, where M is instantaneous mortality rate, and N_0 and N_t are the initial and final abundance of larvae after time t (Rumrill 1990). The comparison of losses of larval food organisms between entrainment and natural mortality was based on the assumption that 100 percent mortality would occur to organisms entrained while water intakes were operating and that all mortality would occur during a single day. Additionally, it was assumed that all pelagic zooplankton in the Project area during water exchange on an average day (i.e., 114.25 million m^3) suffered one day's natural mortality at the rate determined in the literature.

Rumrill (1990) provides estimates of mortality rates for a variety of marine invertebrate larval, and in some cases, through juvenile stages. McGurk (1986) supplies similar information for a variety of larval stages of marine fish. These values provide the basis for the comparison of potential Project entrainment loss to that from natural mortality. Average loss of organisms from entrainment during one LNG carrier loading event would be low, ranging from 0.4 to 0.7percent of the natural morality that would occur in one day. For the lowest literature mortality rate of larval taxa among those reported, daily entrainment loss would be much higher, ranging from 0.7 to 1.8 percent, depending on what water volume was used during one vessel loading cycle and which taxa group data are used. These values, therefore, are conservative estimates when compared to natural mortality that would occur in the Coos Bay system overall, because entrainment would not occur daily, whereas natural mortality would.

While the loss from entrainment of marine fish, including groundfish, coastal pelagic fish, and their prey resources relative to natural mortalities in Coos Bay may be minor, it may adversely affect the supply of food resources to coastal pelagic, groundfish, and Pacific salmon. Further details of how entrainment may affect smaller organisms (e.g., zooplankton and larval fish) are presented in section 3.5.4.3.

4.2.2.9 Temperature Effects in the Marine Slip from LNG Carrier at LNG Terminal

Moderate to large temperature increases have the potential to reduce fish and invertebrate growth, reproductive success, and, if high enough, cause direct mortality. LNG carriers at berth in the LNG Terminal slip have the potential to both warm the water temperature while discharging engine cooling water and to cool the water temperature while loading LNG cargo. Plume modeling was conducted by JCEP to evaluate the three-dimensional thermal character of engine cooling water discharges in the terminal slip from LNG carriers propelled by either steam or dual fuel diesel-electric systems. The model discharge temperatures ranged from 10 to 20.8 °C. The model predicted, three-dimensionally, the distances that engine-heated discharges would attenuate from the LNG carrier discharge portal (i.e., sea chest) to a near-ambient temperature of 0.3°C (0.54°F), the Regulatory Mixing Zone (RMZ). The RMZ is defined as the distance at which water quality standards may be exceeded as long as acutely toxic conditions are prevented and fish habitat and other uses are protected.

Model results showed that, for peak summer ambient flow conditions, water temperatures in the slip that were subject to engine cooling water discharges from steam propulsion carriers would not exceed the thermal RMZ beyond 79.2 feet and 22.1 feet in longitudinal and transverse directions, respectively, with a vertical rise of 12.1 feet. For dual fuel diesel-electric carriers discharging engine cooling water under stratified winter temperature conditions, the RMZ was predicted to extend up to 36.5 feet and 6.9 feet in longitudinal and transverse directions, respectively, with a vertical rise of 1.3 feet. Such temperature differentials would decrease further at greater distances from the point of discharge.

Based on the total estimated slip volume, this would result in an average water temperature increase within the entire slip during a one day vessel loading event that would range from 0.03 to 0.06°F (0.02 to 0.03°C). The water temperature in the slip would be further cooled by contact with the hull of an LNG carrier since loading liquefied gas with a temperature of -260°F (-162°C) would result in the absorption of heat from the water. It was estimated that the hull would absorb an equivalent of 20 percent of the total quantity of heat gained to the slip (see JCEP's Resource Report 2). The elevated temperature of water discharges from engine cooling, therefore, would be ameliorated by the cold hull of the loading LNG carrier, the total volume of water in the slip, and tidal exchanges.

As a result, water in the LNG Terminal slip would be subject to negligible, localized temperature increases during carrier loadings that would not adversely affect EFH of the coastal pelagic, groundfish, or Pacific salmon FMP groups.

4.2.2.10 Operational Lighting

Localized changes in light regime have been shown to affect fish species behavior in a variety of ways (see discussion in sections 3.5.1.3 and 3.5.4.3). As described in further detail in section 1.2.1.4, lighting at the LNG Terminal would likely include a mixture of low-power fluorescent lighting and higher intensity lighting for operations and maintenance, safety, and security. Lighting would primarily be located on shore, in and adjacent to the slip. When an LNG carrier is not in the berth, lighting would be reduced to that required for security. It would be focused upon the structures and not along the water, so as to serve as an attractant or deterrent to fish species. When an LNG carrier is at the berth, it would physically block light from the slip waters and, due to its proximity to the slip wall, would block the fish from getting too close to the lighting on the berth. Lighting would be similar to that already in place at other Coos Bay facilities.

Lighting on the tug dock would be low intensity sufficient for safety and for personnel movements on the trestle out to the tug berth and along the berth itself. The reduced lighting levels near the water would lessen or eliminate any behavioral effects to fish in the Project vicinity. The final details of the lighting design would be determined through consultation with resource agencies, including NMFS and ODFW, in order to minimize potential adverse effects on fish and wildlife resources.

Considering the limited distribution of light that would occur at the LNG Terminal and tug dock areas, mitigation measures to be implemented to reduce light intensity, the availability of ample deep water adjacent to these areas where fish could avoid lights, and based on additional measures to be developed during final design to further minimize light on the water, lighting may affect but would not likely adversely affect EFH of coastal pelagic, groundfish, and Pacific salmon species.

4.2.2.11 Acoustic Effects from Construction and Operation

Underwater noise may affect fish by disturbing their behavior or causing injury or mortality. Effects of noise on aquatic species in Coos Bay from Project-related construction, operation, and maintenance activities were previously discussed for green sturgeon and coastal coho salmon in sections 3.5.1.3 and 3.5.4.3, respectively. Underwater noise would be generated from:

- installation of the sheet pile bulkhead at the LNG berth,
- installation of piles to support the LNG berth, tugboat dock, and temporary dredging pipelines,
- Initial excavation and dredging of the LNG Terminal slip and access channel, and Navigation Reliability Improvements;
- dredging of the eelgrass mitigation site and entrance to the Kentuck Project,
- LNG carrier transit in Coos Bay, and
- general operations at the LNG Terminal.

Individually or combined, these activities would generate underwater sound pressure levels that could elicit behavioral responses in fish and other aquatic organisms.

As discussed in the main BA criteria, dB levels ranging from over 206 dB down to 183 dB can cause adverse effects to fish (Fisheries Hydroacoustic Working Group 2008). Underwater noise may be generated by driving piles on land (dry piles) since some noise propagates through ground and sediments (especially through harder substrates such as rock and clay) and may transfer to the water column somewhere else (known as sound flanking). Wladichuk et al. (2018) modeled potential impacts of land-based pile driving on fish using both current guidelines (FHWG 2008) and new proposed guidelines (Popper et al. 2014). This study found that injury to fish from peak sound pressure levels (206 dB in current guidelines) would occur up to 37 meters from the face of the MOF. Also, this study predicted that injury to both small (less than 2 grams) and large (greater than or equal to 2 grams) fish from cumulative sound exposure levels (183 and 187 dB respectively under current guidelines) would occur up to 1,723 meters from the shoreline. Figure 3.5.1-2 shows the modeled extent of this potential zone of injury in the project area from land-based pile driving at the MOF face.

Based on the results of Wladichuk et al. 2018, installation of land-based piles would increase potential exposure of fish to underwater noise in an area encompassing the navigation channel from the MOF across the bay to the airport and southwest to the vicinity of Southport Lumber yard. These noise thresholds could be reached during pile driving of the 8 mooring bollards at the MOF that would take approximately 14 days to install. Individual fish occurring in this area during pile driving could experience physiological effects sufficient to cause injury. Land-based pile driving at the MOF shown to generate injury-level in-water noise would be limited to the approved in-water work window, which is October 1 through February 15 to minimize risk of physical injury or disturbance to individual Oregon Coast coho and other species in the three fish management groups that may occur in the Project vicinity during construction.

A key source of underwater noise from Project operations is associated with LNG carrier transits. LNG carriers would generate the greatest magnitude of noise relative to any vessels operating in the action area. Peak noise values within one meter (three feet) from an LNG carrier hull would likely be 182 ± 2 Db, although this value is based on LNG carriers in open-ocean transit. Peak noise values would likely be less in Coos Bay where vessels would be traveling at a much slower speeds. As a result, no adverse effects to fish in the estuary would result from LNG carrier transit.

Dredging operations also can produce high underwater noise levels. Fischer (2004) noted dredging source dB levels of 172 and 185 dB at one meter (three feet) from the dredge head. While the upper levels would exceed the lowest effects criteria (the threshold where effects occur to small fish less than two grams), dredging would be constrained to the in-water work period when the abundance of juvenile salmonids in the bay is low. Additionally, it is expected fish would avoid areas within one meter (three feet) of the dredge head. As a result, underwater noise levels from dredging would be minor but would not adversely affect EFH of all three fish management groups.

4.2.2.12 Habitat Effects –Slip, Access Channel, and Pile Dike Rock Apron

Prey species important to local EFH fish species rely on many of the same habitat conditions as the EFH fish species themselves. The food web components, including phytoplankton, zooplankton, detritus, epiphyton, and submerged aquatic vegetation (e.g., eelgrass, macrophytic algae), are all important in supplying the habitat and food base for EFH species within Coos Bay. Eelgrass is one of the more important components that provides refuge for a variety of fish, such as salmon and anchovy. Such refuge may lower predation and allow more opportunity for foraging. The protective structure attribute of eelgrass is primarily for smaller organisms and juvenile life history stages of fish. For example, submerged aquatic grasses are important habitat for small prey species of adult lingcod (in Appendix B-2 of PFMC 2008). Submerged grass meadows provide cover and food for a large number of organisms, including burrowing, bottom-dwelling invertebrates; diatoms and algae; herring that deposit eggs clusters on leaves; tiny crustaceans and fish that hide and feed among the blades; larger fish, and crabs that forage in the meadows at various tides. Previous studies (Akins and Jefferson 1973) have reported that Coos Bay has 1,400 acres of lower intertidal and shallow subtidal flats covered by eelgrass meadows.

Other inter- and sub-tidal habitat components also supply food resources or provide refuge for a variety fish resources, so that modification, disruptions, or loss of these conditions, especially eelgrass, may have adverse effects on EFH resources.

Construction of the LNG Terminal facilities, including the Slip, access channel, pile dike rock apron, MOF, the four sites where Navigation Reliability Improvements would be conducted, Trans Pacific Parkway/ Hwy 101 Intersection Widening, and temporary impact areas, would affect existing estuarine habitat. Where dredging is involved, this would affect about 14.76 acres of intertidal to shallow subtidal habitat, 1.9 acres of eelgrass habitat, and 0.06 acres of salt marsh. These areas would be converted to primarily deep subtidal habitat by dredging the Slip, access channel, and MOF (see table 3.5.1-4 in section 3.5.1.3). About 36.7 acres of upland habitat would be converted to open water, primarily deep subtidal habitat down to -45 feet (NAVD88). In addition, about 2.3 acres of intertidal, eelgrass, and subtidal habitat, would be covered by a three-foot thick layer of rock. This would be accomplished by placing 6,500 cubic yards of well graded 6-inch to 22-inch angular stone with a median size of 14 inches over a 50-foot wide by 1,100 foot long area. The purpose of the new rock apron is to prevent anticipated slope migration near pile dike 7.3 after the access channel is dredged.

Benthic and epibenthic invertebrates that presently inhabit shallow intertidal and subtidal regions within the boundaries of the proposed access channel dredging area would be removed from the bay with the dredged materials are transferred to upland disposal sites. Ghost shrimp and sand shrimp (adults, juveniles, and larvae), amphipods, clams, Dungeness crab, and various demersal (bottom) fish species are important prey for many other fish species, including salmon and groundfish. As a result, the available food supply for EFH fish in the bay would be reduced until the affected benthic and epibenthic communities are re-established within the dredged areas. The resulting deeper habitat would have a character that is less diverse and less productive as benthic food sources.

Many groundfish species are known to occur within the estuary, either seasonally or year-round. Project activities related to dredging are likely to have the greatest impact on flatfish residents of the lower bay, including English sole and starry flounder. Access channel dredging would convert 14.76 acres of shallow water habitat to deepwater habitat. Juvenile English sole and starry flounder are typically found in shallow nearshore waters in estuarine environments. Therefore, the conversion from shallow water to deep water habitat would represent a reduction in habitat quality and quantity over existing conditions. Flatfish and other demersal species are expected to return to the area after dredging is completed. Most rockfish species in the lower bay prefer rocky reef habitat and do not commonly utilize sand/mud substrates that would be affected by dredging. The new rock apron at pile dike 7.3 would provide additional habitat for rockfish, ling cod, cabazon, and bocaccio. Juvenile lingcod and adult cabazon and bocaccio are known to occasionally utilize sandy flats habitat and would experience some loss of such habitat.

However, the sandy habitats that would be removed by dredging are common within the estuary. It is anticipated that groundfish species would be able to relocate to nearby suitable habitats.

While short-term loss of important eelgrass habitat is of concern, it would be a small portion of the total Coos Bay area eelgrass beds of 1,400 acres. Also, the loss of the 2.08 acres of eelgrass by construction and operation of the LNG Terminal would be mitigated at a proposed off-site eelgrass mitigation area south of the west end of the Southwest Oregon Regional Airport where approximately 6 acres of new eelgrass habitat would be created. The 3:1 mitigation ratio would offer a net long-term gain in eelgrass habitat (see appendix O/Compensatory Wetland Mitigation Plan). The interim loss of unvegetated mud flat (intertidal and shallow subtidal habitats) would be restored at (see appendix O/Compensatory Wetland Mitigation Plan) Kentuck Project.

LNG carrier transits through the Coos Bay channel combined with tugboat turning operations would disturb small areas of the channel bottom during arrival and departure. This would cause some short-term loss and/or displacement of organisms. Large organisms (crabs/shrimp) would be able to move and return, while some benthic organisms would have a more extended loss. Overall, an undefined loss of benthic organisms may result from LNG carrier propwash scour during each trip near the slip approach. The magnitude of such loss, however, likely would be small and less than what currently results from bottom disturbance by existing large deep-draft vessel trips. Modeling results have indicated that bottom velocities and related channel disturbance from existing deep-draft vessels would be slightly greater than what would occur from slower traveling LNG carriers (see JCEP's Resource Report 2).

While studies in Coos Bay have indicated that benthic communities inhabiting mud substrates recovered to pre-dredging conditions in four weeks (McCauley et al. 1977), recovery in estuarine channel muds has been reported to typically require six to eight months (Newell et al. 1998). McCabe et al. (1997, 1998) noted benthic organism recovery in the lower Columbia River occurred in three months. Because of the large quantity of proposed dredging, including areas outside the FNC that have a more varied substrate, it may take longer than four weeks to recover the affected habitat relative to what may be more typical as a result of Coos Bay dredging. A short-term loss in bottom habitat, likely less than one year, would affect benthic communities and potential food resources for the EFH fish species in the three FMP groups. Proposed mitigation, including restoration of the Kentuck site and development of new eelgrass habitat, is expected to result in long-term net benefits to EFH. Therefore, while temporary adverse effects to EFH fish species in the three FMP groups may occur, long-term effects and not expected.

4.2.2.13 Habitat Effects –Pipeline HDD

As discussed above, inadvertent return during any of the three HDDs (two across Coos Bay, one across the Coos River) could occur although available information suggests the likelihood is remote. Bentonite by itself is a non-toxic drilling mud (Breteler et al. 1985; Hartman and Martin 1984; Sprague and Logan 1979) although according to Reid and Anderson (1998), the toxicity of bentonite (sodium montmorillonite) in fresh water ranges from 5,000 to 19,000 ppm (mg/liter) based on 96-hour tests for LC50 (the concentration at which 50 percent of the test population dies after 95 hours of exposure) on rainbow trout. The toxicity classifications based on LC50 values ranged from "slightly toxic" to "practically non-toxic" (Reid and Anderson, 1998). In other tests, toxicities to lake whitefish and rainbow trout demonstrated threshold concentrations of 16,613 and 49,838 ppm (mg/liter), respectively (Reid and Anderson, 1998). LC50 concentrations > 10,000 ppm would be considered "practically non-toxic" (Reid and Anderson 1998).

Bentonite, as with any fine particulate material, can interfere with oxygen exchange by the gills of aquatic organisms (EPA 1986). The degree of interference generally increases with water temperature (Horkel and Pearson 1976). Impacts would be localized and would normally be limited to individual fish in the immediate vicinity of the inadvertent return. The majority of highly mobile aquatic organisms, such as fish, would be able to avoid or move away from turbidity spots and plumes (Reid and Anderson 1999). Short-term pulses of suspended sediments (sharp increases within an hour) disrupt the feeding behavior and dominance hierarchies of juvenile coho salmon and elicit alarm reactions that may cause fish to relocate downstream to undisturbed areas (Wilber and Clarke 2001; Berg and Northcote 1985). Other less mobile or immobile organisms, such as clams, mussels and other macroinvertebrates, would incur direct mortality (Wilber and Clarke 2001). Bentonite can smother macroinvertebrates and adversely affect filter-feeders (Falk and Lawrence 1973 in Hair et al. 2002 and Land 1974 in Cameron et al. 2002). Bentonite can also exacerbate or enhance the effects of toxic compounds to fish and aquatic invertebrates if those compounds are present in aquatic habitats (Hartman and Martin 1984). Similar to other fine-grained particulates, bentonite in flowing water is more likely to remain in suspension longer than in standing water. Consequently, effects to coho salmon by a release of bentonite into a waterbody would ultimately depend on volume of the release, volume of water present, and current. Coho salmon inhabiting larger waterbodies with swift currents would be less affected by a given volume of bentonite than those inhabiting small waterbodies with no current. Considering the small size of the area, and short duration of effects to the benthic community, the loss of potential food resources for EFH species, including salmon and groundfish such as starry flounder, would be small.

4.2.2.14 Shading Effects

Shading from over-water structures reduces the amount of light available to phytoplankton and aquatic macrophytes. These may also be areas where predators can hide. The estuarine habitat where shading would occur would involve an industrial area of the slip excavated from upland habitat that would generally provide poor habitat conditions (deep, riprap) and was not originally estuarine habitat. This is a small area with facilities as described in section 3.5.1.3. Consequently, shading impacts to EFH, such as benthic production and potential increased predations, would be small and unsubstantial.

Consequently, shading impacts to EFH, such as benthic production and potential increased predations, would be small and unsubstantial.

4.2.2.15 Aquatic Nuisance Species in Coos Bay Estuary

Invasive species have the potential to modify the food base and induce other ecological modifications in the estuarine area of Coos Bay. Another potential source of invasive species, other than LNG carrier ballast water, is the transfer of organisms between water bodies by construction equipment used in the water, or through other water transfer actions. PCGP has stated that it would not obtain hydrostatic test water from either Coos Bay or the Coos River, in order to prevent the spread of NAS from the estuary to inland watersheds. PCGP currently has procedures in their *Hydrostatic Testing Plan* (see appendix U) to reduce or eliminate the spread of invasive species. Indirect adverse effects to EFH for the three FMP groups are not anticipated to occur, considering the proposed reasonable actions that would be taken to prevent introduction.

4.2.3 Riverine Analysis Area

The riverine analysis area includes all freshwater sources that may be affected by Project actions and that may affect waters historically accessible to salmon. This area primarily includes waters crossed or adjacent to the freshwater portion of the Pipeline, as reported in sections 3.5.3 and 3.5.4 for the two ESA-listed coho salmon ESUs. Effects to EFH in this area would be associated with pipeline construction and operation, associated reconstructed, temporary and permanent road construction, and ancillary facility construction (e.g., meter stations, storage yards).

Effects to coho salmon and their habitat have been addressed in detail in section 3.5.3.3 for the SONCC coho salmon ESU and in section 3.5.4.3 for the Oregon Coast coho salmon ESU. While there are some differences of life history timing among the other Pacific salmon species in the riverine analysis area, Chinook salmon and their distribution are generally a subset of that covered for these two coho salmon. The types of effects to Chinook salmon EFH from Project actions would be mostly the same as for coho salmon. Effects as described in those sections are descriptive of the effects to Pacific salmon EFH in the riverine analysis area, and descriptions below are mostly summaries of the main BA analysis.

4.2.3.1 Acoustic Shock and Underwater Noise

There are many crossings within the range of Pacific salmon where shallow bedrock may occur and where blasting and/or mounted impact hammers may need to be used to construct a trench through the bedrock substrates. Explosives detonated near water produce shock waves that can be lethal to fish, eggs, and larvae by rupturing swim bladders and addling egg sacs (British Columbia Ministry of Transportation 2000). PCGP may opt a variety of actions to reduce the effects to fish, including bubble/air curtains, scare noise to move fish away from the site, and fish removal from the affected area. These and other actions are included in the *Blasting Plan*, and fish removal from the area would be done under the *Fish Salvage Plan* (see section 4.3.3 below); both plans are intended to reduce adverse effects to fish. Prior to any blasting, proper permits would be obtained and agencies notified as required by the associated permits.

Noise, like that generated from an impact hammer at bedrock stream crossings, can also have adverse effects to Pacific salmon. The noise produced by the impact hammer in air would be equivalent to about 182 dB re: 1 µPa @ 1 meter (3 feet) in water. This is near the lower level considered to be directly harmful to fish. Sound levels less than this (e.g., 90 dB) are at the hearing threshold of some salmonids, so some avoidance may occur at lesser sound levels. With the fish removal practices in place, Pacific salmon would not be in the zone of direct impact of such sound. However, associated salvage of fish remaining in isolated crossing areas where blasting or impact hammers are used would likely result in some mortality.

Overall, considering plans and procedures that are in place, and the limited need for blasting or air hammer use, direct impacts to Pacific salmon and their EFH from blasting or impact hammer use would not occur, although associated fish salvage operations would have adverse effects.

4.2.3.2 Suspended Sediment Effects from Stream Crossings

Four crossing methods (dry open cut, direct pipe, HDD, and diverted open cut) would be used for stream crossings along the route where Pacific salmon would occur (see sections 3.5.3.3 and 3.5.4.3). All but four of the stream crossings in the range of the Pacific salmon would be dry open cut (either dam-and-pump or flume). Dry crossing methods, including diverted open cut, would result in minimal impacts but would include temporary increases in suspended sediments in restricted areas. Direct pipe and HDDs would be installed without in-water work, and would not directly affect the aquatic environment and associated species—except in the case of an inadvertent return during an HDD crossing, which could affect stream suspended sediment levels.

Salmonids exposed to moderate to high levels of suspended sediment for extended periods could be adversely affected. At high levels, turbidity directly affects survival and growth of salmonids and other species, interferes with gill function, and adversely affects substrate for egg development (Bash et al. 2001). Turbidity can also reduce macrophyte cover over the long-term by limiting photosynthesis (Goldsborough and Kemp 1988), as well as adversely affecting fish vision, which is a requisite for social interactions (Berg and Northcote 1985), feeding (Vogel and Beauchamp 1999; Gregory and Northcote 1993), and predator avoidance (Meager et al. 2006; Miner and Stein 1996).

Suspended Sediment – Dry Open Cut

Estimated effects on salmonids from suspended sediment were based on models of concentrations at crossings and on literature detailing what effects occurred at other typical crossing types. Newcombe and Jensen (1996) compiled research from many sources that demonstrate effects to anadromous and resident salmonids by various levels of suspended sediment and exposure over time. The model developed in Newcombe and Jensen (1996) is considered reasonable for assessing effects to listed coho salmon, and the results are considered suitable for assessing effects to Pacific salmon EFH. The details of the model are in section 3.5.

Output from each model provides SEV scores. Values range from 0 to 14, where an SEV of 0 indicates no effects, an SEV between 1 and 3 indicates behavioral effects, an SEV from 4 to 8 indicates sublethal effects, and an SEV from 9 through 14 indicates lethal and paralethal effects (see Table 1 in Newcombe and Jensen 1996).

Modeled estimates of the effects of suspended sediment to coho salmon resources from pipeline installation across streams would remain mostly low to moderate (SEV 3 to 5) in the short-term. These effects to coho salmon would likely include short-term avoidance, short-term reduction in feeding, and minor physiological stress. Based on modeled results, effects would be similar among most fifth-field watersheds where salmon are present along the route. A few modeled effects would have higher impact levels if any of the crossing methods have failures.

Overall, the result for either dry crossing method would be that suspended sediment generated during crossing construction would cause at least some short-term adverse effects, primarily avoidance, short-term feeding reduction, and likely some minor stress. No long-term adverse effect would likely occur to Pacific salmon or their EFH unless some major failure occurred during construction.

Following review of an earlier draft, FERC (2018) requested an analysis of any coho salmon or EFH stream that is not directly crossed by the Pipeline, but has a tributary that would be crossed that could have an effect on this fish stream from the tributary stream's downstream sediment distribution based on the severity of ill effects value indicated. However, addressing this comment requires a different methodology than used in the nearest neighbor analysis provided for SONCC coho in section 3.5.3.3 and Oregon Coast coho in section 3.5.4.3. In that analysis, NMFS assumed that the nearest neighbor distance was equivalent to the downstream confluence of the two. However, FERC's request requires measuring the actual distance from the point where the tributary is crossed to the confluence with coho/EFH and would include most of the streams crossed in appendix M/table M-1. For example: a Tributary to Trail Creek at MP 119.84 is 824 meters from the confluence with Trail Creek which provides Pacific salmon EFH. The tributary is an intermittent stream, 2 feet wide crossed by dry open-cut (flume) requiring 2 hours of instream work. Using the appropriate regression model in table 3.5.3-3, at 824 m downstream, the TSS = 14.2 mg/l which yields SEV = 3 (using the Newcombe and Jensen [1996] Model #1 for juvenile and adult salmonids). Thus at the confluence, SEV in the Tributary = 3, but that does not equate to SEV = 3 in Trail creek because the TSS concentration entering from the Tributary would be diluted from 14.2 mg/l. SEV in Trail Creek EFH would be <3. Similar estimates were made for all tributaries (except for ditches) to streams with EFH, either Known or Assumed to be occupied by coho, and are included in table 4.2.3-1. Effects to waterbodies crossed that support or are assumed to support SONCC coho and Oregon Coast coho and effects by crossing nearest neighbor streams are provided in table 3.5.3-23 (SONCC coho) and table 3.5.4-28 (Oregon Coast coho) and are not included in table 4.2.3-1, below.

Every waterbody crossed during construction is eventually connected to an EFH stream. However, downstream distances to an EFH stream may be too large to warrant any meaningful evaluation such as provided in table 4.2.3-1. That was the case for all waterbodies crossed in the Upper Cow Creek watershed. In table 4.2.3-1, risks from downstream TSS by crossing any stream with a bedrock substrate are considered "None-Low" because fine sediment (silt and clay) would not be mobilized in the water column; risks of downstream TSS crossing intermittent streams are considered "None-Low" because those streams would likely be dry during the in-stream construction period (ODFW 2008); risks from downstream TSS by crossing perennial streams are considered "Moderate-High" because flowing water would be present at the time of construction. The highest risk for SEV = 5 (causing minor physiological stress) would occur at the confluence of a tributary to Big Creek (Middle Fork Coquille River watershed), assumed to support coho and EFH because it is occupied by steelhead. All other SEV values at a tributary's confluence to an EFH stream are SEV ≤ 4. However, the estimated TSS concentration at any tributary confluence would be diluted by greater flow rates and water volumes in larger EFH streams and therefore the estimated SEV in the EFH stream would be considerably less than at the confluence.

TABLE 4.2.3-1

Downstream Effects of Instream Construction to Waterbodies with Pacific Salmon EFH Due to Crossing Tributaries with No EFH

Waterbodies Crossed and Waterbody ID	Pipeline Milepost (MP)	Flow	Proposed Crossing Method a/	OHM Width (feet) b/	Tributary to Stream with Salmon EFH c/	EFH Known or Assumed at Confluence	Distance from Pipeline Crossing to Confluence (meters) d/	Instream Duration (hours) e/	Estimated TSS Concentration at Confluence (mg/l) f/	SEV Score at Confluence g/	Risk of TSS at Confluence by Crossing Tributary (rationale) h/
Coos Subbasin (HUC 17100304), Coos Bay-Frontal Pacific Ocean (HUC 1710030403) Fifth-Field Watershed											
Trib. to Stock Slough (BR-S-31)	14.72BR	Intermittent	Flume	2	Laxstrom Gulch	Assumed	27	2	57.8	4	None-Low (intermittent)
Coquille Subbasin (HUC 17100305), North Fork Coquille River (HUC 1710030504) Fifth-Field Watershed											
Steinnon Creek (SS-500-003; BR-S-63)	20.20BR	Perennial	Flume	8	Steinnon Creek	Assumed	1,322	2	12.4	3	Moderate-High (perennial)
Trib. to Middle Creek (S-T02-001 / EE-SS-9073)	25.18	Intermittent	Flume	2	Tributary to Middle Creek	Known	1,135	2	13.9	3	None-Low (intermittent)
Trib. to Middle Creek (BSI-137)	27.01	Intermittent	Flume	7	Middle Creek	Known	50	2	44.3	4	None-Low (intermittent)
Coquille Subbasin (HUC 17100305), East Fork Coquille River (HUC 1710030503) Fifth-Field Watershed											
Trib. to E. Fork Coquille (SS-003-007A)	30.22	Perennial	Flume	10	Trib. to East Fork Coquille	Assumed	144	2	36.8	4	Moderate-High (perennial)
Trib. To E. Fork Coquille (BSI-70)	31.64	Intermittent	Flume	1	East Fork Coquille River	Known	1,375	2	16.8	4	None-Low (intermittent)
Trib. To Elk Creek (S-T01-004 / SS-100-030)	32.56	Intermittent	Flume	4	Tributary to Elk Creek	Assumed	70	2	43.2	4	None-Low (intermittent)
Trib. To Elk Creek (BSP-49)	33.00	Perennial	Flume	10	Elk Creek	Known	1,790	2	14.4	3	Moderate-High (perennial)
Trib. To S. Fork Elk Creek (BSI-251)	35.51	Intermittent	Flume	4	Trib. to South Fork Elk Creek	Known	365	2	28.5	4	None-Low (intermittent)
Coquille Subbasin (HUC 17100305), Middle Fork Coquille River (HUC 1710030501) Fifth-Field Watershed											
Trib. to Big Creek (BLM 35.87 (CSP-2))	35.87	Intermittent	Flume	2	Big Creek	Known	1,142	2	16.0	4	None-Low (intermittent)
Trib. To Big Creek (BLM 36.48)	36.48	intermittent	Flume	2	Big Creek	Known	408	2	24.6	4	None-Low (intermittent)
Trib. To Big Creek (GSI-25/BSI-253)	36.54	intermittent	Flume	6	Big Creek	Known	414	2	24.4	4	None-Low (intermittent)
Trib. To Big Creek (BLM 36.85)	36.85	intermittent	Flume	2	Big Creek	Known	431	2	24.1	4	None-Low (intermittent)

TABLE 4.2.3-1

Downstream Effects of Instream Construction to Waterbodies with Pacific Salmon EFH Due to Crossing Tributaries with No EFH

Waterbodies Crossed and Waterbody ID	Pipeline Milepost (MP)	Flow	Proposed Crossing Method a/	OHM Width (feet) b/	Tributary to Stream with Salmon EFH c/	EFH Known or Assumed at Confluence	Distance from Pipeline Crossing to Confluence (meters) d/	Instream Duration (hours) e/	Estimated TSS Concentration at Confluence (mg/l) f/	SEV Score at Confluence g/	Risk of TSS at Confluence by Crossing Tributary (rationale) h/
Trib. To Big Creek (BSI-252)	36.92	intermittent	Flume	3	Big Creek	Known	307	2	26.9	4	None-Low (intermittent)
Trib. To Big Creek (ESI-19)	37.32	intermittent	Flume	3	Big Creek	Assumed	69	2	39.3	4	None-Low (intermittent)
Trib. To Big Creek (ESP-20)	37.35	Perennial	Flume	15	Big Creek	Assumed	63	4	40.1	5	Moderate-High (perennial)
South Umpqua (HUC 17100302) Subbasin, Olalla Creek-Lookingglass Creek (HUC 1710030212) Fifth-Field Watershed											
Trib. to Shields Creek (BSI-203)	55.94	Intermittent	Flume	8	Shields Creek	Known	735	2	19.1	4	None-Low (intermittent)
Trib. to Shields Creek (Denied Access 13)	56.28	Intermittent	Flume	4	Shields Creek	Known	1,121	2	15.9	4	None-Low (intermittent)
Trib. to Shields Creek (Denied Access 14)	56.34	Intermittent	Flume	4	Shields Creek	Known	1,142	2	15.7	4	None-Low (intermittent)
Trib. to Olalla Creek (S-T02-002)	56.80	Intermittent	Flume	4	Olalla Creek	Known	1,560	2	13.3	3	None-Low (intermittent)
Trib. to Olalla Creek (BSI-140)	57.11	Intermittent	Dam-and-Pump	13	Olalla Creek	Known	1,060	4	3.7	3	None-Low (intermittent)
Trib. to Olalla Creek (BSI-140)	57.14	Intermittent	Dam-and-Pump	13	Olalla Creek	Known	1,060	4	3.7	3	None-Low (intermittent)
Trib. to Olalla Creek (BSI-138)	57.31	intermittent	Flume	10	Olalla Creek	Known	710	2	19.4	4	None-Low (intermittent)
Trib. to Olalla Creek (BSI-147/EE-12)	57.84	intermittent	Flume	4	Olalla Creek	Known	202	2	29.1	4	None-Low (intermittent)
Trib. to Olalla Creek (BSI-151)	58.20	intermittent	Flume	3	Olalla Creek	Known	173	2	30.3	4	None-Low (intermittent)
Trib. to Olalla Creek (BSP-159)	58.55	Perennial	Dam-and-Pump	10	Olalla Creek	Known	51	2	9.1	3	Moderate-High (perennial)
Trib. to Olalla Creek (BSI-132)	59.29	Intermittent	Flume	9	Olalla Creek	Known	636	2	20.2	4	None-Low (intermittent)
Trib. to McNabb Creek (NSP-14)	60.13	Perennial	Dam-and-Pump	6	McNabb Creek	Known	423	2	5.4	3	Moderate-High (perennial)
South Umpqua (HUC 17100302) Subbasin, Clark Branch-South Umpqua River (HUC 1710030211) Fifth-Field Watershed											
Trib. to Willis Creek (BSI-169)	67.00	Intermittent	Dam-and-Pump	2	Willis Creek	Known	111	2	8.1	3	None-Low (intermittent)

TABLE 4.2.3-1

Downstream Effects of Instream Construction to Waterbodies with Pacific Salmon EFH Due to Crossing Tributaries with No EFH

Waterbodies Crossed and Waterbody ID	**Pipeline Milepost (MP)**	**Flow**	**Proposed Crossing Method a/**	**OHM Width (feet) b/**	**Tributary to Stream with Salmon EFH c/**	**EFH Known or Assumed at Confluence**	**Distance from Pipeline Crossing to Confluence (meters) d/**	**Instream Duration (hours) e/**	**Estimated TSS Concentration at Confluence (mg/l) f/**	**SEV Score at Confluence g/**	**Risk of TSS at Confluence by Crossing Tributary (rationale) h/**
Trib. to South Umpqua Rive (SS-004-004/SS-100-012)	69.29	Perennial	Flume	23	South Umpqua River	Known	1,547	4	5.5	3	Moderate-High (perennial)
Trib. to South Umpqua River (SS-004-005/SS-100-013)	69.35	Perennial	Flume	20	South Umpqua River	Known	1,570	4	5.3	3	Moderate-High (perennial)
Trib. to South Umpqua River (SS-004-006/SS-100-014)	69.57	intermittent	Flume	3	South Umpqua River	Known	1,980	2	3.1	2	None-Low (intermittent)
Trib. to South Umpqua River (SS-005-009/SS-100-019)	73.04	intermittent	Flume	3	South Umpqua River	Known	3,762	2	0.3	1	None-Low (intermittent)
Trib. to South Umpqua River (SS-005-013 SS-100-020)	73.51	intermittent	Flume	3	Richardson Creek	Known	2,105	2	2.6	2	None-Low (intermittent)
Trib. to South Umpqua River (SS-005-011 & -12 SS-100-021)	73.56	intermittent	Flume	3	Richardson Creek	Known	2,110	2	2.6	2	None-Low (intermittent)
Trib to Richardson Creek (SS-005-010)	73.73	intermittent	Flume	3	Richardson Creek	Known	2,302	2	2.1	2	None-Low (intermittent)
South Umpqua (HUC 17100302) Subbasin, Myrtle Creek (HUC 1710030210) Fifth-Field Watershed											
Little Lick Creek (BSP-6)	77.71	Perennial	Flume	7	Little Lick Creek	Known	2,075	2	10.0	3	Moderate-High (perennial)
Trib. to Little Lick Creek (BSI-8)	77.93	Intermittent	Flume	13	Little Lick Creek	Known	1,740	4	12.1	4	None-Low (intermittent)
Trib. to Little Lick Creek (BSI-8)	78.02	Intermittent	Flume	2	Little Lick Creek	Known	1,640	2	12.7	3	None-Low (intermittent)
Trib. to North Myrtle Creek (NSP-38)	79.15	Perennial	Dam-and-Pump	8	North Myrtle Creek	Known	130	2	9.6	3	Moderate-High (perennial)
Trib. to N. Myrtle Creek (EE-SS-9038)	79.17	Intermittent	Flume	4	North Myrtle Creek	Known	152	2	40.2	4	None-Low (intermittent)

TABLE 4.2.3-1

Downstream Effects of Instream Construction to Waterbodies with Pacific Salmon EFH Due to Crossing Tributaries with No EFH

Waterbodies Crossed and Waterbody ID	Pipeline Milepost (MP)	Flow	Proposed Crossing Method a/	OHM Width (feet) b/	Tributary to Stream with Salmon EFH c/	EFH Known or Assumed at Confluence	Distance from Pipeline Crossing to Confluence (meters) d/	Instream Duration (hours) e/	Estimated TSS Concentration at Confluence (mg/l) f/	SEV Score at Confluence g/	Risk of TSS at Confluence by Crossing Tributary (rationale) h/
Trib. to N. Myrtle Creek (EE-SS-9039)	79.19	Intermittent	Flume	4	North Myrtle Creek	Known	154	2	40.0	4	None-Low (intermittent)
Trib. to S. Myrtle Creek (BSP-259)	81.38	Intermittent	Flume	2	South Myrtle Creek	Known	263	2	33.9	4	None-Low (intermittent)
Trib. to S. Myrtle Creek (SS-100-023)	81.45	Intermittent	Flume	17	South Myrtle Creek	Known	281	4	33.1	4	None-Low (intermittent)
Trib. to S. Myrtle Creek (EE-SS-9074)	81.93	Intermittent	Flume	5	South Myrtle Creek	Known	806	2	20.9	4	None-Low (intermittent)
South Umpqua (HUC 17100302) Subbasin, Days Creek-South Umpqua River (HUC 1710030205) Fifth-Field Watershed											
Wood Creek (BSP-226)	84.17	Perennial	Dam-and-Pump	8	Wood Creek	Known	1,250	2	0.9	1	Moderate-High (perennial)
Trib. to Fate Creek (BSI-236)	88.2	Intermittent	Dam-and-Pump	2	Fate Creek	Known	440	2	1.4	2	Moderate-High (perennial)
Trib. to Fate Creek (BSI-238 (MOD))	88.23	Intermittent	Flume	1	Fate Creek	Known	450	2	6.0	3	None-Low (intermittent)
Trib. to South Umpqua River (ASI-193 / ASI-191)	94.85	intermittent	Flume	10	South Umpqua River	Known	475	2	5.9	3	None-Low (intermittent)
Trib. to South Umpqua River (ASI-193 / ASI-191)	95.03	Intermittent	Flume	10	South Umpqua River	Known	1,383	2	3.5	2	None-Low (intermittent)
South Umpqua (HUC 17100302) Subbasin, Upper Cow Creek (HUC 1710030206) Fifth field Watershed											
None											
Upper Rogue (HUC 17100307) Subbasin, Trail Creek (HUC 1710030706) Fifth-Field Watershed											
Trib. to West Fork Trail Creek (SS-100-032)	118.80	Intermittent	Flume	2	West Fork Trail Creek	Known	300	2	17.5	4	None-Low (intermittent)
Trib. to Trail Creek (S1-06 (DA-16 (MOD))	119.84	Intermittent	Flume	2	Trail Creek	Known	824	2	14.2	3	None-Low (intermittent)
Trib. to Trail Creek (ASI-205)	120.90	intermittent	Flume	6	Trail Creek	Known	643	2	15.3	3	None-Low (intermittent)
Upper Rogue (HUC 17100307) Subbasin, Shady Cove-Rogue River (HUC 1710030707) Fifth-Field Watershed											

TABLE 4.2.3-1

Downstream Effects of Instream Construction to Waterbodies with Pacific Salmon EFH Due to Crossing Tributaries with No EFH

Waterbodies Crossed and Waterbody ID	Pipeline Milepost (MP)	Flow	Proposed Crossing Method a/	OHM Width (feet) b/	Tributary to Stream with Salmon EFH c/	EFH Known or Assumed at Confluence	Distance from Pipeline Crossing to Confluence (meters) d/	Instream Duration (hours) e/	Estimated TSS Concentration at Confluence (mg/l) f/	SEV Score at Confluence g/	Risk of TSS at Confluence by Crossing Tributary (rationale) h/
Trib. to Indian Creek (ASI-223)	125.91	Intermittent	Flume	5	Tributary to Indian Creek	Assumed	2,625	2	4.7	3	None-Low (intermittent)
Trib. to Indian Creek (ASI-222)	125.98	Intermittent	Flume	1	Tributary to Indian Creek	Assumed	2,244	2	5.7	3	None-Low (intermittent)
Trib. to Indian Creek (RS-4)	126.53	Intermittent	Flume	1	Tributary to Indian Creek	Assumed	2,793	2	4.3	3	None-Low (intermittent)
Trib. to Indian Creek (ASI-221)	126.56	Intermittent	Flume	5	Tributary to Indian Creek	Assumed	2,820	2	4.2	3	None-Low (intermittent)
Deer Creek (ASP-307)	128.49	Perennial	Dam-and-Pump	15	Indian Creek	Known	251	4	3.5	3	Moderate-High (perennial)
Trib. to Indian Creek (ASI-277)	129.46	Intermittent	Flume	4	Indian Creek	Known	3,110	2	3.7	2	None-Low (intermittent)
Upper Rogue (HUC 17100307) Subbasin, Big Butte Creek (HUC 1710030704) Fifth field Watershed											
Trib. to Neil Creek (SS-201-14b (AW-244))	130.83	intermittent	Dam-and-Pump	10	Neil Creek	Known	1,437	2	1.9	2	Moderate-High (perennial)
Trib. to Quartz Creek (S5-01/ ASI-265)	132.75	Intermittent	Dam-and-Pump	1	Quartz Creek	Known	82	2	5.5	3	Moderate-High (perennial)
Trib. to Quartz Creek (ASP-241)	133.35	Perennial	Flume	10	Quartz Creek	Known	1,190	2	9.9	3	None-Low (intermittent)
Upper Rogue (HUC 17100307) Sub-basin, Little Butte Creek (HUC 1710030708) Fifth field Watershed											
Whiskey Creek (ASI-207)	137.48	Intermittent	Flume	10	Whiskey Creek	Assumed	2,211	2	5.9	3	None-Low (intermittent)
Trib. To Whiskey Creek (SS-200-006)	137.50	Intermittent	Flume	30	Whiskey Creek	Assumed	2,314	5	5.5	3	None-Low (intermittent)
Trib. to Lick Creek (ASI-208)	138.26	Intermittent	Flume	10	Lick Creek	Assumed	2,400	2	5.2	3	None-Low (intermittent)
Trib. to Lick Creek (SS-GM-9)	138.36	Intermittent	Flume	2	Lick Creek	Assumed	2,420	2	5.1	3	None-Low (intermittent)
Trib. to Lick Creek (SS-GM-10)	138.44	Intermittent	Flume	2	Lick Creek	Assumed	2,436	2	5.0	3	None-Low (intermittent)
Trib. to Lick Creek (ASI-210)	138.50	Intermittent	Flume	10	Lick Creek	Assumed	2,360	2	5.3	3	None-Low (intermittent)
Trib. to Lick Creek (SS-GM-11)	138.55	Intermittent	Flume	2	Lick Creek	Assumed	2,332	2	5.4	3	None-Low (intermittent)

TABLE 4.2.3-1

Downstream Effects of Instream Construction to Waterbodies with Pacific Salmon EFH Due to Crossing Tributaries with No EFH

Waterbodies Crossed and Waterbody ID	Pipeline Milepost (MP)	Flow	Proposed Crossing Method a/	OHM Width (feet) b/	Tributary to Stream with Salmon EFH c/	EFH Known or Assumed at Confluence	Distance from Pipeline Crossing to Confluence (meters) d/	Instream Duration (hours) e/	Estimated TSS Concentration at Confluence (mg/l) f/	SEV Score at Confluence g/	Risk of TSS at Confluence by Crossing Tributary (rationale) h/
Trib. to Lick Creek (ASI-211)	138.71	Intermittent	Flume	15	Lick Creek	Assumed	2,152	4	6.1	3	None-Low (intermittent)
Trib. to Lick Creek (SS-GM-13)	138.74	Intermittent	Flume	10	Lick Creek	Assumed	2,145	2	6.2	3	None-Low (intermittent)
Trib. to Lick Creek (S-T04-002A/(SS-GM-14)	139.07	Intermittent	Flume	7	Lick Creek	Assumed	2,318	2	5.5	3	None-Low (intermittent)
Trib. to Lick Creek (S-T04-006/((SS-GM-15)	139.21	Intermittent	Flume	8	Lick Creek	Assumed	2,384	2	5.2	3	None-Low (intermittent)
Trib. to Lick Creek (S-T04-007/(SS-GM-16)	139.28	Intermittent	Flume	5	Lick Creek	Assumed	2,405	2	5.1	3	None-Low (intermittent)
Trib. to Lick Creek (S-T04-008/(ASI-217)	139.42	Intermittent	Flume	10	Lick Creek	Assumed	2,445	2	5.0	3	None-Low (intermittent)
Trib. to Lick Creek (ASI-226)	139.59	Intermittent	Dam-and-Pump	7	Lick Creek	Assumed	2,640	2	1.0	1	Moderate-High (perennial)
Trib. to Lick Creek (ASI-227)	139.63	Intermittent	Dam-and-Pump	2	Lick Creek	Assumed	2,650	2	1.0	1	Moderate-High (perennial)
Trib. to Lick Creek (ASI-228)	139.68	Intermittent	Flume	2	Lick Creek	Assumed	2,692	2	4.2	3	None-Low (intermittent)
Trib. to Lick Creek SS-GM-43 (AW-230))	139.75	Intermittent	Flume	10	Lick Creek	Assumed	2,739	2	4.1	3	None-Low (intermittent)
Lick Creek (ASI-233)	140.27	intermittent	Flume	20	Lick Creek	Assumed	3,095	4	3.2	3	None-Low (intermittent)
Trib. to Lick Creek (ASI-189)	140.58	intermittent	Dam-and-Pump	3	Lick Creek	Assumed	3,860	2	0.4	1	None-Low (intermittent)
Trib. to Salt Creek (ASI-187)	141.18	Intermittent	Dam-and-Pump	3	Salt Creek	Known	1,495	2	2.2	2	None-Low (intermittent)
Trib. to Salt Creek (ASI-188)	141.48	Intermittent	Dam-and-Pump	3	Salt Creek	Known	1,155	2	2.8	2	None-Low (intermittent)
Trib. to Salt Creek (RS-17)	141.49	Intermittent	Flume	4	Salt Creek	Known	1,153	2	12.3	3	None-Low (intermittent)
Trib. to Salt Creek (ESI-30)	141.95	Intermittent	Flume	6	Salt Creek	Known	360	2	21.5	4	None-Low (intermittent)
Trib. to Salt Creek (ESI-31)	142.35	intermittent	Flume	10	Salt Creek	Known	542	2	18.9	4	None-Low (intermittent)

TABLE 4.2.3-1

Downstream Effects of Instream Construction to Waterbodies with Pacific Salmon EFH Due to Crossing Tributaries with No EFH

Waterbodies Crossed and Waterbody ID	Pipeline Milepost (MP)	Flow	Proposed Crossing Method a/	OHM Width (feet) b/	Tributary to Stream with Salmon EFH c/	EFH Known or Assumed at Confluence	Distance from Pipeline Crossing to Confluence (meters) d/	Instream Duration (hours) e/	Estimated TSS Concentration at Confluence (mg/l) f/	SEV Score at Confluence g/	Risk of TSS at Confluence by Crossing Tributary (rationale) h/
Trib. to Salt Creek (ESI-37)	143.12	intermittent	Flume	4	Salt Creek	Known	1,193	2	12.0	3	None-Low (intermittent)
Trib. to Long Branch Creek (ESI-38)	143.51	intermittent	Flume	3	Long Branch Creek	Assumed	1,100	2	12.8	3	None-Low (intermittent)
Trib. to Long Branch Creek (ESI-39)	143.74	intermittent	Flume	3	Long Branch Creek	Assumed	782	2	16.0	4	None-Low (intermittent)
Trib. to Long Branch Creek (ESI-40)	143.77	Intermittent	Flume	3	Long Branch Creek	Assumed	620	2	17.9	4	None-Low (intermittent)
Hanley North Canal Irrigation Ditch (EDX-42)	144.14	Intermittent	Flume	2	Long Branch Creek	Assumed	3,288	2	2.8	2	None-Low (intermittent)
Trib. to S. Fork Long Branch GSP-5/ESP-48)	144.70	Perennial	Flume	3	Long Branch Creek	Assumed	2,357	2	5.3	3	None-Low (intermittent)
South Fork Long Branch Creek (GSI-6/ESP-59)	145.27	Intermittent	Flume	3	Long Branch Creek	Assumed	1,770	2	8.0	3	None-Low (intermittent)
Trib. to S. Fork Long Branch (ESI-61)	145.54	intermittent	Flume	14	N. Fork Little Butte Creek	Known	736	4	16.5	4	None-Low (intermittent)
Trib. to N. Fork Little Butte Creek (ESI-55)	146.38	intermittent	Flume	3	N. Fork Little Butte Creek	Known	695	2	17.0	4	None-Low (intermittent)
South Fork Little Butte Creek (ASP-165)	162.45	Perennial	Flume	30	S. Fork Little Butte Creek	Assumed	5,866	5	0.5	1	None-Low (intermittent)

a/ Only waterbodies crossed by dry open-cut construction (fluming or dam-and-pump at streams with bedrock substrates) are included.
b/ OHM – ordinary highwater mark provided in wetland and waterbody delineation surveys. OHM is assumed to be the width of the waterbody during instream crossing period.
c/ These streams are either known to support coho with information from ODFW (2017f) or assumed to support coho if steelhead occur.
d/ Distance measured digitally on USGS topographic base maps with Forest Practices statewide hydrography (ODF 2018) superimposed.
e/ Instream durations based on stream widths, see table 3.5.3-21 (SONCC coho) and table 3.5.4-26 (Oregon Coast coho).
f/ Estimated TSS concentrations derived from watershed-specific equations in table 3.5.3-20 (SONCC coho) and table 3.5.4-25 (Oregon Coast coho) with relationships between distance downstream (x) and TSS concentration (y) for fluming and dam-and-pump construction.
g/ SEV score at the confluence of EFH stream and tributary crossed during construction derived by applying duration of exposure (hours) and TSS concentration (mg/l) in Newcombe and Jensen (1996) Model 1 for juvenile and adult salmonids.
h/ Risks from downstream TSS by crossing all streams with bedrock substrate are considered None to Low; risks of downstream TSS crossing intermittent streams are considered None to Low; risks from downstream TSS by crossing perennial streams are considered Moderate to High.

Suspended Sediment – Other Crossing Methods

The other crossing methods include two HDDs (including the Coos River, discussed above, and the Rogue River), one diverted open cut, and one DP (both in the South Umpqua River). These methods would all be used on large streams containing both coho and Chinook salmon. Considering the low likelihood of elevated sediment from these crossings, the potential for rapid dilution of any excess sediment discharge (e.g., HDD inadvertent return) because of substantial flow in these streams and construction and contingency plans in place (e.g., Drilling Fluid Contingency Plan for Horizontal Directional Drilling Operations), and other factors noted in sections 3.5.3.3 (SONCC coho) and 3.5.4.3 (Oregon Coast coho), no adverse effects to Pacific salmon EFH from elevated levels of suspended sediment would occur at these crossings.

4.2.3.3 Movement Blockage

Dry open-cut construction is expected to cause short-term inhibition of upstream movement by adult salmon, as well as within-stream movements of juvenile coho and Chinook salmon. Restrictions on migration could occur from short-term elevation of suspended sediment and the method of water diversion around the stream crossing area. The fluming process is expected to require from 36 to 96 hours of in-stream work, and dam-and-pump construction is expected to require between 20 and 56 hours of in-stream work. Short-term elevation of turbidity could delay upstream movements during this period. Flume sites would allow some upstream and downstream movement, but complete movement restrictions would occur at dam-and-pump sites. Overall, the levels of suspended sediment and physical structures would not cause lengthy delays to adult coho or Chinook salmon migrating upstream, resulting in unsubstantial effects to the EFH of Pacific salmon.

4.2.3.4 Entrainment and Entrapment

Waterbody crossings using the "dry" crossing methods (i.e., flume or dam-and-pump) may result in some rearing coho and Chinook salmon juveniles being entrapped in streams during fluming or dam-and-pump installations. For typical crossings, once streamflow is diverted through the flume pipe, but before trenching begins, fish trapped in any water remaining in the work area between the dams would be removed and released (salvaged) using the *Fish Salvage Plan* (see appendix T). Salvage methods, which all have a risk of fish injury or mortality, could include seining, dip netting, and electrofishing (see section 4.3.3). Fish not removed successfully could be entrained or impinged in water removal pumps. Overall, some juvenile coho and Chinook salmon are likely to suffer injury or mortality, but with the implementation of Project conservation measures, the numbers would be slight, resulting in a short-term adverse effect to the EFH of Pacific salmon.

4.2.3.5 Riparian Vegetation Removal and Modification

Aquatic resources associated with the EFH of Pacific salmon could be affected as a result of removal of vegetation and habitat at the waterbody crossing sites, as required for pipeline construction and associated facilities. In areas of riparian vegetation, PCGP would narrow to a 75-foot-wide construction right-of-way at waterbody crossings, and maintain a setback between waterbody banks and TEWAs in forested areas. As discussed in sections 3.5.3.3 (SONCC coho) and 3.5.4.3 (Oregon Coast coho), various actions would be taken to reduce the loss of vegetation and restore the habitat. The ECRP (see appendix F) describes the procedures that would be implemented to minimize erosion and enhance revegetation success for the entire Project.

Restricting the low-growth vegetation area to a small portion of the total riparian right-of-way clearing would allow much of ecological function of the riparian conditions to continue. This would limit the overall long-term impacts from loss of riparian habitat to a small portion of each stream crossed, reducing future negative effects to Pacific salmon resources. Some limited intermediate-term adverse effects to salmon habitat function would remain, primarily relating to LWD reduction. The effects of riparian vegetation removal on water temperature and LWD are presented below.

Water Temperature

Clearing the right-of-way would remove shading vegetation from uplands and riparian areas, exposing the land and water to increased sunlight, potentially resulting in direct increases in water temperatures. Additionally, indirect increases in stream water temperatures may occur as water flows over the warmer land surface and eventually reaches the waterbody (Beschta and Taylor 1988). The details of the literature and model assessments of likely temperature changes and effects to EFH are presented in sections 3.5.3.3 and 3.5.4.3. The main conclusion is that water temperature changes to fish-bearing streams from clearing would be slight, possibly a few tenths of a degree Celsius increase. These increases would not be biologically significant, and would result in no substantial adverse effect to Pacific salmon EFH.

Large Woody Debris

A potential effect that would result from forest clearing at waterbody pipeline crossings is the reduction of LWD in streams and on adjacent uplands (Harmon et al. 1986; Sedell et al. 1988). Existing conditions associated with riparian vegetation within all fifth-field watersheds in the range of the Oregon Coast and SONCC coho salmon ESUs are generally undesirable. Streams in these watersheds are generally deficient in LWD. Though most of crossings have less than mature sources of LWD, the Project would remove some of these sources, primarily by clearing the 75-foot-wide right-of-way and maintaining a portion of this area in less than mature forest conditions. PCGP has proposed to use on-site mitigation for impacts to waterbodies by installing LWD at appropriate agency and landowner-approved areas within the construction right-of-way across certain waterbodies (see section 4.3.3). Long-term losses of LWD input would largely be mitigated through riparian replanting of conifers in the right-of-way, as discussed at the beginning of section 4.2.3.5. While there may be some reduction in total stream LWD between the short and long-term, the amount would be relatively small considering the total area that could be affected (most of a 75-foot channel), and the mitigation and enhancements that would be implemented (see section 4.3.3), so that LWD changes would result in minor intermediate-term adverse effects to the EFH habitat of Pacific salmon.

4.2.3.6 Streambank Erosion and Streambed Stability

The clearing and grading of the right-of-way during construction could increase erosion along streambanks, resulting in higher turbidity levels in the waterbodies crossed. Alteration of the natural drainage ways or compaction of soils by heavy equipment near streambanks during construction may accelerate erosion of the banks, increase runoff, and induce the transportation of sediments into waterbodies. Stream crossings that are unstable can ultimately adversely affect aquatic resources through loss of local habitat, and impacts to downstream habitat from the addition of highly unstable sediment. This increases the recovery time of the specific site to stable conditions.

Because of FWS concerns for potential adverse effects to bank and bed stability, PCGP has conducted an initial assessment of crossing conditions of all streams suitable for analysis, based on the FWS risk matrix (GeoEngineers 2017d and 2017e). Based on this analysis, no crossing was rated as having both a high risk of Project impact potential and high risk of stream and site response potential within the range of Pacific salmon. Reassessment of the risk would occur prior to construction. Additionally, PCGP would include additional mitigative actions at the higher risk crossings to help reduce the potential for impacts, including post-construction monitoring of all crossings (see sections 3.5.3.3 and 3.5.4.3). Additional site-specific plans would be developed at selected sites to aid ensuring stream habitat protections. Overall, these actions would reduce potential adverse effects from bank and bed stability to unsubstantial levels for the EFH of Pacific salmon.

4.2.3.7 Aquatic Habitat

There also are potential, indirect effects to aquatic habitat from increased suspended sediment from stream crossings. The most likely effect of suspended sediment increases downstream would increase embeddedness of spawning gravels, with increasing habitat effects closer to the construction location. Considering the estimates of likely suspended sediment levels, some measured change in habitat preference may occur but it would not reach the level of moderate habitat degradation. Where uninterrupted dry open-cut construction occurs, indirect adverse effects to Pacific salmon EFH from crossing-induced suspended sediment are thus not expected.

4.2.3.8 Freshwater Stream Invertebrates

Substrates downstream from in-stream construction sites could be impacted by sediments. Mayflies, caddisflies, and stoneflies prefer large substrate particles in riffles, and are adversely affected by fine sediment deposited in interparticulate spaces (Cordone and Kelley 1961; Waters 1995; Harrison et al. 2007). Fish and benthic macroinvertebrate abundances downstream of pipeline construction sites have been reported as short-term reductions (Reid and Anderson 1999). However, rapid colonization by benthic organisms of disturbed substrate following pipeline construction has been demonstrated in several studies (see section 3.5). Most studies finding effects to benthic resources were from wet open-cut crossings, which have much higher sediment levels (see sections 3.5). Therefore, the overall level of effects of the pipeline crossings on waterbodies, unless crossing sealing failures occur, would be even less than that noted by literature, and would not result in substantial reduction in growth or survival of salmon individuals.

4.2.3.9 Hydrostatic Testing

Water would be required on a one-time basis near the end of construction to hydrostatically test the pipeline. Potential impacts associated with hydrostatic testing include entrainment of fish, reduced downstream flows, impaired downstream uses if test water is withdrawn from surface waters, and erosion, scouring, and a release of chemical additives as a result of test water discharge. PCGP would minimize the potential effects of hydrostatic testing on these watersheds by adhering to the measures in its *Hydrostatic Testing Plan* (see appendix U), including screening intake hoses to prevent the entrainment of fish and other aquatic organisms. Additionally, where water cannot be returned to the original water source, it would be discharged upslope (at least 150 feet from streams with no direct discharge features) to prevent direct water return to the stream. PCGP would obtain all necessary appropriations, withdrawal, and discharge permits through the OWRD. With the implementation of these plans and BMPs, and through obtaining and complying with required permits, adequate measures would be in place to prevent direct or indirect adverse effects to Pacific salmon EFH.

4.2.3.10 Aquatic Nuisance Species

Nonindigenous Aquatic Species (NAS) are aquatic species that degrade aquatic ecosystem function and benefits, in some cases completely altering aquatic systems by displacing native species, degrading water quality, altering trophic dynamics, and restricting beneficial uses (Hanson and Sytsma 2001). Some of the major potential freshwater invasive species are mussels, including the zebra and quagga mussels (*Dreissena polymorpha*, and *Dreissena rostriformis bugenisis*), as well as Chytrid fungus and other species of concern. Management priorities in Oregon concentrate on the species whose current or potential impacts on native species and habitats, and economic and recreational activity in Oregon, are known to be significant (Hanson and Sytsma 2001).

Aquatic nuisance species could potentially be introduced into project area waters by basin transfer through hydrostatic testing waters, or be carried on equipment that is moved from outside of the region or between basins. PCGP has developed BMPs and guidelines to avoid the potential spread of the aquatic invasive species and pathogens of concern (see *Hydrostatic Testing Plan* in appendix U). To prevent the introduction of aquatic nuisance species, PCGP may follow the guidelines of this plan during construction. With the implementation of the details of this Plan and other procedures, introduction of non-native species or movement of species between basins should not occur, resulting in no adverse effects to Pacific salmon EFH.

4.2.3.11 Fuel and Chemical Spills

Fisheries habitats could be adversely affected if petroleum products were accidentally discharged into aquatic environments. Such materials are toxic to algae, invertebrates, and fish. Of the products likely to be present during construction, data compiled from a wide range of sources indicate that diesel fuels and lubricating oils are considerably more toxic to aquatic organisms than other, more volatile products (gasoline) or heavier crude oil (Markarian et al. 1994). Inadvertent spills of fluids used during construction, such as fuels and lubricants, could contaminate wetland soils and vegetation. To minimize the potential for spills and any impacts from such spills, PCGP's SPCCP (see appendix L) would be implemented. In general, hazardous materials, chemicals, fuels, lubricating oils, and concrete-coating activities would be not be stored, nor would refueling operations be conducted within 100 feet (150 feet on BLM and Forest Service lands) of a wetland or waterbody in accordance with FERC's *Procedures* (see appendix C) and the SPCCP (see appendix L), except where no reasonable location is possible and additional containment steps have been taken. The SPCCP would be updated with site-specific information prior to construction. Adherence to these plans and procedures would result in effects to the Pacific salmon EFH that would be unsubstantial.

4.2.3.12 Operation and Maintenance Activities

Once the pipeline is installed, maintenance would include activities such as aerial inspections, gas flow monitoring, visual inspection of surrounding vegetation for signs of leaks, and integrity management, which includes smart pigging to investigate the interior surface of the pipe for any signs of stress cracking, pitting, and other anomalies (see the ECRP in appendix F). All of the proposed maintenance activities would be outlined in the Operations and Maintenance Plan that would be prepared according to operating regulations in DOT 49 CFR Subpart L, Part 192, and would be completed prior to going in-service. These general maintenance activities would require only surface activities and usage of the existing right-of-way, such as insertion of the pig (an internal pipeline cleaning and inspection tool) at one of the pig launching facilities.

Within stream sites, repair work could require isolated flow from the section of pipe that is to be exposed. Impacts would be similar to those discussed above for initial installation, except on a much smaller scale. Repairs that may need to occur outside the fish window period would likely have more site-specific effects to EFH fish resources. Standard BMPs would be followed and needed permits would be obtained to aid in reducing impacts. Very limited effects would occur to riparian areas if repairs were needed, as a portion of the right-of-way would be permanently maintained as largely vegetation free. No vegetation or tree limitations would occur beyond the 30-foot-wide corridor in riparian areas (i.e., up to 100 feet of streams on federal lands, and 25 feet on non-federal lands).

Herbicide Application

Herbicides have the potential to cause toxic effects to different salmonid life stages and to other aquatic species, causing direct impacts if used improperly. However, when herbicides are properly used according to label restrictions and BMPs to control noxious weeds, there is little to no chance of causing injury or mortality to fish or other aquatic organisms.

As discussed in sections 3.5.3.3 (SONCC coho) and 3.5.4.3 (Oregon Coast coho), PCGP would not use herbicides for routine vegetation maintenance, but instead would employ hand and mechanical methods (pulling, mowing, biological, disking, etc.) to prevent the spread of potential weed infestations where feasible, and implement management plans specific to land ownership to ensure proper use and to prevent entry of herbicides into streams. The BMPs would minimize the potential spread of invasive species and minimize the potential adverse effects of control treatments. Herbicides would not be applied by aerial or broadcast spraying. With the implementation of the BMPs, elimination of use of herbicides near streams, and only selective use of these chemicals in areas away from streams, meaningful negative effects to Pacific salmon EFH from herbicides would be unlikely to occur.

4.3 CONSERVATION AND MITIGATION MEASURES

All avoidance, minimization, BMP, and mitigative actions that may reduce, avoid, eliminate, or otherwise offset adverse effects to EFH are considered here as EFH conservation measures for the Project. The conservation and mitigative measures described in the main BA section 3.5 and incorporated in to the text descriptions of the potential effects for the four ESA listed fish species would also apply to the four FMP fish EFHs. These ESA fish conservation measures address the same concern of potential Project-induced adverse effects to habitat for the four FMP fish groups, because portions of the four ESA fish habitat uses overlap in the three Project analysis areas: marine, estuarine, and riverine. Conservation measures for the marine would benefit the EFH of all four FMP fish species; the conservation measures used in the estuarine analysis area would benefit all but the highly migratory EFH; and the measures applied in the riverine analysis area would aid Pacific salmon EFH. While the details of the conservation measures are provided under each of the four ESA-listed species, a summary of most that apply by each of the three analysis areas is provided below. Not all actions that may reduce adverse effects in these analysis areas are listed.

4.3.1 Marine Conservation Measures – All Four FMP EFH

- Federal Water Pollution Control Act prohibits discharge of oil in U.S. waters.
- Requirement of all U.S. port vessels to have a SPCCP to address spills.

4.3.2 Estuarine Conservation Measures – Coastal Pelagic, Groundfish, and Pacific Salmon EFH

- Perform all slip, access channel, Navigation Reliability Improvementsduring lower abundance of the most susceptible fish life stage of the Pacific Coast Salmon Management Group, October 1 through February 15.
- Implement a water quality monitoring program during dredge operations to assess the need for operational controls that assure turbidity levels remain within seasonal permitted limits.
- Implement operational controls to assure compliance with water quality criteria in the CWA Section 401 Certification, which may include ceasing dredging, decreasing cutterhead speed, increasing suction flow rates and using different size or type of dredge, lowering the crest elevation, and/or avoiding sediment stockpiling during peak ebb conditions.
- For the LNG facility, implement a site-specific SPCCP to minimize the potential for accidental releases of hazardous materials.
- During the initial year(s) of operations, monitor LNG carrier transits in Coos Bay to confirm speeds of four to six knots.
- Conduct LNG carrier ballast water exchanges to include both flushing and treatment prior to entering U.S. waters to reduce the transfer of invasive species to the Coos Bay ecosystem.
- Provide low intensity lights on docks and consult on final design to best assure lighting minimizes conditions that could result in fish attraction or predation.
- To the extent possible, use a vibratory hammer to avoid adverse in-water noise effects. Minimize the use of impact driving except for proofing in-water piles.
- Use sound attenuation measures to minimize adverse in-water noise effects from pile driving with an impact hammer;
- Limit total impact strikes per day to less than 3,000 or another amount determined in consultation with NMFS for in-water piles.
- Conduct much of the slip excavation in the dry out of estuarine waters to reduce effects of turbidity and sedimentation on small forage fish with low swimming ability and on other benthic and epibenthic prey species.
- Implement *Hydrostatic Testing Plan* methods to equipment use and cleaning to reduce invasive species spread or entry to the estuary.
- Mitigate for construction that would involve the loss of intertidal and subtidal habitat by restoring habitat at a 3:1 ratio in Kentuck Slough, and for eelgrass lost by planting eelgrass at a 3:1 (appendix O/Compensatory Wetland Mitigation Plan).

4.3.3 Riverine Conservation Measures – Pacific Salmon EFH

- Extensive erosion control methods would be employed including temporary and permanent slope breakers, sediment barriers, mulch, and erosion control fabric.
- Long-term erosion control including final cleanup, final grading, installation of permanent erosion control structures, backfilling and regrading as necessary, and timely preparation of suitable seedbed.
- OHV barriers to reduce post-construction sediment to streams.
- Revegetation including tree seedlings and replanting conifers where appropriate within 15 feet of the right-of-way center, which would aid future stream shading, organic input, and future LWD supply.
- Stump retention on stream banks to improve intermediate-term stream bank stability.
- Narrowing of right-of-way to 75 feet at stream crossing to reduce loss of riparian vegetation and function.
- Stream bank restoration following trenching including returning banks to preconstruction contours where possible and revegetation (see the ECRP).
- Procedures are in place to keep all petroleum products away from stream entry.
- Provide special additional BMPs at stream crossings that have moderate to high risk of channel or stream bank instability resulting from stream morphology or crossing methods at the specific location.
- Provide post-construction monitoring of all stream crossing sites to ensure streambed and bank conditions remain stable.
- Backfill the surface foot of the excavated stream channel with gravel or native cobble except where stream channels did not have this as native material.
- Follow the *Fish Salvage Plan* details including use of collection methods and procedures that would reduce injury and mortality of fish at pipeline crossings and remove fish from potential adverse noise and blasting effects.
- Return removed LWD to the streams following installation and provide additional LWD to fish streams and banks to help maintain or enhance the habitat (see appendix O).
- Additional mitigation to help maintain the ACS on NFS lands and the RMS on BLM lands would also occur that would have direct and indirect benefits to EFH habitat on these lands. This would include actions in watersheds that contain EFH such as:
  - add LWD to several stream miles
  - restore degraded riparian habitat;
  - improve fish passage at existing passage barriers;
  - improve roads and stabilize culverts;
  - pre-thin to improve riparian habitat;
  - decommission and waterbody crossings and close roads; and
  - stormproof roads (e.g., waterbars, ditch cleaning) reducing risk of road failure that would add fine sediment to streams.

4.4 EFFECTS DETERMINATION

4.4.1 Highly Migratory Species EFH

The proposed action **would not adversely affect** EFH for highly migratory species because accidental spills and releases at sea, if they should occur, are not expected to diminish water quality within the marine analysis area. The volumes of hydraulic oil and fuel spills from a single LNG carrier would be very small in relation to the size of the ocean.

4.4.2 Coastal Pelagic Species EFH

The proposed action **may adversely affect** EFH for coastal pelagic species in the short-term due to loss of eelgrass habitat until such habitat is re-established at the eelgrass mitigation site and until disturbed estuarine habitat is restored and recovers. Short-term loss of benthic food resources would also result from dredging of the access channel and NRI areas. Small juvenile and larval stages of fish could be entrained or impinged and suffer mortality from the cooling water intakes of LNG carriers while at berth; but a substantive loss is unlikely.

4.4.3 Groundfish EFH

The proposed action **may adversely affect** EFH for groundfish species in the short-term due to loss of eelgrass habitat until such habitat is re-established at the eelgrass mitigation site and until disturbed estuarine habitat is restored and recovers. Short-term loss of benthic food resources would also result from dredging of the access channel and NRI areas. Over the long-term, eggs, larval, and small juvenile life stages of fish occupying waters near the LNG carriers at the Terminal dock could be entrained or impinged, and suffer mortality by cooling water intakes, but a substantive loss is unlikely.

4.4.4 Pacific Salmon EFH

Effects to freshwater Pacific Coast Salmon EFH by the proposed action **may adversely affect** riverine habitats by impacting substrates and suspended sediment water quality over the short-term, as well as by removal of riparian vegetation, which could affect LWD supply over the long-term. Also, juvenile coho or Chinook salmon entrapped in isolated areas at pipeline stream crossings, as well as removal from stream crossing areas, would result in minor fish mortalities. Short-term loss of benthic food resources would also occur from slip dredging. Juvenile salmon stages could be entrained or impinged, and suffer mortality from cooling water withdrawal in the estuary.

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Jordan Cove Energy Project, L.P.
Thermal Plume Study

Prepared for:

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Lyndhurst, NJ

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8544

1.0 THERMAL PLUME STUDY

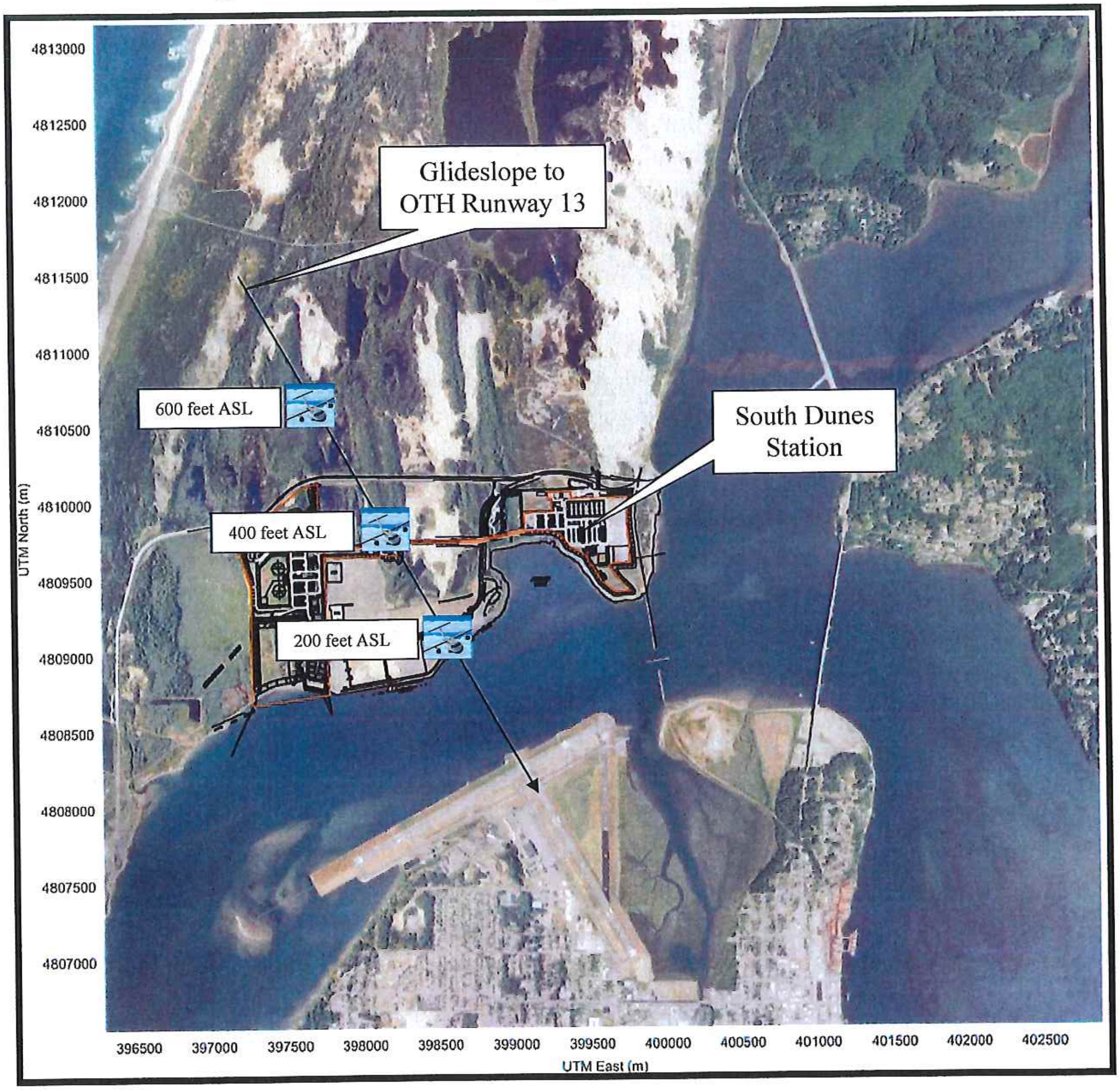
1.1 Introduction

Jordan Cove Energy Project, L.P. is proposing to construct and operate a liquefied natural gas (LNG) export terminal on an approximate 168-acre site located on the bay side of the North Spit of Coos Bay, Oregon between Coos Bay Navigation Channel Miles (CM) 7.0 and 8.0. The project, known as the Jordan Cove Energy Project (JCEP) LNG Terminal Project, or Project (or Facility) will consist of facilities to receive, liquefy, temporarily store, and send out up to approximately six million metric tons per annum (MMTPA) of LNG. The LNG terminal will be capable of loading LNG ships ranging in capacity from 89,000 cubic meters (m^3) to 160,000 m^3. The LNG loaded onto the ships will be transferred by cryogenic service piping from two 160,000 m^3 (1,006,000 barrels) full-containment LNG storage tanks where it will be stored in a liquefied state until it is pumped out to the LNG vessels. The following liquefaction facilities are proposed for the Project:

- Four liquefaction trains, each with the capacity of 1.5 MMTPA;
- Two feed gas cleaning and dehydration trains with a combined natural gas throughput of approximately 1 billion SCF/day (Bscf/d);
- Refrigerant storage and resupply system;
- Aerial Cooling System (Fin-Fan) to reject heat removed during the LNG liquefaction process; and
- The South Dunes Power Plant, a nominal 420 megawatt (MW) natural gas fired combined-cycle electric power plant for the purpose of powering the natural gas liquefaction process systems.

The proposed Project will utilize five GE LM6000 PG combustion turbines, each with an exhaust stack 119 feet above grade (or 167 feet above sea level (ASL)), used primarily for powering the natural gas liquefaction process systems. The proposed Facility will be located at approximately 43.434024 North Latitude, 124.243219 West Longitude, North American Datum 1983 (NAD83). The approximate Universal Transverse Mercator (UTM) coordinates of the proposed facility are 399,383 meters Easting, 4,809,765 meters Northing, in Zone 10, NAD83. The project site is proximate to the normal air traffic patterns of North Bend Municipal Airport (currently known as the Southwest Oregon Regional Airport or OTH), which is approximately located 1.6 km to the South of the proposed South Dunes Power Station. Figure 1-1 shows the location of the South Dunes Station along with the glide slope to runway 13 of the Southwest Oregon Regional Airport.

Figure 1-1: Site Location Map with glideslope to OTH



An analysis of the potential for the South Dunes Power Station and Gas Conditioning system exhaust plumes to impact flight operations directly over the proposed Project was made in accordance with a request from Jordan Cove Energy Project, L.P.

1.2 Vertical plume velocity guidelines

The Federal Aviation Administration (FAA) has identified thermal plumes as being a potential flight hazard where pilots should avoid flight in the vicinity of those plumes (Section 7-5-15 of the Aeronautical Information Manual: Official Guide to Basic Flight Information and ATC Procedures, February 2012). The FAA has issued guidance for pilots to fly upwind of possible thermal plumes in order to avoid the potential for the high temperature thermal exhausts to cause air turbulence around the aircraft. The FAA currently does not have any guidelines for conducting thermal plume assessments but is currently conducting studies to further characterize the effects of thermal plumes. Until those FAA studies are completed, pilots are encouraged to exercise caution when flying in the vicinity of thermal plumes.

Since the development of a simple-cycle gas turbine power station at the end of a runway in Australia in the mid-1990s, the Australian Civil Aviation Safety Authority (CASA) has taken an active role in the review of the siting of facilities with the potential to affect aviation activities. Potential hazards that could affect the safety of aircraft include tall visible or invisible obstructions. Invisible obstructions include industrial exhausts that generate significant turbulence due to high velocity and buoyancy. CASA has issued an Advisory Circular, (CASA-AC-139-5, 2012) that specifies the requirements and methodologies to be used to assess whether a new industrial plume is likely to have adverse implications for aviation safety. The CASA guidance includes a range of critical plume velocity (i.e., the velocity at which the vertical plume rise may affect the handling characteristics of aircraft in flight such that there may be a momentary loss of control) of between 4.3 and 10.6 meters per second (m/s). The selection of critical plume velocity is based upon a range of considerations including the phase of flight affected, the size of aircraft, the frequency of use of flight path, presence of air traffic control, and human factors. It should be noted that a vertical velocity of 4.3 m/s is associated with typical towering cumulous clouds while cumulonimbus clouds (i.e., thunderstorms) typically have vertical velocities in the 10-25 m/s range.

The aim of this assessment is to determine the potential for the plumes emitted from the Project to exceed the minimum critical plume velocity of 4.3 meters per second (m/s) within the flight path to the Southwest Oregon Regional Airport.

1.3 Stack Exhaust Characteristics

The assessment focused on the Project components most likely to generate a plume vertical velocity that could exceed the critical plume velocity. Therefore, the assessment focused on those Project components with the most substantial momentum flux at stack exit and buoyancy flux at stack exit, which is a function of exhaust flow and temperature. The facility equipment, that would generate the greatest plume vertical velocity are the five GE LM6000 combustion turbines due to their large volumetric flows and proximity to one another. Thus, this study focused on determining a maximum calculated vertical velocity due to the combustion turbine exhaust plumes.

The Project also utilizes thermal oxidizers as part of the gas conditioning systems and air cooled condensers as part of the combined cycle power plant operations. The total combined volumetric flow rate from the two thermal oxidizers is 4% of the total flow from the five combustion turbines. Thus, it is expected that the plume vertical velocity generated from the thermal oxidizers will be substantially lower in magnitude than the plume vertical velocity from the combustion turbine stacks. Similarly, the two air cooled condensers are expected to have a minimal contribution to a plume vertical velocity outside of an immediate area above the units. This is due to the low exit velocity for each fan (typically below 3-5 m/s) and due to the minimal temperature differences between the fan exhausts and the ambient temperature. For these reasons, it is expected that the buoyancy flux and momentum fluxes would be minimal outside of the direct area above the units (i.e., within a few hundred feet above the fan deck).

The stack exhaust characteristics for each of the five combustion turbines are shown in the following Table 1:

Table 1: Combustion Turbine Exhaust Characteristics

Stack Exhaust Parameters	GE LM6000 Combustion Turbines	
	English	Metric
Height	119 feet	36.27 meters
Flowrate	355,123 ACFM	167.6 m^3/s
Velocity	75.36 ft/sec	22.97 m/s
Temperature	251.8 F	395.3 Kelvin
Diameter	10.0 feet	3.05 meters

1.4 Modeling Methodology

This assessment was based upon both a conservative theoretical approach, which determines the potential for turbulence generated by the plume-averaged vertical velocity of Project's exhaust plumes as well as a conservative modeling approach using the Project design and local meteorological conditions. Additional approaches using typical meteorological conditions were also developed to provide representative plume vertical velocities.

Theoretical Approach

This method uses worst-case assumptions of calm winds and neutral atmospheric conditions for the entire vertical extent of the plume to determine the worst-case impacts. It should be noted that this methodology determines the maximum potential vertical velocity in the direct airspace above the South Dunes Station combustion turbine exhaust stacks but does not determine the vertical velocities as a function of horizontal distance from the stacks. This theoretical approach is presented to define the critical plume height at which, the vertical velocity exceeds the threshold of 4.3 m/s.

The methodology followed in this assessment is outlined in the Aviation Safety and Buoyant Plumes paper presented at the Clean Air Conference in South Wales, Australia, by Peter Best et al. This paper is included in Appendix A. The methodology presented and used in the assessment has been based upon well-verified laboratory and theoretical treatments of the rise and spread of a buoyant plume. The plume growth involves several stages of development detailed below:

Stage 1: In the first stage near to the stack exit, the high plume momentum results in a short distance in which the conditions at the center of each plume are unaffected by ambient conditions. The potential plume core in which maximum vertical velocity and temperature remain constant extends to a distance of approximately 6.25 * D (where D is stack exit diameter) in calm wind conditions. At the end of this stage, the plume average vertical velocity is approximately half of the stack exit velocity.

Stage 2: The plume dynamics and trajectories in this stage respond to ambient air, with much cooler air being entrained into the outer regions of the plume. The momentum and buoyancy of the plume significantly influence the plume rise as this air mixes into the plume and provides dilution to decrease plume vertical velocities. This dilution is sensitive to ambient wind speeds and thus, the use of calm wind conditions is considered to be conservative.

Stage3: At this time the plume rise is due entirely to the buoyancy of the plume and continues until such time that there is an equalization of turbulence conditions within and outside of the plume. This final rise occurs at considerable distances and heights from the stack exit and where the effective vertical velocity would be close to zero. This stage is not assessed quantitatively as near-zero vertical velocities are associated with minor to negligible turbulence.

In addition to the theoretical approach for calculating potential plume vertical velocities based upon calm wind conditions, an alternative methodology was utilized for calculating expected vertical velocities based upon more typical meteorological conditions at the site. This approach utilized more typical horizontal wind conditions expected at the site (based upon the 20th percentile recorded wind speed at OTH of 2 m/s) rather than the worst-case assumption of calm winds throughout the plume. The methodology followed for the typical meteorological conditions assessment is outlined in the paper: Potential for Power Plant Stack Exhaust to Disrupt Aircraft Operations (Joel Reisman and David LeCureux). The methodology presented and used in the assessment has been based upon well-verified laboratory and theoretical treatments of plume rise that is utilized by U.S. EPA in most of their dispersion models.

Modeling Approach

Using the combustion turbine exhaust parameters presented in Table 1, modeling was performed using the AERMOD computer dispersion model to assess the minimum plume dilutions within vertical planes in the regional area around the South Dunes Station. The modeled plume dilutions were then used to develop volumetric averaged plume temperatures resulting in theoretical maximum vertical velocities in both the horizontal and vertical planes around the South Dunes Station. In addition to the using the minimum modeled plume dilutions (i.e., the maximum modeled concentrations) an additional case was developed utilizing more typical, albeit infrequent, meteorological conditions based upon the 98th percentile maximum modeled concentrations. By using this methodology, a vertical velocity was calculated based upon meteorological conditions that would be expected to occur only 175 hours in a year.

The AERMOD model is a state-of-the-art steady-state Gaussian plume model that can be used to assess concentrations from a wide variety of sources associated with an industrial source complex. The model includes the PRIME (Plume RIse Model Enhancements) algorithm for improved treatment of building downwash and cavity area effects. Specifically, the AERMOD model with PRIME features enhanced plume dispersion coefficients due to the wake turbulence and reduced plume rise caused by descending streamlines and increased entrainment in the wake of a structure. One of the important aspects of the PRIME algorithm is its ability to model the downwind turbulent cavity (i.e., near wake) and far wake areas on a three dimensional scale. Thus, the AERMOD model is preferred for modeling the South Dunes Station combustion turbines given the large number of building tiers and structures on the site that create a variety of turbulent cavity regions. The AERMOD model is applicable for assessing the air quality concentrations for locations at industrial sources where aerodynamic downwash is important, in rural or urban areas, in flat or rolling terrain, and for point elevation above ground level.

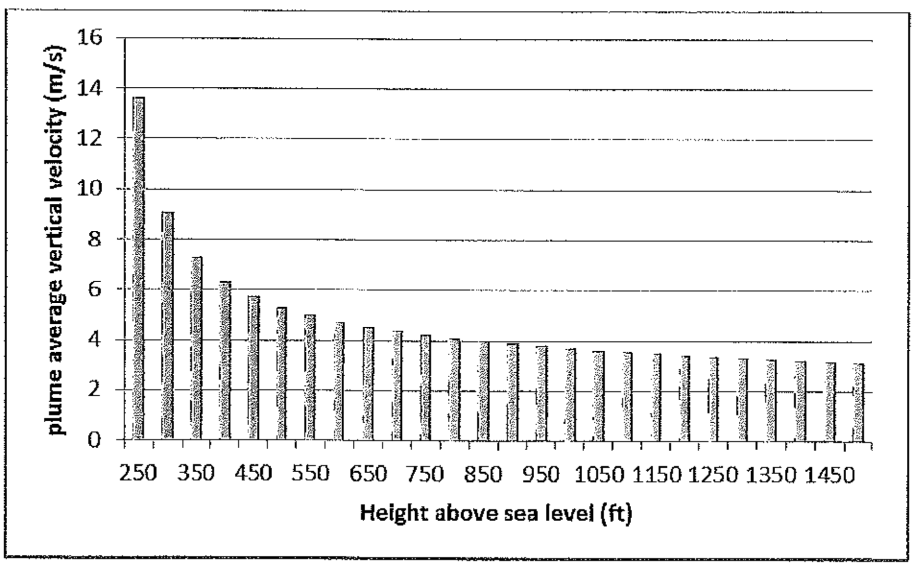
The thermal plume analysis utilized five years of meteorological data collected from 2007-2011 from the meteorological tower at the Southwest Oregon Regional Airport. The assessment focused on a 10 km x 5 km area starting at the landing point of Runway 13 at the airport. Vertical planes were developed for 100 feet vertical increments at levels from 100 feet to 1,000 feet ASL (i.e., the heights at which the maximum vertical velocities may be expected to occur from this Project).

The modeled plume dilutions across the 5 years of meteorological data and over the 50 square kilometer horizontal planes at ten heights were then utilized to develop volumetrically averaged plume temperatures. The difference in plume temperature and ambient temperature would lead to the acceleration of an air parcel due to the density differences at a given level. A conservative method to calculate plume vertical velocity was developed using the meteorological concept of convective available potential energy (i.e., CAPE or potential buoyancy) that is typically used to calculate the maximum theoretical vertical velocity of thunderstorms.

Using the modeled plume temperatures, a convectively driven vertical velocity is calculated at each modeled level by integrating (i.e., summing) the calculated layer CAPE at each 100 ft vertical increment above sea level. This methodology assumes that positive buoyancy will occur at each modeled level such that the vertical velocity will keep increasing until it reaches the equilibrium level (i.e., the level at which the plume temperature equals the ambient temperature). This methodology results in a conservative estimate of vertical velocity in a column of air since it is based upon layering maximum modeled plume temperatures regardless of the time and space that they would occur.

1.5 Modeling Results

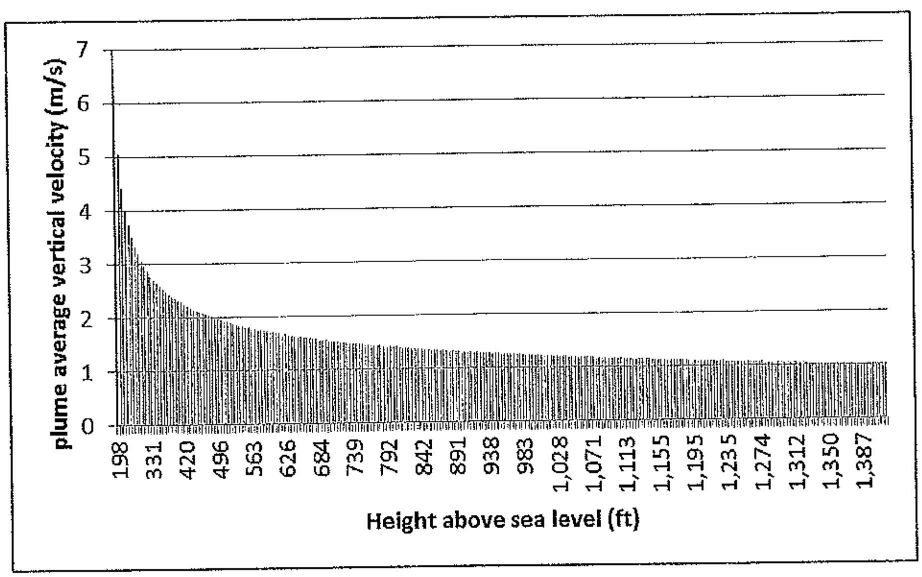
Using the methodologies described in Section 1.4, the maximum theoretical plume vertical velocity was calculated for the area directly above the South Dunes Station exhaust stacks. The results are detailed in Appendix B and summarized in the following chart at various heights above sea level.



As shown in the chart, the vertical velocity exceeds the threshold of 4.3 m/s up to a height of 750 feet above sea level. The values presented in the chart above are very conservative estimates of the plume average vertical velocity as they assume the wind profile is constant with height and with no wind shear but in reality, there is considerable variation with height in light winds and even light horizontal winds would substantially reduce the predicted vertical velocities. Also, these vertical velocities are for the area directly above the South Dunes Station exhaust stacks. For example, even at a height of 1,500 above sea level the plume radius would be on the order of 200 feet from the stack centerline.

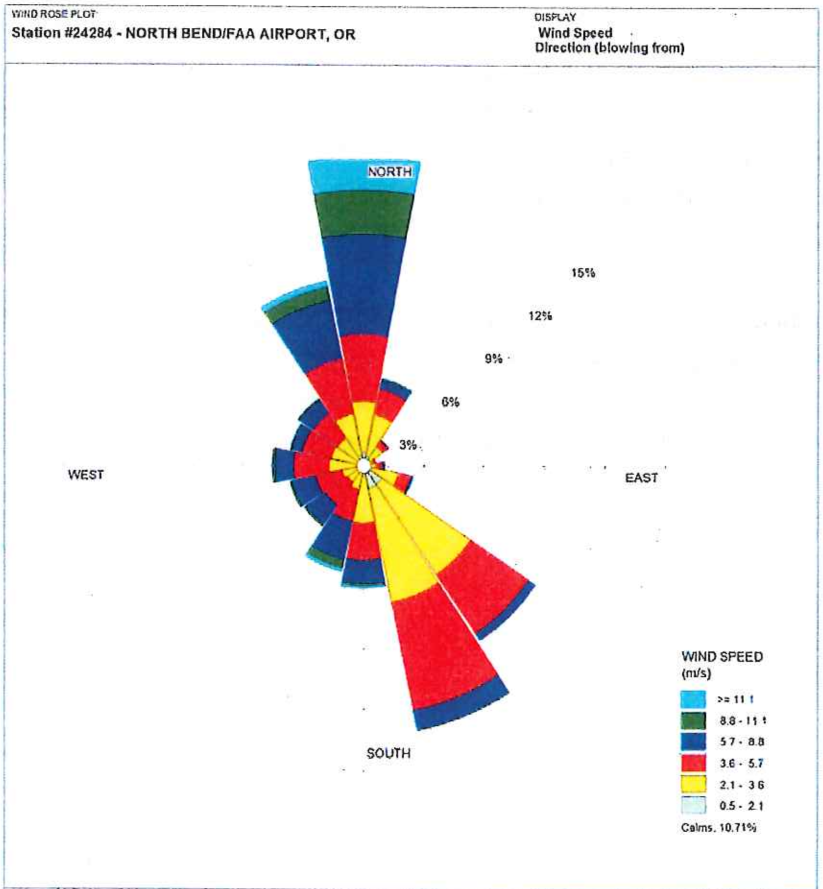
As shown in Figure 1-2 the frequency of calm winds in Coos Bay is approximately 10% of the year on an annual basis. The majority of winds occur from the North/Northwest and from the South/Southeast such that the plumes from the South Dunes Station would infrequently travel within the glide path to OTH. Additionally, winds from the East that would serve to push a plume into the glideslope to OTH Runway 13 occur infrequently (5% of the year) and at speeds greater than 2 m/s.

The results of the theoretical modeling assuming a minimal horizontal wind shear (i.e., a wind speed of 2.0 m/s) indicates that the vertical velocity exceeds the CASA threshold up to a height of 70 feet above stack top or 234 feet above sea level. A wind speed of 2.0 m/s or less would be expected to occur up to 20% of the year at the site. These results are summarized in the following chart.



The results of the modeling using five years of meteorological data with the AERMOD dispersion model are presented graphically at three flight levels (i.e., 200 feet, 400 feet, and 600 feet) in Appendix C with the units of meters per second. As shown in the graphics and as expected, there is a substantial vertical velocity gradient over the South Dunes Station, which confirms the results of the theoretical modeling presented earlier in regards to magnitude and horizontal extent of the plume. By using the 98th percentile modeled concentration results (representing the dispersion resulting in worst case plume vertical velocities for 175 hours per year) the results show that the CASA threshold is exceeded in the general direct airspace above the South Dunes Power Plant and quickly dissipates to less than 1.0 m/s in the direct flight path to the airport.

Figure 1-2: Southwest Oregon Regional Airport Windrose



1.6 Summary of Results

An assessment of the plume-average vertical velocity associated with the operation of the South Dunes Station combustion turbines was conducted using both conservative theoretical and modeled methodologies and for both worst-case and typical meteorological assumptions. The results of the theoretical assessment indicate that there is a potential for the CASA vertical velocity threshold to be exceeded up to a height of approximately 750 feet above sea level over the South Dunes Station exhaust stacks (at this height the plume diameter is approximately 180 feet under calm wind conditions). However, even by assuming a more realistic amount of horizontal wind shear, the calculated extent of exceedances of the CASA threshold extends to approximately 230 feet above sea level.

The results of the modeled assessment also indicate that the CASA vertical velocity threshold may be exceeded within the airspace above the South Dunes Station. It is expected based upon both the theoretical and modeled assessments that the CASA threshold would not be exceeded in the flight path to the airport under more typical, albeit still infrequent, wind conditions from those used in the worst-case assessment. Under these more typical meteorological conditions the CASA threshold would not be expected to be exceeded other than in the area directly above the South Dunes Power Plants exhausts.

The results of the assessment confirm the FAA guidance for pilots to fly upwind of possible thermal plumes in order to avoid the potential for the high temperature thermal exhausts to cause air turbulence around the aircraft. Specifically, in the airspace directly above the South Dunes Station there exists the possibility of exceeding the CASA thresholds such that pilots should avoid flight in the vicinity of those plumes.

Appendix A
Aviation and Safety of Buoyant Plumes

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Clean Air Conference, Newcastle, New South Wales, Australia, 2003

AVIATION SAFETY AND BUOYANT PLUMES

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Summary

Very buoyant plumes generally experience good dispersion but can, in some circumstances, affect aviation safety. Large in-plume vertical velocities can occur in calm conditions with minimal wind shear. Recent civil aviation guidelines seek to restrict the horizontal or vertical extent where average in-plume vertical velocities exceed a threshold that can threaten aircraft performance or structural stability. Key plume calculation procedures require adequate predictions or measurements of vertical profiles of wind and turbulence parameters. The TAPM scheme proves useful but requires additional features for complex source geometry. A hybrid approach overcomes most of these limitations, whilst treating the initial plume development in more detail. Design issues for typical stack configurations are discussed.

Keywords: Plume velocities, stacks, cooling towers, flares, safety

1. Introduction

Over the past 25 years, considerable laboratory, field and theoretical work has been undertaken on the dispersion of very buoyant plumes from industrial sources. Such sources have traditionally included single or multi-flue stacks for major power stations, cooling towers and gas turbine generating plants where large volume flows, together with high exit temperatures, produce some of the highest buoyancy fluxes for normal power station configurations. With the increasing emphasis on gas and similar alternatives for power generation and the recent consideration of stack-in-tower configurations for locations where dry cooling is preferred, highly buoyant plumes are becoming the rule. In addition, industrial flares or unintended releases from pressurised pipelines can yield plumes with large momentum and/or buoyancy fluxes and may have structures approximating line or area sources. Recent dispersion analyses (Weil et al 2001) have shown that very buoyant plumes can readily interact with the overlying inversion and have plume spread dominated by buoyancy for most of the near-field. Plume rise and spread descriptions may need to be revisited.

High buoyancy plumes can, however, give rise to other problems that may require addressing in environmental impact assessments. High buoyancy plumes rise quickly and have significant in-plume vertical velocities. Should the facility be close to local airfields or aviation transport routes, any aircraft encountering the buoyant plumes may experience sufficient vertical uplift and turbulence to cause some temporary disruption to the manoeuvrability of aircraft, especially light commercial (rather than jet) aircraft.

There are no publicly-available field studies that document the decline of in-plume velocities with plume travel time for a variety of conditions necessary to produce validated modelling schemes. Various experimental and theoretical work was conducted around open-cycle and combined-cycle gas turbines at Kuala Lumpur, with field measurements taken for stack-top windspeeds in the range 2-8 m/s (but not for calm conditions). The Cessna aircraft used (Flinders Institute for Atmospheric and Marine Sciences) was fitted out to measure turbulence and air quality parameters as well as aircraft variables. The unpublished results showed a strong decrease of in-plume vertical velocities with windspeed and height, core vertical velocities a factor of approximately 2 greater than plume-averaged values and significant influences on aircraft handling for near-instantaneous (~ 1 sec) exposures to strong plume velocities, especially if encountered by surprise.

The importance of vertical motion in causing aviation problems is better documented by the number of light aircraft incidents reported during strong convection in Australia (Spillane and Hess 1988). During extreme events, naturally-occurring vertical velocities can reach 8 m/s.

The current studies were conducted for an environmental impact assessment of a 700 MW open cycle gas-fired turbine near an army aviation centre at Oakey in southern Queensland. Previous studies by Spillane (1980) on moist plumes were adapted to treat buoyant plumes from closely located sources in calm and low windspeed neutral conditions (Katestone

Scientific 1997). At the time, there was no model recommended by the Civil Aviation Safety Authority of Australia (CASA) and, indeed, very little guidance internationally as to the manner in which available velocity thresholds should be interpreted. Representations were made and generally accepted that the threshold vertical velocity of 4.3 m/s recommended by Australia and New Zealand authorities should be viewed as a plume-average rather than plume centreline criterion.

Critical (but extreme) aviation conditions are expected to be very light winds and neutral stability to heights of 500 m or more. For most assessment sites, there is unlikely to be a substantial database of near-surface and upper-level wind and temperature information to estimate the frequency of occurrence of such rare cases. Recognising this, CASA recently recommended the use of the CSIRO TAPM model for producing long-term databases of such profiles at any location within Australia and for providing a publicly-available method of calculating plume vertical velocities in the near-field of a single plume source (CASA 2003). The TAPM treatment of plume rise (Hurley and Manins 1995) uses coupled non-linear first-order differential equations for the plume volume G, buoyancy F and momentum M fluxes that are generalisations of the original Briggs (1975) plume rise formulation, based on the work of Glendening et al (1984) for stable atmospheres with complex structures. The TAPM scheme does not include any influence of source-altered flow fields or moisture content. It is also strictly valid only for single sources, with multiple sources being treated only via use of a plume enhancement factor, a relatively coarse device for describing near-field plume dynamics. For cooling tower sources, moisture emissions, the confluence of adjacent plumes and the influence of suction occurring due to tower bypass flow can be important (Rezacova and Sokol, 2000). This paper restricts attention to essentially dry plumes with no interactions with distorted flow fields.

Aviation safety risk assessments require the evaluation of concurrence of adverse vertical velocities with the presence of aircraft in the vicinity of the plume and a spectrum of aircraft types and pilot skill. Ideally, a generalised scheme should facilitate the prediction of likely pilot response to such events but publicly-available schemes are not yet available. As for many air quality problems, the main difficulties are assessing the relevance of traditional techniques to the forecasting of extreme conditions and determining the reliability of such assessments based on existing knowledge.

The present paper outlines the available plume calculation methodologies for the Spillane and TAPM approaches, addresses the modifications necessary for multiple sources and assesses the utility of the various schemes for dispersion and meteorological modelling in providing initial and detailed assessments. The high buoyancy of the plumes diminishes the utility of various design alternatives such as increasing stack separation, reducing exit velocity and changing the orientation of discharge. Practical measures are discussed.

2. General considerations

For the generic stack problem, we choose the case of multiple but identical sources of high initial exit velocity and temperature but low enough water vapour content to neglect latent heat considerations. In light winds, influences of the aerodynamic wakes or other effects of stack or cooling tower structures can be neglected. The initial stage (exit conditions) is assumed to be a plume emanating from a stack of height h_s and diameter D, with plume exit velocity either uniform over the cross-section (with a value V_{exit}) or, more likely, a non-uniform velocity profile with plume average velocity V_{exit}. The exit virtual potential temperature θ_s, volume flow $\pi D^2 V_{exit}/4$ and initial buoyancy flux $F_o = gV_{exit} D^2 (1 - \theta_a/\theta_s) / 4$ are readily calculated, with θ_a denoting ambient conditions. The ambient airspeed at stack top is denoted u_e with $K_o = V_{exit}/u_e$ being the initial plume to ambient velocity ratio.

An outline is given in the following sections of the Spillane and TAPM plume dynamics modules for single plumes (retaining their respective notations). The physical interpretation of the processes is outlined in Section 3 with the additional considerations needed for multiple plumes.

2.1 Spillane methodology

The plume radius a, orientation ϕ and velocity V are followed along the plume trajectory. Five equations are solved numerically for the normalised vertical velocity $K = V/u_e$:

Radial growth of a forced-plume bending in a wind:

$$\frac{da}{ds} = \beta_n \cos\phi / K + \beta_e \left| 1 - \frac{\sin\phi}{K} \right| \quad (1)$$

Rate of entrainment, E, into the plume:

$$2E / V = (\frac{da}{ds} + (\lambda^2 \cos\phi) / 2F_r^2) / (1 - \sin\phi / 2K) \quad (2)$$

Momentum flux, Va, (longitudinal)

$$\frac{d(Va)}{ds} = 2E - V\frac{da}{ds} \quad (3)$$

Trajectory curvature; transverse momentum flux

$$\frac{d\phi}{ds} = \left(2\,Ea\,u_e \cos\phi - \left(F \sin\phi\right) / 2.25V\right) / \left(Va\right)^2 \quad (4)$$

Flux of heat:

$$\frac{d\left(Va^2 \Delta\theta / \theta\right)}{ds} = 0, \text{ in a neutral environment} \quad (5)$$

where the notation is as follows:

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Exhibit 37

a = plume top-hat radius;
s = distance along plume trajectory;
ϕ = angle of plume centre line to vertical ;
$K = V/u_e$;
V = plume-averaged speed.
$\beta_n = 0.40$; $\beta_e = 0.16$; $\lambda = 1.11$;
F_r^2 = Froude No = $V^2/(ag\Delta\theta/\theta)$
F = flux of buoyancy = $\lambda^2a^2Vg\ \Delta\theta/\theta$; $\Delta\theta = \theta_p - \theta_e$ and suffices p and e for plume and environment.
θ = virtual potential temperature.

Initial conditions for ϕ, V, a and z are set for the end of the momentum rise stage (for a single plume) or at the end of the merged plume stage (for multiple plumes). An along-plume distance step of Δs = 20 m is used, and the appropriate value of $u_e(z)$ adopted for non-uniform profiles.

For the case of calm conditions, analytic solutions are possible, one for the product Va at any height, the other a linear increase of $a = 0.16\ (z - z_v)$ where the virtual source height (above stacktop) $z_v = 6.25\ D\ [1 - (\theta_e / \theta_s)^{1/2}]$. For $z > 6.25\ D > z_v$ we have:

$$(Va)^3 = (Va)_o^3 + 0.12 F_o \left[(z - z_v)^2 - (6.25D - z_v)^2\right]$$
$$\text{where } (Va)_o = V_{exit}\, D/2\,(\theta_e/\theta_s)^{1/2} \qquad (6)$$

2.2 CSIRO TAPM methodology

The TAPM mean plume rise estimation takes the Glendening et al (1984) approach but assumes that the horizontal plume velocity instantaneously takes up the ambient horizontal velocity at stack height. Cartesian co-ordinates are adopted. The differential equation for plume volume flux G:

$$\frac{dG}{dt} = 2R\ w_p\left(\alpha\ w_p + \beta\ u_e\right) \qquad (7)$$

neglects a third term due to ambient turbulence entrainment. $w_p = \frac{dz_p}{dt}$ is the plume vertical velocity, α = 0.1 and β = 0.6 are vertical and bent-over entrainment coefficients and R is the plume radius. For the buoyancy flux F, it assumes:

$$\frac{dF}{dt} = -\frac{sM}{u_p}\left(A u_a + w_p\right) \qquad (8)$$

where $s^2 = \frac{g}{\theta_a}\frac{\partial\theta_a}{\partial z}$ gives the ambient buoyancy frequency (s = 0 in neutral conditions), $u_p^2 = u_e^2 + w_p^2$, A = 1/2.25 and M is determined by $\frac{dM}{dt}$ = F (= F_o in neutral conditions). By definition,

$$G = \frac{\theta_e}{\theta_p} u_p R^2,\ F = g u_p R^2 \frac{\Delta\theta}{\theta_p},\ u_p R^2 = G + F/g,$$
$$w_p = M/G \qquad (9)$$

Initial conditions are set with G, F and M evaluated with $w_p = V_{exit}$, $R = R_s = D/2$ but with the initial integration having

$$R = R_o = R_s\left(V_{exit} / \left(u_a^2 + V_{exit}^2\right)^{1/2}\right)^{1/2} \qquad (10)$$

The plume rise height is terminated when F = 0 and plume and ambient dissipation rates are equal. The plume dimensions are based on $R = 0.4\ (z - h_s)$ or equivalent prescriptions.

3. Treatment of multiple plumes

For N multiple, identical sources with stack separation d, Table 1 summarises the expected multi-stage plume development as well as Figure 1. The first stage is the rapid (almost vertical) rise of the individual plumes due to their momentum. The external surface of the plume entrains air as it rises (and the vertical velocities are reduced). The end of the momentum-dominated phase occurs when this entrainment reaches the plume core, the plume centreline has a vertical velocity equal to V_{exit} and the velocity profile will be essentially Gaussian. The peak (core) vertical velocity is therefore V_{exit} but the plume average value is 0.5 V_{exit}. Conservation of momentum therefore requires the plume width to have effectively doubled from its initial value a_o.

In this first phase, the plume travels a height of 6.25 D in calm conditions and 0.4 K_oa_o for K_o reasonably large (based on laboratory experiments). Davidson (1994) has also shown that an analytic form for plume rise in a uniform wind has an initial component of 6.2 D exp (-3.3/K_o).

In the second stage, the plume dynamics and trajectories respond to ambient conditions, with much cooler air being entrained into the stack plume. The buoyancy of the plumes has significant influences on the rise as this air mixes into the plume and provides dilution of the exhaust. This dilution is very sensitive to ambient wind speed. For multiple plumes from closely-spaced stacks, this leads almost immediately to a height at which two plumes first touch each other (and plume merging commences) when the effective plume radius is equal to half the stack separation (this is exact in calm winds and approximately correct for light winds). Total merging is assumed to occur when the single plume radius equals stack separation. Conservation of buoyancy flux and Froude number (a reasonable assumption for coherent plumes) leads to a conclusion that the plume radius and vertical velocity will be increased overall by a factor of $2^{0.25}$ = 1.189 by the merging of 2 adjacent plumes.

For more than two stacks, the situation is more complex. In calm conditions, the combined plumes from pairs of stacks will coalesce shortly after to form a coherent plume, assumed to be complete before the single plume radius, a^{sp}, is ½ d (N-1) At this height, the combined plume velocity V_m and radius a_m are $N^{0.25}$

greater than for a single plume. For non-calm conditions, a simplified treatment shows that total merging is likely to occur soon after the merging of two adjacent plumes, for winds at right angles to the line of separation of the stack. For winds at smaller angles ω to the line of stacks, the process is more sequential and the effective stack separation can be reduced by a factor proportional to cos ω.

In the third stage of plume development, plume rise is due entirely to the buoyancy of the (merged) plume and continues until there is an equalisation of turbulent conditions within and outside the plume. The effective average vertical velocity is then close to zero. The third stage of plume development can then be treated as that of a single merged plume (with different initial conditions for a, V and ϕ) passing through different atmospheric layers with varying horizontal velocity u_e. The Katestone software uses a simple successive substitution method to determine a, E (the entrainment), V and ϕ in that order. These equations are valid up to a critical value of ϕ_c ($\phi_c < \pi/2$) at which either the assumptions become invalid or plume rise should be effectively terminated.

These equations can be used in the second stage prior to plume touching and in the third stage once merging has been completed. Plume height is calculated by aggregating $\Delta s \cos \phi$, centreline displacement by aggregating $\Delta s \sin \phi$. For each Δs, the appropriate ambient windspeed is determined by linear interpolation (or power law curve fitting of available meteorological profile measurements or predictions).

A fourth stage can occur if the coherent plume reaches the base of the overlying inversion (height Z_i). Some of the plume will punch through the inversion base, albeit with reduced vertical velocity. The remainder will be effectively trapped within the inversion layer with essentially zero vertical velocity. Weil et al (2001) show that the penetration in convective conditions depends on $F_*^{2/3}$ where $F_*=F/(u_e w_*^2 Z_i)$ and w_* is the convective velocity scale. There is as yet little guidance on plume dimensions and vertical velocity for the penetrative component.

Table 1: Key parameters for the various stages of development for merging plumes.

Stage	Average plume velocity		Plume width	Plume height	Plume angle	Comments
	Vertical	Horizontal				
Stack exit	V_{exit}	0	a_o	h_s	0°	
End of jet phase	$0.5 V_{exit}$	$u_e(z) + V \sin \phi_o$	$2a_o$	$h_s + z_o$	ϕ_o	$z_o = K_o a_o < 6.25D$
Plumes first touch	$V_t \cos \phi_t$	$u_e(z) + V_t \sin \phi_t$	a_t	z_t	ϕ_t	$V_t < 0.5 V_{exit}$
End of plume merging	$V_m \cos \phi_m$	$u_e(z) + V_m \sin \phi_m$	a_m	z_m	ϕ_m	$a_m \approx N^{1/4} a^{sp}$ $V_m \approx N^{1/4} V^{sp}$
Coherent merged plume	$V \cos \phi$	$u_e(z) + V \sin \phi$	a	z	ϕ	$V < V_m$ $a > a_m$
Maximum plume rise	0	$u_e(z) + V \sin \phi$	a_c	z_c	ϕ_c	$\phi_c < 90°$
Inversion interaction	Low	Shear-affected	Enhanced	$> Z_i$	Variable	(Weil et al 2001)

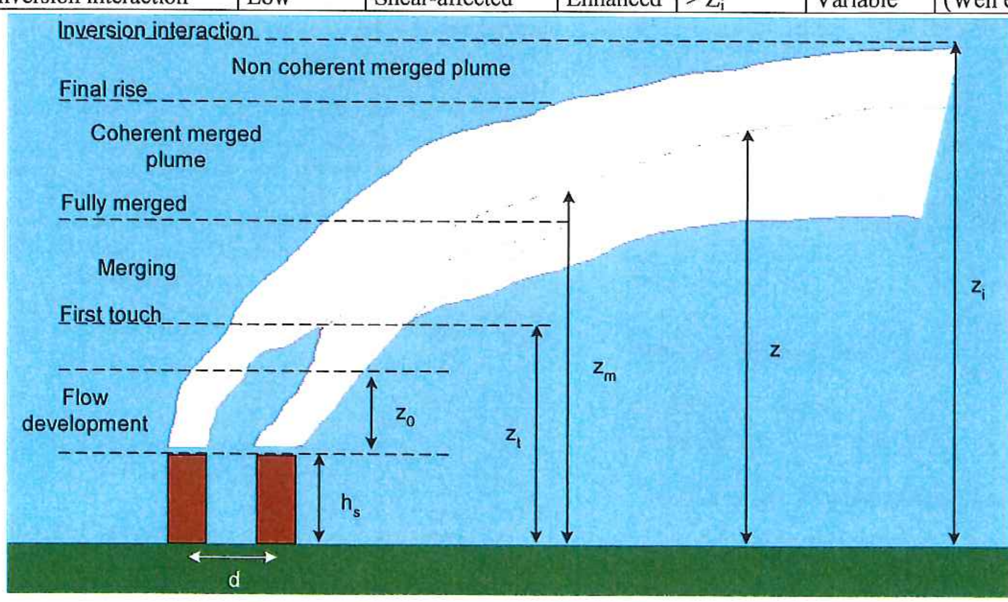

Figure 1: Schematic of plumes merging.

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4. Illustrative examples

The simplest cases assume identical sources with stack separation d operating in a neutral and unbounded atmosphere with uniform conditions. For the Spillane approach, Table 2 gives the resulting plume-average vertical velocities for the cases with V_{exit} = 38.9 m/s, h_s = 35 m, F = 2300 m^4/s^3 and N = 1 and separately N = 2 with d = 25 m.

The heights experiencing threshold exceedances are dramatically reduced going from calm to light winds. The TAPM approach for single plumes gives similar results if some allowance is made for an initial displacement offset z_0 (Figure 2).

Table 2: Plume average vertical velocities (m/s) for uniform calm and light wind conditions in a neutral atmosphere

Height	Calm		u_e = 1.5 m/s		u_e = 3 m/s	
	Single	Double	Single	Double	Single	Double
100	12.2	12.2	9.0	9.3	6.9	8.3
200	7.8	9.2	5.5	7.0	3.6	5.1
300	6.5	8.0	4.4	5.8	2.6	3.9
500	5.3	6.6	3.2	4.5		2.8
700	4.8	6.0	2.6	3.7		2.2
1000	4.1	5.2				

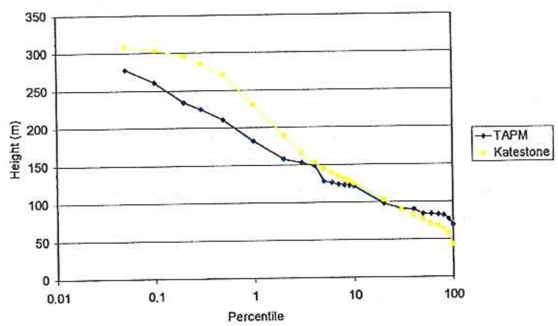

Figure 2: Comparison of methodologies for plume height calculations for a 5 year period.

5. Meteorological modelling

Meteorological inputs are critical for a reasonable treatment of risk, especially for near-calm conditions at stack-top and above. Unfortunately, it is these very conditions under which near-surface measurements (together with stability-dependent profile laws) or TAPM-like prediction methodologies are likely to be poor indicators of actual conditions, at least for inland sites (Jackson et al 2003). Presumably this quandary lead CASA to recommend the TAPM approach. If measurements are available from a nearby 30-100 m tower, we would recommend their use unless TAPM results are carefully tuned to the appropriate surface conditions.

Recent project work near Williamtown Airport gave a comparison of five years of hourly TAPM results with available balloon and 30 m tower measurements. The main conclusions were:

- Moderate interannual variability in the actual and predicted occurrence of light winds at 30 m and above.
- TAPM tends to underpredict the frequency of occurrence of very light winds (< 1 m/s) compared to tower observations (typically 1.2 - 3.5% compared to 5.7 - 14.9%).
- For available balloon profiles, TAPM overpredicted the frequency of very light winds at 600 m and 900 m agl.
- Very few measurements are available in the crucial 100-500 m height range.

6. Synthetic approaches

The Spillane approach has been adapted to take in the TAPM wind profile conditions. Figure 3 compares the cumulative probability distributions for critical heights (where the in-plume average velocity drops below 4.3 m/s) obtained by using either the TAPM wind predictions or the interpolated measured winds, for the case of two 35 m high, 54 m separated combined-cycle units of total capacity over 800 MW. Close agreement is obtained.

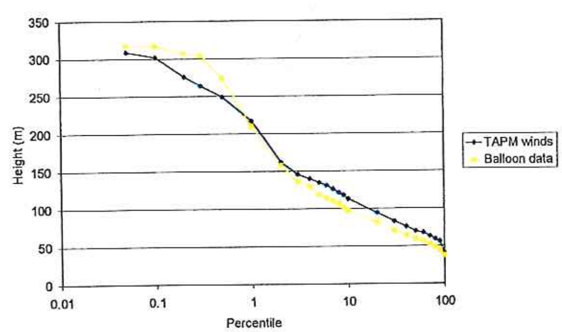

Figure 3: Comparison of Spillane plume height calculations for TAPM - generated and measured winds.

7. Design options

Decreasing the exit velocity will reduce the initial flow development length but plume buoyancy is the key factor in the magnitude of the vertical velocity. Similarly any reduction in stack height gives little benefit to aviation safety concerns and may risk poor plume dispersion in high-wind conditions (due to building wake influences). Increasing the stack separation does delay the time when plumes merge but with little overall practical benefit (Figure 4). Horizontally-pointing stack exits will reduce initial momentum but again buoyancy is dominant.

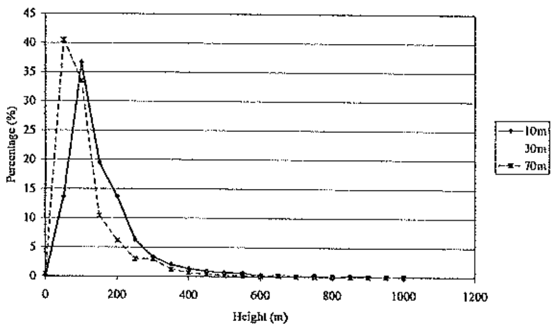

Figure 4: Frequency of critical height for varying stack configurations.

The reduction of plume buoyancy by using heat recovery results in a very significant reduction of critical heights but open-cycle operation usually has to be considered in any risk assessment. For critical cases, it appears better to take advantage of the relatively small zone of influence on vertical velocities and the usual requirement of CASA to identify stack locations for low-flying aircraft. A notice to aircrew together with real-time indication of site operations may be effective in most situations.

8. Conclusions

Methodologies now exist for major point sources and point to the dominating role of initial plume buoyancy. Detailed measurements are required for light-wind conditions and are readily taken by experienced research aircrews. TAPM methodologies are reasonable for single plumes but inappropriate for multiple plumes. For key sites, remote sensing equipment is required to gather reliable wind statistics in the critical 100-500 m range. Theoretical advances are needed to treat inversion penetration in very light-wind conditions and to extend the methods to moist plumes and different source geometries.

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Appendix B
Theoretical Methodology Results

Appendix B
Results of Theoretical Assessment

Height above stack (m)	Plume Radius (m)	Vertical Velocity (m/s)	Height above MSL (feet)
25.3	3.6	13.6	250
40.5	6.0	9.1	300
55.8	8.5	7.3	350
71.0	10.9	6.3	400
86.3	13.4	5.7	450
101.5	15.8	5.3	500
116.7	18.2	5.0	550
132.0	20.7	4.7	600
147.2	23.1	4.5	650
162.5	25.5	4.4	700
177.7	28.0	4.2	750
192.9	30.4	4.1	800
208.2	32.9	4.0	850
223.4	35.3	3.9	900
238.7	37.7	3.8	950
253.9	40.2	3.7	1000
269.1	42.6	3.6	1050
284.4	45.1	3.6	1100
299.6	47.5	3.5	1150
314.9	49.9	3.4	1200
330.1	52.4	3.4	1250
345.3	54.8	3.3	1300
360.6	57.2	3.3	1350
375.8	59.7	3.2	1400
391.1	62.1	3.2	1450
406.3	64.6	3.1	1500

Appendix C
Graphical Results of Modeling Assessment

Figure 1: Maximum vertical velocity at 200 feet ASL (Worst-case Meteorological Conditions)

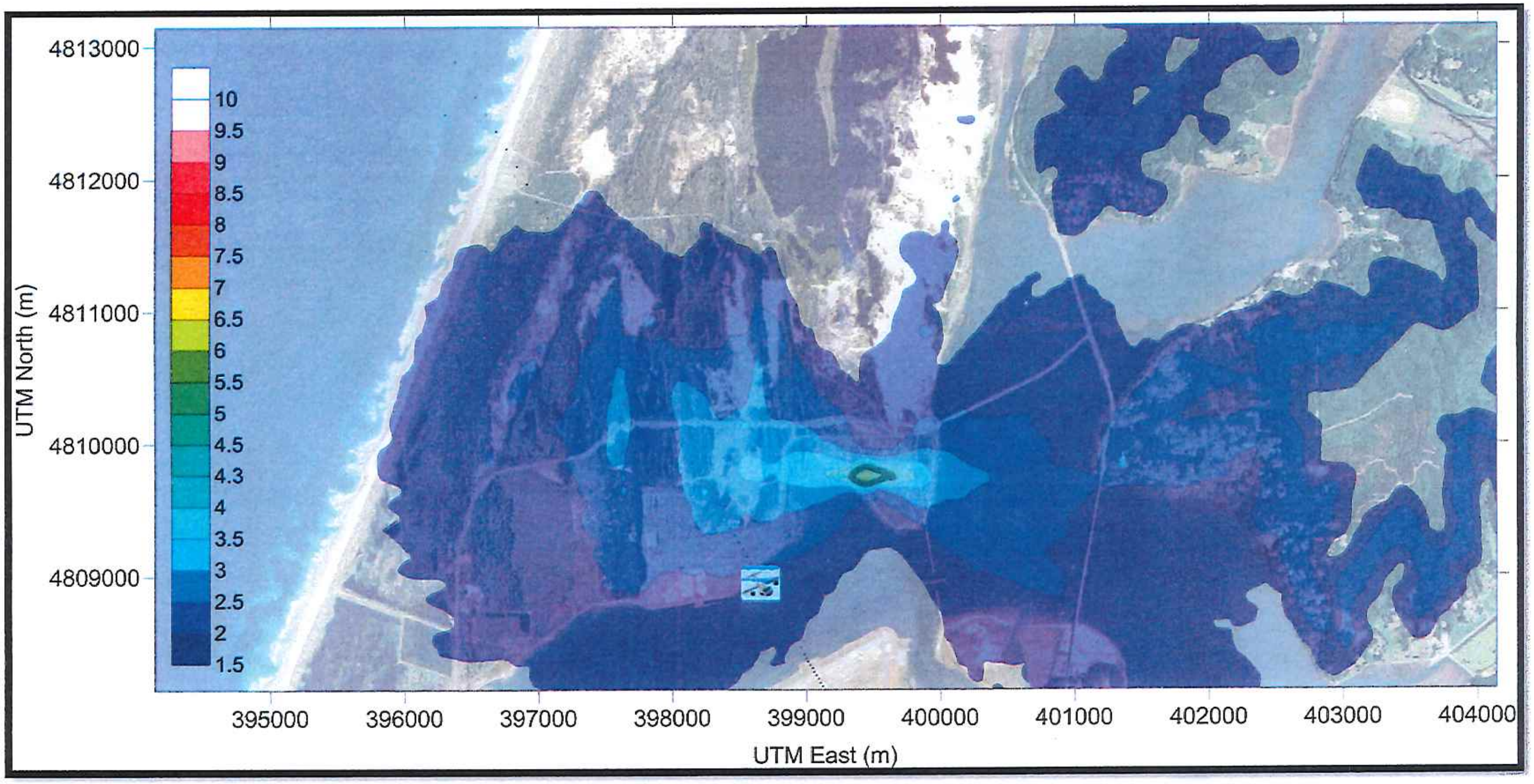

Figure 2: Maximum vertical velocity at 400 feet ASL (Worst-case Meteorological Conditions)

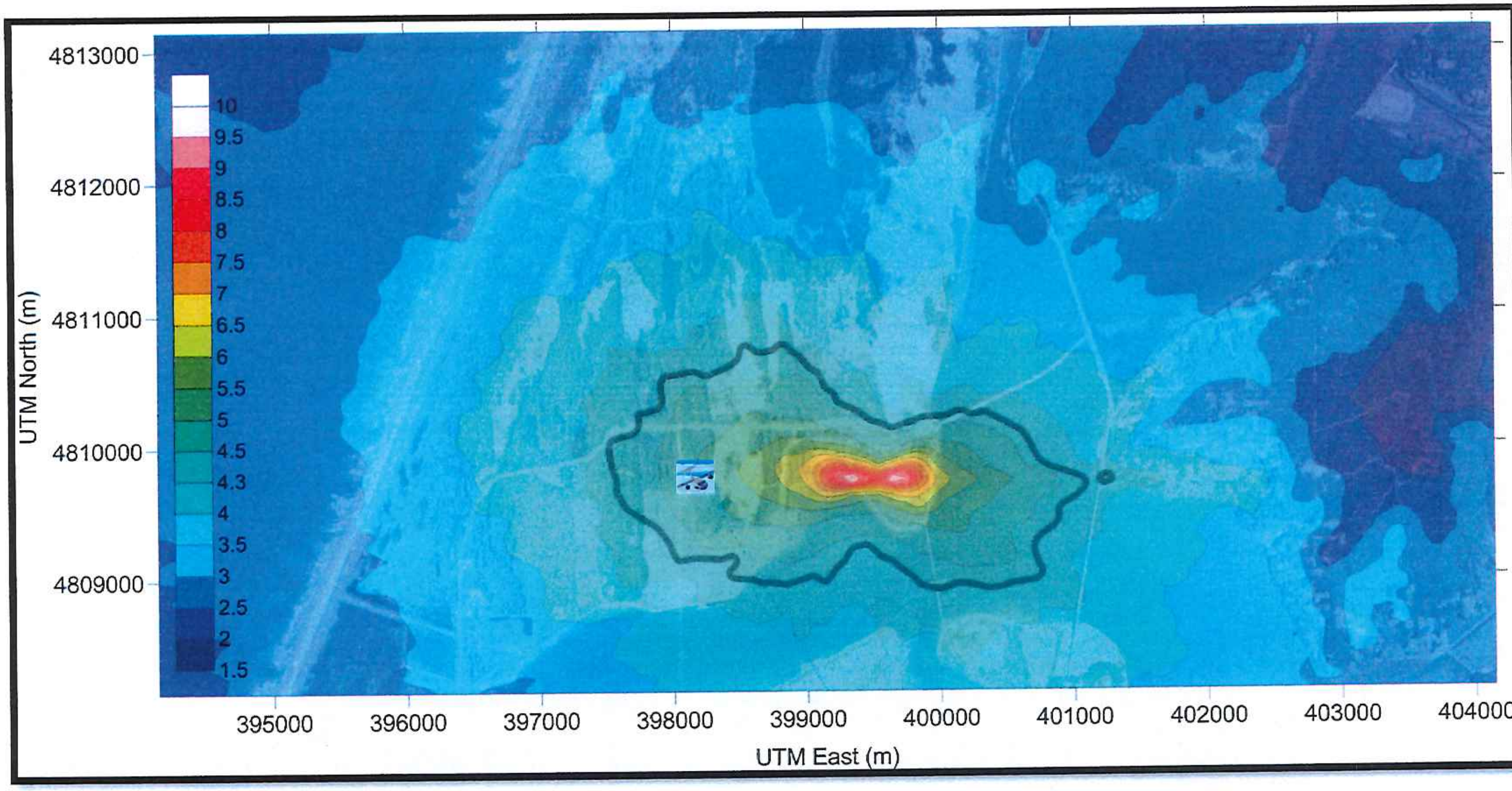

Figure 3: Maximum vertical velocity at 600 feet ASL (Worst-case Meteorological Conditions)

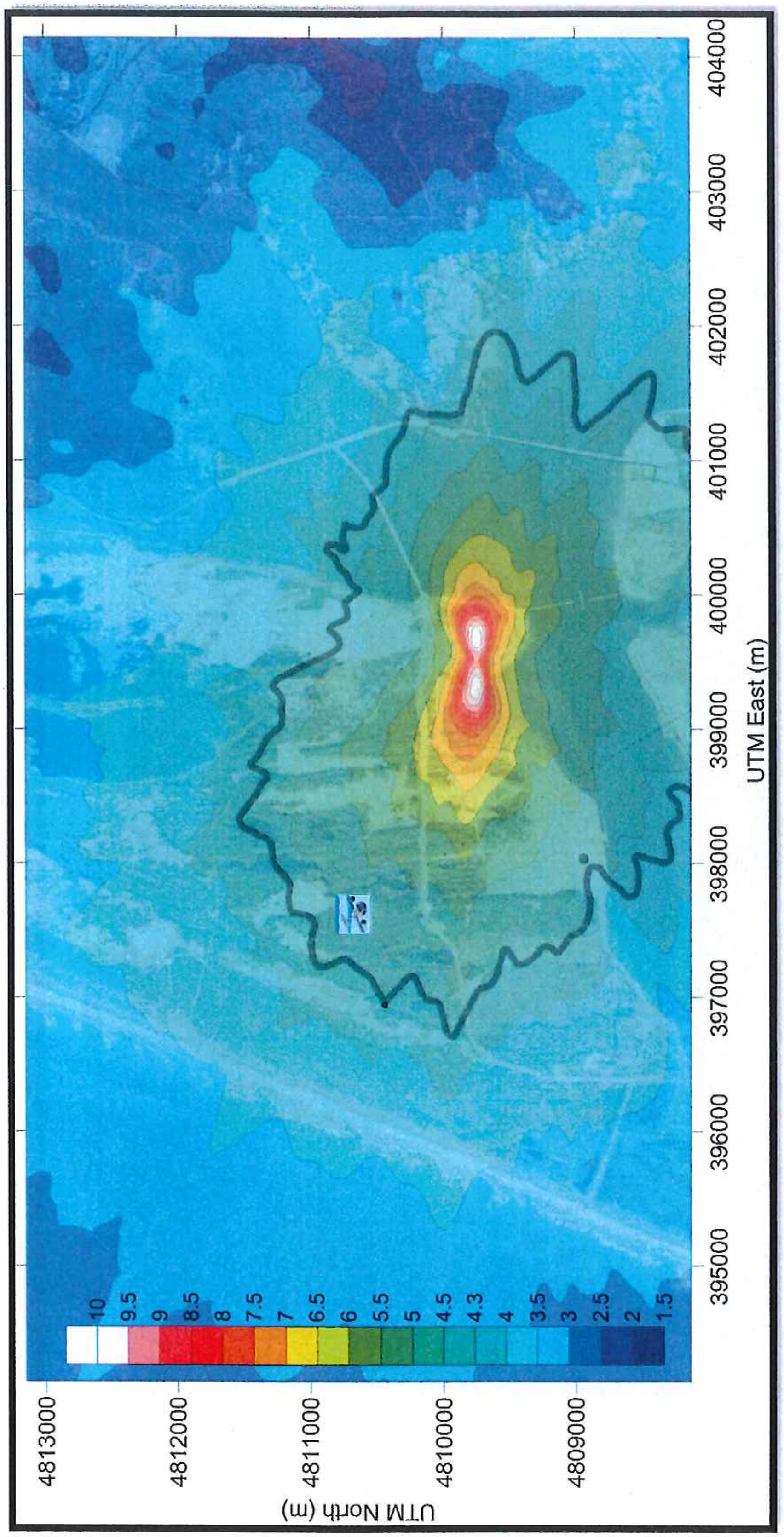

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Figure 4: Maximum vertical velocity at 200 feet ASL (Infrequent Meteorological Conditions)

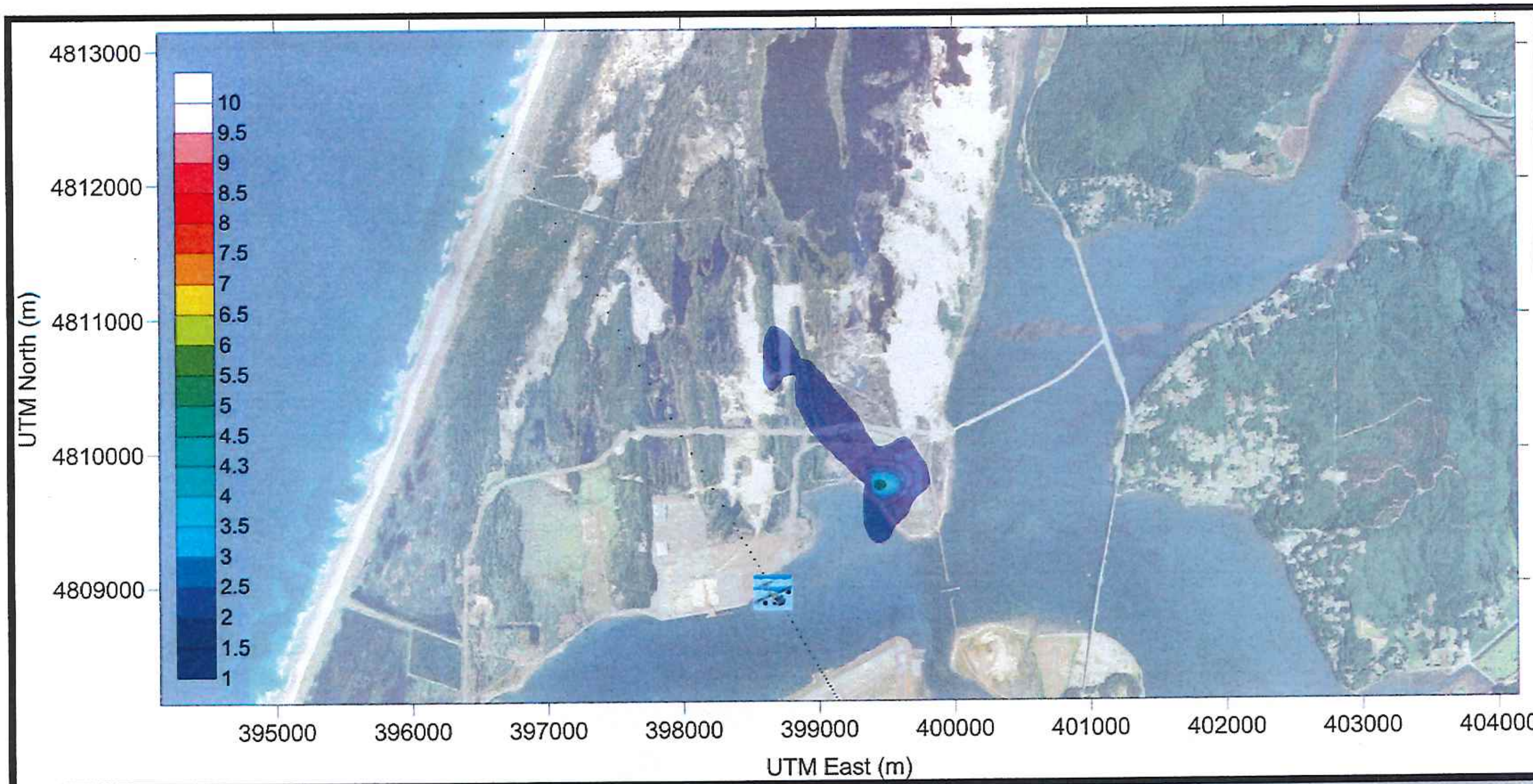


Figure 5: Maximum vertical velocity at 400 feet ASL (Infrequent Meteorological Conditions)

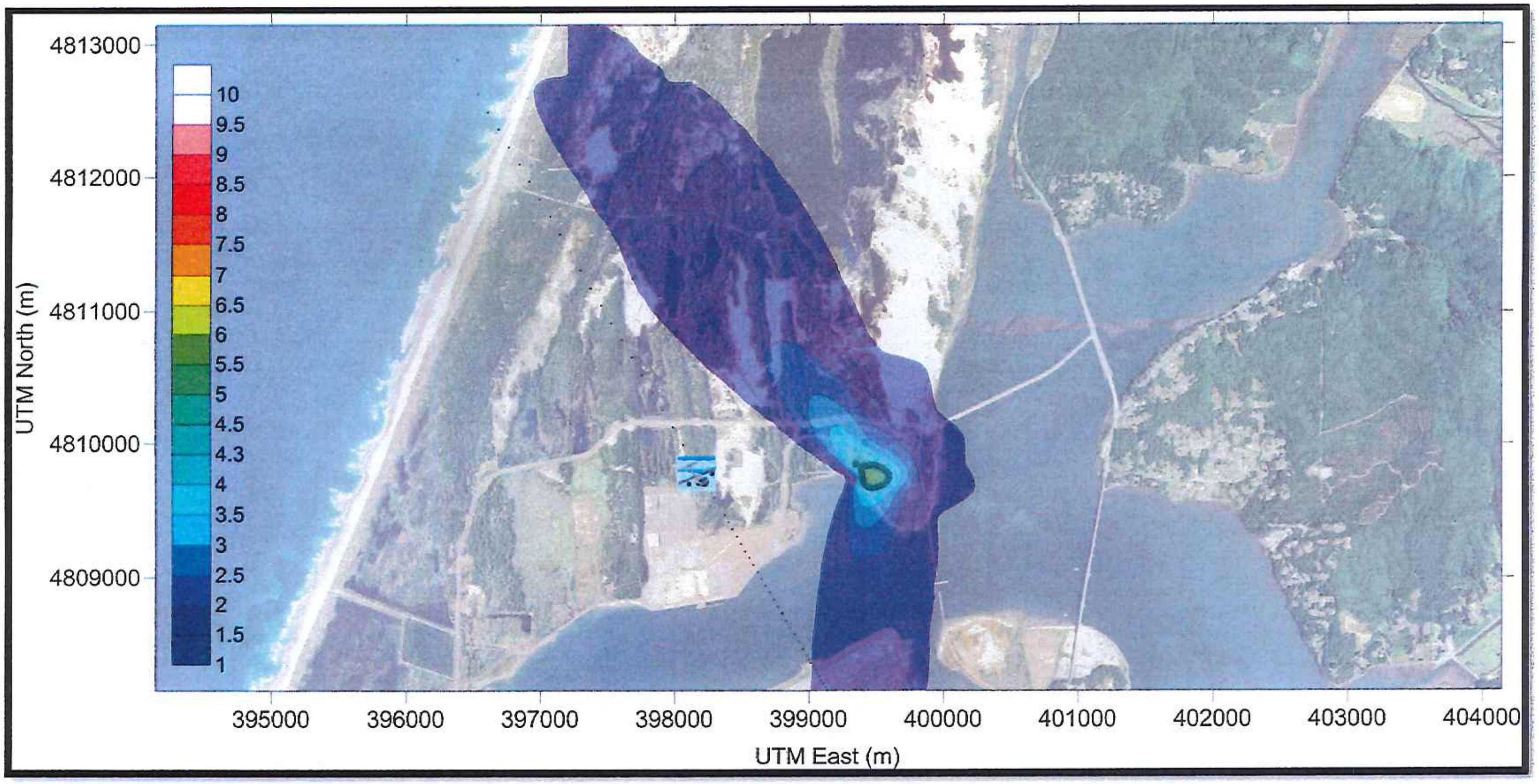
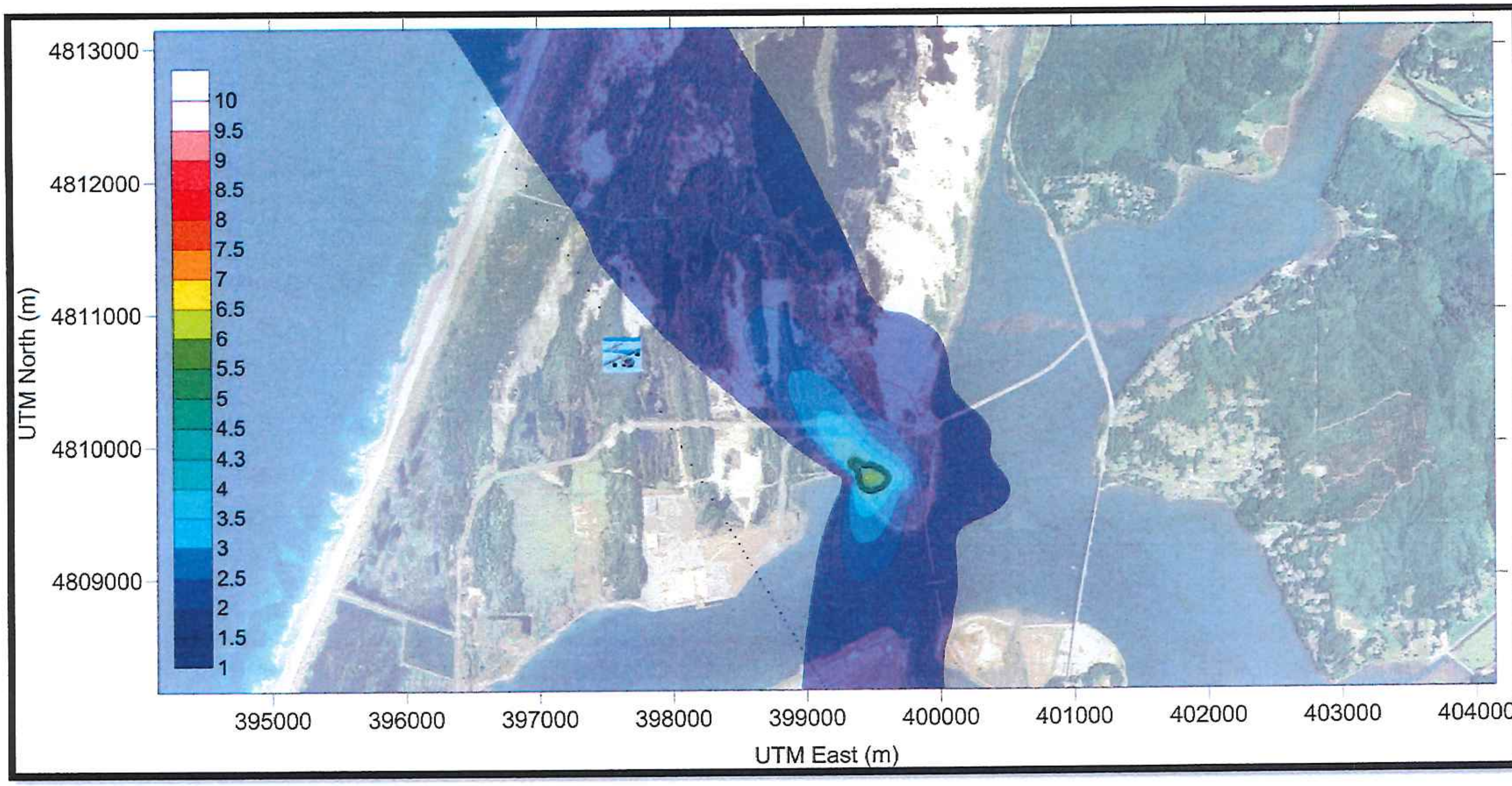
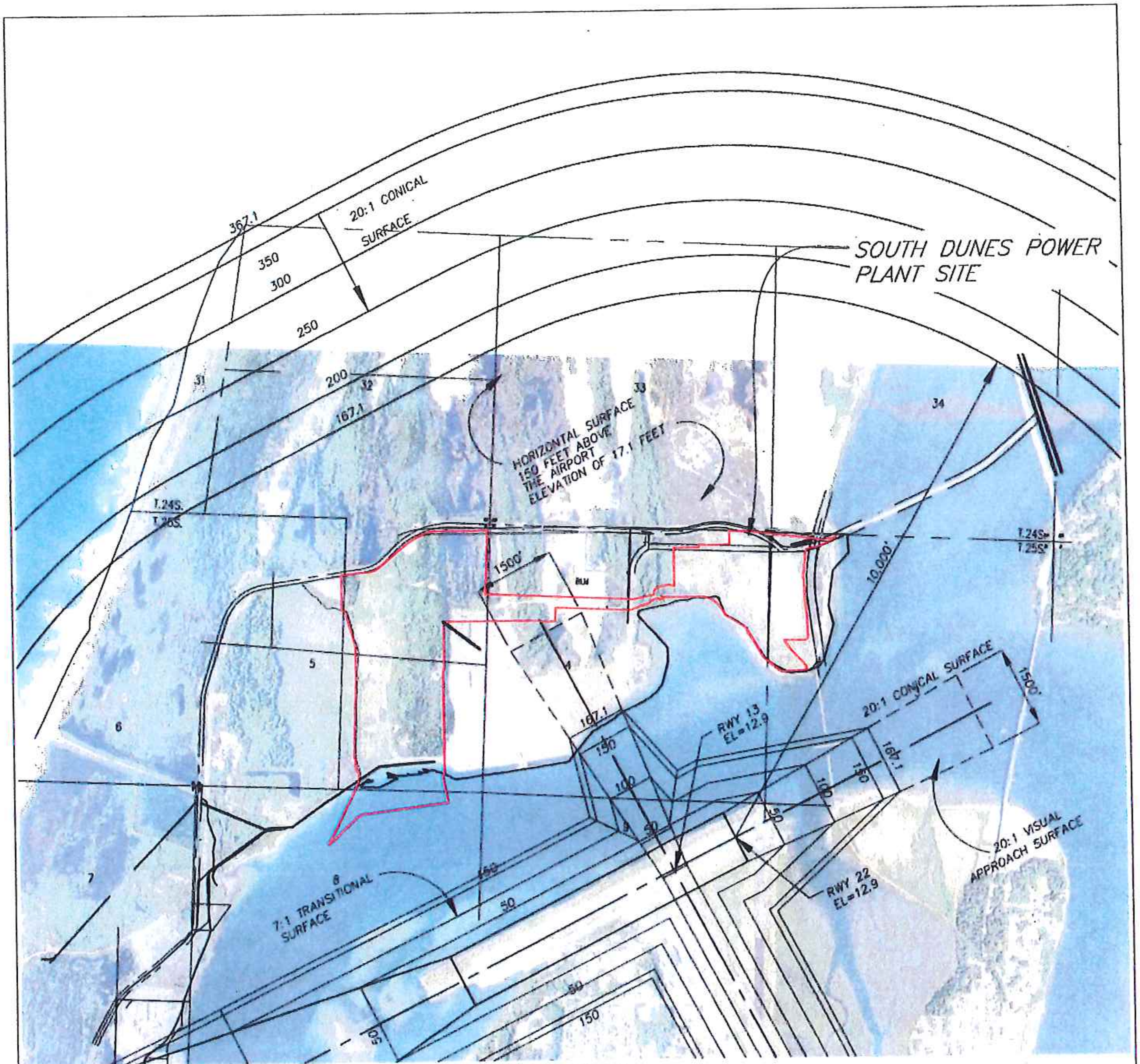


Figure 6: Maximum vertical velocity at 600 feet ASL (Infrequent Meteorological Conditions)





NOTE: AIRPORT SURFACE INFORMATION FROM COOS COUNTY. PART 77 SURFACES BASED UPON 2002 AIRPORT MASTER PLAN PREPARED BY W&H PACIFIC

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EXPLANATION

LOCATION OF PROPERTY

\\Coosbaysvr1\projects\2015\615047-Planning\152-CoosCoPlng\Dwgs

SHN Consulting Engineers & Geologists, Inc.	Jordan Cove LNG Airport Imaginary Surfaces Coos County, Oregon	Jordan Cove LNG	REV Description:
			Doc No: J1-000-CIV-SUR-SHN-00007-01
			REV: A — REV Date: 11-DEC-15
	SHN 615047.152 — 615047-Balance of County Figs		Figure 15

Exhibit 38

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