MILLENNIUM BULK TERMINALS—LONGVIEW SEPA ENVIRONMENTAL IMPACT STATEMENT

SEPA FISH TECHNICAL REPORT

PREPARED FOR:

Cowlitz County
207 4th Avenue North
Kelso, WA 98626
Contact: Elaine Placido, Director of Building and Planning

IN COOPERATION WITH:

Washington State Department of Ecology, Southwest Region

PREPARED BY:

ICF
710 Second Avenue, Suite 550
Seattle, WA 98104

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Contents

Tables

Figures

Acronyms and Abbreviations

ACM	Active Channel Margin
Applicant	Millennium Bulk Terminals—Longview, LLC
BNSF	BNSF Railway Company
CDID	Consolidated Diking Improvement District
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CRC	Columbia River Crossing
CRD	Columbia River Datum
DART	Data Access in Real Time
dB	decibels
dB_{RMS}	decibel root-mean-squared
DPSs	Distinct Population Segments
dwt	dead weight tons
DWZ	Deep Water Zone
Ecology	Washington State Department of Ecology
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESUs	Evolutionary Significant Units
FR	Federal Register
g/m^2	grams per square meter
HEA	habitat equivalency analysis
HPA	hydraulic project approval
IPaC	Information, Planning, and Conservation
Management Agreement	2008-2017 United States v. Oregon Management Agreement
mg/L	milligrams per liter
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NTU	nephelometric turbidity unit
OHW	ordinary high water
OHWM	ordinary high water mark

PAHs	polycyclic aromatic hydrocarbons
PCE	primary constituent element
PHS	Priority Habitats and Species
Port	Port of Longview
ppm	parts per million
PTS	permanent threshold shift
RCW	Revised Code of Washington
Reynolds facility	Reynolds Metal Company facility
RMS	root mean square
SEL	sound exposure level
SEPA	State Environmental Policy Act
SMA	Shoreline Management Act
SPL	sound pressure level
SWZ	Shallow Water Zone
TEEC	trace elements of environmental concern
TTS	temporary threshold shift
UP	Union Pacific Railroad
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

Chapter 1
Introduction

This technical report assesses the potential fish and fish habitat impacts of the proposed Millennium Bulk Terminals—Longview project (Proposed Action) and the No-Action Alternative. For the purposes of this assessment, fish refers to the fish habitat conditions and the documented fish occurrences and fish likely to occur in the project area and surrounding area. This report describes the regulatory setting, establishes the methods for assessing potential fish and fish habitat impacts, presents the historical and current fish and fish habitat conditions in the study area, and assesses the potential for impacts on fish and fish habitat.

1.1 Project Description

Millennium Bulk Terminals—Longview, LLC (Applicant) is proposing to construct and operate a coal export terminal (Proposed Action) in Cowlitz County, Washington along the Columbia River (Figure 1). The coal export terminal would receive coal from the Powder River Basin in Montana and Wyoming, and the Uinta Basin in Utah and Colorado via rail shipment. The coal export terminal would receive, stockpile, and load coal onto vessels and transport the coal via the Columbia River and Pacific Ocean to overseas markets in Asia.

1.1.1 Proposed Action

Under the Proposed Action, the Applicant would develop the coal export terminal on 190 acres (project area) primarily within an existing 540-acre site that is currently leased by the Applicant (Applicant's leased area). The project area is adjacent to the Columbia River in unincorporated Cowlitz County, Washington near Longview, Washington (Figure 2). The Applicant currently operates and would continue to operate a bulk product terminal within the Applicant's leased area.

BNSF Railway Company (BNSF) or Union Pacific Railroad (UP) trains would transport coal on BNSF main line routes in Washington State, and the BNSF Spur and Reynolds Lead in Cowlitz County to the project area. Coal would be unloaded from rail cars, stockpiled, and loaded by conveyor onto ocean-going vessels for export at two new docks (Docks 2 and 3) located in the Columbia River.

Once construction is complete, the Proposed Action could have a maximum annual throughput capacity of up to 44 million metric tons of coal per year. The coal export terminal would consist of one operating rail track, eight rail tracks for storing up to eight unit trains, rail car unloading facilities, a stockpile area for coal storage, conveyor and reclaiming facilities, two new docks in the Columbia River (Docks 2 and 3), and shiploading facilities on the two docks. Dredging of the Columbia River would be required to provide access to and from the Columbia River navigation channel and for berthing at the two new docks.

Vehicles would access the project area from Industrial Way (State Route 432), and vessels would access the project area via the Columbia River. The Reynolds Lead and BNSF Spur track—both jointly owned by BNSF and UP and operated by Longview Switching Company (LVSW)—provide rail access to the project area from a point on the BNSF main line (Longview Junction) located to the east in Kelso, Washington. Coal export terminal operations would occur 24 hours per day, 7 days per week. The coal export terminal would be designed for a minimum 30-year period of operation.

At full terminal operations, approximately 8 loaded unit trains each day would carry coal to the export terminal, 8 empty unit trains each day would leave the export terminal, and an average of 70 vessels per month or 840 vessels per year would be loaded, which would equate to 1,680 vessel transits in the Columbia River annually.

Figure 1. Project Vicinity

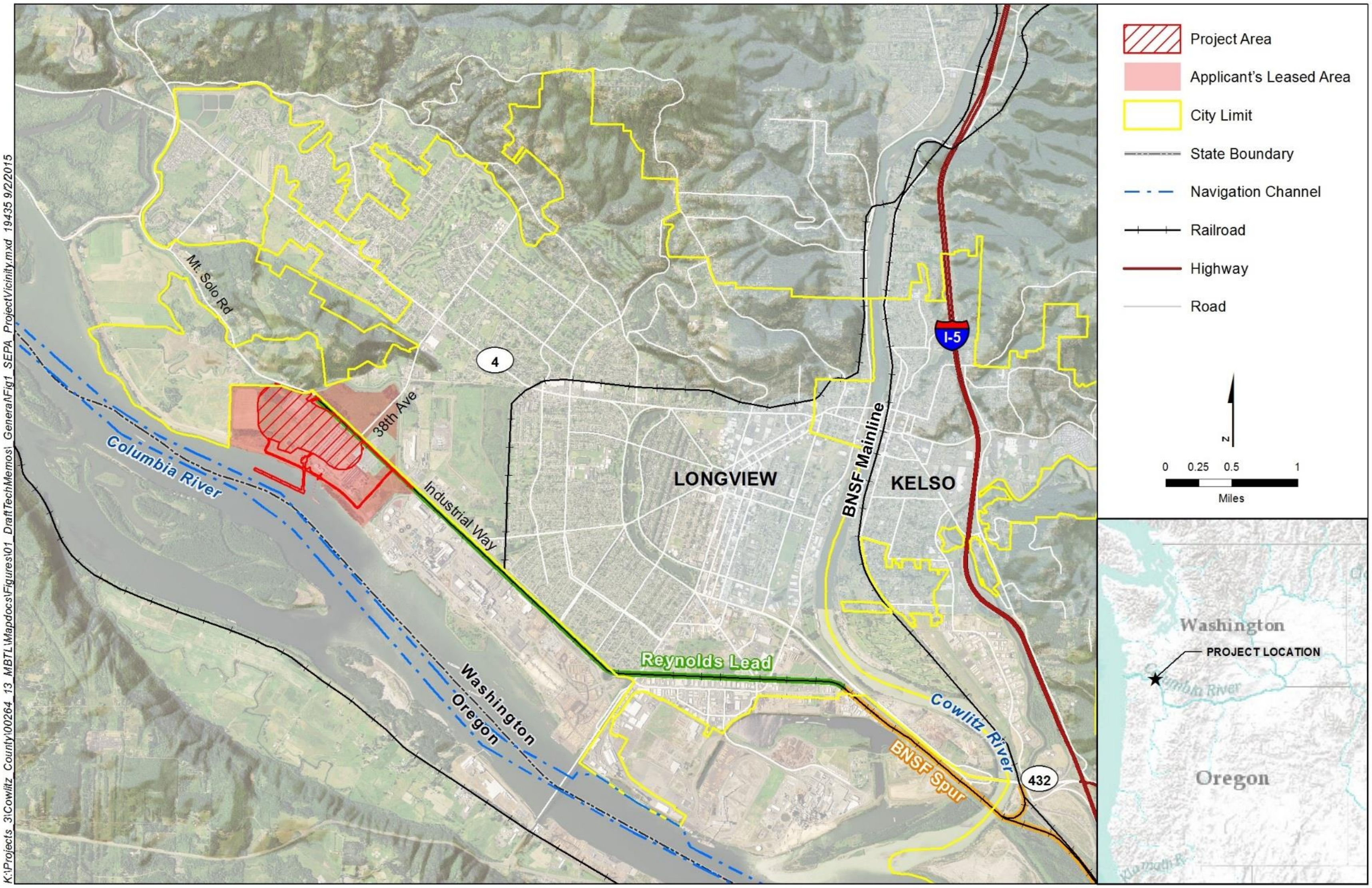
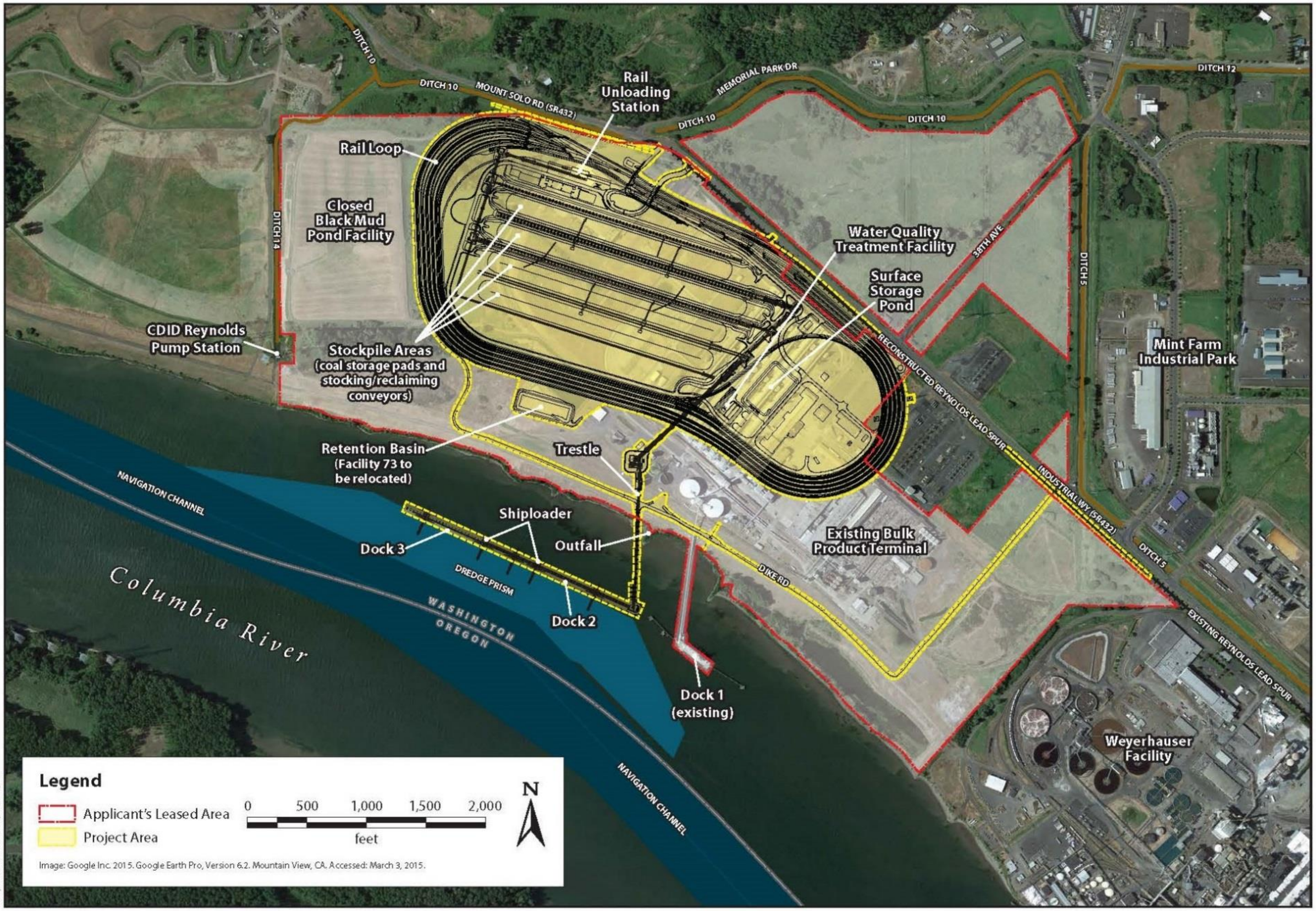


Figure 2. Proposed Action



1.1.2 No-Action Alternative

The Applicant plans to continue operating its existing bulk product terminal located adjacent to the project area. Ongoing operations would include storing and transporting alumina and small quantities of coal, and continued use of Dock 1. Maintenance of the existing bulk product terminal would continue, including maintenance dredging at the existing dock every 2 to 3 years. The Applicant plans to expand operations at the existing bulk product terminal, which could include increased storage and upland transfer of bulk products utilizing new and existing buildings. The Applicant would likely need to undertake demolition, construction, and other related activities to develop expanded bulk product terminal facilities.

If the coal export terminal is not constructed, the Applicant would likely propose expansion of the bulk product terminal onto areas that would have been subject to construction and operation of the proposed coal export terminal. Additional bulk product transfer activities could involve products such as a calcined pet coke, coal tar pitch, cement, fly ash, and sand or gravel. Any new operations would be evaluated under applicable regulations. Upland areas of the project area are zoned Heavy Industrial and it is assumed future proposed industrial uses in these upland areas could be permitted. Any new construction would be limited to uses allowed under existing Cowlitz County development regulations.

1.2 Regulatory Setting

The jurisdictional authorities and corresponding regulations, statutes, and guidance for determining potential impacts on fish are summarized in Table 1.

Table 1. Regulations, Statutes, and Guidance for Fish

Regulation, Statute, Guideline	Description
Federal	
National Environmental Policy Act (42 USC 4321 *et seq*.)	Requires the consideration of potential environmental effects. NEPA implementation procedures are set forth in the President's Council on Environmental Quality's Regulations for Implementing NEPA (49 CFR 1105).
Endangered Species Act (16 USC 1531 *et seq*.)	Requires federal actions, such as issuing a permit under a federal regulation (e.g., NEPA, Clean Water Act, Clean Air Act) must undergo consultation with USFWS and/or NMFS to ensure the federal action is not likely to jeopardize the continued existence of any listed threatened or endangered animal species or result in the destruction or adverse modification of designated critical habitat. NMFS is responsible for managing, conserving, and protecting ESA-listed marine species. USFWS is responsible for terrestrial and freshwater species. Both NMFS and USFWS are responsible for designating critical habitat for ESA-listed species.

Regulation, Statute, Guideline	Description
Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267)	Requires fishery management councils to include descriptions of essential fish habitat and potential threats to essential fish habitat in all federal fishery management plans. Also requires federal agencies to consult with NMFS on activities that may adversely affect essential fish habitat.
State	
Washington State Environmental Policy Act (WAC 197-11, RCW 43.21C)	Requires state and local agencies in Washington to identify potential environmental impacts that could result from governmental decisions
Washington State Growth Management Act (RCW 36.70A)	Defines a variety of critical areas, which are designated and regulated at the local level under city and county critical areas ordinances.
Washington State Shoreline Management Act (90.58 RCW)	Requires cities and counties (through their Shoreline Master Programs) to protect shoreline natural resources.
Washington State Hydraulic Code (WAC 220-660)	Under the Hydraulic Code, WDFW issues a hydraulic project approval for certain construction projects or activities in or near state waters. The hydraulic code was specifically designed to protect fish life.
Clean Water Act Section 401 Water Quality Certification	Ecology issues Section 401 Water Quality Certification for in-water construction activities to ensure compliance with state water quality standards and other aquatic resources protection requirements under Ecology's authority as outlined in the federal Clean Water Act.
Local	
Cowlitz County SEPA Regulations (CCC 19.11)	Provide for the implementation of SEPA in Cowlitz County.
Cowlitz County Critical Areas Ordinance (CCC 19.15)	Regulates activities within and adjacent to critical areas.
Cowlitz County Shoreline Master Program (CCC 19.20)	Regulates development within shoreline jurisdiction, including the shores of the Columbia River, a Shoreline of Statewide Significance.

Notes:
NEPA = National Environmental Policy Act; CFR = Code of Federal Regulations; Corps = U.S. Army Corps of Engineers; CEQ = Council on Environmental Quality; USFWS = U.S. Fish and Wildlife Service; NMFS = National Marine Fisheries Service; ESA = Endangered Species Act; USC = United States Code; WAC = Washington Administrative Code; RCW = Revised Code of Washington; WDFW = Washington Department of Fish and Wildlife; Ecology = Washington State Department of Ecology; SEPA = State Environmental Policy Act; CCC = Cowlitz County Code

1.3 Study Area

The project area for the Proposed Action would be located 63 river miles (RM) upstream of the Pacific Ocean on the northern shoreline of the Columbia River Estuary in Cowlitz County, Washington. The study area accounts for the area where potential underwater noise impacts would likely extend. Underwater noise disturbance thresholds have been established by the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) for fish, primarily salmonids, which occur in the Columbia River adjacent to the project area; therefore, these thresholds were used to help establish the study area relative to fish. The underwater noise study area includes the main channel of the Columbia River in which construction noise could disturb fish. It extends between the following approximate boundaries: downstream near the downstream end of

Walker Island (RM 60.4) on the Oregon side and Barlow Point (RM 61.6) on the Washington side, and upstream near the City of Rainier (RM 67.0) on the Oregon side and the Lewis and Clark Bridge (RM 66.0) on the Washington side (Grette 2014a) (Figure 3). This area extends a distance of approximately 3.92 miles upstream and downstream of the project area in the Columbia River (measured respectively, from the upstream and downstream extents of the proposed docks at the project area). The study area for direct impacts is based on the distances at which underwater noise is estimated to reach noise disturbance thresholds (i.e., 150 decibels [dB] root mean square[1] [RMS]) for fish from impact and vibratory pile driving (Grette 2014a).

At full build out, the Proposed Action would load 70 vessels (Panamax and/or Handymax) per month. Vessels of this size generate wakes, which in certain circumstances can strand fish on shallow sloping beaches. Therefore, the study area for indirect impacts from project-related vessel traffic extends from the project area downstream to the mouth of the Columbia River to accommodate an analysis of the potential effects of fish stranding (Figure 4). The study area for indirect impacts related to potential coal spills includes the rail routes for Proposed Action-related trains in Cowlitz County and Washington State that would be used to transport coal to the coal export terminal.

[1] Root mean square (RMS) is the square root of the energy divided by the impulse duration. This level is the mean square pressure level of the pulse.

Figure 3. Fish Direct Impacts Study Area

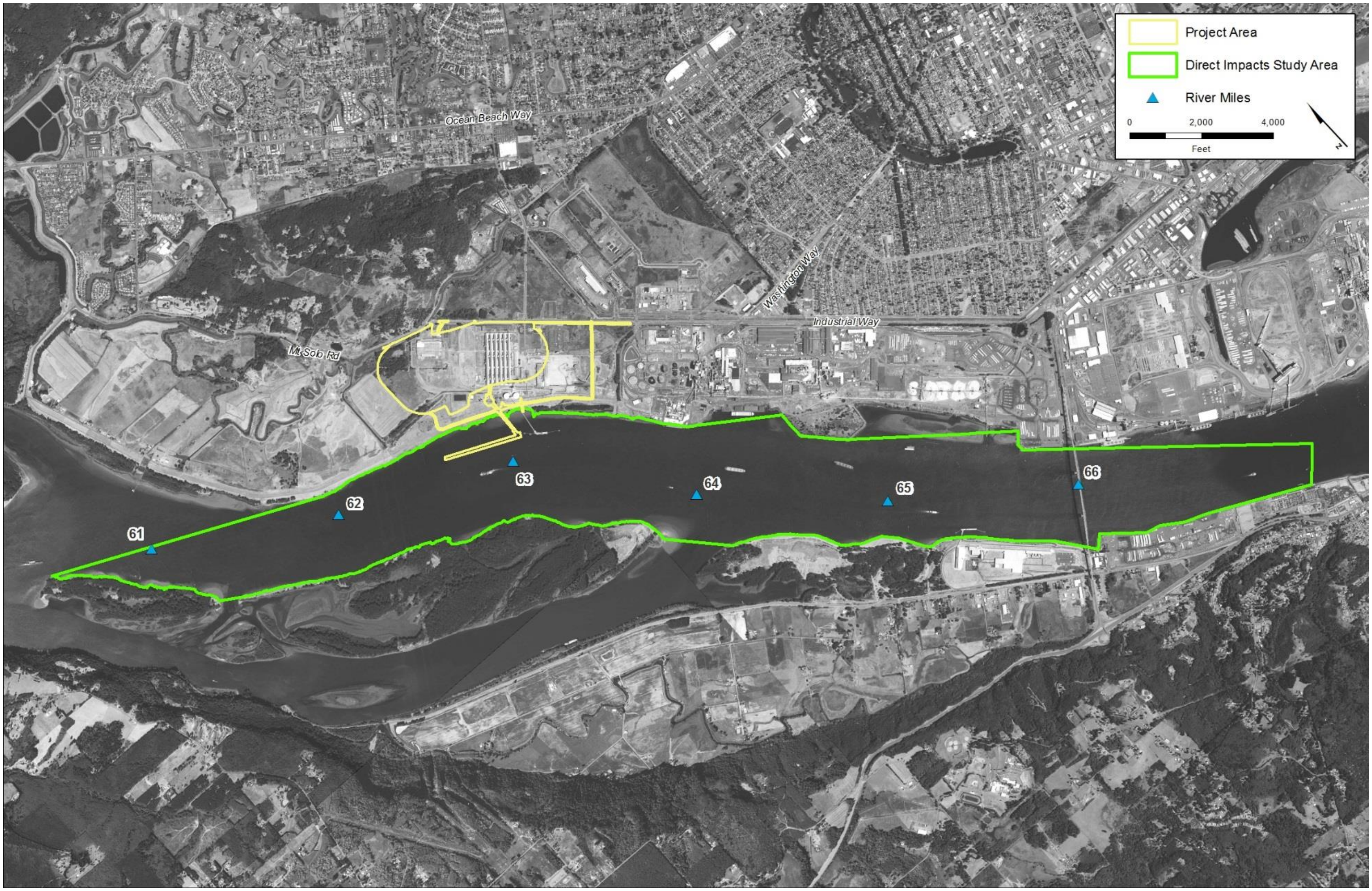
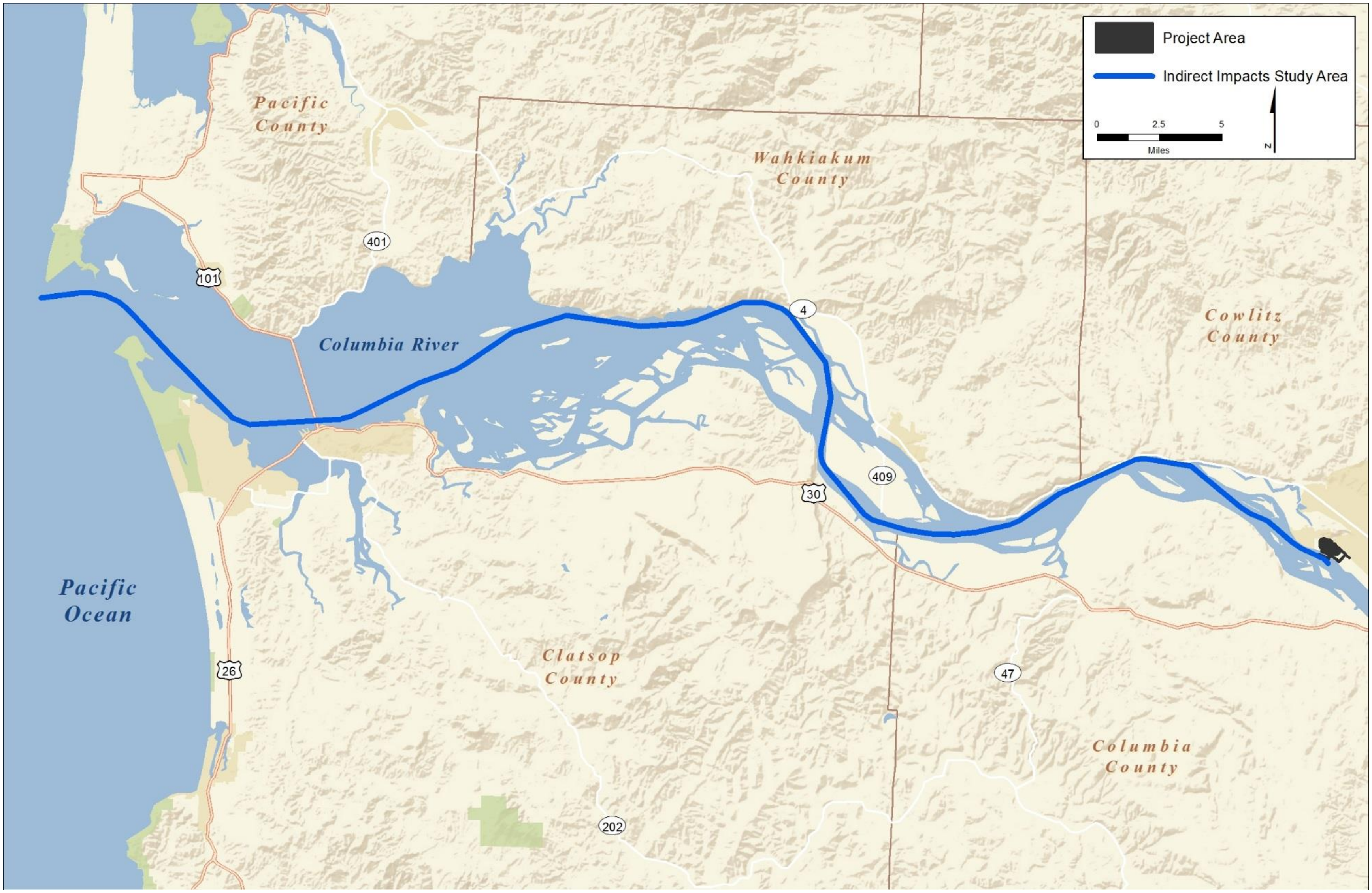


Figure 4. Fish Indirect Impacts Study Area



Chapter 2
Existing Conditions

This chapter describes the methods for assessing the existing conditions and determining impacts, and the existing conditions in the study areas as they pertain to fish and fish habitat.

2.1 Methods

This chapter explains the methods for assessing the existing conditions and determining impacts, and describes the existing conditions in the study area as they pertain to fish and fish habitat. This assessment is based on ICF's review of information collected specifically for this technical report, as well as available information concerning fish and aquatic resources in the Columbia River. It specifically addresses existing aquatic and shoreline habitat conditions within the project areas, as well as areas adjacent to the project areas potentially affected directly and indirectly by construction and operation. This includes the shoreline and offshore areas associated with the proposed deepwater terminals, aquatic habitats subject to temporary impacts during construction, aquatic habitats affected by construction and maintenance dredging to create and maintain vessel access to the export terminal, and impacts of vessels transiting in the Columbia River between the project area and the mouth of the Columbia River.

2.1.1 Data Sources

The following sources were used to evaluate fish and fish habitat characteristics of the study area.

- One site visit conducted by ICF fish biologists on January 29, 2014.
- Reports prepared by Grette Associates for the Applicant as part of the permit application supporting materials.
    - Docks 2 and 3 and Associated Trestle Direct Effects of Construction (Grette 2014a).
    - Affected Environment Biological Resources. Technical Report and associated appendices (Grette 2014b).
    - Permanent Impacts to Aquatic Habitat (Grette 2014c).
    - Docks 2 and 3 and Associated Trestle Indirect Effects of Structures and Site Operations (Grette 2014d).
    - Docks 2 and 3 and Associated Trestle: Proposed Mitigation Measures to Minimize Construction and Long-Term Effects (Grette 2014e).
- National Oceanic and Atmospheric Administration (NOAA) Fisheries West Coast Region species list (2014a).
- NOAA Fisheries listing packages (2014a, b).
- USFWS (2014) Information, Planning, and Conservation (IPaC) system online database.
- Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) geographic information system data for the study area (2015a).

- Washington Department of Fish and Wildlife (2015b) SalmonScape data for the study area and vicinity.
- Washington State Department of Natural Resources, Natural Heritage Program, February 2014 database (accessed by ICF on April 7, 2014).
- Washington State Department of Ecology (Ecology) 303(d) /305(b) Integrated Report Viewer (accessed by ICF in December 2016).
- Fish Passage and Timing Data Columbia River Data Access in Real Time (DART), Columbia Basin Research, University of Washington (juvenile and adult fish passage) (Columbia River Basin 2013).
- Fish Passage Center. Query of adult passage at Bonneville Dam: graph with current year, last year, and 10-year average (Fish Passage Center 2014).
- Comments received from interested parties during the scoping period relative to fish and wildlife, as summarized in the SEPA Scoping Report (February 10, 2014).
- Other scientific literature and sources of technical information as cited in the text.

2.1.2 Impact Analysis

The following methods were used to evaluate the potential impacts of the Proposed Action and No-Action Alternative on fish and fish habitat. For the purposes of this analysis, construction impacts are based on peak construction period and operations impacts are based on maximum throughput capacity (up to 44 million metric tons per year).

Potential impacts on fish and fish habitat were determined by considering the species that are likely to occur in the study area based on field surveys, site visits, the presence of suitable habitat and geographic range, and documented species occurrences and habitat conditions. For documented occurrences, focus was on fish species identified in the WDFW PHS database. The PHS program provides comprehensive information on important fish, wildlife, and habitat resources in Washington. It is the principal means by which WDFW provides fish, wildlife, and habitat information to public and private entities for planning purposes. In addition, the USFWS list of federally listed species in Cowlitz County and the NMFS West Coast Region species list of fish (which are also included in the PHS database) were also considered.

WDFW maintains a PHS geospatial database that maps likely locations of priority species occurrences and priority habitats. Priority species in the PHS program include fish and wildlife species classified under state law (Washington Administrative Code [WAC] 232-12-297) as threatened, endangered, or sensitive, as well as species that are candidates for such classification. Other PHS species include vulnerable aggregations of species or groups of animals that are susceptible to significant population declines due to their inclination to aggregate, and species of recreational, commercial, and/or tribal importance. The PHS database also includes state-monitored species, which are not considered special-status but are monitored for status and distribution trends. Geospatial PHS data containing mapped locations of priority species occurrences and priority habitats was obtained from WDFW (Washington Department of Fish and Wildlife 2015a). This PHS data was overlaid with the study area to determine presence of documented priority fish species and habitat occurrences.

A list of special-status fish species was compiled for the study area, consisting of those species federally listed as threatened, endangered, proposed, or candidate species, and fish species listed in the WDFW PHS database.

A list of federally listed fish species for Cowlitz County was generated from the USFWS IPaC online planning tool (U.S. Fish and Wildlife Service 2014).

A list of state priority species that occur in Cowlitz County was obtained from the WDFW PHS program website (Washington Department of Fish and Wildlife 2015a).

A list of federally protected fish and their habitat, including essential fish habitat, that could occur in the study area was also compiled from the NMFS (2015) West Coast Region website.

The impact analysis for fish habitat is quantitative; however, the impact analysis for fish species is qualitative because fish are generally mobile and their presence and abundance within the study area cannot be quantitatively predicted at any one location or time. In addition, a species reaction to an impact mechanism, such as construction-generated noise, can be different for each species given the variability in species' hearing frequencies, mobility, vision, and overall sensitivity (e.g., juvenile fish may be more sensitive and susceptible to potential impacts than adult fish). Therefore, impact mechanisms are identified and a qualitative impact discussion describes the potential effect an impact mechanism could have on species that may be in the study area during construction and operations.

2.2 Existing Conditions

The existing environmental conditions related to fish and fish habitat in the study areas are described in the following sections.

2.2.1 Project Area

The project area for the Proposed Action is located along the north side of the Columbia River at river mile 63, within unincorporated Cowlitz County and adjacent to the City of Longview.

The project area was once productive marsh and riparian floodplain habitat used by many species of fish for spawning, foraging, and rearing. It is now extensively modified for flood control, industrial development, and deep draft vessel traffic, and its value for fisheries is now primarily as a migratory corridor from upstream spawning areas to downstream rearing and foraging areas in the estuary and marine environments.

Adjacent lands to the north and west are largely undeveloped and are used for a combination of agricultural and recreation activities. Lands to the south and east are heavily industrialized and include a large Weyerhaeuser Lumber processing and export terminal and the Port of Longview (Port). The Port is a multipurpose deep-draft terminal encompassing 478 acres and over one mile of waterfront at river mile 66 on the Columbia River. The marine terminal includes nine berths handling bulk, break bulk, and cargoes for or from domestic barge and international (Panamax sized) ocean vessels. During 2010, the Port had 154 vessel calls, totaling 2.3 million metric tons of cargo (Port of Longview 2010). In 2012, this number increased to 225 vessel calls, reflecting the increased capacity provided by a new bulk export grain terminal capable of handling more than 8 million metric tons annually (Kulisch 2013).

In the 1920s, Consolidated Diking Improvement District (CDID) #1 constructed a levee along the Columbia River shoreline to protect Longview area properties from Columbia River flooding. In conjunction with the levees, the CDID also excavated a series of ditches to facilitate development of low-lying properties. These ditches, which lie north and west of the project area, drain both stormwater and shallow groundwater from properties within CDID #1. The ditch water is ultimately discharged to the Columbia River through pump stations. The topography of the 540-acre Applicant's leased area varies by location, although overall it is generally flat. Current topography on the property south of Industrial Way indicates the majority of the upland portion of the project area is in the range of elevation +5 to +12 feet above the Columbia River Datum (CRD).

This area is currently developed with a variety of facilities and structures associated with the Reynolds facility. Most of the approximately 540-acre Applicant's leased area that is located south of Industrial Way is paved with asphaltic concrete and Portland cement concrete pavements. The western portion of the Applicant's leased area extends into wooded areas and grass-covered fields.

2.2.2 Study Area

The hydrology of the region, as described in the SEPA Groundwater Technical Report (ICF 2017a) is characterized by two major aquifers: the upper alluvial aquifer (i.e., shallow groundwater) and a deeper confined aquifer. Shallow groundwater is present in the upper 75 to 100 feet of alluvium, and is in direct communication with the Columbia River. Multiple groundwater zones are present in the upper alluvial aquifer due to the interbedded nature of the alluvium. A deeper confined aquifer is present below approximately 300 feet below ground surface in coarser sands and gravels where production and supply wells draw groundwater. Both aquifers are in direct communication with the Columbia River.

The average annual rainfall recorded between 1931 and 2005 for Longview, Washington, is 46.17 inches. Approximately 44% of the total precipitation falls between November and January during winter storms. The average annual snowfall is just less than 5 inches. July and August are typically the two driest months of the year (Western Region Climate Center 2011, as cited in URS 2014).

The baseline conditions of the Lower Columbia River (Bonneville Dam to the Columbia River Mouth) and the study area are moderately to highly modified as a result of historical and ongoing human activities that have altered natural habitat conditions. The mainstem Columbia River environment is deeper than it was historically because of the deepening and periodic dredging of the shipping channel and the berthing areas in and adjacent to the proposed docks. The hydrologic regime and water temperature conditions have been altered by the operation of the Federal Columbia River Power System throughout the Columbia River Basin. Floodplain habitats have been disconnected from the riverine environment and in some cases eliminated. Finally, the shoreline and riparian environment has been substantially altered by extensive shoreline armoring and protection, construction of overwater structures, and development in adjacent upland and riparian zones. These modifications have eliminated and substantially altered habitat conditions and degraded habitat-forming processes, resulting in corresponding changes to the biological communities associated with these habitats. A more thorough discussion of the changes in the vegetation zones can be found in the SEPA Vegetation Technical Report (ICF 2017b).

By the mid-twentieth century a significant portion of the study area had been diked, dredged, and filled (Graves et al. 1995 in Johnson et al. 2003). Alteration of the natural hydrograph by the operation of upstream dams and reservoirs, surface water diversions, and other water uses have decreased seasonal and annual flow variability and altered the timing of the hydrograph peak discharge and base discharge. Peak spring flows are now smaller, begin earlier, and last longer than they did historically. Winter flows are generally higher on average, but periodic peaks have been dampened or eliminated (Bottom et al. 2008). Overall, the average daily discharge in the Lower Columbia and the study area has decreased by approximately 16% relative to the historical norm (Bottom et al. 2008). The average annual flow for the Columbia River at Beaver Army Terminal near Quincy, Oregon, is approximately 236,600 cubic feet per second (cfs). The river's annual discharge rate fluctuates with precipitation and ranges from 63,600 cfs in a low water year to 864,000 cfs in a high water year (U.S. Geological Survey 2014). The change in flow conditions has altered estuarine dynamics in the study area. River flows can reverse direction during periods when river flows are low and incoming tides are large, and these reversal events now occur more frequently because the magnitude and timing of minimum flows has changed. Although the flow may reverse in response to tidal fluctuation, salt water does not intrude as far upstream as the study area and the water remains fresh through the tidal cycle. The study area can be considered a high-energy environment, characterized by strong currents, active bedload transport, and variable patterns of sediment of deposition and erosion (Grette 2014b).

Considerable effort has been expended to preserve, protect, enhance, and restore salmon habitat in the lower Columbia River subbasin, below Bonneville Dam. These efforts have included purchasing properties, working with private landowners and other interested parties to protect, enhance, and restore habitats in support of salmon recovery, as well as improving conditions for other aquatic and terrestrial wildlife. Appendix A, *Restoration Projects in the Lower Columbia River Subbasin*, lists these completed projects. A map of these projects is provided on the Lower Columbia Estuary Partnership website (www.estuarypartnership.org).

Key terms used in this section are defined in Table 2.

Table 2. Definitions of Key Terms

Term	Acronym	Definition
Active channel margin	ACM	The shoreline and nearshore edge habitat, extending from the OHWM (+11.1 feet) to 0 feet CRD
Columbia River Datum	CRD	The adopted fixed low water reference plane for the lower Columbia River.
Decibel	dB	A logarithmic unit used to express the ratio of two values of a physical quantity, often power or intensity.
Deep water zone	DWZ	The area extending waterward from the edge of the SWZ, approximately 450 feet ranging in depth from -20 feet CRD to -45 feet CRD. Water depths are based on an OHWM of +11.1 feet, CRD.
Distinct population segment	DPS	The smallest division of a taxonomic species permitted to be protected under the Endangered Species Act.
Essential fish habitat	EFH	Per the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, EFH includes those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.
Evolutionarily significant unit	ESU	A population of organisms that is considered distinct for purposes of conservation.
Peak	PEAK	The instantaneous maximum overpressure or underpressure observed during each pulse during pile driving.

Term	Acronym	Definition
Primary constituent element	PCE	A physical or biological feature essential to the conservation of a species for which its designated or proposed critical habitat is based on, such as space for individual and population growth, and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements; cover or shelter; sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and habitats that are protected from disturbance or are representative of the species' historic geographic and ecological distribution.
Priority habitat and species	PHS	Program fulfilled by Washington Department of Fish and Wildlife to provide important fish, wildlife and habitat information to local governments, state and federal agencies, private landowners and consultants, and tribal biologists for land use planning purposes.
Root mean square	RMS	The square root sound of the energy divided by the impulse duration. Essentially, the average of the PEAK energy measured over time.
Shallow water zone	SWZ	The fully inundated near-shore zone extending from the edge of the ACM at 0 feet CRD out to -20 feet CRD.
Sound exposure level	SEL	A metric for acoustic events, often used as an indication of the energy dose.
Temporary threshold shift	TTS	Temporary shift in auditory threshold, such as temporary hearing loss.

2.2.2.1 Aquatic Habitat Types

The aquatic habitat in the study area is discussed in terms consistent with the habitat equivalency analysis (HEA) model, which provides a framework for describing habitat quality in the context of habitat availability and suitability as a function of water depth and physical attributes. The aquatic portion of the study area adjacent to the project area is composed of three broad habitat types (Grette 2014b): the Active Channel Margin (ACM), the Shallow Water Zone (SWZ), and the Deep Water Zone (DWZ). The riparian zone is also considered in terms of its interactions with aquatic habitats, as the riparian zone is the transition from aquatic to upland habitat. A cross-section of the aquatic habitat adjacent to the project area is provided in Figure 5, showing the maximum widths and typical depth profiles based on CRD, of each of these habitat types adjacent to the project area near the proposed docks. A plan view showing the extent of each habitat type is provided in Figure 6.

Riparian Zone

The discussion of the riparian zone here is focused on those elements relevant to aquatic habitat important to fish and fish habitat. The riparian zone includes lands less than 200 feet landward from ordinary high water (OHW) (+11.1 feet CRD) (Figures 5 and 6). Shoreline armoring and CDID dikes have contributed to what is typically low-complexity and artificially steepened upper shoreline with no floodplain connectivity in the downstream two-thirds of the vicinity of the proposed docks. Landward of the shoreline, most of the riparian area has been so heavily modified that there is little remaining function (Grette 2014b). There is a small area of intact riparian assemblage, immediately upstream of Dock 1; however, it consists primarily of nonnative and invasive species (ICF 2017b). There is little potential for a remnant area of riparian habitat to contribute biological material (e.g., leaf litter, woody material, and insects) to the aquatic areas, nor does it provide shade or other physical function. In comparison to shoreline areas with intact riparian habitat, the HEA[2] model would rank shoreline habitat at a relatively lower value, especially when compared to similar areas with intact riparian habitat (e.g., Lord Island, immediately across the river) (Grette2014b). Lord Island also provided habitat for Columbia white-tailed deer. Refer to the SEPA Wildlife Technical Report (ICF 2017h) for further information regarding on Columbia white-tailed deer.

[2] HEA is a tool that can be used to estimate habitat gains and losses across a range of habitat types

Figure 5. Cross-Section of Shoreline Habitats Adjacent to the Project Area

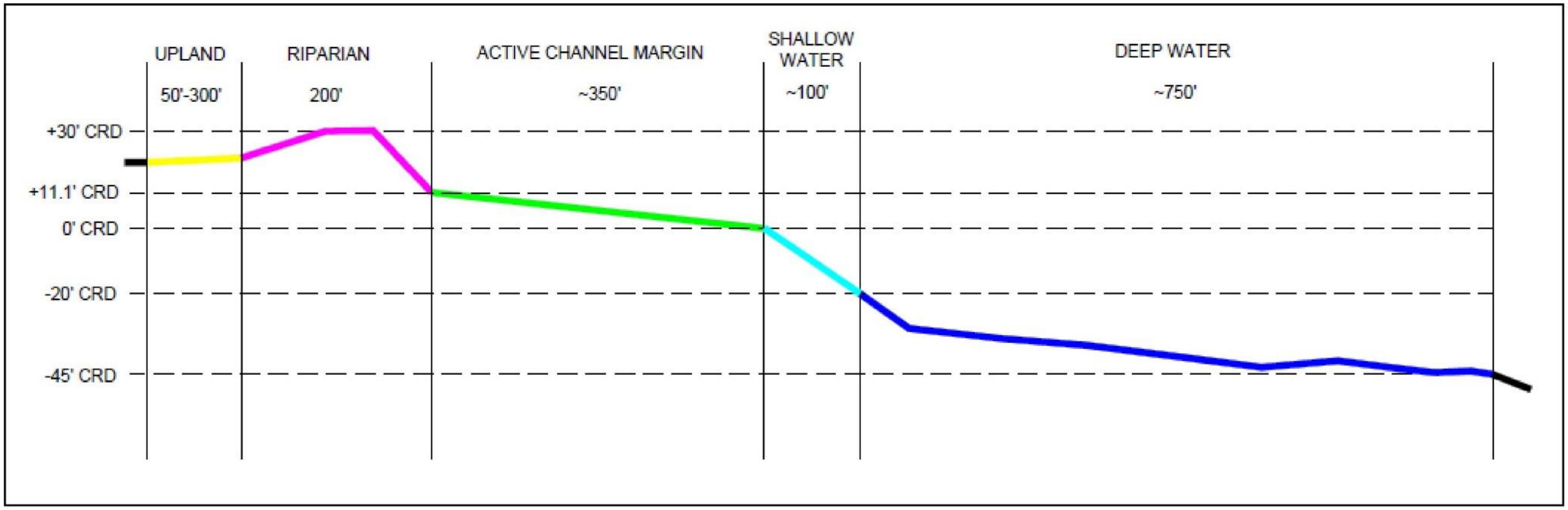
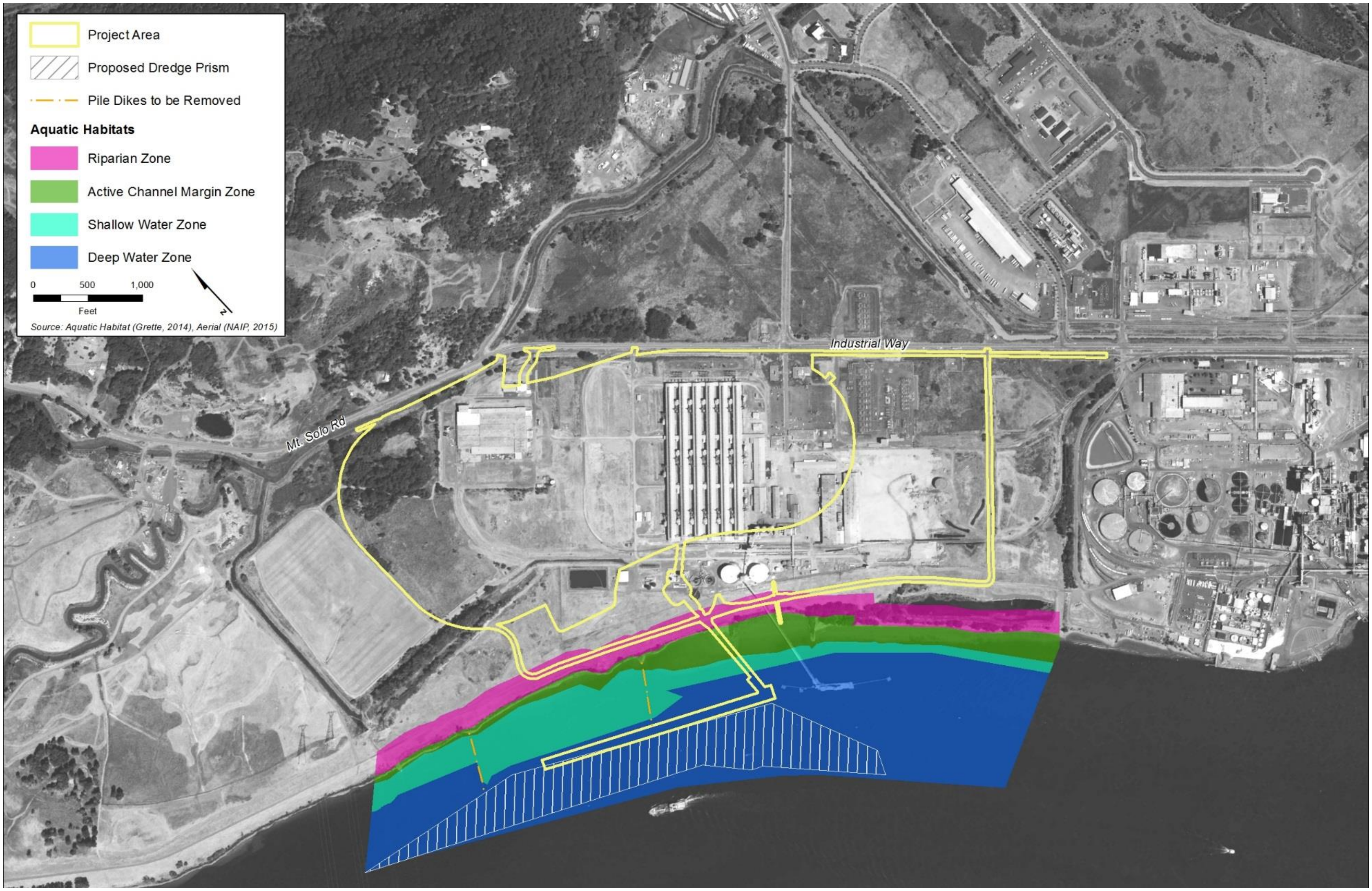


Figure 6. Aquatic Habitat Types Potentially Affected by the Proposed Action



Active Channel Margin

The ACM is defined as the shoreline and nearshore edge habitat, extending from the OHW line[3] (+11.1 feet CRD) to 0 feet CRD (Figures 5 and 6). For comparison purposes, the mean low water line is at approximately +2.7 feet CRD (National Oceanic and Atmospheric Administration 2013). Water levels in the ACM fluctuate continuously and portions are periodically dewatered because of tidal influence and river flow conditions, with the extent and duration of exposure dependent on site-specific topography. The ACM near the proposed docks covers approximately 25 acres and extends from 25 to 350 feet offshore. The shoreline portion of the ACM (less than 1.5 acres) is sparsely vegetated and consists of sandy substrate with little organic matter (Grette 2014b). Habitat functions in the ACM are strongly influenced by the condition of the shoreline and adjacent riparian zone. The shoreline in this area is highly modified by dikes and riprap armoring with scattered large woody debris.

Generally the ACM provides foraging and rearing habitat for juvenile salmonids, particularly those expressing a stream-type life history (National Marine Fisheries Service 2011). Steelhead trout (*Onchorhyncus mykiss*), lamprey, adult eulachon (*Thaleichthys pacificus*), and sturgeon are less likely to be found in the ACM because these species generally prefer deeper open water habitats (Carter et al. 2009, Gustafson et al. 2010, Independent Scientific Review Panel 2013). However, periodic occurrence of these species cannot be discounted. Larval and juvenile sturgeon may drift or move incidentally into inundated habitats in the ACM. Larval eulachon dispersal into the ACM is also probable.

Shallow Water Zone

The SWZ includes the fully inundated near-shore zone extending from the edge of the ACM at 0 feet CRD out to -20 feet CRD (Figures 5 and 6). The SWZ near the proposed docks covers approximately 34 acres extending from approximately 25 to 500 feet offshore. Bottom structure is primarily (90%) flat or shallow sloping substrate, with some moderate slopes out to depths of about -25 feet CRD, where the habitat becomes markedly steeper. Two pile dikes and one overwater dock extend into the SWZ and likely provide both cover and refuge for prey and predator species, but they are not likely to substantially inhibit migration past the project area. The substrate consists primarily of silty river sand with little organic matter (Grette Associates 2014b).

Deep Water Zone

The third major habitat type in the study area is the DWZ, which extends in depths beyond -20 feet CRD (Figures 7 and 8). The DWZ habitat type encompasses about 117 acres near the proposed docks, extending from the edge of the SWZ. At approximately 450 feet from the shore, this zone is about -20 feet deep CRD, extending to a maximum depth of -45 feet deep CRD approximately 1,200 feet from shore. The DWZ is used as an upstream migration corridor by adult salmonids returning to their spawning grounds and as a downstream corridor by juvenile salmonids of sufficient size to avoid predators and forage in open water. Steelhead are likely to be present periodically throughout the year in the DWZ as different summer and winter-run populations migrate through the area as juveniles and adults. Adult and subadult bull trout (*Salvelinus confluentus*) may also be found foraging in these deepwater habitats, particularly when eulachon, migrating juvenile salmonids, and other potential prey species are present in abundance. Eulachon (adults and larvae) are likely to be present during adult migration and larval dispersal. White sturgeon (*Acipenser transmontanus*)

[3] The OHW line is equivalent to the mean higher high water line in the tidally influenced Lower Columbia River

(adults, subadults, larvae, and juveniles) and green sturgeon (*Acipenser medirostris*) (adults and subadults) are likely to occur in the DWZ. Adult and juvenile lamprey may be present in the DWZ in the spring, summer, and fall during migration between freshwater and marine habitats (Table 3). There are a two pile dikes and one dock that extend into the DWZ. These structures are likely to influence but not inhibit the migration of juvenile salmonids, and they are likely to provide both resting and ambush habitats for predatory species including pikeminnow, bass, and piscivorous birds.

2.2.2.2 Columbia River Downstream of Project Area

The Columbia River estuary extends upstream from the mouth of the Columbia River to the Bonneville Dam (Simenstad et al. 2011). It has been considerably degraded from past use due to diking and filling and from water withdrawal for agricultural, municipal, and industrial purposes. The estuary is influenced by a number of physical structures (e.g., jetties, piles, pile dikes, bulkheads, revetments, and docks) that contribute to its overall degradation. Habitat-forming processes in the estuary have been altered by loss of upriver sediment input (now constrained behind upriver dams), changes in flow patterns that move sediments and modify landforms, and channel deepening and dredging. The near-elimination of overbank flood events and the separation of the river from its floodplain have altered the food web and reduced floodplain habitats of particular importance to ocean-type salmon runs (salmonids that typically rear for a shorter time in tributaries and a longer time in the estuary) (National Marine Fisheries Service 2011).

The estuary also is influenced by a number of physical structures (jetties, pilings, pile dikes, bulkheads, revetments, docks, etc.) that contribute to its overall degradation, but the extent of their impacts is poorly understood. Over-water and instream structures in the estuary number in the thousands and alter river circulation patterns, sediment deposition, and light penetration; they also form microhabitats that often benefit predators. In some cases, structures reduce juvenile access to low-velocity habitats (National Marine Fisheries Service 2011).

Habitat forming processes in the lower river and estuary have also been altered by loss of upstream sediment input (now constrained behind upriver dams), changes in flow patterns that move sediments and modify landforms, and channel deepening and dredging. The full impact of these changes is unknown. Some of the concerns about impacts on sediment transport and channel forming processes have been addressed by the use of instream dredge disposal alternatives and disposal methods to help sustain in-channel islands and shallow water habitats (National Marine Fisheries Service 2011). Stranding associated with existing ship wakes is an example of another threat to salmon and steelhead in the estuary. A study completed by ENTRIX (2008) identified 217 beach segments (out of 1,046 beach segments assessed) between the project area and the river mouth on which there is more than a minimal likelihood of fish stranding. Seventy of these sites occur in three clusters: Puget Island (RM 43–47), near Pt. Barlow (RM 61–62), and Walker and Lord Islands (RM 61–65) (Figure 7).

2.2.2.3 Focus Fish Species

This summary focuses primarily on fish species of special interest/concern, including federally and state-listed threatened and endangered species, and their designated critical habitat, as well as species of commercial, recreational, or cultural importance. Table 3 outlines the focus fish species, the status of the species (i.e., state and federal), habitat types these species typically occupy, and their seasonal occurrence in the study area. Existing conditions and habitat use by focus fish species are described by habitat type in the following sections and summarized in Table 3.

Table 3. Status of Focus Species and Seasonal Presences in the Study Area

Species, ESU/DPS	Federal Status[a]	Life Stage	Sept			Oct			Nov			Dec		
			A[b]	S[b]	D[b]	A	S	D	A	S	D	A	S	D
Chinook Salmon														
Snake River fall-run ESU	T	Adults			X[c]			...						
		Subyr		...[d]	...		...	...		...	...			
Lower Columbia River ESU	T	Adults			X			X						
		Yrlng												...
		Subyr		...	...		...	...		...	...	...		
Upper Willamette River ESU	T	Yrlng												...
		Subyr		...	...		...	...		...	...	...		
Coho Salmon														
Lower Columbia River ESU	T	Adults			X			X			X			X
		Subyr		...			...			...		...	...	
Chum Salmon														
Columbia River ESU	T	Adults						X			X			
		Subyr										...	...	
Steelhead Trout														
Snake River DPS	T	Adults			X			...						
Upper Columbia River DPS	T	Adults			X			...						
Middle Columbia River DPS	T	Adults			X			...[e]						
Lower Columbia River DPS	T	Adults			X			X			X			X
Bull Trout														
Columbia River DPS	T	Adults		...	...		...	...		...	...		...	...
Cutthroat Trout														
Columbia River DPS	NL	Adults/Juveniles		X	X		X	X		X	X		X	X
Green Sturgeon														
Southern DPS	T	Adults/Subadults		X	X		X	X						
Northern DPS	SOC	Adults		X	X		X	X						
		Subadults		X	X		X	X						
White Sturgeon														
Lower Columbia River		Adults		X	X		X	X		X	X		X	X

		Subadults	X	X	X	X	X	X	X	X
Eulachon										
Southern DPS	T	Adults					...	...	X	X
		Eggs/Larvae					...	...	X	X
Pacific & River Lamprey										
Multiple populations	NL	Adults	X	X	X	X				
		Ammoceotes	X	X	X	X	X	X	X	X

Notes:

[a] T denotes federally threatened (no Endangered in this table), "NL denotes Not Listed, SOC denotes Species of Concern.

[b] A, S, and D represent the HEA habitat categories of ACM, SWZ, and DWZ; see Grette (2014b) for additional information.

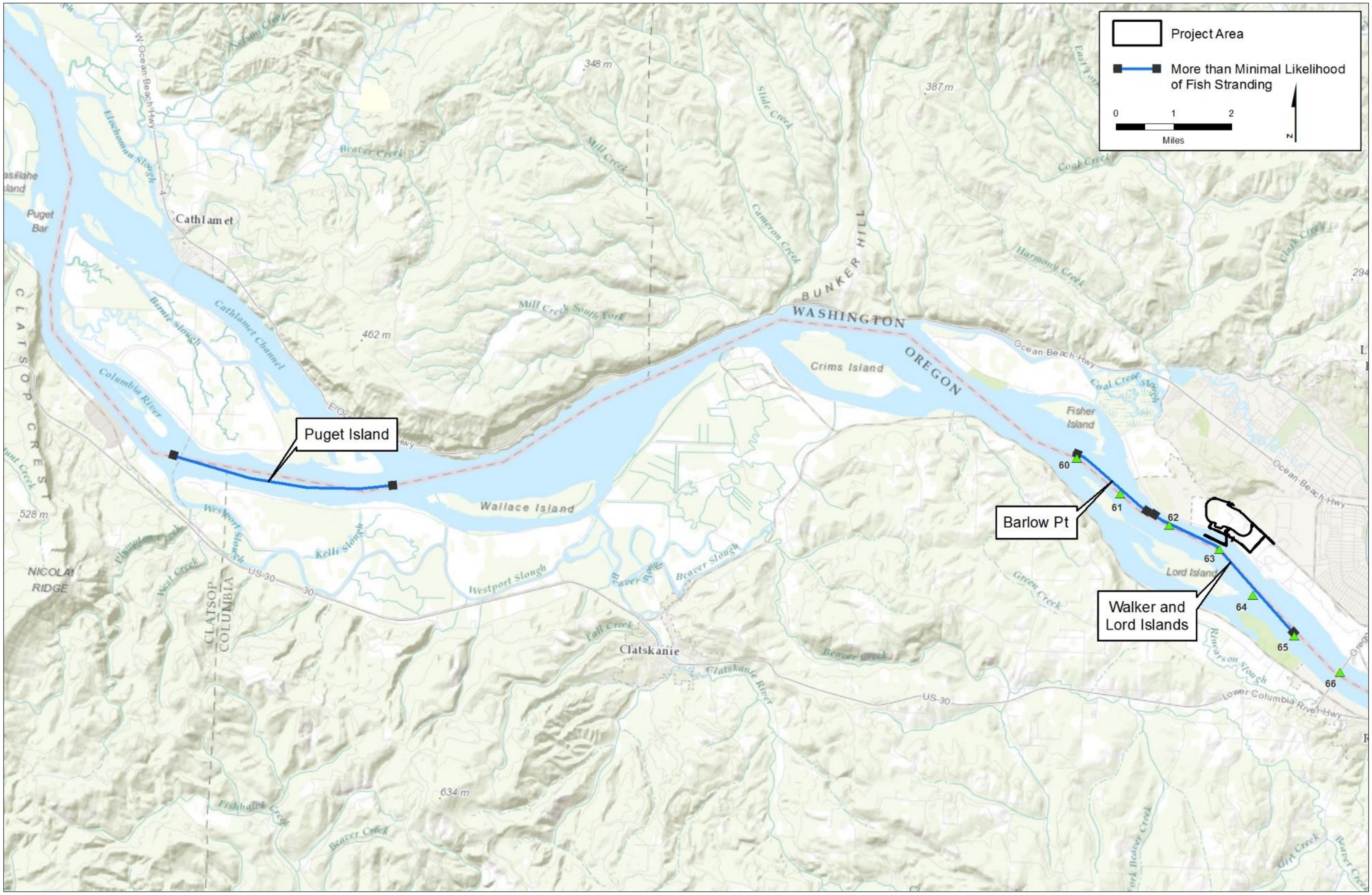
[c] X denotes expected or potential presence; see Grette Associates (2014c) for additional information.

[d] "..." denotes expected presence but low relative abundance; see Grette Associates (2014b) for additional information.

[e] The Middle Columbia River DPS includes a very small proportion of winter-run fish (Klickitat River, Fifteen-Mile Creek); because passage data at Bonneville Dam indicate that the vast majority of steelhead have passed the dam by early October, it is assumed that this includes winter steelhead spawning above it.

ESU = Evolutionary Significant Unit; DPS = Distinct Population Segment; Subyr = subyearling; Yrlng = yearling.

Figure 7. Fish Stranding Sites



The study area provides habitat for a variety of anadromous and resident fish species found in the Columbia River. Anadromous salmonids occurring within the study area include the following species: Chinook (*Onchorhyncus tshawytscha)*, coho (*Onchorhyncus kisutch*), pink (*Onchorhyncus gorbuscha*), sockeye (*Onchorhyncus nerka*), and chum (*Onchorhyncus keta*) salmon; steelhead; bull trout; and coastal cutthroat trout (*Onchorhyncus clarkii clarkii*). Because of variable migration timing and duration of estuarine habitat use, one or more of these anadromous salmonid species are present in the Lower Columbia River throughout the year, as adults migrating upstream to spawning habitats, outmigrating juveniles, juveniles rearing in the estuary for extended periods, or, in the case of cutthroat trout and bull trout, as foraging subadults and adults. The study area also supports a variety of additional native and introduced fish species. Other anadromous or estuarine migrant species include green and white sturgeon, eulachon, shad (subfamily Alosinae), striped bass (*Morone saxatilis*), starry flounder (*Platichthys stellatus*), and Pacific lamprey (*Entosphenus tridentatus*) and river lamprey (*Lampetra ayresi*).

Resident freshwater fish expected to occur in the study area and vicinity include both coldwater (trout) and warmwater (bass, crappie, and bluegill [*Lepomis macrochirus*]) species, and locally migratory species (three spine sticklebacks (*Gasterosteus aculeatus*), peamouth chub [*Mylocheilus caurinus*]). Several resident fish species are predatory, feeding on a variety of small fish, including juvenile salmonids. These predators include the native northern pikeminnow (*Ptychocheilus oregonensis*), and introduced species such as walleye (*Sander vitreus*), crappie, and largemouth bass (*Micropterus salmoides*) and bass (*Micropterus dolomieui*).

Salmon and Trout

Eight threatened or endangered salmon Evolutionary Significant Units (ESUs), five threatened steelhead Distinct Population Segments (DPSs), one threatened bull trout DPS, and their designated critical habitats occur in the Lower Columbia River and the study area (Table 3) (Bottom et al. 2008, National Marine Fisheries Service 2011). In addition, essential fish habitat (EFH) has been designated for Chinook and coho salmon in the Lower Columbia River. The Columbia River estuary is used primarily as migratory and rearing habitat, and no salmonid spawning takes place in the study area. Adult anadromous salmonids travel through the estuary and lower river relatively quickly during their migration to upstream spawning grounds, remaining primarily in offshore deepwater habitats (Table 3 provides seasonal presence in the study area). In contrast, juvenile salmonids are present year round, use a wider variety of habitats, and exhibit more variable downstream migration speed, taking advantage of shallow water and ACM for foraging and seeking cover.

General salmon reproductive strategies can be divided into two groups: stream-rearing and ocean-rearing (noted in Table 3). Stream-rearing fish tend to spend extended periods, usually more than a year, rearing in fresh water before migrating to the ocean. Examples of stream-type fish are steelhead, coho, and spring-run Chinook salmon. In contrast, ocean-type juvenile salmonids tend to return to the ocean in the same year they were spawned. Examples of ocean-type fish are chum salmon, and fall-run Chinook salmon. These strategies affect how each population uses the estuary and how it may be affected by the Proposed Action. Because stream-type salmon spend more time rearing in their natal streams and associated rivers, they arrive in the estuary at a relatively larger size than ocean-type salmon and therefore use the estuary differently and are affected by different factors. For example, stream-type salmon arrive in the estuary as larger fish and generally use the estuary as a migration route rather than rearing habitat, and are affected mostly by predation and flow. Ocean-type salmon move into the estuary at a smaller size and use the estuary as rearing habitat before entering the ocean. They are also affected by flow, but are more affected by habitat conditions in the estuary than are stream-type fish (Fresh et al. 2005). Salmonid occurrence by species and season are summarized in Table 3 (Bottom et al. 2008, Johnson et al. 2003, Fresh et al. 2005).

Habitat use and timing patterns of nonlisted salmon and steelhead populations are similar to the listed salmonid species (Table 3). Other salmonids, such as cutthroat trout, have complex life histories, consisting of both anadromous and resident populations that make extensive use of the lower river and estuary for foraging (Trotter 1989). Given the diverse run timing and life-history strategies exhibited by salmonids (Fresh et al. 2005) some life stage of salmon or trout could be present in the study area at any time. Salmon and steelhead use of the study area is described in the following sections by aquatic habitat type.

Designated critical habitat for federally protected salmonids in the study area consists of two primary constituent elements: migration corridors and estuarine areas. Migration corridors must be free of obstruction with healthy water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channel, and undercut banks to support juvenile and adult mobility and survival. Estuarine areas must be free of obstruction with water quality and salinity conditions to support juvenile and adult physiological transitions between fresh and saltwater with natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and with juvenile and adult forage, including aquatic invertebrates and fishes to support growth and maturation.

Additionally, the Columbia River is also EFH, as defined by the Magnuson-Stevens Fishery and Management Conservation Act for Chinook salmon and coho salmon. EFH for Pacific salmon is defined as those waters and substrate necessary to support salmon production, a long-term sustainable salmon fishery, and salmon contributions to a healthy ecosystem. To achieve that level of production, EFH must include those streams, lakes, ponds, wetlands and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California. Thus, any discussion regarding the existing fish habitat conditions as well as potential impacts on fish habitat is applicable to EFH for Pacific salmon (i.e., Chinook salmon and coho salmon).

Active Channel Margin Use by Salmon and Steelhead

A fully functioning ACM provides natural cover, shoreline complexity, shade, submerged and overhanging large woody debris, logjams, and aquatic vegetation. All of these elements are identified in the primary constituent elements (PCEs) of critical habitat for Endangered Species Act (ESA)-listed salmon and steelhead, as well as bull trout (Grette 2014b). The ACM provides important habitat for juvenile salmon, with different species using different habitat types at different life stages. PCEs are defined as those physical and biological features of a landscape that a species needs to survive and reproduce. Table 3 identifies the salmon and steelhead species and season when individuals may be present in the ACM affected by the Proposed Action.

Use of the ACM varies both between and within species depending on locally specific adaptation for some life stages. Some salmonid species and populations rear in the lower river and estuary for extended periods (weeks to months) prior to entering the ocean; others spend very little time in the estuary and are unlikely to be present in the ACM for extended periods (Bottom et al. 2008, Johnson et al. 2003). Roegner and Sobocinski (2008) found that subyearling Chinook and chum salmon are the most likely species to be found in the shallow nearshore habitats that compose the ACM. Juvenile chum salmon are abundant in shallow nearshore areas from March through May. Subyearling Chinook (likely ocean-type) are commonly found in the shallow margins of the ACM from March through July. Healthy ACM provides abundant macroinvertebrate forage and cover for protection from predation supporting increased growth, survival, and fitness. Information on use of the Columbia River estuary by the less abundant anadromous salmonid species (cutthroat and bull trout) and those species having life histories with limited freshwater rearing and migration (pink and chum salmon) is limited (Carter et al. 2009), although Carter et al. (2009) do report juvenile cutthroat trout use backwater and channel margin habitats during presmolt and smolt life stages in the Columbia River estuary. In contrast, steelhead and stream-type Chinook salmon are typically larger when they reach the estuary and are more likely to be found farther offshore in the SWZ or DWZ.

As stated above, the ACM near the proposed docks has been extensively modified. Consequently, it does not provide high-quality habitat for juvenile salmonids and other species that prefer shallow water habitats. These species are nonetheless likely to occur in the study area as they migrate downstream to better quality rearing in the lower river and estuary and/or during outmigration to the ocean (Table 3).

Shallow Water Zone Use by Salmon and Steelhead

The SWZ is used by adult salmon and steelhead as a migratory corridor and as foraging habitat by larger juveniles that are more capable swimmers in open water environments. Juvenile Chinook salmon, and sockeye salmon and steelhead smolts are typically found in deeper open water areas in the SWZ foraging on phytoplankton, invertebrates, and small fish (Bottom et al. 2008, Carter et al. 2009). Juvenile Chinook salmon are most commonly present from March through July but may be found in the SWZ during any month of the year. Juvenile coho salmon and steelhead are less likely to be found in the shallower areas but are abundant in deep water offshore habitats during their outmigration period (Roegner and Sobocinski 2008), indicating a likelihood of occurrence in the deeper areas of the SWZ.

Subyearling and yearling salmonids typically move offshore into the SWZ as temperatures increase in late spring and summer and as juveniles gain sufficient size to forage within the open water column (Carter et al. 2009). In general, survival and growth of juvenile salmonids is dependent upon habitats with ample food resources, resting areas (i.e., areas of slow current), refuge from predation, shoreline relief, side channels, and overhanging cover and banks. The SWZ near the proposed docks is made up of relatively high-energy habitat, with a sandy and silt bottom, and little organic matter, and is subject to erosion and deposition (National Marine Fisheries Service 2011). Consequently, this area is unlikely to provide substantial forage habitat for juvenile fish within the water column or along the bottom.

Generally, juvenile salmonids do not reside in specific habitats in the Lower Columbia River for extended periods, remaining in a given area for just a day or two before moving downstream to new suitable habitats (Bottom et al. 2008, Johnson et al. 2003). Carter et al. (2009) reported migration rates for tagged yearling and subyearling salmon of tens of kilometers per day. Given the simplicity of the shallow water habitat near the proposed docks and poor quality of the adjacent ACM, migratory fish are likely to move quickly through the area.

Deepwater Zone Use by Salmon and Steelhead

The DWZ zone provides a migratory corridor for adult salmon and steelhead and foraging and migratory habitat for larger juvenile Chinook salmon, coho salmon, and sockeye salmon and steelhead smolts pursuing phytoplankton, invertebrates, and small fish (Bottom et al. 2008, Carter et al. 2009, Roegner and Sobocinski 2008). Generally, juvenile salmonids do not reside in specific habitats in the Lower Columbia River for extended periods, remaining in a given area for just a day or two before moving downstream to new suitable habitats (Bottom et al. 2008, Johnson et al. 2003). Juvenile and adult salmon and steelhead are likely to be found in the DWZ during their respective migration and rearing periods (Table 3) as outmigrating salmonids (particularly stream type) tend to use deep water (Carter et al. 2009). The DWZ is also a dynamic environment, characterized by high flows and sediment transport. Sediment type is composed mostly of fine grain sands with little to no gravel or cobble for structure (Grette 2014b).

Bull Trout (Char)

Columbia River bull trout are listed as threatened, and there is one extant population in a subbasin that drains to the Lower Columbia River below Bonneville Dam; the Lewis River. Bull trout migrate to the mainstem Columbia River to rear, overwinter, or migrate to and from spawning areas. This indicates the possibility that more distant populations (e.g., Klickitat, Deschutes, Willamette) may migrate to and forage in the project vicinity or could in the future, but the extent to which different bull trout populations use the lower Columbia River is uncertain (Carter et al. 2009). The Lower Columbia Recovery Team considers the mainstem Columbia River to contain core habitat that may be important for full recovery of Columbia River bull trout (U.S. Fish and Wildlife Service 2002). Bull trout have occasionally been observed in the lower Columbia River as foraging or migrating adults and subadults, most likely originating from accessible lower Columbia River tributaries with extant bull trout populations. Subadults may occur in the study area throughout the year in shallow rearing habitats of the ACM and SWZ while adults are more likely to occur in the deeper areas of the SWZ and the DWZ (U.S. Army Corps of Engineers 2004b). However, bull trout are opportunistic predators and routinely move between aquatic habitat types in search of prey so they could be present anywhere in the study area during periods when they are likely to occur in the Lower Columbia River (Table 3).

Eulachon

Eulachon are small anadromous fish in the smelt family (*Osmeridae*), sometimes known as Columbia River smelt (among other names), that spawn in coastal rivers and migrate to the ocean to rear to adulthood. The historical range of this species extends from northern California to Bristol Bay, Alaska. NMFS has classified all extant eulachon populations from the southern end of the range in northern California to the Nass River in British Columbia (exclusive) as belonging to the Southern DPS of the species, and has listed this DPS as threatened under the ESA (*Federal Register* [FR], Volume 75, page 13012). Eulachon are a migratory anadromous species that spend the majority of their lives (2 to 5 years) in marine habitats but return to natal tributary rivers to spawn after reaching adulthood (75 FR 13012).

Eulachon reach sexual maturity and typically spawn in mid- to late-winter, spawning may also occur from November to April (Gustafson et al. 2010). Adults congregate in open water and scatter their fertilized eggs over a variety of substrates. The eggs are adhesive, remaining attached to the substrate through a relatively short incubation period lasting about two weeks at typical water temperatures; eggs survive best in pea-sized gravel and coarse sandy substrates. The newly hatched larvae are captured by currents immediately after hatching and are transported rapidly downstream to estuarine and ocean habitats. Larvae that are dispersed into low current areas may remain in the estuary for weeks or months before growing into juveniles large enough to migrate to marine waters on their own. Most larvae are carried directly to the ocean where they rear to adulthood (Carter et al. 2009).

Prior to construction of dams in the Columbia River, eulachon may have migrated as far as Hood River to spawn. Currently eulachon migrate to the base of Bonneville Dam and spawn in the main river channel and many of the downstream tributaries, including the Grays, Elochoman, Kalama, Cowlitz, Lewis, and Sandy Rivers (Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife 2001). The Lower Columbia River up to Bonneville Dam and the lower reaches of those tributary streams that provide potential spawning habitats (i.e., Grays, Elochoman, Cowlitz, Kalama, Lewis, and Sandy Rivers) have been designated as critical habitat (76 FR 65324). Currently, the lower mainstem Columbia River and the Cowlitz River support the majority of eulachon production in the system (Gustafson et al. 2010). However, in years of relative abundance, spawning occurs broadly in the tidally influenced portions of the Columbia River and its tributaries (Grette 2014b). Adult migration in the Columbia River system is likely related to river temperature reaching 39.2°F and may begin in December, usually peaking in February and continuing through May (Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife 2001). In 2001, Howell et al. (2001) reported on spawning and distribution of larval eulachon, noting that, while spawning occurred widely in the mainstem and in tributaries as far upstream as the Sandy River (RM 120), the majority of the spawning likely occurred in the Cowlitz River and at a location just downstream of Barlow Point (RM 59.6). During the same spawning season, Romano et al. (2002) used artificial substrates to collect eulachon eggs as a way of identifying spawning sites in the main stem (based on the assumption that if eggs are collected spawning must have occurred nearby). They sampled locations between river mile 30 and river mile 85 near the mouth of the Lewis River. They collected the greatest number of eggs between river mile 56 and river mile 61 (Germany Creek to Barlow Point), and to a lesser extent river mile 67 through river mile 69 (mouth of the Cowlitz River to Cottonwood Island). Howell et al. (2001) took samples at several stations at seven fixed transects to assess the distribution of larvae across the river. They showed larvae were distributed nearer the Washington Shore at transects 7 downstream from Sandy River, and at transects 6 (downstream side of Lewis and Clark Bridge) and transect 5 downstream of Barlow Point. This likely reflects larvae moving downstream from spawning areas in the tributaries. Cross-channel distribution at transects farther downstream was more uniform, reflecting cross channel dispersion of larvae spawned in the tributaries and more intense mainstem spawning between Germany Creek and Barlow Point.

WDFW and the Oregon Department of Fish and Wildlife conducted plankton tows to sample for eulachon eggs and larvae between the Port of Longview above Barlow Point and the channel below the Cowlitz River mouth, including four sample sites offshore near the project area (Mallette 2014). Peak larval abundance occurred in mid-March during two of the three survey years and in late April/early May in the third year (Mallette 2014). As part of a related one-time sampling effort, eulachon eggs and larvae were documented in plankton tows at six sample sites (inshore and offshore) near the project area between river miles 62.8 and 64.0 in February 2012 (Mallette 2014: Report B). Eggs could be present from December through April; however, peak spawning season is usually in February or March. Larval eulachon, particularly from spawning aggregations in the Cowlitz River, likely pass through the study area as they are transported downriver. Further, it is likely that at least limited spawning occurs in the mainstem Columbia River, as documented on the Oregon side of the Columbia River by Mallette (2014). Mallette (2014) found the greatest numbers of eulachon larvae in samples collected well downstream of the Lewis, Kalama, and Cowlitz Rivers and upstream of the Elochoman River (rivers with known eulachon spawning). While the relatively distance of sampling events to known spawning areas does not discount the possibility that larvae in samples may be the product of spawning in these tributaries, Mallette (2014) concluded that these findings highlight the potential for at least limited spawning in the mainstem Columbia River.

Adults deposit eggs in areas where the substrate consists of coarse sand/fine gravel (National Marine Fisheries Service 2010). Eggs are spherical and have a double membrane that, upon fertilization, peels back to form an adhesive peduncle (Howell et al. 2001). Eggs adhere to the surface of the substrate and incubate over a period of about 30 to 40 days, depending on temperature. Upon hatching, the larvae become part of the drift as (presumably) passive plankters and are rapidly transported out to sea (Howell et al. 2001). Larval fish, particularly from spawning aggregations in the Cowlitz River, are likely to pass through the study area as they are transported downstream. Eggs attached to large sand grains and pea-sized gravel may be disbursed from the spawning area flows in the Columbia River. The river channel in the study area is dynamic, with sand waves present in the area indicative of bedload movement. Given that incubation can be 30 to 40 days, there could be regular movement of eggs through the SWZ and DWZ of the study area conveyed by moving currents and bedload transport. Eggs could be present From December through April; however, peak of spawning season is usually in February or March.

Dredging in the Columbia River is identified as an activity of concern for eulachon conservation because this activity takes place in proximity to known and potential eulachon habitats. Dredging activities during the migratory and spawning period could entrain and kill adult fish, eggs, and larvae; bury and smother incubating eggs; or cause stress and disturbance that could contribute to decreased spawning success (National Marine Fisheries Service 2010).

Sturgeon

Both green and white sturgeon may be present in the deepwater component of the study area as adults and subadults. Two green sturgeon DPSs occur in in the Lower Columbia River. The northern DPS, currently listed as a federal species of concern, includes spawning populations from the Eel River in California to the Umpqua River in Oregon. The southern DPS, currently listed as threatened under the ESA, includes spawning populations from the Sacramento River basin. While this species does not spawn in the Columbia River or its tributaries, subadult and adult green sturgeon originating from all major spawning populations are known to use the Lower Columbia River and other coastal estuaries in Oregon and Washington for holding habitat in the summer and early fall (Adams et al. 2002, Lindley et al. 2011, Moser and Lindley 2007). Lindley et al. (2008 and 2011) investigated migration patterns of green sturgeon tagged with acoustic transmitters on their spawning grounds and in known nonspawning aggregation sites. They discovered that green sturgeon undertake long season migrations from spawning grounds to overwinter in marine waters off of the coast of Vancouver Island, British Columbia. In the late spring and summer green sturgeon enter and inhabit a number of estuarine and coastal sites, including the Columbia River estuary, Willapa Bay, Grays Harbor, and the estuaries of certain smaller rivers in Oregon, especially the Umpqua River estuary. Moser and Lindley (2007) suggested that growth opportunities for green sturgeon are higher in estuaries because they are warmer than shelf waters and food is abundant. Green sturgeon from different natal rivers use the Columbia River estuary from May through October (peak in July and August). The most prevalent tags reported by Lindley et al. (2011) were from fish tagged in the Klamath and Rogue Rivers, but fish from the Sacramento River (southern DPS) were also present. Based on the size of green sturgeon and the number of tagged fish reported in the estuary, the Columbia River estuary appears to be an important component of foraging habitat for adult and juvenile green sturgeon belonging to the northern and southern DPSs.

Sturgeon are most commonly found in association with the bottom, where they feed on a mixture of aquatic insects and benthic (i.e., bottom-dwelling) invertebrates (Adams et al. 2002, Independent Scientific Review Panel 2013). Fish become a larger component of the diet as sturgeon increase in size. This species is known to spawn in the mainstem Columbia River in fast flowing waters near Bonneville Dam and in deepwater areas of the lower river (Independent Scientific Review Panel 2013, Parsley et al. 1993). Spawning lasts from 38 to 48 days extending from late April through early July during high runoff periods when water is turbid and turbulent. Adults are broadcast spawners, releasing their adhesive eggs over boulder and cobble substrate in areas with strong currents. Incubation lasts 7 to 14 days. Upon hatching the free-swimming embryos are broadly dispersed by currents as far as 100 miles downstream before settling. Post-settlement embryos seek out deep habitats with low light and large cobble or boulder substrates, remaining in cover for 20 to 25 days before they emerge as actively feeding larvae (Independent Scientific Review Panel 2013). The DWZ near the proposed docks does not provide suitable substrates for white sturgeon spawning or larval rearing so these life stages are unlikely to occur for extended periods in this area.

In contrast, juvenile white sturgeon are found throughout the Lower Columbia River and use a wide variety of habitats, including both main-channel and off-channel areas. They are most commonly found at depths greater than 33 feet (Independent Scientific Review Panel 2013). White sturgeon adults, sub adults, and young of the year are usually found at depths greater than 36 feet (McCabe and Tracy 1994), but habitat use can vary considerably. For example, Parsley et al. (2008) tracked the movement patterns of subadult and adult white sturgeon ranging from 20 to 48 inches in length in the Columbia River estuary and observed complex daily and seasonal patterns of habitat selection. Tagged sturgeon were readily observed in the study area in summer but virtually absent in winter. When present they exhibited diurnal movement patterns, occupying habitats deeper than 33 feet during the day and moving to shallower waters, sometimes less than 15 feet deep, at night. The tagged fish were broadly distributed across available suitable habitat, but individuals demonstrated strong site fidelity, restricting their daytime and nighttime movements to the same general area. The water depth preferences of white sturgeon indicate this species is most likely to be found in the DWZ, but individuals may also be present in the SWZ and, infrequently, in the ACM.

The white sturgeon population in the Columbia River downstream from Bonneville Dam has been among the most productive sturgeon populations in North America. Abundance and biomass have been estimated at 36.1 fish/acre and 88 pounds/acre, respectively (DeVore et al. 1995 cited in Independent Scientific Review Panel 2013). Current white sturgeon biomass in the unimpounded lower mainstem appears to be less than levels seen during pristine conditions before significant exploitation in the late 1800s (Jones et al. 2011). White sturgeon downstream from Bonneville Dam continue to range freely throughout the lower river mainstem, estuary, and marine habitats to take advantage of dynamic seasonal patterns of food availability. Individual growth, condition, and maturation values from the Lower Columbia River remain among the highest observed for white sturgeon range-wide. Habitat use of subadults and adults varies with habitat availability. Where habitat is relatively homogenous, such as in marine waters, estuaries, low gradient mainstem areas of the lower basin, and reservoirs, white sturgeon move frequently and range widely, presumably in search of scattered or mobile food resources. Many white sturgeon movement and migration patterns appear to be associated with feeding. Primary prey items appear to be the benthic amphipod *Corophium salmonis* and the opossum shrimp *Neomysis mercedis* (Romano and Rien 2001). In the Lower Columbia River below Bonneville Dam, white sturgeon have been observed migrating upstream in the fall and downstream in the spring (Parsley et al. 2008). During early life stages, white sturgeon in the Lower Columbia River use a variety of habitats. Age-0 fish in the Lower Columbia River prefer deep (30–125 feet), low velocity areas where substrate particle sizes are small (e.g., sand; Parsley et al. 1993). Juvenile and subadult white sturgeon occupy a wide variety of depths (7–130 feet; Parsley et al. 1993 and 2008). Some juvenile white sturgeon preferentially used low velocity areas over sandy substrates at depths ranging from 7 to 190 feet in the Columbia River (Fisheries and Oceans Canada 2014), while others exhibited diel depth preferences Parsley et al. (2008). Given the abundance and mobility of white sturgeon in the Lower Columbia River, there likely would be some present during construction and operation of the Proposed Action.

Lamprey

Lamprey in general are a primitive anadromous fish species that spend their adult lives in the ocean but return to freshwater habitats for spawning and larval rearing. Two species, Pacific and river lamprey, are known to spawn in tributaries to the Columbia River and therefore migrate through the study area as adults and juveniles. Adults pass through the Lower Columbia River from March through October on their return migration to spawning tributaries (Columbia River Research 2014). Lamprey ascend rivers by swimming upstream briefly, then sucking to rocks, resting, and then proceeding.

Pacific lamprey populations may include mature adults that spawn within a few weeks of entering their spawning tributaries and immature adults that hold in freshwater overwinter and spawn between March and July the following spring (Clemens et al. 2013). Spawning takes place in the spring in low-gradient sections of water with gravel and sandy bottoms, when water temperatures are between 50 and 60°F. Females are very fecund, depositing between 10,000 and 100,000 extremely small eggs. Adults die within 3 to 36 days after spawning (Clemens et al. 2013).

The young (ammocoetes larvae) hatch in 2 to 3 weeks and are dispersed by currents to slack-water areas with soft substrates, where they settle in sediments, which are soft and rich in dead plant materials. They quickly burrow into the muddy bottom where they live for a period of 3 to 8 years as filter feeders consuming microscopic plants (mostly diatoms) and animals. As filter feeders, they are susceptible to pollutants in the water column and sediments, which originate from various sources such as urban and agricultural runoff. Because this species depends on muddy bottoms, backwater areas, and low gradient areas during its juvenile life stage, it is susceptible to loss or modification of wetlands, side channels, back eddies, and beaver ponds resulting from agricultural, forestry, or urban development practices or channelization for flood control. Late in the ammocoetes life stage, unknown factors trigger a metamorphosis, from which lamprey juveniles emerge. During high water periods, in late winter or early spring, the juveniles migrate to the ocean where they mature. During their ocean phase, Pacific lamprey are scavengers, predators, and/or parasites on larger animals such as salmon and marine mammals. They may undertake migrations in the Pacific Ocean, considerable distances from their natal river (Beamish 1980). After 2 to 4 years in the ocean they return to freshwater to spawn.

River lampreys are associated with large river systems such as the Fraser, Columbia, Klamath, Eel, and Sacramento Rivers. They exhibit a similar life history to the Pacific lamprey, including an ammocoete larval stage lasting 4 to 6 years. River lamprey ammocoetes also settle in slack water areas with muddy sediments and filter feed on microscopic organism (Moyle 2002). They differ from Pacific lamprey in that they are smaller in size, a bit less fecund, with females laying between 12,000 and 37,000 eggs, and they are shorter lived. The length of adult life from the onset of metamorphosis until death following spawning is 2 years (Beamish 1980). The difference in longevity stems from their shorter ocean phase. River lamprey spend only 3 to 4 months in salt water, remaining close to the mouths of their natal rivers and foraging on smaller prey, such as herring and smelt (Beamish 1980).

The study area lacks suitable spawning substrates for either species. Therefore, adults are likely to be present only during upstream migration. Silver et al. (2007) and Jolley et al. (2012) investigated the presence and distribution of larval Pacific lamprey in the Willamette and Columbia Rivers. They found ammocoetes of several age classes in the Willamette River and at a few locations in the Columbia River. They observed anecdotally that larvae were more often found along underwater ledges at relatively steep drop-offs to deep water; and that shallow, flat, and sandy areas that appeared to present suitable habitat, were devoid of larvae. They speculate that those apparently suitable areas may have been dry during the summer months preceding the study because of lower regulated flows. They captured Pacific lamprey ammocoetes at two sites in the Columbia River near the mouth of the Cowlitz River. These ammocoetes were likely spawned in tributaries and either transported or migrated to the Columbia River. Their presence in the study area indicates the possibility that some ammocoetes could settle near the Proposed Action. The ACM and SWZ near the proposed docks generally lack the slack water environments required for ammocoete rearing, and the sediments in this area are mobile and lacking in the organic matter associated with suitable ammocoetes rearing habitat. The distribution of ammocoetes reported by Silver et al. (2007) indicates that ammocoetes may be transported through the area or migrate through the study area to suitable habitat downstream. Juvenile and adult lamprey may be present in the SWZ and DWZ during their respective migration periods (Table 3).

Nonfocus Fish

Other common native and introduced fish species are also expected to occur in the study area and are addressed more generically (Table 4). These are a mix of fish of interest because they are important food fish (harvested commercially and recreationally), game fish (harvested recreationally only), or on Washington's PHS list. Two of the species, mountain whitefish (*Prosopium williamsoni*) and leopard dace (*Rhinichthys falcutus*), are on Washington's PHS list as state candidate species. Both species are widely distributed in the Columbia and Fraser River basins. The other species in this group are important as commercial or recreational species. Most are abundant and widely distributed in the system, including several introduced species. Some are known predators of juvenile salmonid, such as largemouth bass, northern pikeminnow, smallmouth bass, striped bass, and walleye.

Table 4. Nonfocus Fish Species that Could Occur in the Study Area

Species	Reason for Interest	Native or Introduced
Channel catfish (*Ictalurus punctatus*)	WDFW game fish	I
Common carp (*Cyprinus carpio*)	WDFW food fish	I
Largemouth bass (*Micropterus salmoides*)	WDFW game fish	I
Leopard dace (*Rhinichthys falcutus*)	WDFW PHS	N
Mountain sucker (*Catostomus platyrhuchus*)	WDFW PHS, WDFW game fish	N
Mountain whitefish (*Prosopium williamsoni*)	WDFW game fish	N
Northern pikeminnow (*Ptychocheilus oregonensis*)	WDFW game fish	N
Peamouth (*Mylocheilus caurinus*)	WDFW game fish	N
Perch (family Percidae)	WDFW game fish	I
Shad (subfamily Alosinae)	WDFW food fish	I
Smallmouth bass (*Micropterus dolomieu*)	WDFW game fish	I
Suckers (family Catostomidae)	WDFW game fish	N
Sunfish (family Centrarchidae)	WDFW game fish	I
Striped bass (*Morone saxatilis*)	WDFW game fish	I
Walleye (*Sander vitreus*)	WDFW game fish	I

Notes:
Source: Grette 2014b.
WDFW = Washington Department of Fish and Wildlife; PHS = Priority Habitats and Species

2.2.2.4 Commercial, Tribal, and Recreational Fishing

Commercial, tribal, and recreational fisheries in the lower Columbia River are managed by the states of Washington and Oregon and tribes, subject to the terms of the 2008-2017 *United States v. Oregon* Management Agreement (Management Agreement). The Management Agreement establishes tribal harvest allocations and upholds the right of tribes to fish for salmon in their usual and accustomed fishing grounds. Commercial fisheries in these waters are managed under the Columbia River Compact, a congressionally mandated process that adopts seasons and rules for Columbia River commercial fisheries (National Marine Fisheries Service 2015). Tribal fish resources are discussed in the Final EIS (Volume I).

In Washington, commercial fishing seasons and rules are established by the Columbia River Compact, which comprises the Washington and Oregon Departments of Fish and Wildlife Directors, or their delegates, acting on behalf of the Oregon and Washington Fish and Wildlife Commission. The Columbia River Compact is charged by congressional and statutory authority to adopt seasons and rules for Columbia River commercial fishers. When addressing commercial seasons for salmon, steelhead and sturgeon, the Columbia River Compact must consider the effect of the commercial fishery on escapement, treaty rights, and sport fisheries, as well as the impact on species listed under the federal ESA. Although the Columbia River Compact has no authority to adopt sport fishing seasons or rules, it is their inherent responsibility to address the allocation of limited resources among users (National Marine Fisheries Service 2015).

In Washington State, recreational fishing seasons and rules are updated annually and presented in the Washington Sport Fishing Rules pamphlet. Sport fishing seasons are generally established from July 1 through June 30 of the following year. The pamphlet covers all fresh waters and marine waters in Washington State, including the lower Columbia River, and establishes the seasons and rules for recreational fishing for finfish and shellfish/seaweed.

Commercial and recreational fishers primarily target hatchery-produced salmon and steelhead, as well as sturgeon and other game fish.

2.2.2.5 Sediment and Water Quality Conditions

Sediment conditions in the study area are generally uniform with slight variations between aquatic habitat types. ACM sediments are primarily sand mixed with silt, SWZ sediments are primarily sand, and DWZ sediments are primarily silt mixed with sand (Grette 2014b). Sediments within the dredge prism meet sediment disposal guidelines and are considered clean by the U.S. Army Corps of Engineers (Corps), U.S. Environmental Protection Agency (EPA), and Ecology (U.S. Army Corps of Engineers Dredged Material Management Office 2010 in Grette 2014b). Recent sediment characterization indicates less than 0.2% organic matter in deep areas and typically less than 0.3% in shallow areas. Eulachon eggs usually settle into coarse sands and gravels in relatively deep water, while the shallow and DWZs are largely made up of silty river sand and therefore not considered high quality habitat for eulachon eggs.

The Lower Columbia River is listed as a Washington State 303(d) impaired water and is classified by Ecology as a Category 5 polluted water for dissolved oxygen, temperature, bacteria, dieldrin, polychlorinated biphenyls, 2,3,7,8 TCDD, and 4,4,4 DDE (Washington State Department of Ecology 2016). At the project area, the Columbia River is listed as 303(d) impaired for bacteria and temperature. Over the years, downstream salinity patterns have changed, but intrusion and salinity in the study area are generally similar to historical patterns. Turbidity in the study area is variable based on a number of factors. For example, over 5 days of water quality monitoring for dredging, background levels (upstream from active dredging) ranged from the mid-20s to the mid-60s nephelometric turbidity units (NTUs) at all water depths (U.S. Army Corps of Engineers Dredged Material Management Office 2010 in Grette 2014b). Water temperature in the study area ranges from low 40s to low 70s (°F), which is slightly warmer than historical values (Bottom et al. 2008). Salmonids typically move from habitat areas as temperatures approach 66°F, and the study area habitat within the ACM and upper SWZ likely reaches this threshold and may become unsuitable for juveniles salmonids in the summer months. Refer to the SEPA Water Quality Technical Report (ICF 2017c) for further information regarding water quality conditions near the project area.

2.2.2.6 Fish Predators

Several bird, mammal, and fish species present in the Columbia River estuary are known to prey on one or more of the focus fish species. For example, cormorants and Caspian terns are significant avian predators that are known to target juvenile salmonids and eulachon. Osprey and bald eagles are also known fish predators, capable of taking both juvenile and smaller adult salmonids. Steller and California sea lions are primary predators on adult fish, including salmon, steelhead, and sturgeon in the Lower Columbia River (National Marine Fisheries Service 2013). However, the study area does not currently or historically support sea lion congregations, and it is unknown whether terns congregate in these areas (Jefferies et al. 2000). Native and nonnative fish species, including northern pikeminnow, smallmouth bass, and walleye, are known to be significant predators on juvenile fish and are capable of exploiting habitats present in the study area. Specifically, pikeminnow and smallmouth bass are known to associate with shoreline and channel modifications like riprap armoring, revetments, and pile dikes, which provide suitable holding habitat for lie-inwait predation (Pribyl et al. 2004). In contrast, walleye use deeper, open water habitats but they are also known to associate with artificial and natural structures when they are present (Pribyl et al. 2004). The existing dock, pile dikes, and other shoreline and channel modifications are likely to provide suitable habitat for these predatory fish species.

2.2.2.7 Fish Stranding

A growing body of evidence indicates that juvenile salmon and other fish are at risk of stranding on wide, gently sloping beaches because of wakes generated by deep draft vessel passage (Bauersfeld 1977; Hinton and Emmett 1994; Pearson et al. 2006;, ENTRIX 2008). Depending on the slope and breadth of a beach, wakes from passing vessels can travel a considerable distance, carrying fish and depositing them on the beach where they are susceptible to stress, suffocation, and predation.

Pearson et al. (2006) published the most detailed study of Columbia River fish stranding completed to date. They evaluated stranding at three sites in the Lower Columbia River: Sauvie Island, Barlow Point (adjacent to the project area), and County Line Park. The sites were chosen because prior work had established them as sites with high risk of stranding (Bauersfield 1977). Pearson et al. (2006) observed 126 vessel passages, 46 of which caused stranding. They also measured numerous site variables such as fish density (measured via beach seining), site topography, river stage, current velocity, tidal stage, tidal height, and a variety of vessel variables including direction of movement, velocity, ship type, ship size, and displacement. From the study, certain sites appear to be more susceptible to stranding than others. For example, the highest occurrence of stranding was at Barlow Point, where 53% of the observed passages resulted in stranding. Stranding occurred less frequently at Sauvie Island (37% of the observed passages resulted in stranding) and County Line Park (15% of observed passages resulted in stranding) (Pearson et al. 2006). The Proposed Action would add 1,680 vessel transits to the Columbia River at full buildout (840 vessels transiting to and from the project area), which would introduce additional permanent risk of fish stranding in the Columbia River. It should be noted, however, that Barlow Point is directly downstream from the project area. Vessels would be slowing as they approach the docks and accelerating as they leave the docks, which could reduce the size of vessel wakes. Other sites downstream of Barlow Point would be susceptible to increased risk of fish stranding because of the vessels associated with the Proposed Action.

Chapter 3
Impacts

This chapter describes the impacts on fish and fish habitat that would result from construction and operation of the Proposed Action or the ongoing activities of the No-Action Alternative.

3.1 Proposed Action

The Applicant has identified the following design features and best management practices to be implemented as part of the Proposed Action. These were considered when evaluating potential impacts of the Proposed Action. Some or all of these measures may be terms and conditions of permits that would be issued for the project, should the project be permitted.

- The Applicant would design the trestle to be long and narrow, and at a height above the OHWM to minimize shading in the shallow water zone. From shore, the trestle would measure 24 feet in width for 700 feet, and 51 feet in width for the final 150 feet. The top of the deck would be +22 feet CRD and the bottom of the deck +19.5 feet CRD. Therefore, the bottom of the deck would be more than 8 feet above OHW. This design would minimize overall impacts in shallow water, including impacts on habitat connectivity along the shoreline.
- The Applicant would locate Docks 2 and 3 entirely in deepwater habitat to distance the structure and terminal activities from shallow water areas.
- The Applicant would install pile caps on all project-related piling to minimize perching/roosting opportunities for piscivorous birds on the trestle and docks.
- The Applicant would locate the berthing area at water depths of at least -20 feet CRD to avoid habitat conversion from shallow to deepwater during dredging.
- The Applicant would locate the berthing area in deepwater closer to the navigation channel to minimize the scope of future maintenance dredging.
- The Applicant would direct project lighting downward or at structures, and would incorporate shielding to avoid spillage of light into aquatic areas.
- The Applicant would include a pinpoint light source at the end of the shiploading boom, aimed straight down into the ship hold area to avoid a broader beam that could cause light spillage.
- The Applicant would remove the piles slowly to minimize sediment disturbance and turbidity in the water column.
- Prior to pile extraction, the Applicant would break the friction between the pile and substrate to minimize sediment disturbance.
- The Applicant would conduct impact pile-driving using a confined bubble curtain or similar sound attenuation system capable of achieving approximately 9 dB of sound attenuation.
- During pile removal and pile driving, the Applicant would place a containment boom around the perimeter of the work area to capture wood debris and other materials released into the waters

as a result of construction activities. The Applicant would collect all accumulated debris and dispose of it upland at an approved disposal site. The Applicant would deploy absorbent pads should any sheen be observed.

- The Applicant would provide a containment basin on the work surface on the barge deck or pier for piles and any sediment removed during pulling. The Applicant would dispose of any sediment collected in the containment basin at an appropriate upland facility, as with all components of the basin (e.g., straw bales, geotextile fabric) and all pile removed.
- Upon removal from substrate, the Applicant would move the pile expeditiously from the water into the containment basin. The Applicant would not shake, hose, strip, or scrape the pile, nor leave it hanging to drip or any other action intended to clean or remove adhering material from the pile.
- The Applicant would limit the impact of turbidity to a defined mixing zone and otherwise comply with WAC 173-201A.
- The Applicant would not stockpile dredged material on the river bottom surface.
- The Applicant would contain all dredged material in a barge prior to flow lane disposal; dredged material would not be stockpiled on the riverbed.
- During hydraulic dredging, the Applicant would not operate hydraulic pumps unless the dredge intake is within 3 feet of the bottom.
- The Applicant would remove any floating oil, sheen, or debris within the work area as necessary to prevent loss of materials from the site. The Applicant would be responsible for retrieval of any floating oil, sheen, or debris from the work area and any damages resulting from the loss.
- The Applicant would dispose materials to the flow lane using a bottom-dump barge or hopper dredge. These systems release material below the surface, minimizing surface turbidity.
- The Applicant would have a spill containment kit, including oil-absorbent materials, on site to be used in the event of a spill or if any oil product is observed in the water.
- The Applicant would not allow barges to ground out during construction.
- The Applicant would be required to retrieve any floating debris generated during construction using a skiff and a net. The Applicant would dispose of debris at an appropriate upland facility. If necessary, the Applicant would install a floating boom to collect any floated debris generated during in-water operations.
- The Applicant would not allow land-based construction equipment to enter any shoreline body of water except as authorized.
- The Applicant would store, handle, and use all fuel and chemicals in a fashion to ensure that they do not enter the water.

The following construction activities could affect fish.

- Permanent removal or temporary alteration of fish habitat and prey resources from dredging and pile installation.
- Noise impacts associated with pile driving.

- Shading of aquatic habitat from docks, construction equipment, and construction vessels.
- Spills and leaks from equipment or storage of potentially hazardous materials (i.e., fuel, hydraulic fluids, lubricants or other chemicals)

The following operation activities could affect fish or fish habitat.

- Shading of aquatic habitat from docks and vessels.
- Spills and leaks of potentially hazardous materials associated with operations (i.e., fuel, hydraulic fluids, lubricants, or other chemicals).
- Vessel-generated noise.
- Vessel-generated wakes resulting in fish stranding.
- Loss or impairment of fish and benthic habitat during maintenance dredging.
- Loss or impairment of fish and benthic habitat from coal dust deposition in aquatic environments.

Potential impacts on fish and fish habitat from the Proposed Action are described below.

3.1.1 Construction: Direct Impacts

Construction of the Proposed Action would occur on currently developed and disturbed lands and within the Columbia River. Potential construction impacts on fish and fish habitat would include permanent removal or temporary alteration of habitat, elevated underwater noise associated with pile driving, temporary overwater shading, and spills and leaks of hazardous material.

Temporarily Alter or Permanently Remove Aquatic Habitat

Construction would result in the alteration and removal of aquatic habitat in the Columbia River adjacent to the project area. Riparian vegetation at the project area is sparse and riparian habitat conditions are degraded. Project construction would not result in measurable impacts on riparian vegetation or habitat conditions at the project area.

Habitat in the Columbia River would be permanently altered and removed by the placement of piles. A total of 610 of the 630 36-inch-diameter steel piles required for the trestle and docks would be placed below the OHW mark (Millennium Bulk Terminals–Longview 2016), permanently removing an area equivalent to 0.10 acre (4,312 square feet) of benthic habitat. The majority of this habitat is located in DWZ (Grette 2014a). The placement of piles would displace benthic habitat, and the areas within each pile footprint would cease to contribute toward primary or secondary productivity. Individual pile footprints are relatively small (7.07 square feet) and are spaced throughout the dock and trestle footprint. Benthic, epibenthic (i.e. living at the water-substrate interface), or infaunal (i.e., beneath the surface of the river floor) organisms within the pile footprint at the time of pile driving would likely perish.

Creosote-treated piles would be removed from the deepest portions of two existing timber pile dikes. In total, approximately 225 lineal feet of the dikes would be removed. Overall, the removal of creosote-treated woodpiles from the Columbia River would be a beneficial impact, as any remaining creosote in those piles would be removed from the aquatic environment. However, removal of the piles could potentially result in temporary increases in suspended sediments, short-term contamination of water, and long-term contamination of sediments from creosote released during extraction. Creosote contains a mixture 200 to 250 compounds, with primary components composed of polycyclic aromatic hydrocarbons (PAHs) (Brooks 1995), which are known to be toxic to aquatic organisms including invertebrates and fish and can cause sublethal and lethal effects (Eisler 1987, Brooks 1995).

Creosote and associated chemicals are known to bioconcentrate in many aquatic invertebrates (Eisler 1987, Brooks 1995). This could expose higher trophic level species such as fish to creosote/PAH compounds through the food chain. Many vertebrates, including fish, however, metabolize PAHs and excrete them, reducing the potential risk to higher trophic level species (National Marine Fisheries Service 2009).

Most of the components of creosote are heavier than water and sink in the water column. PAHs from creosote accumulate in sediments and are likely to persist and degrade at the site of pile removal or wherever they settle after suspension (National Marine Fisheries Service 2009). However, PAHs from sediment are less bioavailable to aquatic species and thus these organisms are not likely to bioaccumulate PAHs from sediments (Brooks 1995).

Over the long term, the source of creosote would be removed or capped by the sediment falling into the hole left by the extracted pile. Water quality would improve over time; the concentration of creosote in the sediment would be expected to decrease, and the potential pathway of exposure for wildlife through contamination of prey would be reduced.

The in-water work windows would be defined by the permits that may be issued for the construction of the project. The in-water work windows presented here are consistent with WAC 220-110-206, which was repealed effective July 1, 2015 by Washington State Rule 15-02-029. No new in-water work windows have been defined and the project-specific in-water work periods would be defined during permitting. Dredging is proposed between August 1 and December 31, per the recently repealed WAC 220-110-206) and would permanently alter a 48-acre area of benthic habitat in the DWZ (below -20 feet CRD) by removing approximately 500,000 cubic yards of benthic sediment to achieve a water depth of -43 feet CRD, with a 2-foot overdredge allowance. Within the proposed dredge prism (i.e., extent of the area to be dredged), the amount of deepening would vary based on existing depths, from no removal up to approximately 16 feet of removal. The majority of the area of the proposed dredge prism is at or below a depth of -31 feet CRD. Hydrodynamic modeling and sediment transport analysis performed by WorleyParson (2012) evaluated the potential effects that could result from dredging, sediment deposition, and maintenance dredging. Overall, WorleyParsons (2012) found that the accretion rate would be approximately 12,000 cubic yards per year within the dredge prism; however accretion rates could fluctuate significantly year-over-year based on flow conditions. Maintenance dredging would likely only be required on a multiyear basis, or following special extreme flow events (WorleyParsons 2012). The preferred method for disposing of dredge material is flow-lane disposal so those sediments are not removed from the river, but remain in the river and are transported and deposited in areas where they can provide habitat for benthic species and benthic dependent species. Thus dredged materials are expected to be disposed of within the flow lane, adjacent to the navigation channel, allowing these sediments to support the downstream sediment transport system (Grette 2014a, 2014c). This area would be located within an area of approximately 80 to 110 acres between approximately river mile 60 and river mile 66. However, it could be that some or all of the dredged materials could be used for preloading of the stockpile pads and then disposed of at an appropriate off-site upland facility. Specific disposal methods for dredged materials would be determined during permitting and federal ESA Section 7 consultation.

Much of the scientific literature evaluating the effects of turbidity on fish is discussed in relation to turbidity concentrations associated with dredging. The dredging that would occur for the Proposed Action would remove approximately 500,000 cubic yards of sediments, and temporary increases in turbidity associated with other related activities (e.g., pile driving and pile dike removal) would generally be lower than those associated with larger dredging activities (i.e., dredging of the navigation channel). Several studies indicate that suspended sediment concentrations occurring near dredging activity do not cause gill damage in salmonids. Servizi and Martens (1992) found that gill damage was absent in under yearling coho salmon exposed to concentrations of suspended sediments lower than 3,143 milligrams per liter (mg/L). A negligible risk of gill tissue damage is also expected for adult and subadult salmonids exposed to turbidity generated by dredging activities because salmonids in these life stages are generally more tolerant of elevated suspended sediment levels (Stober et al. 1981) and are generally able to avoid localized areas of elevated turbidity associated with construction activities.

Suspended sediments have been shown to cause stress in salmonids but at concentrations higher than those typically measured during dredging. Subyearling coho salmon exposed to suspended sediment concentrations above 2,000 mg/L were physiologically stressed as indicated by elevated blood plasma cortisol levels (Redding et al. 1987). Although turbidity may cause stress to salmonid species, studies by Redding et al. (1987) found that relatively high suspended sediment loads (2,000–2,500 mg/L) did not appear to be severely stressful to yearling salmon.

Although it is difficult to determine exactly how much of a temporary increase in turbidity would result from the covered activities, increases in suspended sediments are expected to be relatively short term, occurring during in-water construction activities and maintenance dredging. Thus, in-water construction and maintenance activities would not result in chronic sediment delivery to adjacent waters because sediments would be disturbed only during in-water work. Construction related dredging is proposed to occur from August 1 through December 31, when many fish species would be present within the study area (Table 3). Impacts on water quality from dredging would be minimized with the preparation and implementation of a dredging plan in compliance with the dredged material management program as required by state agencies (Ecology and Washington State Department of Natural Resources) and federal agencies (Corps and EPA). Adhering to a plan developed in compliance with the dredged material management program would minimize but not eliminate, water-quality impacts, ensuring that potential impacts are temporary and localized in nature. No long-term changes in the baseline conditions in the study area would be expected to occur. It is assumed that dredging would occur between 7:00 a.m. and 10:00 p.m., Monday through Friday, per the Cowlitz County Code Chapter 10.25, which restricts construction noise to these hours, unless the activity is authorized by a valid conditional use permit, a SEPA determination, or a permit approval condition.

Those fish that are present in the construction area when the effects are manifest are likely to avoid the area until the effects dissipate. Carlson et al (2001) observed out-migrating salmon smolts moving in-shore when encountering either a dredge or discharge plume before resuming their prior distribution a short distance downstream. An evaluation of dredge disposal in the lower Columbia River found that white sturgeon may slightly shift habitat use toward disposal areas during disposal, possibly in response to prey items associated with dredged materials (Parsley et al. 2011). Hence, short-term, localized increases in turbidity associated with the Proposed Action dredging and dredge disposal activities would not likely result in significant physiological impacts on fish, their habitat, or their prey.

Behavioral effects related to increased turbidity are another consideration. Some of the documented behavioral effects of turbidity on fish include avoidance, disorientation, decreased reaction time, increased or decreased predation, and increased or decreased feeding activity. However, many fish species (especially estuarine species) have been documented to prefer higher levels of turbidity for cover from predators and for feeding strategies. For example, increased foraging rates for juvenile Chinook salmon were attributable to increase in cover provided by increased turbidity, while juvenile steelhead and coho salmon had reduced feeding activity and prey capture rates at relatively low turbidity levels. Juvenile Chinook salmon were also found to have reduced predator-avoidance recovery time after exposure to turbid water. (ECORP Consulting, Inc. 2009). Thus, while there may be some beneficial behavioral effects from increased turbidity, it is expected that for many of the focus fish species and native non-focus fish species behavior effects from increased turbidity would generally be negative.

The Proposed Action would permanently affect approximately 48 acres of benthic habitat due to dredging activities (i.e., removal of benthic habitat and benthic organisms) and construction of the docks (i.e., construction of new in-water structure and related shading of the aquatic environment). Water quality could be affected by coal dust. These potential impacts are discussed below. Other elements of these two PCEs, such as water quantity, natural cover, and salinity would not be impacted by the project.

Entrain Aquatic Organisms during Hydraulic Dredging

Fish, fish eggs, and fish larvae (i.e., eulachon eggs, lamprey ammocoetes) that occur within the dredge prism could become entrained during hydraulic dredging. It is assumed that adherence to the in-water work window for the Proposed Action, to be defined in permits issued for the Proposed Action, would be protective of the most vulnerable life-history stages for affected fish; however, some life-history stages could occur in the dredge prism year-round (i.e., lamprey ammocoetes). Thus, not all potential impacts associated with entrainment during hydraulic dredging would be avoided. Additionally, the in-water work window would not be defined until the Applicant obtains the necessary permits to construct the Proposed Action, and dredging would occur periodically over the life of the project. Proposed mitigation measures presented in the Final EIS (Volume I) would address impacts on all fish and life history stages.

The majority of benthic, epibenthic, and infaunal organisms within the proposed dredge prism would be removed and would perish during dredging. Recolonization by benthic, epibenthic, and infaunal organisms would be rapid, and disturbed habitats would return to reference conditions following recolonization by benthic organisms (McCabe et al. 1996). Typically, 30 to 45 days are required for benthic organisms to recolonize disturbed environments.

Increase Underwater Noise during Pile Driving

The following analysis is a summary of the Grette (2014a) evaluation of the potential impacts on fish from underwater noise generated during pile-driving activities. The Grette (2014a) analysis was reviewed and evaluated by ICF, and the approach taken for the analysis is consistent with the current approach for evaluating the effects of underwater noise on fish, specifically underwater noise generated by pile-driving activities.

Docks 2 and 3 and their associated trestle would be supported by 630 36-inch steel piles, 610 of which would be installed in aquatic areas below OHW. The Dock 2 and 3 structures would be located completely within DWZ habitat (below -20 feet CRD) and would comprise the majority of the pile to be installed. Each pile would be installed using a vibratory driver until it meets practical resistance, at which point an impact pile driver would be used to proof the pile and complete installation to the necessary weight-bearing capacity.

Most piles would be installed to a depth approximately 140 to 165 feet below the mudline to provide the necessary resistance to support the overwater structures (i.e., Docks 2 and 3, the ship loaders, and conveyors) (Grette 2014a) The duration of vibratory and impact pile driving required to install each pile would be dependent upon the depth at which higher density materials (e.g., volcanic ash or dense sand and gravels) are encountered; shallower resistance would require less vibratory and more impact driving, while deeper resistance would require more vibratory and less impact driving.

Sound generated by impact pile driving has the potential to affect fish in several ways, ranging from alteration of behavior to physical injury or mortality, depending on the intensity and characteristics of the sound, the distance and location of the fish in the water column relative to the sound source, the size and mass of the fish, and the fish's anatomical characteristics (Hastings and Popper 2005). Refer to the SEPA Noise and Vibration Technical Report (ICF and Wilson Ihrig 2017) for further information regarding noise and vibration.

Both peak sound pressure level (SPL) and sound exposure level (SEL) can affect fish hearing through auditory tissue damage or temporary shifts in sensitivity to sounds (referred to as a temporary threshold shift [TTS]). Exposure to very loud noise or loud noise for extended periods may result in permanent reductions in sensitivity or permanent threshold shifts (PTS). Generally TTS would occur at lower levels than those resulting in auditory tissue damage, which result in PTS. The effects of hearing loss in fish may relate to the fish's reduced fitness, which may increase the vulnerability to predators and/or result in a reduced ability to locate prey, inability to communicate, or inability to sense their physical environment (Hastings and Popper 2005). Popper et al. (2005) found fish experiencing TTS were able to recover from varying levels of TTS, including substantial TTS, in less than 18 hours post exposure. Meyers and Corwin (2008) reported evidence that fish can replace or repair sensory hair cells that have been damaged in both the inner ear and lateral line, indicating that fish may be able to recover from PTS over a period of days to weeks.

In June 2008, NMFS, USFWS, the U.S. Federal Highway Administration, and several state transportation agencies agreed to interim criteria intended to protect fish from underwater noise generated by pile driving during bridge construction and retrofitting (Fisheries Hydroacoustic Working Group 2008). In general, the interim criteria establish thresholds for injury and behavioral effects from pile-driving generated underwater noise. There are three criteria for injury related to underwater noise: the first is based on peak pressure levels of 206

dB_{PEAK}[4] for impulse-type noise (e.g., pile driving), and the other two are based on accumulated sound exposure levels (i.e., sound energy integrated over time), the first of which is 187 dB cumulative $_{SEL}$ [5]for fish greater than or equal to 2 grams (e.g., most juvenile salmon and trout), and the other is 183 dB cumulative $_{SEL}$ for fish less than 2 grams (e.g., larval lamprey). Underwater noise levels of 150 decibels root-mean-squared (dB_{RMS}) may cause behavioral effects in fish species, such as startle response, disruption of feeding, or avoidance of an area. Depending on site-specific conditions, construction timing, duration, and other factors, exposure to these levels may cause behavioral changes that result in potential injury (Washington State Department of Transportation 2015). Potential adverse behavioral affects include interruption of foraging activities, avoidance of feeding or spawning areas, or movement away from cover, impaired predator avoidance (Washington State Department of Transportation 2015).

This analysis assumes that in-water pile driving would occur over two proposed construction seasons. In order to accomplish impact pile driving during limited work windows, multiple pile-driving rigs are expected to be in use simultaneously on the same day. The simultaneous use of multiple rigs may reduce the total duration of pile driving sound as some overlap in active driving may occur.

Considering the large number of piles to be driven, and the potential for multiple rigs to operate simultaneously, this analysis assumes that vibratory and/or impact pile driving may occur continuously during each working day of the Applicant-proposed in-water construction window (September 1 through December 31). Local Ordinance (Cowlitz County Code: Chapter 10.25) restricts construction noise to the hours of 7 a.m. to 10 p.m. unless the activity is authorized by a valid conditional use permit, a SEPA determination, or a permit approval condition. Various underwater reference noise values were reviewed, in order to select the appropriate noise values that would likely be generated by pile-driving activities. Of the various reference pile data available (ICF Jones & Stokes and Illingworth and Rodkin 2009, Washington State Department of Transportation 2015), sound levels from the Columbia River Crossing (CRC) 48-inch diameter steel test piling (David Evans Associates 2011) were selected as reference levels for the 36-inch-diameter steel piling proposed for the analysis. Although the pilings were larger for the CRC project, the proximity of the two sites and the similar conditions (i.e., depth, currents, and substrates) are expected to be more comparable than more distant locations such as Puget Sound or areas of California, where other reference data has been obtained for 36-inch-diameter steel piling (Grette 2014a).

Substrate characteristics between the CRC site and the project area are relatively similar, and pile driving conditions and underwater noise levels generated are anticipated to be similar. The greatest per-pile levels for each type of sound (i.e., single strike at 217 dB_{PEAK}, 201 dB_{RMS}, and 185 dB_{SEL}) were selected. These values are generally greater than reference values recorded for 36-inch-diameter piling at various other locations, and thus represent the potential worst-case for noise levels generated during pile driving (Grette 2014a).

Further, the hydroacoustic monitoring conducted for the CRC test pile also tested the efficacy of both confined and unconfined bubble curtains for attenuation of underwater noise from pile driving (David Evans Associates 2011). For 48-inch-diameter steel piling, both confined and

[4] dB_{PEAK} is the instantaneous maximum overpressure or underpressure observed during each pulse. When evaluating potential injury impacts on fish, peak sound pressure (dB_{PEAK}) is often used.

[5] dB cumulative SEL is a metric for acoustic events and is often used as an indication of the energy does. SEL is calculated by summing the cumulative pressure squared (p^2), integrating over time, and normalizing to 1 second.

unconfined bubble curtains consistently attenuated sound levels by 10 dB or more, measured at a distance of 33 feet from the source. At another Washington State Department of Transportation project completed downstream at Puget Island, the confined bubble curtain attenuated sound levels by 13 dB (measured at 43 feet) after on-site modifications (Washington State Department of Transportation 2010). Thus, the assumption that sound values would be attenuated by 9 dB during use of a confined bubble curtain in this analysis is considered realistic, achievable, and likely conservative (Grette 2014a).

Both the NMFS and the USFWS are concerned with potential impacts of elevated underwater noise levels during pile driving on federally protected fish species, such as salmonids, green sturgeon, and eulachon. NMFS and the USFWS have developed standard thresholds for disturbance/behavioral changes and injury (Table 5). Sound at or above these thresholds is evaluated on a site- and project-specific basis to determine whether potential impacts could occur, and whether any impacts on individuals resulting from underwater noise generated by pile driving could occur. Injury threshold values typically result from impact pile driving, as opposed to vibratory pile driving because sound- or pressure-related injuries, such as barotraumas, are thought to result from the rapid rise times and fluxes in over- versus under-pressure during a pile strike (Grette 2014a).

Table 5. Underwater Sound-Level Thresholds for Endangered Species Act-Listed Fish

Species	Effect Type	Threshold
All Listed Fish[a]	Injury, cumulative sound (fish ≥2 grams): onset of TTS (auditory response), with onset of auditory tissue damage and nonauditory tissue damage with increasing cumulative sound	$187dB_{SELcum}$
	Injury, cumulative sound (fish <2 grams): similar to above, onset of nonauditory tissue damage occurs at lower sound levels with smaller fish	$183dB_{SELcum}$
	Injury, single strike: onset of TTS and auditory tissue damage from single strike	$206dB_{PEAK}$
	Behavioral Disruption	$150dB_{RMS}$

Notes:

[a] Injury thresholds are based on interim criteria that were developed for salmonids based on data specific to hearing generalists with swim bladders (Carlson et al. 2007). NMFS also applied these thresholds to other listed fish with swim bladders (e.g., green sturgeon) and sometimes conservatively to fish without swim bladders (e.g., eulachon). Injury descriptions are based on information summarized in Carlson et al. (2007).

TTS = temporary threshold shift; dB = decibel; SEL = sound exposure level; cum = cumulative; RMS = root mean square.

Source: Grette 2014a.

It is standard practice to use the Practical Spreading Loss model to evaluate the potential effects of pile driving and determine the distance at which sound associated with pile driving would attenuate to specific levels (i.e., effect thresholds), except where cumulative sound is being considered.

The Practical Spreading Loss model is defined as:

$$TL = 15 * \text{Log}\,(R_1/R_2)$$

where:

TL = Transmission Loss, the difference between SPLs in dBs at distances R_1 and R_2; also $SPL_2 – SPL_1$

R_1 = distance at which transmission loss is estimated

R_2 = distance from source at which sound is known or measured (typically 10m)

In order to solve for R_1, the distance required for SPLs to attenuate to a desired level (e.g., threshold or ambient condition) based on reference SPLs at a known distance (R_2, typically at 10m), the terms are rearranged as follows:

$$R_1 = R_2 * 10\text{^}(TL/15)$$

In this case, the Practical Spreading Loss model was used to solve for R_1 in order to calculate distance to injury (single strike, 206 dB_{PEAK}) and distance to disturbance (150 dB_{RMS}) for federally protected fish during impact pile driving (Grette 2014a).

In addition to thresholds for single pile strikes, NMFS has established injury thresholds for fish based on cumulative sound exposure to account for the potential effects of impact pile driving over the course of a workday. Cumulative sound exposure is calculated using the NMFS Stationary Fish model (available at http://www.wsdot.wa.gov/Environmental/Biology/BA/BAguidance.htm#noise) (Grette 2014a).

The Stationary Fish model requires the number of pile strikes over an entire workday to determine the potential cumulative injury for fish based on dB_{SEL}. However, NMFS incorporated the concept of "effective quiet" into the model, which assumes that sound cannot accumulate and contribute toward cumulative injury below 150 dB_{SEL}. Because of this, one can calculate the maximum distance possible for cumulative injury independent of pile strikes. This can be accomplished either using the Practical Spreading Loss model to determine the distance required to attenuate sound at the source to 150 dB_{SEL}, or by iteratively increasing the pile strikes in the Stationary Fish model until it returns a consistent (rather than increasing) distance value because it is basing the calculation on effective quiet (Grette 2014a).

Rather than predicting daily pile strikes (which are anticipated to be highly variable), the Stationary Fish model was used to determine the distance to cumulative injury based on effective quiet. The maximum distance of potential cumulative effects occurred at approximately 5,000 strikes for fish greater than or equal to 2 grams (threshold 187dB_{SELcum}) and at approximately 2,000 strikes for fish less than 2 grams (threshold 183 dB_{SELcum}). This represents a distance of 1,775 feet for both size classes (Grette 2014a).

The model predicts that impacts on fish would not increase for more than approximately 2,000 pile strikes in a day for fish less than 2 grams or 5,000 pile strikes in a day for larger fish. This is because additional pile strikes do not result in additional cumulative energy. Furthermore, this predicted cumulative injury area is a liberal estimate (the largest possible) of the potential injury area for fish based on the stationary fish model. This conservative approach protects fish because, should fewer pile strikes occur on any given day, the area of potentially injurious sound would be smaller. Because there is no assumed upper limit on pile strikes, this approach includes scenarios where multiple pile-driving rigs are used simultaneously on a single day.

NMFS currently assumes a 12-hour recovery period where fish are not exposed to sound from pile driving in order to reset daily accumulated $_{SEL}$ calculations (Stadler and Woodbury 2009). As is standard practice, this analysis assumes that this 12-hour recovery period of nonexposure would occur between pile driving work periods (i.e., 12-hour pile driving days) (Grette 2014a).

Distances to Injury and Disturbance Thresholds

The results of the practical spreading loss and stationary fish models using the reference levels for injury and disturbance are summarized in Table 6. Noise attenuation and fish movement models predicted that underwater noise thresholds would be exceeded, resulting in injury or behavior impacts, at distances ranging from 45 feet (single sound strike) to 3.92 miles (cumulative sound). The specific distances and effects for listed fish are provided in Table 6. Because the number of pile strikes per day would be variable, it was assumed that a minimum of 5,000 strikes would occur. Increasing pile strikes beyond 5,000 would not affect the distance at which thresholds would be exceeded for all federally protected fish. Predicted noise reduction using confined or unconfined bubble curtains or similar attenuation devices would be at least 9 dB, based on observations at the Columbia River Crossing (David Evans Associates 2011) and at Puget Island (Washington State Department of Transportation 2010).

Table 6. Underwater Noise Thresholds and Distances to Threshold Levels

Species	Effect Type	Threshold	Distance to Effect Threshold[a]
All Federally Protected Fish	Injury, cumulative sound (≥2 grams)	187 dB_{SEL}	1,775 feet[b]
	Injury, cumulative sound (<2 grams)	183 dB_{SEL}	1,775 feet[b,c]
	Injury, single strike	206 dB_{PEAK}	45 feet[d]
	Behavior	150 dB_{RMS}	3.92 miles

[a] Impact Pile Driver Operation, 36-inch steel pile with 9 dB attenuation from use of confined bubble curtain.

[b] This represents the point at which the model for distance to threshold for cumulative sound no longer increases with increased pile strikes. For 187 dB $_{SELcum}$ (fish ≥ 2 grams), this is at 5,003 strikes; for 187dB_{SELcum} (fish >2 grams), this is at 1,992 strikes. The concept of effective quiet makes the 1,775-foot distance applicable to both thresholds and therefore is applicable to fish both greater than and less than 2 grams.

[c] Given the Proposed Action location and adherence to the proposed in-water work window, most salmonids in the area during construction are assumed to be > 2 grams (187 dB_{SELcum} threshold), except possibly for very early subyearling chum salmon in December

[d] Because the distance to cumulative sound thresholds are greater than the distance to the single-strike sound threshold, this analysis follows the NMFS dual criteria guidance and moves forward solely considering the larger values.

Impact pile driving could occur from September 1 through December 31. To install 610 pilings in-water would require two years, based on the proposed in-water work window for impact pile driving. Pile driving would occur during working days, Monday through Friday. Each pile is expected to take between 20 and 120 minutes to set using an impact pile driver, depending on when the resistant layer is met during installation. The contractor would determine the sequencing of the pile driving and the overall number of driving rigs to be used; this analysis assumes that multiple pile-driving rigs may be used simultaneously. It is possible that impact pile driving could occur at any time, as permitted by Cowlitz County Code, during the proposed in-water work window for impact pile driving (September 1 through December 31), and that it could be continuous over some working days, particularly if multiple rigs are operating in areas of shallow practical resistance. However, given variable subsurface conditions, it is expected there would be days where periods of impact driving are shorter and/or intermittent throughout the workday. Pile-driving activities could affect federally protected salmon, steelhead and trout, eulachon and green sturgeon, as well as fish species that are not protected or listed.

3.1.1.1 Impacts on Salmon and Steelhead

Based on the proposed September 1 through December 31 in-water work window for impact pile driving, all life-history stages of the following ESUs/DPSs are expected to be absent from study area during this period:

- Snake River spring-/summer-run ESU Chinook salmon
- Upper Columbia River spring-run ESU Chinook salmon
- Snake River ESU sockeye salmon
- Upper Willamette River DPS steelhead

The potential for pile-driving activities to affect these species is considered negligible, and thus they are not considered further with respect to potential impacts from pile-driving activities.

Subadult and adult bull trout are occasionally observed within the Columbia River mainstem within the study area and could be present during any season. However, bull trout are expected to occur infrequently and in very low numbers relative to all other salmonids. The likelihood of bull trout presence at any given time is very low, and the potential for pile-driving activities to affect bull trout is considered negligible. According to USFWS (2002), bull trout in the Lower Columbia Recovery Unit could have migrated seasonally from tributaries downstream into the Columbia River to overwinter and feed. However, the extent to which bull trout in the Lower Columbia Recovery Unit currently use the mainstem Columbia River is unknown. Therefore, bull trout are not considered further with respect to potential impacts from pile-driving activities.

Federally protected adult and juvenile salmon and steelhead that could be present in the study area during the proposed in-water work windows include juvenile fish from five ESUs and adult fish from eight ESUs/DPSs, as summarized in Table 7.

Table 7. Summary of Salmonid ESUs/DPSs Potentially Present during the Impact Pile-Driving Proposed Work Window (September 1–December 31) by Life Stage, Month, and Habitat Zone

Species, ESU/DPS	Federal Status[a]	Life Stage	Sept			Oct			Nov			Dec		
			A[b]	S[b]	D[b]	A	S	D	A	S	D	A	S	D
Chinook Salmon														
Snake River fall-run ESU	T	Adults			X[c]			...						
		Subyr		...[d]	...		...	...		...	...			
Lower Columbia River ESU	T	Adults			X			X						
		Yrlng												...
		Subyr		...	...		...	...		...	...	...		
Upper Willamette River ESU	T	Yrlng												...
		Subyr		...	...		...	...		...	...	...		
Coho Salmon														
Lower Columbia River ESU	T	Adults			X			X			X			X
		Subyr		...			...			...		...	...	
Chum Salmon														
Columbia River ESU	T	Adults						X			X			
		Subyr										...	...	
Steelhead Trout														

Species, ESU/DPS	Federal Status[a]	Life Stage	Sept			Oct			Nov			Dec		
			A[b]	S[b]	D[b]	A	S	D	A	S	D	A	S	D
Snake River DPS	T	Adults			X			...						
Upper Columbia River DPS	T	Adults			X			...						
Middle Columbia River DPS	T	Adults			X			...[e]						
Lower Columbia River DPS	T	Adults			X			X			X			X

[a] "T" denotes federally threatened (no Endangered in this table).
[b] A, S, and D represent the HEA habitat categories of ACM, SWZ, and DWZ; see Grette (2014b) for additional information.
[c] "X" denotes expected presence; see Grette Associates (2014b) for additional information.
[d] "..." denotes expected presence but low relative abundance; see Grette Associates (2014b) for additional information.
[e] The Middle Columbia River DPS includes a very small proportion of winter-run fish (Klickitat River, Fifteen Mile Creek); because passage data at Bonneville Dam indicate that the vast majority of steelhead have passed the dam by early October, it is assumed that this includes winter steelhead spawning above it.
ESU = Evolutionary Significant Unit; DPS = Distinct Population Segment; Subyr = subyearling; Yrlng = yearling.

Affect Juvenile Chinook Salmon Habitat Use and Timing

The majority of juvenile Chinook from all ESUs out-migrate through the study area during the spring and summer or early fall. However, a relatively small number of subyearlings from ocean-type ESUs may be present in the SWZ and DWZ during some or all of the September 1 to December 31 proposed work window for impact pile driving (Table 7). Overall habitat use and timing for juvenile Chinook salmon is summarized as follows (Grette 2014a).

- Juvenile Chinook salmon from the Snake River fall-run ESU exhibit multiple rearing strategies, but the majority of juveniles outmigrate as yearlings or large subyearlings during a well-defined period between late spring and early fall. These fish move through the tidal freshwater region at a large size and occur primarily in deeper water rather than the shallow margin.

- Juvenile Chinook salmon from the Upper Willamette River ESU exhibit multiple rearing strategies, but the majority of juveniles outmigrate as yearlings or large subyearlings during a well-defined period in late winter and spring. These fish move through the tidal freshwater region at a large size and occur primarily in deeper water rather than the shallow margin.

- Juvenile Chinook salmon from the Lower Columbia River ESU are associated with multiple runs and are thus associated with multiple rearing strategies. However, the majority of juveniles from this ESU outmigrate either as spring-run yearlings during the late winter and spring or as fall-run fry and fingerlings between the late winter and early summer. Any late-season fall-run subyearlings are expected to outmigrate through the tidal freshwater region at a large size and occur primarily in deeper water rather than the shallow margin.

Subyearling coho salmon from the Lower Columbia River ESU and subyearling chum salmon from the Columbia River ESU are expected to occur in the estuary during the proposed in-water work window; however, presence of individuals would represent low relative abundance in comparison to annual outmigration periods for each ESU. Subyearling coho salmon present in the estuary between September and December would represent individuals moving amongst off-channel rearing areas. Any subyearling coho salmon present within the estuary are expected to overwinter in low-velocity tributaries or off-channel habitats prior to outmigrating the following spring as yearlings. Subyearling chum outmigrate soon after emergence and rear in the lower estuary. Any subyearling chum present in the river mainstem of the tidal freshwater region during the in-water work period would therefore be expected to move rapidly through the study area. Mainstem Columbia River habitats are considered to be used by juvenile salmon as a migratory corridor where presence in any given location is temporary and relatively short-term.

Cause Potential Injury to Juvenile Salmon

Because the distance to cumulative sound thresholds are greater than the distance to the single-strike sound threshold, this analysis follows the NMFS dual criteria guidance and moves forward solely considering the larger values. Sound above the potential cumulative injury threshold (183/187 dB_{SELcum}) may occur within 1,775 feet of impact pile driving (both upstream and downstream), for a maximum distance of 1.1 miles along the shoreline (1,775 feet upstream and downstream, along the 2,300-foot length of Docks 2 and 3 for a total distance 5,850 feet). This is approximately 0.44 square miles.

Approximately 21% (0.09 square mile) of this area is above -20 feet CRD, inclusive of the ACM and SWZ. This area provides relatively low-quality habitat for small (< 4 inches) subyearling salmon. Areas across the river and downstream provide greater (and more diverse) natural cover as well as floodplain connectivity, contributing to higher-quality critical habitat for rearing juvenile salmon.

Any subyearling salmon present in the 0.09-square-mile area during impact pile driving would be susceptible to sound-related injury due to cumulative exposure. The risk of injury for some individual smaller subyearling salmon is low based on relative abundance expected in the study area, but not discountable for the following salmon (in decreasing order of likelihood based on timing and relative abundance).

- Lower Columbia River Chinook salmon
- Upper Willamette River Chinook salmon
- Snake River fall-run Chinook salmon
- Lower Columbia River coho salmon
- Columbia River chum salmon

The mainstem Columbia River (Deep Water) comprises the remaining 79% of the aquatic area exposed to potentially injurious sound from impact pile driving. Any yearling or larger (> 4 inches) subyearling salmon present in this area would be susceptible to sound-related injury during pile driving due to cumulative exposure. The risk of injury for some individual yearling and larger subyearling salmon is low but not discountable for the following salmon (in decreasing order of likelihood based on timing and relative abundance).

- Lower Columbia River Chinook salmon (larger subyearlings and yearlings)
- Upper Willamette River Chinook salmon (larger subyearlings and yearlings)

- Snake River Fall-run Chinook salmon (larger subyearlings only)

It is possible that juvenile fish could leave areas of potentially injurious sound, either as an avoidance response or during the course of normal outmigration behavior, in which case they may not experience sufficient cumulative sound to cause injury.

Affect Adult Salmon Habitat Use and Timing

Adult from eight ESUs/DPSs of salmon and steelhead may migrate upstream through the study area within DWZ habitat during some or all of the proposed September 1–December 31 impact pile driving work window.

Adults from three of the eight ESUs/DPSs are expected to be in the Lower Columbia River each of the four months when pile-driving activities are anticipated to occur.

- Adult steelhead from the Lower Columbia River DPS migrate year-round (winter- and summer-run fish); therefore, individuals are expected to be present from September 1to December 31.
- Adult coho from the Lower Columbia River ESU could migrate through the tidal freshwater region from August through February and could be present from September 1 to December 31.
- Adult chum from the Columbia River ESU migrate through the tidal freshwater region during October and November, which is entirely within the September 1–December 31 period.
- Adults from the remaining five ESUs/DPSs are expected only in September and October.
- Lower Columbia River Chinook (fall-run component only)
- Snake River fall-run Chinook (in low abundance after September)
- Snake River steelhead (in low abundance after September)
- Upper Columbia River steelhead (in low abundance after September)
- Middle Columbia River steelhead (in low abundance after September)

Based on historical run-timing data from Bonneville Dam, 95% of adult Chinook and steelhead migrating upstream past the dam have done so by the end of the first week of October (inclusive of hatchery fish and nonlisted populations). For Chinook, typically 50% of adults have migrated past the Bonneville Dam by the end of August. For steelhead, that number is closer to 60%.

None of these ESUs/DPSs spawn in the mainstem of the river within the area of elevated sound (Table 6), adult salmonids do not forage in freshwater, and migrating fish are not expected to hold in this section of the river (versus holding near the confluence to a spawning tributary). Therefore, all migrating adult salmon and steelhead are expected to move quickly through the study area.

Migrating Chinook salmon in the Columbia River travel approximately 23 miles per day (median, from Keefer et al. 2004). Migrating steelhead in the Columbia River travel 19–25 miles per day in reaches not adjacent to spawning tributaries (English et al. 2006). Migration rates for coho and chum specific to the Columbia River are not available, but surrogates can be used to estimate them. As reviewed in Sandercock (1991), upstream migration rates for coho may be 0.8–1.7 miles per hour, which results in approximately 9–20 miles per day assuming fish actually migrated 12 hours in each day (see Sandercock 1991). Chum salmon in the Yukon River averaged migration rates of 23 miles per day (Buklis and Barton 1984). In general, Chinook, chum, and steelhead would be expected to travel most swiftly through this section of the river (approximately 23 miles per day), with coho travelling somewhat slower (approximately 9–20 miles per day).

Overall, the proportion of adults from each of the eight ESUs/DPSs that could be present during some or all of the impact pile-driving period would move through the study area rapidly. No adult is expected to hold within or occupy the study area for an extended period.

Cause Potential Injury to Adult Salmon

Based on habitat use and timing, adult salmonids potentially migrating through the tidal freshwater region during the proposed September through December impact pile-driving work window would include all of the adults from the Columbia River chum salmon ESU, many of the adults from the fall-run component of the Lower Columbia River Chinook salmon ESU, many of the adults from the Lower Columbia River coho salmon ESU, and some of the adults from the Snake River, Upper Columbia River, Middle Columbia River, and Lower Columbia River steelhead DPSs. These fish would be actively migrating upstream at an estimated rate of 9–22 miles per day. The relative amounts (all, many, some) are based on the proportion of the total migration period that occurs within the impact pile-driving period (September through December) for each ESU/DPS (Grette 2014a).

Active pile driving would not occur continuously (all hours, all days) between September 1 and December 31; therefore, not all of the adults migrating upstream during this time would experience sound from pile driving. However, those adult salmon and steelhead that do migrate through the study area during active pile driving could experience potentially injurious sound. Assuming fish were to travel through the entire area (as opposed to avoiding portions of it) this distance traveled would be between 0.67 and 1.1 miles, depending on whether driving occurred at closely or widely spaced locations. Based on the migration speeds reviewed above, adult fish migrating upstream could pass through these areas in approximately 20 to 90 minutes. It is therefore not discountable that some adult salmonids from these ESUs/DPSs could be susceptible to sound-related injury while actively migrating through the study area, depending on the actual duration of sound exposure and proximity to pile driving for individual fish (Grette 2014a).

Current NMFS guidance is to apply the 187dB_{SELcum} injury threshold to all salmonids greater than 2 grams; however, this is an overly conservative approach (see Carlson et al. 2007). Carlson et al. (2007) conclude that for fish greater than 200 grams (applicable to all adult salmonids considered in this assessment), the threshold for nonauditory tissue injury (including injuries resulting from rapid oscillations in gas-filled spaces) is 213 dB_{SELcum}. The conservative approach used to model sound in this assessment predicts 214 dB_{SELcum} at 10 meters from pile driving. Therefore, because cumulative sound above 214 dB_{SELcum} would be limited to such a small area, it is extremely unlikely that adult fish would experience enough sound to result in injury to nonauditory tissues. However, adult fish could be susceptible to auditory injury (hair cell damage) and hearing effects from TTS from cumulative sound exposure, should sufficient exposure occur (Grette 2014a).

Increase Potential Risk for Behavioral Effects on Salmon

As described in ICF Jones & Stokes and Illingworth and Rodkin (2009), 150 dB_{RMS} is a conservative threshold that is applied in most Biological Opinions to evaluate when impact pile driving/proofing could result in temporary behavioral responses in fish, which could in turn result in such effects as reduced predator avoidance and reduction in foraging efficiency. Also as described in ICF Jones & Stokes and Illingworth and Rodkin (2009), NMFS and USFWS do not provide scientific support for this threshold. Therefore, whether behavioral effects actually occur and then subsequently result in injury through behavioral changes or significant disruption of normal behavioral patterns must be evaluated on a project-specific basis dependent upon factors such as site characteristics, project details, and species life history and habitat use within the potential exposure area (Grette 2014a).

SPLs (not cumulative) may exceed the behavioral disturbance threshold of 150 dB_{RMS} up to 3.92 miles from the site during active pile driving. Underwater noise would only propagate into areas that are within line-of-site of the noise source; therefore, the area affected is less than 3.92 miles because islands and bends in the river prevent sound propagation beyond this distance. As mentioned previously, juvenile salmon from five ESUs and adult salmon and steelhead from eight ESUs/DPSs may migrate through the Columbia River adjacent to the project area during the impact pile-driving period (Table 6). However, juvenile and adult fish are expected to move through the study area relatively quickly as a function of active migratory behavior Grette 2014a).

Affect Nonlisted Salmon and Steelhead

Several nonlisted salmon ESUs and steelhead DPSs also migrate in the Columbia River through the study area and could be affected by pile-driving activities, similar to listed salmon and steelhead described previously. These include Chinook salmon from three ESUs (Deschutes River summer/fall-run, Middle Columbia River spring-run, and Upper Columbia River summer/fall-run), sockeye salmon from two ESUs (Okanogan River and Lake Wenatchee), as well as a number of artificial propagation programs (e.g., coho salmon re-introduction and/or hatchery programs established by member tribes of the Columbia River Inter-Tribal Fish Commission) (Grette 2014a).

During impact pile driving, adults and subyearlings from the Deschutes River summer-/fall-run and Upper Columbia River summer-/fall-run ESUs may be present in the study area, with timing and presence most similar to Snake River fall-run Chinook. Some adults are expected to be present in the study area during September, and adult migration through the area could continue into October. Subyearling fish may be present in very small numbers through November (Grette 2014a).

Presence, timing, and use of fish from artificial propagation programs are similar to listed ESUs by species and life-history types. Based on the timing and use summarized in Table 6, during impact pile driving, presence of some adults from these programs is expected; juveniles (subyearling and yearlings) are expected in relatively low numbers with variable timing and use by species and life history (Grette 2014a).

Based on similarities in presence, timing, and use, the analyses for listed salmonids can be generally applied to the nonlisted salmon and steelhead (Grette 2014a).

3.1.1.2 Impacts on Eulachon

The areas of potentially disturbing and injurious sound described previously for salmonids also can be applied to eulachon. However, because many of the cumulative injuries associated with underwater sound are related to the interaction between SPLs and a fish's swim bladder, the application of the cumulative injury threshold to eulachon is conservative (and therefore protective) as eulachon lack a swim bladder. As described above, the distances to thresholds are 1,775 feet for cumulative injury and 3.92 miles for disturbance. Impact driving would likely occur on most working days (Monday through Friday) within the proposed in-water work window (September 1–December 31). On some days impact driving may occur over most or even all of the day, but during much of the construction period, it would be for shorter durations and at times may be discontinuous (Grette 2014a).

Adult eulachon could arrive in the study area as early as November, although most adults would migrate through the study area later, coincident with peak spawn timing between February and March. Eggs from early spawners could be distributed from the tributaries downstream to portions of the study area where suitable incubation conditions occur (i.e., sand waves) shortly thereafter. Emergent larvae could be present in the study area as early as December. However, based on the timing of peak spawning, and because incubation occurs for one to two months, peak larval transport would not be expected until February or later (Grette 2014a).

Little information exists upon which to base assumptions about eulachon habitat use within the area of potentially elevated sound, such as preferential depths and migration behavior versus spawning for adults. Therefore, in order to present a conservative evaluation that is protective of the species, it is assumed that adult eulachon may be distributed anywhere throughout this area, and that not all adult fish are actively migrating through it. It is also assumed that eggs and incubating larvae, whether spawned in the area or delivered from upstream locations, may be distributed throughout areas where sand wave bed forms occur. As reviewed in Gustafson et al. (2010), larvae in the water column are quickly transported downstream and therefore are assumed to be moving with the current (Grette 2014a).

Cause Potential Injury to Eulachon

The area of potentially injurious sound is assumed the same as that delineated for salmon and steelhead (1,775 feet from pile-driving activities, which would include an area covering approximately 0.44 square mile). Any adult eulachon present during pile driving would be at risk of sound-related injury. Although the risk of injury to individual fish is low, based on relative abundance in the study area during pile-driving activities (Table 3), it is not discountable. Some fish may be moving through the area, reducing their risk of exposure to cumulative sound injury, or adult fish could leave and/or avoid areas of potentially injurious sound, as part of an avoidance response or during the course of normal behavior, in which case they may not experience sufficient cumulative sound to cause injury. However, some adult eulachon present in the area of impact may experience cumulative injury from pile driving in November and December. Nevertheless, based on the timing of adult returns to the Columbia River, this would probably be a very low number of fish relative to the entire annual eulachon run.

Eulachon eggs and larvae could experience sound that is potentially injurious for adult and juvenile fish, but based on the proposed timing for impact pile driving this would be an extremely low proportion of eggs and larvae produced in any given spawning year. Further, it is not appropriate to apply the same thresholds to larval fish and eggs. There is little information available on the effects of sound in general on fish eggs and larvae (Popper and Hastings 2009), and almost nothing specific to the effect of sound from pile driving (Bolle et al. 2012). As reviewed by Popper and Hastings (2009), there is some indication in the literature that sound (e.g., broadband noise) or sound pressure (e.g., blasts or even mechanical simulations such as drops) can affect egg, embryo, and larval survival and development. Because eulachon eggs adhere to sediments and therefore stay within or move slowly through areas of elevated sound, they may be more susceptible to prolonged exposure to cumulative sound from pile driving regardless of the distance at which injury may occur. Larvae are more likely to be transported quickly through areas of elevated sound, and may therefore be less susceptible to any cumulative effects. Common sole (*Solea solea*) larvae exposed to cumulative sound in excess of the standard injury threshold exhibited no increase in mortality (Bolle et al. 2012). The risk of injury generally applies to the earliest part of the run, and over a relatively small area of the potential incubation and migration area (Grette 2014a).

Increase Potential Risk for Behavioral Effects on Eulachon

Potentially disturbing sound from impact pile driving may extend up to 3.92 miles from the project area during active pile driving; this represents an approximately three square-mile area within which adult eulachon could be affected. As indicated previously, little is known about the behavioral effects of pile driving sound on fish, but it is possible that adult eulachon present in this area could be at greater risk of predation because of underwater sound generated during pile-driving activities. This risk is low but not discountable for adult eulachon (Grette 2014a).

Similar to injury thresholds, it is not appropriate to apply the behavioral threshold to larval eulachon, particularly given the paucity of information of the effects of sound in general, and from pile driving specifically. Should sound from impact pile driving affect these fish at any distance from the project area, active behavioral responses would not be expected based upon their small size and weak swimming behavior (Grette 2014a).

3.1.1.3 Impacts on Green and White Sturgeon

The areas of potentially disturbing and injurious sound described for salmonids can be applied to green and white sturgeon, which also have a swim bladder. Based on the calculations and assumptions described for salmonids, including the maximum pile strike assumptions in the cumulative sound model and use of an attenuation device, the distances to thresholds are 1,775 feet for cumulative injury and 3.92 miles for disturbance (Figure 4).

To minimize the potential for impacts on other fish, impact pile driving would occur between September 1 and December 31. Based on this timing, it is expected that some green sturgeon may be present in the Lower Columbia River during the early part of the work period but that numbers of fish would decline thereafter as they leave the estuary to winter in the Pacific Ocean. White sturgeon are expected to be present throughout the work period. When present in the Columbia River, green sturgeon are known to occur as far upstream as Bonneville Dam but are predominately present below river mile 37 (Adams et al. 2002). The project area is at river mile 63. Therefore, while some green sturgeon may be generally present within the area of potentially elevated sound, it is expected that their number would be small. There is a relatively low likelihood of these fish being present in the area of potentially elevated sound during the summer, and that likelihood would further decline throughout the pile-driving period.

White sturgeon, on the other hand, are found throughout the lower Columbia River and are expected to be within the study area during pile driving activities.

Cause Potential Injury to Green and White Sturgeon Threshold

Green sturgeon have been observed swimming at speeds of 1.3–3.9 feet per second in tidal environments in the San Francisco Bay estuary (Kelly and Klimley 2012). White sturgeon are assumed to have similar swimming speeds as green sturgeon. Based on this swimming speed, Southern DPS green sturgeon and white sturgeon would pass through areas of potentially elevated sound within 20 and 75 minutes, depending on speed and distance, and some green and white sturgeon could be susceptible to sound-related injury while actively migrating through the study area. However, given the low number of green sturgeon expected to use areas upstream of the study area and the proposed timing for pile driving, this is expected to be a very low proportion of the Southern DPS green sturgeon using the Columbia River in any given year. White sturgeon are expected to be more abundant and would be likely to occur within the study area throughout the proposed timing for pile driving.

Application of the $187dB_{SELcum}$ injury threshold to fish > 200 grams is an overly conservative approach (see Carlson et al. 2007). As with salmonids, adult and subadult green and white sturgeon at this location would be expected to be > 200 grams and are expected to have a much higher threshold for nonauditory tissue injury. It is extremely unlikely that subadult or adult green and white sturgeon would experience cumulative sound sufficient to result in injury to nonauditory tissues. However, they could be susceptible to auditory injury (hair cell damage) and hearing effects from TTS from cumulative sound exposure, should sufficient exposure occur (Grette 2014a).

Increase Potential Risk of Behavioral Effects on Green and White Sturgeon

Potentially disturbing sound from impact pile driving may extend up to 3.92 miles from the project area. Adult or subadult Southern DPS green sturgeon may move downstream through this area, particularly early in the in-water work period. White sturgeon may occur within the study area and may be moving upstream or downstream. Using the same analysis of distances and swimming speeds, those fish would pass through the study area in less than one day but could experience potentially disturbing sound from pile driving during this migration period. However, the risk that individual adult and subadult green and white sturgeon would experience elevated sound and potentially be at greater risk of predation is considered low (Grette 2014a).

Mitigation measures address impacts on all fish caused by increased underwater noise during pile driving.

3.1.1.4 Impacts on Pacific Lamprey and River Lamprey

It is well documented that hydroacoustic impacts can be significant, causing injury or mortality, for fish with swim bladders. Lampreys do not have swim bladders and it is therefore difficult to determine the extent of this impact. Fish without swim bladders are thought to be at lower risk from underwater noise than fishes with swim bladders (Hastings and Popper 2005 in Lord 2011). No thresholds for disturbance or injury have been established for such fish. Therefore, hydroacoustic impacts on lamprey should not be discounted, but they cannot be quantified or analyzed with any level of certainty (Lord 2011). Impacts on lampreys from project related pile driving would be expected to be less harmful than impacts on salmon and sturgeon and other fish species with swim bladders.

Increase Shading

Overwater structures (i.e., docks and large vessels) can increase shading to the aquatic environment beneath and adjacent to the structure, which can result in changes to productivity as well as fish behavior, predation, and migration. Barges necessary for construction of in-water elements of the Proposed Action would create temporary overwater structure, which would reduce the amount of light entering the water. This temporary reduction in light level is not anticipated to result in changes to aquatic habitat conditions and, therefore, would not change the ambient light in the environment.

Juvenile and subadult salmonids use the nearshore areas for feeding and rearing, and as a migratory corridor. As small individuals, they stay in shallow waters to avoid large fish predators found in deeper water. As these fish grow larger, they will feed on the forage fish, such as herring (family Clupeidae), sand lance (family Ammodytidae), and surf smelt (*Hypomesus pretiosus*), that spawn and rear in shallow intertidal areas.

The use of a barge or other similar large vessel could affect juvenile and subadult salmonid migration within the shallow water habitat areas. However, their use would primarily be during the in-water construction period (September 1–December 31) and would be mostly required for installation of support piling for Docks 2 and 3. Pile-driving activities would be expected to be much more disruptive to fish than the shading created by construction-related barges and vessels, and would likely affect migration and foraging opportunities within the study area to a greater extent (i.e., fish migrating within the study area would not be expected to be near construction barges during pile driving due to the elevated noise levels, thus fish would not be expected to be affected by shading associated with construction barges). Barges and similar large vessels may also be used for construction of Docks 2 and 3, which could occur outside of the proposed in-water window and thus could affect juvenile and subadult salmonid migration in the shallow-water habitat. However, specific timing and methods for construction of Docks 2 and 3 would be determined during permitting.

Result in Spills and Leaks

Construction activities would occur on land as well as in and over waters of the Columbia River. During all construction-related activities there is the potential risk of temporary water quality impacts resulting from the release of hazardous materials such as fuels, lubricants, hydraulic fluids, or other chemicals (SEPA Hazardous Materials Technical Report [ICF 2017d]). Overall, it is assumed that a spill would be less than 50 gallons because limited quantities of potentially hazardous materials would be stored and used during construction at the project area. These materials could enter surface waters of the Columbia River or drainage ditches near the project area. Such spills could affect aquatic habitat or fish that could be near the discharge point, resulting in potential toxic acute or subacute impacts that could affect the respiration, growth, or reproduction of the affected fish or other aquatic organisms. Over-water and in-water work increases this risk as well as the potential for construction debris or materials to enter the Columbia River. The potential for these types of impacts would be avoided or greatly reduced given protective measures to guard against these risks, including: construction best management practices, avoidance and minimization measures, in-water work restrictions, and regulatory requirements, such as those associated with 401 Water Quality Certification. The SEPA Water Quality Technical Report (ICF 2017c) includes a detailed discussion on the potential risks to and impacts on water quality associated with the Proposed Action.

3.1.2 Construction: Indirect Impacts

Construction of the Proposed Action would not result in indirect impacts on fish because construction impacts are immediate and no construction impacts would occur later in time or farther removed in distance than the direct impacts.

3.1.3 Operations: Direct Impacts

Operations associated with the Proposed Action would occur on land and on dock and trestle structures in the Columbia River. Potential direct impacts related to operation of the Proposed Action are discussed below.

Increase Shading

Overwater structures (i.e., docks and large vessels) can increase shading to the aquatic environment beneath and adjacent to the structure, which can result in changes to productivity as well as fish behavior, predation, and migration. The trestle would result in approximately 0.3 acre of new overwater coverage in shallow-water areas above -20 feet CRD (SWZ), while Docks 2 and 3 and a portion of the trestle would result in 4.83 acres of new overwater coverage in DWZ habitat below -20 feet CRD. Vessels loaded at Docks 2 and 3 during project operations would further increase the shading beyond Docks 2 and 3 in DWZ habitat. At full build out, the Applicant anticipates serving 70 vessels per month; thus, it is expected that there would be two vessels at Docks 2 and 3 at all times. The worst case would be two Panamax vessels being loaded simultaneously. Panamax vessels are approximately 965 feet in length with a beam of 106 feet, for an overall area of 102,290 square feet (2.35 acres). Two Panamax ships would add 204,580 square feet (4.7 acres) of overwater surface area located over DWZ habitat, for a total of 9.83 acres being shaded. The study area encompasses approximately 1,300 acres, primarily DWZ habitat. Docks 2 and 3 as well as vessels being loaded at the docks would shade approximately 0.8%. As mentioned above, juvenile salmonids tend to migrate in SWZ habitat; thus, shading of DWZ habitat would likely affect juvenile salmonids to a lesser extent than adults or larger juveniles that tend to migrate in DWZ habitat. Overall, shading of DWZ habitat would be less likely to affect primary productivity, as primary productivity tends to be higher in SWZ habitat. Based on the location of Docks 2 and 3 over DWZ habitat and the relatively small area shaded in relation to the overall study area, the shading impact would be relatively low.

As reviewed in Carrasquero (2001), light attenuation from overwater structures in freshwater environments can lead to lowered primary productivity (phytoplankton and macrophyte producers). Reduced primary productivity, including reduced stock of algae and macrophytes, can in turn influence the epibenthic community on which other organisms depend. Reduction of primary productivity in DWZ habitat would not likely translate to reductions of epibenthic communities, which are more prevalent in SWZ habitat.

Light attenuation could affect fish migration, prey capture, and predation. Salmon fry are known to use darkness and turbidity for refuge. However, they tend to migrate along the edges of shadows rather than penetrate them (Simenstad et al. 1999). Studies in the northwest have documented this behavioral tendency to use shadow edges for cover during migration (Shreffler and Moursund 1999). The underwater light environment also affects the ability of fishes such as bass, to see and capture their prey, including juvenile salmonids. Foraging opportunities for juvenile fish are generally associated with SWZ habitat (areas above -20 feet CRD), which are expected to provide greater availability of benthic organisms as compared to DWZ habitat (areas below -20 feet CRD). Juvenile salmon primarily migrate in SWZ habitat, although larger juveniles do migrate in DWZ habitat. Juveniles migrating in DWZ habitat are likely migrating relatively quickly and not rearing for extended periods in any particular area. The trestle is the only structure that would generate shade in SWZ habitat. The potential shading created by the trestle would be relatively low because the trestle is elevated over the water surface elevation of the ordinary high water mark (OHWM) by approximately eight feet, allowing light to penetrate beneath the trestle, which would not be expected to have a measurable effect on primary productivity or fish behavior, migration, or predation in SWZ habitat.

The design and orientation of the trestle would further minimize the potential effects of shading. The elevation of the trestle combined with the relatively narrow width of the deck (24 feet), the height, and the width would allow some natural light to pass beneath the structure during all seasons. In addition, the north–south orientation of the trestle relative to the path of the sun overhead would reduce the amount of shading cast beneath it, as compared to if the structure were oriented east to west.

The docks and vessels would be located over the DWZ, but could provide shaded habitat for larger predatory fishes, such as bass, northern pikeminnow, as well as piscivorous birds (Carrasquero 2001). Support piling for the docks could also create flow shears (i.e. back-eddies), which could increase the potential predation of juvenile salmonids and other fish migrating or otherwise occurring within the SWZ and DWZ (Carrasquero 2001). The extent or magnitude to which an increase in overwater surface area may alter the predator-prey relationship at the project area is unknown, but it is assumed that the relationship would change and an increase in predation would be likely. The extent or magnitude to which an increase in overwater surface area could alter the predator-prey relationship in the study area is unknown, but it is assumed that the relationship would change and an increase in predation could occur where larger subyearling, yearling, or larger juvenile fish encounter the docks in the DWZ. This likely would likely not apply to smaller subyearling fish when encountering the trestle as they migrate within the ACM and SWZ.

In addition to shading, Proposed Action-related features such as support piling, docks, and trestle could provide suitable habitat for piscivorous birds. The level of activity on the docks and trestle would likely reduce the potential for birds to use such features as roosting habitat (Grette 2014e). As part of the proposed design, the Applicant would install pile caps on all Proposed Action-related piling to minimize perching and roosting opportunities for piscivorous birds on the trestle and docks. Thus, the Proposed Action would not be expected to result in a measurable increase in predation of fish by piscivorous birds.

Result in Spills or Leaks

Routine operations could result in spills or leaks at the project area from vehicles, trains, or equipment that could potentially affect water quality and the condition of aquatic habitat in the Columbia River and drainage ditches in the vicinity. Overall, it is assumed that a spill would be less than 50 gallons because limited quantities of potentially hazardous materials would be stored and used during operations at the project area. Refueling of vehicles during operations would occur off site at approved refueling stations, or fuel would be delivered to the project area by a refueling truck (capacity of 3,000 to 4,000 gallons). Refueling trucks are required to carry appropriate spill response equipment, and are thereby prepared to respond and reduce the potential risk and impacts associated with a fuel spill. Vessel bunkering (i.e., a vessel receiving fuel while at the dock) would not occur at the project area. Thus, the risk of spills from vessel transfers in the project area would not increase. Potential impacts on fish and fish habitat are similar to those described for construction leaks and spills in Section 3.1.1, *Construction: Direct Impacts* Appropriate training and implementation of prevention and control measures would guard against these risks, greatly reducing the potential for these types of impacts. Further information is contained in the SEPA Water Quality Technical Report (ICF 2017c) and SEPA Hazardous Materials Technical Report (ICF 2017d).

Spill Coal

Direct impacts on the natural environment from a coal spill during operations of the Proposed Action could occur; however, local, state, and federal permit processes would require features and site design that would be expected to reduce coal spills. Direct impacts resulting from a spill during coal handling at the coal export terminal would most likely be minor because the amount of coal that could be spilled would be relatively small. Also, impacts would be minor because of the absence of aquatic environments in the project area and the contained nature and design features of the terminal (e.g., enclosed belt conveyors over water, transfer towers, and shiploaders). Potential physical and chemical effects of a coal release on the aquatic environments that occur adjacent to the terminal are described below.

Aquatic environments could potentially be affected from a coal spill both physically and chemically. A coal spill could have physical effects on aquatic environments, including abrasion, smothering, diminished photosynthesis, alteration of sediment texture and stability, reduced availability of light, temporary loss of habitat, and diminished respiration and feeding for aquatic organisms. The magnitude of these potential impacts would depend on the amount and size of coal particles suspended in the water, duration of coal exposure, and existing water clarity (Ahrens and Morrisey 2005). Therefore, the circumstances of a coal spill, the existing conditions of a particular aquatic environment (e.g., river shoreline, open water, pond, wetland), and the physical effects on aquatic organisms and habitat from a coal spill would vary. Similarly, cleanup of coal released into the aquatic environment could result in temporary impacts on habitat, such as smothering, altering sediment composition, temporary loss of habitat, and diminished respiration and feeding for aquatic organisms. The recovery time required for aquatic resources would depend on the amount of coal spill and the extent and duration of clean-up efforts, as well as the environment in which the incident occurred. It is unlikely that coal handling in the upland portions of the coal export terminal would result in a spill of coal that would affect the Columbia River. This is unlikely because the rail loop and stockpile areas would be contained, and other areas adjacent to the coal export terminal are separated from the Columbia River by an existing levee, which would prevent coal from being conveyed from upland areas adjacent to the rail loop to the Columbia River. Coal could be spilled during shiploading operations because of human error or equipment malfunction. However, such a spill would likely result in a limited release of coal into the environment due to safeguards to prevent such operational errors, such as start-up alarms, dock containment measures to contain spillage /rainfall/runoff, and enclosed shiploaders.

The chemical effects on fish, aquatic organisms, and habitats would depend on the circumstances of a coal spill and the existing conditions of a particular aquatic environment (e.g., shoreline, open water, pond, wetland). Some research suggests that physical effects are likely to be more harmful than the chemical effects (Ahrens and Morrisey 2005).

A recent coal train derailment and coal spill in Burnaby, British Columbia, in 2014, and subsequent cleanup and monitoring efforts provide some information about the potential impacts of coal spilled in the aquatic environment. Findings from spill response and cleanup found there were potentially minor impacts in the coal spill study area, and that these impacts were restricted to a localized area (Borealis Environmental Consulting 2015). Further information is provided under *Operations: Indirect Impacts.*

3.1.4 Operations: Indirect Impacts

Potential indirect impacts associated with proposed operations could occur as a result of vessel traffic in the Columbia River between the project area and the confluence with the Pacific Ocean. These potential impacts include fish stranding associated with vessel wakes. Periodic maintenance dredging could result in removal of benthic habitat and associated impacts on aquatic invertebrates. Also, coal dust could indirectly affect fish and fish habitat.

Cause Fish Stranding from Vessel Wakes

Ecology has monitored the number of vessel entries into the Columbia River of commercial cargo and passenger vessels of 300 gross tons or larger and tank vessels carrying oil products of all sizes since 1993. Over that period there has been about a 2% per year decline in the number of vessels crossing the Columbia River Bar (Figure 8). This is in part due the completion of the Columbia River Federal Navigation Channel Improvements Project, which dredged the Columbia River Ship Channel from near the entrance to the Port of Portland near river mile 106 to a depth of -43 feet CRD. This allowed the newer and larger Panamax and Handymax vessels to navigate the river and call at Columbia River ports, thereby reducing the number of smaller vessels navigating the Columbia River.

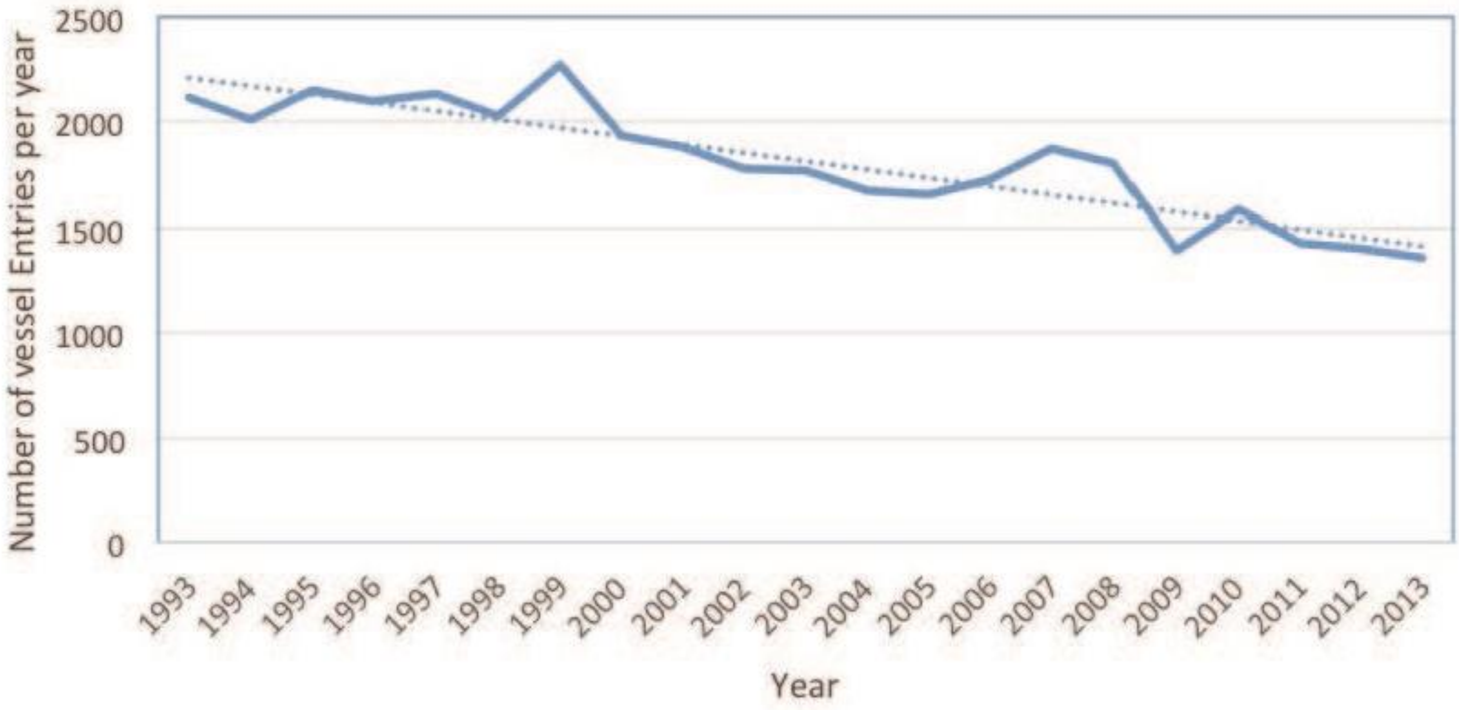
At full build out, the Proposed Action would have the capacity to serve up to 70 cargo vessels per month (840 vessels per year) with a throughput capacity of 44 million metric tons per year of coal. This would result in 1,680 vessel transits in the lower Columbia River (840 vessels each transiting to and from the project area).

The fleet serving the Proposed Action would consist of Panamax and Handymax vessels. Panamax vessels anticipated to use the export terminal average about 65,000 dead weight tons (dwt) and measure approximately 738 feet long by 105 feet wide with a draft of 43 feet. They are designed to fit snuggly but safely in the lock chambers of the Panama Canal. Handymax vessels are the workhorses of the dry bulk market. They are usually less than 60,000 dwt and measure approximately 490 to 655 feet long by 105 feet wide with a draft of 36 feet.

Depending on various factors such as the slope and breadth of a beach, river stage, tidal stage, depth of water vessels are transiting in, and vessel size and speed, wakes from passing vessels can travel a considerable distance. When these wakes meet the shoreline, they can carry fish and deposit them on the beach, potentially stranding them where they would be susceptible to stress, suffocation, and predation before they could return to the water.

Physical conditions affect the risk of fish stranding in the lower Columbia River caused by vessel wakes have been documented in several studies (Bauersfeld 1977; Hinton and Emmett 1994; Ackerman 2002; Pearson et al. 2006; Pearson and Skalski 2006). The physical conditions influencing the risk of fish stranding include gentle shoreline slopes (i.e., less than 5% slope), sandy substrate along the shoreline, confined river channel, proximity of the navigation channel to the shoreline, river tidal stage/elevation at the time of vessel passage, presence of a berm running parallel to the shoreline and shoreward of the 18-foot depth contour, and presence of shoreline features such as vegetation, riprap, bank faces, and debris.

Figure 8. Number of Vessels Entering the Columbia River per Year



Source: Washington Department of Ecology, "Vessel Entries and Transits for Washington Waters" Annual Reports for 1993-2013. Includes Cargo and passenger vessels equal to or greater than 300 gross tons and oil tank vessels of any size. Includes vessels entering the Columbia River destined for ports in Washington and Oregon.

Prior studies have evaluated the risk for stranding along different portions of the Columbia River (Pearson et al. 2008). Shorelines in the lower estuary (river miles 0 to 22) were determined to be too distant from the navigation channel to pose a stranding risk. Between river miles 22 and 104, approximately 33 of the 82 miles of shoreline pose a risk of fish stranding by ship wakes due to the shoreline being close to the navigation channel, not shielded from wave action, and having a beach slope of less than 10%. Of those 33 miles of shoreline approximately 8 miles have a high susceptibility for stranding based on the screening criteria (Pearson et al. 2008). Because Pearson's study considered only the physical conditions that contributed to the susceptibility of stranding along the shoreline in the lower Columbia River and not the abundance or distribution of fish, there was no attempt to quantify the potential extent of fish stranding in the lower Columbia River (Pearson et al. 2008).

The susceptibility of fish stranding by vessel wakes not only depends on physical conditions along the shoreline but also the presence of fish in the channel margins and nearshore areas adjacent to the shoreline. Subyearling Chinook salmon appear to be more susceptible to stranding, accounting for approximately 80% of the fish stranded by vessel wakes along the lower Columbia River (Hinton and Emmett 1994; Dawley et al. 1984; Pearson et al. 2006) while accounting for only 49% of fish captured in beach seine samples along the same shorelines (Pearson et al. 2006).

Studies indicate juvenile salmon and other fish are a/t risk of stranding on wide, gently sloping beaches because of wakes generated by deep draft vessel passage (Bauersfeld 1977; Hinton and Emmett 1994; Pearson et al. 2006; ENTRIX 2008).

In the lower Columbia River, the presence of fish in nearshore channel margin areas varies seasonally by species. However, fish are present year round in the lower Columbia River. Previous studies have found that fish also use different areas of the river, depending on age and life-history stage, and not all juvenile salmonids appear to be equally susceptible to stranding. The majority of strandings appear to affect subyearling Chinook salmon. Subyearling chum and coho salmon are also stranded but in much lower numbers than subyearling Chinook salmon. Other salmonids such as juvenile sockeye salmon, pink salmon, steelhead, yearling Chinook and coho salmon, do not appear to be as susceptible to vessel wake stranding based on their habitat use in the lower Columbia River (Grette Associates 2016). In general, subyearling Chinook salmon are present in the shallow river margin during winter, spring, and early summer but not during the late summer and fall. NMFS (2012) did not identify ship wake stranding from ship wakes as a limiting factor or threat to eulachon. Grette (2016) noted that "overall, eulachon are not expected to be susceptible or exposed to wake stranding risk in the lower Columbia River." This is supported by the fact that eulachon were not observed stranded or in beach seines conducted by Pearson et al. (2006, in Grette Associates 2016).

While the scientific literature generally acknowledges the connection between wakes generated by deep-draft vessels and fish stranding in the lower Columbia River, the literature has not identified methods to quantify the current level of stranding in the lower Columbia River, nor has a model been developed that could accurately predict the extent of stranding caused by deep-draft vessels in the lower Columbia River. Thus, while the Proposed Action would increase deep-draft vessel traffic in the lower Columbia River, which could contribute to an increase in fish stranding, it would be speculative to attempt to quantify fish stranding from vessels associated with the Proposed Action. SEPA Rules require the consideration of environmental impacts that are likely, not merely speculative (WAC 197-11-060). In accordance with this requirement, the EIS discloses the potential for impacts related to fish stranding due to vessel wakes, but does not quantify the potential impact because the worst-case scenario cannot be developed with any reasonable certainty (WAC 197-11-080-3(a)). While vessel operations in the lower Columbia River are federally regulated, the Applicant has no authority to control or influence vessel operations, either directly or indirectly.

Cause Physical or Behavioral Responses to Vessel Noise

Vessels transit the Columbia River each year carrying oil, freight, and materials to and from ports along the river. Approximately 3,980 commercial vessel transits occurred on the Columbia River in 2014, including approximately 2,750 by cargo and passenger vessels larger than 300 gross tons (Washington State Department of Ecology 2015). Hemmera Envirochem et al. (2014) measured sound pressure levels of one Panamax-class vessel passing Victoria on Vancouver Island, Canada, at a speed of 11.1 knots. Sound pressure levels measured were approximately 155 dB_{RMS} at 67 meters, decreasing to less than 150 dB_{RMS} at approximately 110 meters. These source sound levels exceed identified thresholds for potential behavioral disturbance for fish and may cause avoidance or other behavioral responses (Fisheries Hydroacoustic Working Group 2008). Fish near transiting vessels could change behavior in response to the vessel noise but would not likely be injured.

Result in Further Impacts during Maintenance Dredging

Maintenance dredging would likely only be scheduled to occur on a multi-year basis or following extreme flow conditions; however, such dredging could be needed as frequently as every year to maintain required water depths at Docks 2 and 3 and to allow access from the docks to the navigation channel, especially in the years following the initial dredging work (WorleyParsons 2012). Maintenance dredging would require additional permitting, beyond any permits that may be issued to construct the project. It is assumed that flow lane disposal would be the preferred method for disposal of dredge material, provided the sediments were clean.

Sediment accretion in the proposed dredge prism would most likely occur as a result of bedload transport due to river currents, and local scour and sediment redistribution from propeller wash. Hydrodynamic modeling and sediment transport analysis was conducted for the proposed Docks 2 and 3 berthing/navigation basin. Sedimentation is complex in a newly dredged basin. Specific morphologic data is unavailable for the proposed new dredging basin; therefore, the rate of accretion can only be estimated roughly. Based on current accretion estimates, rough estimates for annual accretion height is approximately 0.16 foot (0.07–0.26 foot range), and annual accretion volume is approximately 11,675 cubic yards (4,670–23,350 cubic yard range) (WorleyParsons 2012). WAC 220-660-160 provides general design considerations for new terminals, to minimize impacts fish life that the project would generally comply with, whenever feasible.

Impacts on the benthic invertebrate community would be similar to those described for initial dredging associated with construction activities. Compared to the initial dredging effort, maintenance dredging would remove a relatively small amount of material, including benthic, epibenthic, and infaunal organisms, resulting in some mortality of invertebrate organisms and temporary disruption of benthic productivity. Habitat within the proposed dredge prism is in

DWZ habitat where benthic productivity is expected to be relatively low compared to shallow water habitats (McCabe et al. 1997).

Maintenance-related dredging activities could affect fish in a manner similar to the initial dredging associated with construction activities. Fish could potentially be affected by increased turbidity and noise associated with dredging activities (Todd et al. 2014). Turbidity would be elevated during maintenance dredging and impacts would be similar to those described above for construction under Section 3.1.1, *Construction: Direct Impacts*. Noise could potentially cause masking and behavioral changes in fish but is unlikely to cause auditory damage (Central Dredging Association 2011; Dickerson et al. 2001; Todd et al. 2014).

Generate Coal Dust

Coal dust and fugitive coal particles could be generated by the Proposed Action through the movement of coal into and around the project area and onto vessels. Coal dust could also become airborne from the large stockpiles that would be located in the project area.

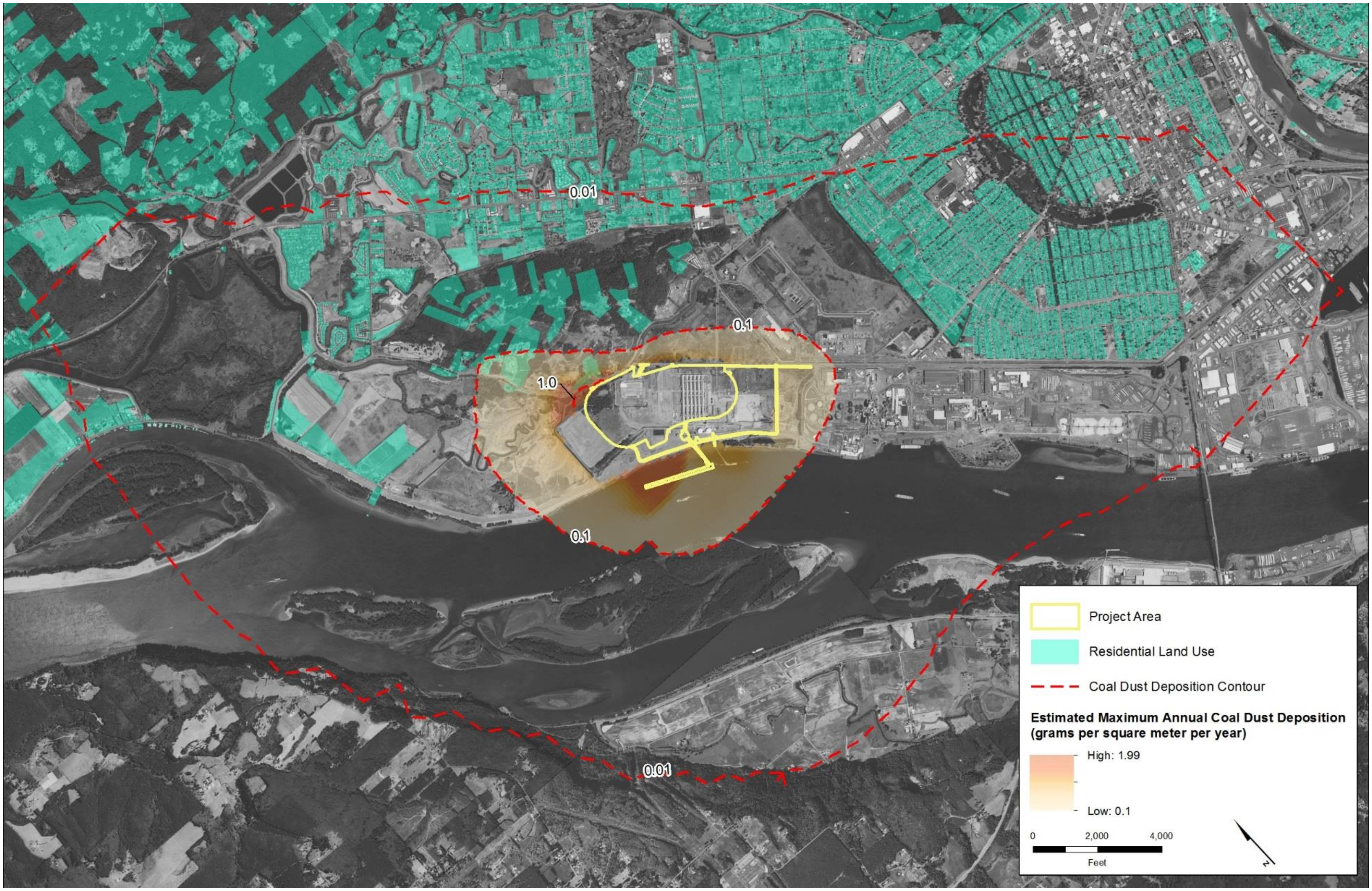
The potential extent and deposition rate of coal dust particles less than 75 microns was modeled as part of the analysis conducted relative to air quality and human health during the preparation of the Environmental Impact Statement (SEPA Air Quality Technical Report [ICF 2017e]) for additional details). Based on this modeling, the estimated maximum annual coal dust deposition at or beyond the project area would range from 1.99 grams per square meter per year (g/m^2) adjacent to the project area, to 0.01 g/m^2 per year approximately 2.4 miles from the project area, as described in the SEPA Coal Technical Report (ICF 2017f). Assuming a maximum deposition rate of 1.99 g/m^2 per year adjacent to the project area, and at the minimum flow[6] recorded over the 23-year period of record for 1 day, coal dust deposition directly into the river, assumed to be an area of approximately 3 million square meters (1.16 square miles) in the study area, would result in a change in suspended sediment concentration of less than 1 part per 10 billion (0.000075 mg/L).

Based on the models, the zone of deposition would extend primarily northwest of the project area and over the Columbia River, encompassing forested hills, riparian habitat along the shoreline, and extending across the Columbia River to Lord and Walker Islands. Deposition rates ranging from 0.4 g/m^2/year in the Columbia River adjacent to the project area to 0.1 g/m^2/year in the Columbia River at Lord Island (Figure 9), with declining concentrations moving away from the project area.

Although concerns regarding coal dust are commonly expressed relative to air quality and human health concerns, wind-born coal dust could potentially affect fish through physical or toxicological means. Ahrens and Morrisey (2005) conducted a literature review on the biological effects of unburnt coal in the marine environment. The following discussion is distilled from that review. Coal particles could affect aquatic wildlife in a manner comparable to any form of suspended particulates, such as tissue abrasion, smothering, obstruction, or damage to feeding or respiratory organs, and other effects resulting from reduced quantity or quality of light. Another potential manner in which coal could affect aquatic wildlife is through coal leachates. Unburnt coal can be a source of acidity, salinity, trace metals, hydrocarbons, chemical oxygen demand, and potentially macronutrients if they leach from the coal matrix into aquatic habitats.

[6] The minimum recorded flow at the Columbia at Beavery Army Terminal, Quincy, Oregon, is 65,600 cubic feet per second (1969 to 2014).

Figure 9. Modeled Average Annual Coal Dust Deposition



Toxic constituents of coal include PAHs and trace metals, which are present in coal in variable amounts and combinations dependent on the type of coal. The coal type, the mineral impurities in the coal, and environmental conditions determine whether these compounds can be leached from the coal. Some PAHs are known to be toxic to aquatic animals and humans.

Metals and PAHs could also potentially leach from coal to the pore water of sediments and be ingested by benthic-feeding organisms, providing a mechanism for subsequent ingestion by other organisms throughout the food chain. However, the low aqueous extractability and bioavailability of the contaminants minimizes the potentially toxic effects (Ahrens and Morrisey 2005). The type of coal anticipated to be exported from the Proposed Action is alkaline, low in sulfur and trace metals. Furthermore, because the Columbia River is a dynamic riverine system the constituents of the coal dust would be distributed and diluted to even lower concentrations as they are transported downstream.

Coal has a heterogeneous chemical composition and specific impacts related to its toxic contaminants are highly dependent on the specific coal composition and source (Ahrens and Morrisey 2005). The majority of coal transported to and from the project area would be from the Powder River Basin. A 2007 U.S. Geological Survey (USGS) report investigated the quality of coal from the Powder River Basin, including the concentrations of trace elements of environmental concern, which include antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, selenium, and uranium. According to the study conducted by the USGS (2007), trace elements of environmental concern (TEEC) are generally low in the Powder River Basin coals in comparison to other mining regions, although exact concentrations were not known at the time of this report. Table 8 presents the average concentrations of each TEEC sampled in parts per million. However, at a maximum coal deposition rate of 1.99 g/m^2/year, a coal density of 0.83 grams per cubic centimeter, and at the minimum flow recorded over the 23-year period of record for one day, TEEC deposition directly into the river assumed to be an area of approximately 3,000,000 square meters would result in a change in concentration for each of the elements of concern on the order of $1x10^{-13}$ to $1x10^{-15}$ g/L.

Table 8. Average Concentration of Trace Elements in Wyodak and Big George Coal Beds, Powder River Basin, Wyoming

Trace Element of Environmental Concern	Average Concentration in Sampled Coal (ppm)
Antimony	0.10
Arsenic	1.43
Beryllium	0.18
Cadmium	0.06
Chromium	2.63
Cobalt	1.93
Lead	1.26
Manganese	10.05
Nickel	1.58
Selenium	0.57
Uranium	0.46

Source: U.S. Geological Survey 2007.
ppm = parts per million

If coal dust generated at the project area accumulated without being disturbed throughout the summer dry season (assuming 120 days duration), the anticipated change in TEEC concentration for the minimum recorded flow over one day would be on the order of $1x10^{-10}$ to $1x10^{-12}$ g/L. Again, this change would not be measureable and is not anticipated to affect human health or affect aquatic organism functions (i.e., respiration, feeding).

The concentration of PAHs in Power River basin coal was not investigated for this report because PAHs are only released during combustion. Because the rate of coal dust deposition is so low it is likely unmeasurable and the concentration of trace elements of environmental concern are considered low, impacts on water quality are anticipated to be low.

Research suggests that the bioavailability of contaminants in coal is limited, and that at levels of coal contamination at which estimates of bioavailable concentrations of contaminants might give cause for concern, the acute physical effects are likely to be more harmful than the chemical effects (Ahrens and Morrisey 2005). However, the variable chemical properties of coal could conceivably result in contaminant mobility and enhanced bioavailability in the aquatic environment. Coal can be a source of acidity, salinity, trace metals, PAHs), and chemical oxygen demand (a measure of organic pollutants found in water). Interactions between coal and water could alter pH and salinity, release trace metals and PAHs, and increase chemical oxygen demand. However, if and how much these alterations occur in the aquatic environment and whether the alterations are significant enough to be potentially toxic to aquatic organisms depends on many factors, including the type of coal, the relative amount of time the coal is exposed to water, dilution, and buffering.

In summary, fugitive coal dust from project operations is not expected to increase suspended solids in the Columbia River to the point that there would be a demonstrable effect on fish distribution, abundance, survival, or acute physical effects. Additionally, the potential risk for exposure to toxic chemicals contained in coal (e.g., PAHs and trace metals), according to one study, would be relatively low because these chemicals tend to be bound in the matrix structure and not quickly or easily leached. Further, any coal particles would be transported downstream by the flow of the river and either carried out to sea or distributed over a broad area, further reducing the potential for adverse impacts on fish from suspended solids.

Affect Commercial and Recreational Fishing

Project-related increases in vessel traffic in the lower Columbia River and associated underwater noise could affect fishing in the study area. Increases in vessel traffic could cause behavioral responses, including quicker migration or avoidance of the navigation channel. The 70 large commercial vessels anticipated per month under the Proposed Action would be limited to the navigation channel. If adult fish targeted in commercial and recreational fishing were to alter behavior in response to underwater noise from vessels, they could avoid the navigation lanes or migrate quickly through them. Commercial and recreational fishing vessels in the navigational channel would be disrupted and need to move out of the navigation channel when large vessels are approaching or present. The Proposed Action would slightly affect commercial or recreational fishing access for fishing activities. The potential impacts of the Proposed Action on commercial and recreational fishing vessels are addressed in the SEPA Vessel Transportation Technical Report (ICF 2017g).

Coal Spill during Rail Transport

The potential indirect impacts of a coal spill during rail transport from a Proposed Action-related train are based on the likelihood of a Proposed Action-related train incident occurring and the consequences of an incident were it to occur. Final EIS Chapter 5, Section 5.2, *Rail Safety*, estimates the number of Proposed Action-related train incidents that could potentially occur during coal transport within Cowlitz County and Washington State. In Cowlitz County, the predicted number of loaded coal train incidents is approximately one every 2 years. The predicted number of loaded coal train incidents in Washington State is approximately five per year.

Not every incident of a loaded coal train would result in a rail car derailment or a coal spill. A train incident could involve one or multiple rail cars and could include derailment in certain circumstances. The size and speed of the train and the terrain at the location of the incident would influence whether the incident resulted in a coal spill that could affect fish. A broad range of spill sizes from a partial rail car to multiple rail cars could occur as a result of a Proposed Action-related train incident.

If an incident resulted in a coal spill, impacts on aquatic environments would depend on the location of the spill, the volume of the spill, and success of efforts to contain and clean up the spill. It is expected that coal spills in the terrestrial and built environments would be easier to contain and clean up than spills in an aquatic environment. Spills on land may have a quicker response time and cleanup in some locations due to their visibility and easier access for cleanup equipment, compared to spills into aquatic environments.

Research suggests that the bioavailability of contaminants in coal is limited, and that at levels of coal contamination at which estimates of bioavailable concentrations of contaminants might give cause for concern, the acute physical effects are likely to be more harmful than the chemical effects (Ahrens and Morrisey 2005). However, the variable chemical properties of coal could conceivably result in contaminant mobility and enhanced bioavailability in the aquatic environment. Coal can be a source of acidity, salinity, trace metals, PAHs, and chemical oxygen demand (a measure of organic pollutants found in water). Interactions between coal and water could alter pH and salinity, release trace metals and PAHs, and increase chemical oxygen demand. However, if and how much these alterations occur in the aquatic environment and whether the alterations are significant enough to be potentially toxic to aquatic organisms depends on many factors, including the type of coal, the relative amount of time the coal is exposed to water, dilution, and buffering.

The following summary of an aquatic impact assessment describes the derailment of a coal train in Burnaby, British Columbia in 2014, and subsequent cleanup and recovery of the spilled coal. Further information on the spill, efforts to recover the spilled coal, and monitoring results are provided here for context of the potential impacts of a coal spill from a train derailment.

On January 11, 2014, a Canadian Pacific train derailed in Burnaby, resulting in release of metallurgical[7] coal from three rail cars adjacent to and into Silver Creek, approximately 350 meters upstream of Burnaby Lake. Based on discussions with regulatory agencies, the rail company decided to follow a precautionary principle risk management approach, and remove

[7]The Proposed Action would handle subbituminous, or thermal coal from the Powder River Basin, which is different than metallurgical coal. Thermal coal is lower in carbon content and calorific value and higher in moisture.

the majority of the coal from the spill site. Coal was recovered between March 4 and April 2, 2014, using a vacuum-truck system and/or hand tools. Approximately 143 tons of mixed coal, organic matter, and mineral fines were removed.

The conclusions at the end of the monitoring completed as part of the aquatic impact assessment focused on four major elements: water quality, sediment quality, sediment and sediment leachate/porewater toxicity, and bioaccumulation potential. Monitoring locations were established upstream and downstream of coal recovery areas to provide a control/impact comparison. In situ and analytical water quality sampling was conducted between February 28 and April 1, 2014, prior to and during cleanup activities. Other monitoring efforts were completed on two dates, May 30/31 and April 2. (Borealis Environmental Consulting 2015).

The in situ water quality sampling between February 28 and April 1, 2014, focused on temperature, turbidity, conductivity, pH, dissolved oxygen, salinity, and oxidation-reduction potential. The analytical sampling program focused on the following parameters:

- Alkalinity
- Chloride
- Hardness
- Extractable Petroleum Hydrocarbons
- Nutrients (NH3, NO3, NO2, C)
- pH
- PAHs
- Sulfate
- Sulfide
- Total and dissolved metals
- Total and dissolved solids
- Total and suspended solids

Triton (2014, in Borealis Environmental Consulting 2015) compiled in situ and analytical data were compared with available Provincial and federal water quality guidelines for the protection of freshwater aquatic life. The resultant data indicated that sampled parameters were within applicable water quality guidelines, with some exceptions (e.g., that were not deemed to be spill related (CN 2014a, b, in Borealis Environmental Consulting 2015).

The intent of the monitoring for the aquatic impact assessment was to determine the potential agents of impact; where those impacts occur, whether chemicals in water and sediment occur at concentrations seemed to result in impacts, whether chemicals in water and sediment have adverse impacts on resident organisms, and whether those chemicals are taken up by organisms (bioaccumulation) over time.

For water quality, monitoring results indicated that water quality was deemed generally consistent with the British Columbia Ministry of Environment and/or the Canadian Council of Ministers of the Environment guidelines protective of aquatic life.

For sediment quality, site sediment concentrations of three metals (cadmium, copper, and nickel) and various PAHs (mainly downstream of the coal recovery area) exceeded both British Columbia and Canada freshwater sediment guidelines and background or reference area concentrations. The exceedance of site sediment concentrations of the three metals was only noted at one location, the Burnaby Lake reference site, which was located upstream of the spill area and not affected by the spill. No exceedances were noted in the exposed sites or the other reference location. These results support the assertion that the elevated levels of cadmium, copper, and nickel at the Burnaby Lake reference site must either be naturally occurring or originate from a source other than the coal spill.

Additional laboratory toxicity tests (of sediment samples) provided more specific information regarding the bioavailability of these parameters, and the potential for biological impacts. The bioaccumulation potential test results for invertebrates (i.e., represented by freshwater oligochaetes) conducted with Silver Creek/Burnaby Lake sediment samples, in comparison with both laboratory control samples and reference areas, indicate that PAHs present in specific, localized areas downstream of the derailment site have the slight potential to accumulate in benthic invertebrates resident in those areas. However, further mitigation of these sediments was not recommended, nor was additional study in the form of a Tier 2 assessment,[8] as it is not anticipated that higher tropic levels would experience any significant adverse effects, and there are unlikely to be impacts beyond the spatial extent assessed during the Aquatic Impact Assessment (i.e., downstream of the coal recovery area) (Borealis Environmental Consulting 2015).

For sediment and sediment porewater toxicity, test results for the fish, invertebrate, and algae tests conducted with Silver Creek/Burnaby Lake sediment samples in comparison with both laboratory control samples and reference areas indicate that samples were nontoxic to all species tested in most areas, with the exception of one monitoring site, at which samples yielded marginal but statistically significant effects on the survival of benthic macroinvertebrates (i.e., midges and amphipods). The results indicate that the sediments located approximately 160 meters downstream of the spill site have the potential to affect freshwater invertebrates, and that PAHs in sediments have a slight potential to bioaccumulate in benthic invertebrates. However, the results of the aquatic impact assessment indicate that, while there are potentially minor impacts restricted to a very small localized area, the coal in sediments post-recovery is of a low volume in relation to the volume of coal spilled and that these sediments should be left in place to undergo natural attenuation. Further mitigation of these sediments was not recommended (Borealis Environmental Consulting 2015).

3.2 No-Action Alternative

Under the No Action Alternative, the Applicant would not construct the Proposed Action. Current operations would continue, and the existing bulk product terminal would be expanded. Any expansion activities would not require a permit from the Corps or a shoreline permit; thus, no impacts on aquatic habitats would occur because of an expansion of the exiting bulk product terminal. New construction, demolition, or related activities to expand the bulk terminal could occur on previously developed upland portions of the project area. This could affect upland areas and habitats that do not provide suitable fish habitat.

It is assumed that growth in the region would continue, which would allow continued operation of the export terminal and the adjacent bulk terminal site within the 20-year analysis period (2018–2038). Cleanup activities, relative to past industrial uses, would continue to occur. This could affect developed areas and associated disturbed upland habitats. Vessel traffic is expected to continue and any fish disturbance or injury associated with vessel movements would continue at levels similar to

[8]The aquatic impact assessment included a Tier 1 assessment, which focused on risks to water and sediment quality, and resident aquatic biota in Silver Creek and Burnaby Lake. A Tier 2 assessment would have addressed any potential impacts on higher tropic levels (i.e., fish, birds, amphibians, reptiles) and aquatic habitats further downstream of Silver Creek and Burnaby Lake, but was not required or recommended.

current conditions; however, no additional measurable impact on fish or fish habitat would be expected to occur under the No Action Alternative because no in-water work would occur.

Chapter 4
Required Permits

The Proposed Action would require the following permits in relation to fish and fish habitat.

- **Shoreline Substantial Development and Conditional Use Permits**. Cowlitz County administers the Shoreline Management Act (SMA) through its Shoreline Management Master Program. The Proposed Action would have elements and impacts within SMA jurisdiction (CCC 19.20) and would thus require a Shoreline Substantial Development and Conditional Use permit from Cowlitz County and Ecology.
- **Critical Areas Permits**. The Proposed Action would require local permits related to impacts on regulated critical areas. CCC 19.15 regulates activities within and adjacent to critical areas and in so doing regulates fish and wildlife habitat conservation areas (including streams and their buffers), frequently flooded areas, and other sensitive areas. Cowlitz County would require an application for Planning Clearance, a Fill and Grade Permit, Building Permits, Shoreline Permit, Floodplain Permit, and Critical Area Permit, and would review the Environmental Impact Statements for consistency with the County's critical areas ordinance.
- **Construction and Development Permits—Cowlitz County.** The Proposed Action would require fill and grade permits (CCC 16.35) and construction permits (CCC 16.05) for clearing and grading and other ground disturbing activities, as well as construction of structures and facilities associated with the Proposed Action.
- **Clean Water Act Authorization.** Construction and implementation of the Proposed Action would result in impacts on waters of the United States, including wetlands. Because impacts would exceed 0.5 acre, Individual Authorization from the Corps under Section 404 of the Clean Water Act and appropriate compensatory mitigation for the acres and functions of the impacted wetlands would be required.

  An Individual Water Quality Certification from Ecology under Section 401 of the Clean Water Act and a National Pollution Discharge Elimination System permit under Section 402 of the Clean Water Act would also be required for construction of the Proposed Action. Additional details regarding the permitting process related to the Clean Water Act can be found in the SEPA Water Quality Technical Report (ICF 2017c).
- **Hydraulic Project Approval.** The Proposed Action would require a hydraulic project approval (HPA) from the WDFW due to project elements that would affect and cross the shoreline of the Columbia River. The HPA would consider effects on riparian and shoreline/bank vegetation in issuance and conditions of the permit, including for the installation of the proposed docks and pilings, as well as for interior culverts or other crossings of drainage features.

Chapter 5
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Appendix A

Restoration Projects in the Lower Columbia River Subbasin

Appendix A
Restoration Projects in the Lower Columbia River Subbasin

Table A-1 provides a list of restoration projects in the lower Columbia River subbasin, below Bonneville Dam, that have been completed. This list was provided to the Cowlitz County and the Washington State Department of Ecology by the Columbia River Estuary Partnership. The list provides the project name, location, and acres of restoration. Further information on these projects can be found on the Columbia River Estuary Partnership website (www.estuarypartnership.org).

Table A-1. Lower Columbia River Subbasin Restoration Projects

	Locational Information		Acreage
Project Name	**Latitude**	**Longitude**	**Restored**
Hamilton Creek Chum Channel	45.639100	-121.979000	7
Alder Creek Fish Passage Restoration	45.831900	-122.954000	
Buckmire Slough	45.704300	-122.726000	65
Columbia Slough Confluence Habitat Enhancement	45.642500	-122.766000	20
Duncan Creek Dam Fish Passage Restoration	45.615800	-122.041000	
Duncan Creek Chum Channel Restoration	45.613100	-122.051000	
Honeyman Creek	45.791900	-122.855000	58
Horsetail Creek	45.591900	-122.075000	96
John R Palensky (Burlington Bottoms)	45.639000	-122.825000	275
Lewis River Riparian Enhancements, Cowlitz Tribe	45.869000	-122.732000	1
Lewis River East Fork (La Center Wetlands Floodplain Rest.)	45.858500	-122.670000	453
Lewis River East Fork Floodplain Restoration - Clark Co	45.844200	-122.653000	10
Lower Washougal Delta Habitat Complexing	45.585000	-122.390000	
Scappoose Bay Malarkey Ranch	45.802200	-122.848000	
Stephens Creek	45.468800	-122.670000	
Mirror Lake - Young Creek Culvert Removal	45.545400	-122.207000	30
Mirror Lake Restoration	45.543100	-122.240000	27
Multnomah & Wahkeena Creeks- Benson Lake Site	45.578100	-122.126000	9
Ramsey Wetland Complex Off-Channel Habitat Design and Restoration	45.627300	-122.762000	3
Sandy River Delta Riparian Forest Restoration, Multiple Phases	45.555800	-122.377000	367
Sandy River Dam Breach	45.554700	-122.378000	51
Sandy River Delta Revegetation - BPA	45.558700	-122.381000	40
Sandy River Delta Revegetation - COE	45.565500	-122.383000	110
Sauvie Island North Unit CREST/PC Trask	45.821500	-122.811000	308
Scappoose Bay Hogan Ranch	45.802000	-122.830000	10
Scappoose Bottomlands Restoration	45.783300	-122.867000	30
Steigerwald NWR	45.567200	-122.308000	
Thousand Acres, Sandy River Delta Restoration	45.546600	-122.350000	75
Woods Landing/Columbia Springs	45.599000	-122.540000	

Project Name	Locational Information		Acreage Restored
	Latitude	Longitude	
Lower Willamette River Riparian and Wetland Enhancement	45.465500	-122.668000	30
Multnomah Channel Natural Area - Metro Site	45.685300	-122.870000	72
Tryon Creek Off Channel Habitat Enhancement	45.422500	-122.659000	4
Smith & Bybee Lakes	45.615800	-122.728000	22
Abernathy Creek Riparian Restoration	46.197600	-123.161000	84
Abernathy Creek Tidal Restoration	46.193400	-123.167000	22
Barrett Slough	46.136900	-123.868000	
Big Creek	46.165800	-123.593000	3
Brownsmead/Blind Slough	46.214600	-123.529000	20
Chinook River Diversion Habitat Reconnection	46.269400	-123.929000	
Chinook River WDFW Conservation & Restoration	46.301300	-123.959000	420
Crazy Johnson Creek Conservation	46.374800	-123.548000	
Crims Island Acquisition & Restoration	46.173200	-123.141000	190
Grays Bay - Crooked Creek Conservation	46.294900	-123.670000	
Grays Bay - Crooked Creek 2 Conservation & Restoration	46.297800	-123.668000	
Grays Bay - Deep River. Svensen's Landing Acq. & Rest.	46.316200	-123.701000	155
Grays Bay - Deep River Confluence Acquisition & Restoration	46.308500	-123.718000	
Grays Bay - Devils Elbow Phase 1 Acquisition	46.313000	-123.669000	
Grays Bay - Devils Elbow Non-AA Acquisition & Rest - Johnson Farm	46.314900	-123.673000	88
Dibblee Point	46.113000	-122.991000	18
Lower Elochoman Tidal - Thomas Properties Acquisition & Restoration	46.224500	-123.389000	305
Fort Clatsop - Colewart Creek	46.128700	-123.879000	46
Fort Columbia	46.257200	-123.925000	96
Germany Creek Acquisition & Restoration	46.193500	-123.126000	7
Gnat Creek Tidal Wetlands Restoration	46.187400	-123.533000	20
Gorley Springs, Grays R.	46.368100	-123.551000	
Green Slough	46.133200	-123.873000	
Hanson Creek	46.145000	-123.867000	
Haven Island	46.116500	-123.808000	75
Integrated Pest Management	46.194100	-123.647000	
Johnson Slough	46.114400	-123.872000	
Julia Butler Hansen NWR - Mainland Unit tidegate modifications	46.257800	-123.430000	110
Julia Butler Hansen NWR - Tenasilahe Island Water Circulation	46.238700	-123.462000	92
CSR Acquisition & Restoration	45.991000	-122.863000	
Grays Bay - Kandoll Farm Conservation & Restoration	46.323900	-123.653000	183
Karlson Island Restoration	46.206600	-123.600000	314
Knappton Cove Acquisition	46.283600	-123.800000	438
Larson Slough	46.121300	-123.875000	

Project Name	Locational Information		Acreage Restored
	Latitude	Longitude	
Lewis & Clark River Dike Breaches	46.093900	-123.849000	25
South Tongue Point (Liberty Lane)	46.188700	-123.753000	10
Lord - Walker Islands	46.137300	-123.031000	335
Louisiana Swamp	46.116200	-123.278000	35
Lower Kalama Delta habitat complexing	46.037500	-122.870000	5
Skamakowa Creek - Dead Slough Restoration	46.278900	-123.454000	
Meglar Creek	46.249300	-123.863000	2
Grays Bay - Mill Road Conservation & Restoration	46.319400	-123.657000	55
Nelson Creek Riparian Enhancement	46.239700	-123.379000	
NOAA Marine Debris Crab Pot Recovery	46.254900	-123.980000	
Otter Point	46.136400	-123.876000	33
Perkins Creek Restoration and Enhancement	46.129800	-123.914000	1
Puget Island	46.159000	-123.368000	
Kerry Island Acquisition & Restoration	46.126000	-123.356000	88
Grays Bay - Seal Creek Slough Acquisition	46.324700	-123.666000	
Grays Bay - Secret River Acquisition	46.311900	-123.691000	
Skipanon Slough, 8th St Dam Tidegate Restoration	46.158800	-123.926000	
Vera Slough	46.164200	-123.890000	
Walker Island Conservation	46.145900	-123.047000	
Wallacut River	46.319100	-124.011000	46
Walluski River Kerr Property	46.130200	-123.780000	35
Walluski River North, Elliot property #1	46.135100	-123.781000	55
Warren Slough	46.188500	-123.584000	
Willow Grove Acquisition & Restoration	46.171900	-123.039000	
Wolf Bay Acquisition & Restoration	46.170500	-123.693000	
Youngs/ Walluski confluence	46.149600	-123.811000	
Abernathy Creek Habitat Rest. and Riparian Protection	46.211000	-123.150000	
Coal Creek Slough	46.182700	-123.071000	
Conyers Creek	46.100400	-123.201000	
Columbia Estuary Environmental Ed Program	46.232600	-123.387000	3
Sharnelle Fee Property	46.093500	-123.766000	50
Trestle Bay Jetty Breach	46.219700	-123.994000	628
Grays Bay - Doumit Property	46.309100	-123.677000	
Crooked Creek Upstream	46.294600	-123.654000	
Batwater Station	46.166400	-123.125000	26
Eagle Island, Cowlitz Tribe LWD placement	45.938100	-122.684000	5
Hardy Creek Spawning and Rearing Channel	45.632400	-121.998000	
Scappoose Confluence Restoration	45.768900	-122.874000	4
BES/COE Sec 1135 Columbia Slough Restoration	45.577800	-122.632000	2
Birnie Creek Una Road Fish Passage	46.204600	-123.381000	
Eagle Island Acquisition	45.932300	-122.695000	
Brooks Slough	46.258500	-123.416000	
Clark's Dismal Nitch	46.250900	-123.865000	

Project Name	Locational Information		Acreage Restored
	Latitude	Longitude	
Clatskanie Bottoms - NAWCA	46.133300	-123.331000	200
Deer Island	45.963700	-122.839000	350
Duck Creek Bridge & Fish Passage	46.250200	-123.317000	
Grays Bay - Deep River. Campbell Acquisition	46.322000	-123.700000	
Grays PUD Bar	46.357800	-123.570000	5
Harborton Wetlands	45.616000	-122.797000	
John Day River Marsh	46.161200	-123.725000	
Lewis and Clark NWR preservation	46.209800	-123.641000	
Lewis River Preserve	45.816900	-122.611000	125
Lockwood Creek Recovery Enhancement	45.851500	-122.653000	9
Mason Creek Rearing Pool/Chum Channel Creation	45.833100	-122.631000	
McCarthy Creek	45.653900	-122.850000	235
Nelson Creek Doumit Property Conservation	46.237100	-123.389000	
Port of Astoria Warrenton Airport Dike Breach	46.156900	-123.863000	30
Ridgefield NWR re-vegetation	45.797000	-122.760000	240
Round Lake	45.743200	-122.854000	100
Ryan Point	45.613400	-122.618000	
Sandy Island Conservation	46.006600	-122.863000	
Sauvie Island NAWCA: Racetrack/Gay Lakes, Mudhen/Footbridge units	45.740000	-122.784000	315
Sauvie Island North Unit DU Wetlands Project	45.826900	-122.804000	400
Ridgefield NWR Bachelor Island	45.824400	-122.777000	678
Shillapoo Wildlife Area	45.698900	-122.747000	80
Smith and Bybee Lakes Water Control Structure	45.614600	-122.736000	1600
Teal Slough	45.816600	-122.838000	69
Vanport Wetlands, Columbia Slough	45.601200	-122.687000	62
Westport Slough Levee Removal	46.127100	-123.243000	
Whitaker Ponds Natural Area, Columbia Slough	45.573600	-122.610000	12
Washougal Oaks Natural Area	45.568600	-122.276000	15
Kloppman LWD	45.944500	-123.041000	
Carcus Creek LWD	45.993900	-123.090000	
Clatskanie River Fish Passage Improvement	45.942300	-123.045000	
Lewis River North Fork RM 13.5	45.933700	-122.651000	6
Upper Elochoman Salmon Conservation Project	46.281600	-123.268000	
Lower Dean Creek Restoration	45.828100	-122.629000	4
Lockwood Creek Phase 3	45.855500	-122.635000	
Lockwood Creek Rest, Clark Pub Utilities	45.852600	-122.644000	6
Zmrhal/Rauth Coweeman Restoration	46.150200	-122.780000	4
Walters Stream Restoration	46.297200	-123.446000	2
Crosel Creek Acquisition	46.163400	-123.799000	
Blind Slough Swamp - Nature Conservancy Land	46.196600	-123.574000	
Gnat Creek North	46.190500	-123.533000	60
Grays River LWD Habitat Complexing	46.371700	-123.557000	
Kennedy property acquisition	45.981300	-122.867000	

Project Name	Locational Information		Acreage Restored
	Latitude	Longitude	
Pierce Island restoration	45.621400	-122.012000	8
Julia Butler Hansen NWR - Steamboat Slough	46.250100	-123.434000	68
Milton Creek Riparian Planting	45.861900	-122.869000	
Milton Creek LWD	45.917700	-122.942000	
Clatskanie RIver Floodplain Restoration	46.100300	-123.193000	23
Woodard Creek - Reach 1 Restoration	45.620700	-122.021000	1
Grays River Reach 2D Restoration	46.370300	-123.550000	4