FINAL
BIOLOGICAL ASSESSMENT

TERMINAL 4 EARLY ACTION
PORT OF PORTLAND, PORTLAND, OREGON

Prepared for Submittal to

U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue, MS ECL-112
Seattle, Washington 98101

For Coordination with

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

Prepared by

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Portland, Oregon 97224

In Association with

NewFields
4720 Walnut Street Suite 200
Boulder, Colorado 80301

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μg/L	micrograms per liter
Action Memo	*Action Memorandum for a Removal Action at the Port of Portland Terminal 4 Site within the Portland Harbor Superfund Site, Portland, Multnomah County, Oregon*
AOC	Administrative Order on Consent for Removal Action
ARAR	applicable or relevant and appropriate requirement
BA	Biological Assessment
CDF	Confined Disposal Facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
Corps	U.S. Army Corps of Engineers
CPUE	catch per unit effort
dB	decibel
DEQ	Oregon Department of Environmental Quality
DO	dissolved oxygen
DPS	Distinct Population Segment
EcoRA	Ecological Risk Assessment
EE/CA	Engineering Evaluation/Cost Analysis
EFH	Essential Fish Habitat
EPP	Environmental Protection Plan
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
GPS	Global Positioning System
HDPE	high density polyethylene
HPAH	high polycyclic aromatic hydrocarbon
IRM	International Raw Materials
LWD	Large Woody Debris
mg/L	milligrams per liter
MNR	monitored natural recovery
MSFCMA	Magnuson Stevenson Fisheries Management and Conservation Act
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
NPL	National Priorities List
NTCRA	Non-Time-Critical Removal Action

NTU	nephelometric turbidity unit
ODFW	Oregon Department of Fish and Wildlife
OHWM	ordinary high water mark
ORS	Oregon Revised Statutes
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCE	Primary Constituent Element
PEC	probable effects concentration
pg/L	picograms/liter
Port	Port of Portland
ppm	parts per million
RAO	Removal Action Objective
RI/FS	Remedial Investigation/Feasibility Study
RM	River Mile
SFA	Sustainable Fisheries Act
SP&S	Spokane, Portland, and Seattle
TEC	threshold effects concentration
TSS	total suspended solids
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geologic Service
WQC	Water Quality Certification

1 INTRODUCTION AND BACKGROUND

This document presents the draft Biological Assessment (BA) for the Non-Time Critical Removal Action (NTCRA) being conducted to address contaminated sediments at the Port of Portland, Oregon (Port) Terminal 4. The NTCRA is being performed consistent with the U.S. Environmental Protection Agency (USEPA) Action Memorandum issued on May 11, 2006 (Action Memo; USEPA 2006).

In 2000, the USEPA added the Portland Harbor Superfund Site (Superfund Site or Site) to the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, *et seq*. (CERCLA or Superfund). The Superfund Site Initial Study Area encompasses about 6 miles of the Willamette River in Portland, Oregon and includes the Terminal 4 facility. The Port owns Terminal 4 and leases land there to several marine tenants.

In fall 2001, the USEPA and 10 of the potentially responsible parties entered into an Administrative Order on Consent (AOC) for a Remedial Investigation/Feasibility Study (RI/FS) at the Superfund Site, CERCLA-10-2001-0240 (USEPA 2001). The RI/FS will characterize the nature and extent of contamination, assess the biological and human health risks at the Superfund Site, and evaluate remedial action alternatives to address contaminated sediments causing unacceptable effects to human health and the environment. The AOC explicitly allows Early Actions to be conducted to address known contamination at locations within the Superfund Site. This NTCRA is consistent with the definition of Early Action in the AOC.

Contaminants potentially exceeding acceptable levels were identified in Terminal 4 sediment samples during a RI led by the Oregon Department of Environmental Quality (DEQ) (Hart Crowser 2000), and led to a determination that a Removal Action at Terminal 4 is warranted. Accordingly, the Port is conducting a NTCRA under a separate AOC for Removal Action, CERCLA 10-2004-0009, executed by the Port and USEPA in October 2003 (USEPA 2003).

Under the Removal Action AOC, the Port conducted an Engineering Evaluation and Cost Analysis (EE/CA) for the Terminal 4 Removal Action in which various Removal Action alternatives were evaluated and compared for relative performance at meeting CERCLA criteria for NTCRAs (BBL 2005). The EE/CA ranked the alternatives based on CERCLA criteria. Based on the EE/CA, the USEPA issued the Action Memo in which it documented the clean up decision for the Removal Action. The Removal Action given in the Action Memo includes the following (USEPA 2006):

- A Confined Disposal Facility (CDF) in Slip 1
- A combination of dredging, capping, and Monitored Natural Recovery (MNR) in Slip 3
- A combination of MNR and capping in Wheeler Bay and Berth 401
- MNR for the area north of Berth 414

As part of the Removal Action, a compensatory Mitigation Action is required to comply with Section 404(b)(1) of the Clean Water Act.

The removal action objectives (RAOs) established for the Removal Action Project Area (see Section 2.1 for the definition of the Removal Action Project Area) are to: (1) reduce ecological and human health risks associated with sediment contamination within the Removal Action Project Area to acceptable levels, and (2) reduce the likelihood of recontamination of sediments with the Removal Action (USEPA 2006).

The Removal Action described in the Action Memo is considered an agency action under the Endangered Species Act (ESA) and is therefore required to substantively comply with the ESA. The ESA of 1973 (as amended) requires protection of threatened and endangered species and their habitats. Section 7(a)(2) of the ESA requires that "each Federal agency shall, in consultation with and with the assistance of the Secretary, ensure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with affected States, to be critical, unless such agency has been granted an exemption for such action by the Committee pursuant to subsection (h) of this section." Section 7 of the ESA further requires that for a major construction activity, the action agency must submit a BA if listed species or designated critical habitat may be present in the Action Area (see Section 2.1 for a description of the Action Area).

This BA provides an Effects Analysis and Determination for effects of the Removal Action and Mitigation Action on federally listed species for the purpose of evaluating compliance with the substantive requirements of the ESA in the context of the EE/CA's applicable or relevant and appropriate requirements (ARARs) analysis (USEPA 2006).

In addition, this BA provides an Effects Analysis and Determination for Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the 1996 Sustainable Fisheries Act (SFA) (Appendix A). Under this legislation, an EFH evaluation of impacts is necessary for activities that may adversely affect EFH. EFH is defined by the MSFCMA in 50 CFR 600.905-930 as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" and is designated for groundfish, coastal pelagic, and Pacific salmon composites.

1.1 Project Setting

The project is located at the Port's Terminal 4 Facility (Terminal 4) at 11040 North Lombard Street in Portland, Oregon (Figure 1). Terminal 4 is within or adjacent to the Superfund Site on the eastern shore of the Willamette River downstream of the St. Johns Bridge and between River Miles (RMs) 4 and 5.

The Willamette River is a tributary to the Columbia River at approximately RM 102. It is the 10th largest river in the contiguous United States in terms of streamflow. The Willamette Basin is 11,460 square miles in size and constitutes 12 percent of the land area of Oregon (Willamette Restoration Initiative 1999). The Willamette Basin is divided into 12 subbasins. The lower reach of the Willamette River—the subbasin that includes the City of Portland—extends from the mouth upstream to the falls at Oregon City (RM 26.5 of the Willamette River). Land uses within the Lower Willamette River watershed in the vicinity of Portland and its suburbs are urban/industrial, residential, and rural/agricultural. Many of the state's heaviest industrial users are present in the Lower Willamette watershed. As a result, development has caused the removal of optimal habitat characteristics for juvenile salmonids, including extensive off-channel wetland and shallow water beach areas for rearing and resting.

Terminal 4 in the Lower Willamette River is an active marine terminal with a high volume of commercial and recreational traffic, and as such, undergoes periodic maintenance dredging and other maintenance activities associated with terminals of this type. Initially, dredging activity at Terminal 4 began with the work that provided fill for the general terminal space and created Slips 1 and 3 between 1917 and 1921. In the process, the former Gatton's Slough and adjacent Willamette River shoreline were reconfigured. The Port's dredging activities provided dredged material for the City of Portland's Commission of Public Docks facility. Maintenance dredging of the slips and improvements to the terminal's harbor face occurred periodically in ensuing years. Slip 1 was last dredged in 1988 and Slip 3 was last dredged in 2003.

Land use surrounding Terminal 4 is industrial. The upland area comprises about 283 acres (Parsons Brinkerhoff 2002) including the Toyota lease areas, and is generally flat in grade in proximity to the slips. The surface covering is primarily asphalt, with minor areas of gravel and/or ballast associated with the rail lines. At present, a relatively large volume of soil is stockpiled within the Slip 1 uplands because of recent grading of the adjacent Toyota facility. The EE/CA work plan (BBL 2004a) summarized local conditions and information is included in the Environmental Baseline (Section 4) of this BA.

In general, physical habitat conditions in the Action Area (see Section 2.1 for a definition of Action Area) and vicinity are degraded for many habitat elements considered for listed species. The Action Area lies within a highly active area of the Portland Harbor and Portland metropolitan area, and is within the Industrial Sanctuary as designated by the City of Portland's Comprehensive Plan. As a result, physical development (e.g., shoreline modification and dredging) and high disturbance (e.g., vessel traffic and ship wakes) that would be expected for these areas are present.

1.2 Listed Species and Evaluation Methods

Table 1 lists species that are listed under the ESA and that may occur in the vicinity of Terminal 4[1]. The species given in these tables were obtained from U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) most current species lists and online materials (NMFS 2006; USFWS 2006; Appendix B).

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[1] The ESA defines a "species" to include any distinct population segment (DPS) of any species of vertebrate fish or wildlife. For Pacific salmon, NMFS considers an Evolutionarily Significant Unit (ESU) a "species" under the ESA. For Pacific steelhead, NMFS has delineated DPSs for consideration as "species" under the ESA.

Table 1
Federally Listed Species that May Occur in the Action Area

Chinook Salmon (*Oncorhynchus tshawytscha*)		
Lower Columbia River ESU	Threatened Federal Register (FR) Vol. 64, No. 56, March 24, 1999	Designated September 2, 2005
Upper Willamette River ESU	Threatened FR Vol. 64, No. 56, March 24, 1999	Designated September 2, 2005
Coho Salmon (*O. kisutch*)		
Lower Columbia River ESU	Threatened FR Vol. 70, No. 123, June 28, 2005	Not Applicable
Chum Salmon (*O. keta*)		
Columbia River ESU	Threatened FR Vol. 64, No. 57, March 25, 1999	Designated September 2, 2005
Steelhead (*O. mykiss*)		
Lower Columbia River DPS	Threatened FR Vol. 63, No. 53, March 19, 1998	Designated September 2, 2005
Upper Willamette River DPS	Threatened FR Vol. 64, No. 57, March 25, 1999	Designated September 2, 2005
Bald Eagle (*Haliaeetus leucocephalus*)	Threatened FR Vol. 60, No. 133, July 12, 1995	Not Applicable

In evaluating potential effects to these species, this BA compiles the best available scientific and commercial data for the proposed project and considers the current environmental baseline, species information, and key habitat elements in the vicinity of Terminal 4 that may be affected by the proposed action. Factors considered include effects to listed species, the species' biological requirements and life history information, habitat components and conditions within the project vicinity, distribution and abundance of listed species, the potential for impacts to critical habitat, and the ability to minimize and mitigate for adverse effects identified. The methods outlined in *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NMFS 1996) and the *Endangered Species Consultation Handbook* (USFWS and NMFS 1998) were used as guides to analyze potential effects. The effects determinations made here are based on this information, and use this information to determine whether the proposed action is likely to adversely affect listed species or designated critical habitat.

Several listed plant species (Golden paintbrush, Willamette River daisy, Howellia, Bradshaw's lomatium, Kincaid's Lupine, and Nelson's checker mallow) and bird species (Yellow-billed cuckoo, Streaked horned lark) were initially investigated for consideration during this analysis, but they were determined not to warrant further analysis based on the conclusions of recent BAs (Oregon DEQ and USEPA 2002; Port of Portland and EES 2004a and 2004b; Anchor 2005) completed for projects in the vicinity of Terminal 4, which reported that these species are not present in the Lower Willamette River near Terminal 4. Based on these previous determinations of their absence in the vicinity of Terminal 4, no further discussion of these plant or wildlife species is included in this BA.

Several fish species that may occur in the Action Area have been considered for listing under the ESA, but were determined not to warrant listing. These species include Pacific lamprey (*Lampetra tridentata*), which were petitioned for listing, but it was determined on December 20, 2004 that Pacific lamprey is not a listable entity[2] In addition, the southwestern Washington/Columbia River Distinct Population Segment (DPS) of coastal cutthroat (*Oncorhynchus clarki clarki*) was considered for listing, but on July 5, 2002, the proposed rule was withdrawn due to improved understanding of the abundance of these populations (USFWS 2002).

[2] The *Finding on a Petition to List Three Species of Lampreys as Threatened or Endangered Species* found that "[n]either the information presented in the petition nor that available in Service files presents substantial scientific or commercial information to demonstrate that the Pacific lamprey located in the lower 48 states is a listable entity. Accordingly, we are unable to define a listable entity of the Pacific lamprey. Since the population of Pacific lamprey cannot be defined as a DPS at this time, thus ineligible to be considered for listing, we did not evaluate its status as endangered or threatened on the basis of either the Act's definitions of those terms or the factors in section 4(a) of the Act" (USFWS 2004).

2 REMOVAL ACTION

This section describes the Removal Action as selected in the USEPA Action Memo (USEPA 2006), including methods for construction and measures that will be taken to reduce impacts to listed species.

2.1 Removal Action Project Area and Action Area

The terms "Removal Action Project Area" and "Action Area" are used in this BA to discuss geographic areas relevant to the project. The former is a project boundary previously defined in the AOC, while the latter includes those areas potentially affected by the proposed project (Figure 2).

The Removal Action Project Area is defined by the AOC as follows: "…that portion of the Site adjacent to and within the Port of Portland's Terminal 4 at 11040 North Lombard, Portland, Multnomah County, Oregon: extending west from the ordinary high water line on the northeast bank of the lower Willamette River to the edge of the navigation channel, and extending south from the downstream end of Berth 414 to the downstream end of Berth 401, including Slip 1, Slip 3, and Wheeler Bay." Under the EE/CA, the *Site Characterization Report* (BBL 2004b) divided the Terminal 4 Removal Action Project Area into subareas based on an initial evaluation of sediment chemistry and operational and engineering considerations, as follows:

- Berth 401
- Slip 1 (This slip includes Berths 405 and 408)
- Wheeler Bay
- Slip 3 (This slip includes Berths 410 and 411 and Pier 5)
- North of Berth 414

A summary of the Removal Action is depicted on Figure 3, and shows these locations. Figure 4 shows a summary of the existing physical conditions in the Removal Action Project Area.

The Action Area is defined as the area to be affected directly or indirectly by the federal action (50 CFR §402.02). The basis for the Action Area takes into consideration project activities that pose potential impacts to listed species and their habitats, including the following activities that will occur in the vicinity of the construction activity:

- Pile removal, which can result in temporary turbidity
- Pile installation, which can result in increased sound pressure levels and temporary turbidity
- Dredging and capping, which can result in the temporary resuspension of sediments or contaminants in the water column

Because noise impacts due to pile driving have the potential to reach the farthest distance beyond the Removal Action Project Area, this activity was used to set the extent of Action Area boundaries. For aquatic areas, given the combination of a high volume of commercial and recreational vessel traffic in the river, it is estimated that peak baseline underwater noise levels would be in a range similar to a ferry terminal or busy port (150 decibels [dB]). The following assumptions are made:

- According to the practical spreading model used by USFWS and NMFS, sound pressure will attenuate at a rate of 4.5 dB per doubling distance; sound will stop when it reaches the nearest land mass and will attenuate more rapidly in shallow water (Rogers and Cox 1988).
- A peak underwater sound pressure level from impact installation of a 24-inch pile will be 217 dB (measured at 10 meters [33 feet] from the source) (WSDOT 2006).
- A bubble curtain or other sound attenuation device capable of at least a 15 dB reduction in sound pressure level will be used, lowering the anticipated peak sound pressure level at the point of impact to 202 dB.

Based on these assumptions, in the absence of landforms that attenuate pressure, peak sound pressure levels will decrease to the NMFS expected 180 dB limits of potential harm to fish (Hastings 2002) within 293 meters (958 feet) of a steel pile that is installed with an impact hammer and to ambient levels within approximately 18 miles[3]. Land masses, such

[3] Practical Spreading Model: $R_1 = (10^{(TL-15)})(R_2)$ where R_1 = distance from source, TL = transmission loss in dB, and R_2 = distance from source of initial sound measurement. For this analysis, $R_1 = (10^{(22-15)})(10)$ = 293 meters for 180 dB and 29,286 meters (18.2 miles) for 150 dB.

as bends in the river, stop sound pressure waves. River banks are encountered at turns in the river at approximately RM 3 and RM 6; thus, the aquatic boundaries of the Action Area are therefore defined by these features to be RM 3 to RM 6.

For airborne noise, it is estimated that peak baseline noise levels at Terminal 4 would be in a range similar to trucking equipment (approximately 90 dB). The following assumptions are made:

- According to the standard reduction for point source noise, airborne noise generated by the project will attenuate at a rate of 6 dB per doubling distance.
- Typical airborne noise level (measured at 50 feet from the source) from pile driving will be 110 dB (WSDOT 2006).

Based on these assumptions, peak airborne noise levels will decrease to ambient airborne noise levels at Terminal 4 within 400 feet (0.07 mile); however, for this analysis, a 0.5 mile radius will be used to limit the terrestrial extent of the Action Area to match the setback recommended by USFWS for protection of eagle nests with a line of sight to the noise source (USFWS 1986). The closest bald eagle nest to the project is located approximately 1.9 miles east of the Terminal 4 project area (Section 3.3.1).

Thus, for purposes of this BA, the Action Area is defined as the mainstem Willamette River in the vicinity of the Terminal 4 Removal Action Project Area, to include 1.3 miles (to RM 6.0) upstream of Terminal 4 and downstream 1.7 miles (to RM 3.0), including the land immediately adjacent to the Terminal 4 area for a 0.5 mile distance (Figure 2). These areas are set to be consistent with recent research on pile driving and noise (WSDOT 2006) as well as BAs for activities potentially affecting bald eagles (Port of Portland and EES 2004a). Although the Action Area is broadly defined here in order to set the extent of potential effects to listed species, most effects are generally expected to be confined to the area adjacent to the points of action (dredging, capping, and pile driving) and within the limit of the 180 dB limit of potential harm for Pacific salmonids and within the 0.5 mile protective setback for bald eagle, as described in detail in Section 5.

2.2 Removal Action, Construction Methods, and Conservation Measures

The Removal Action includes 1) a CDF in Slip 1; 2) a combination of dredging, capping, and MNR in Slip 3; 3) a combination of MNR and capping in Wheeler Bay and Berth 401; and 4) MNR, dredging, and/or capping for the area north of Berth 414 (Figure 3)[4].

The at-grade CDF in Slip 1 will serve to contain sediment dredged from Slip 3; an earthen containment berm will be constructed at the mouth of Slip 1 to serve as an isolation/retaining structure for the dredged sediment in the CDF (Figure 5). In addition, the CDF will have excess capacity available for other dredged sediment from the Portland Harbor Superfund Site or other cleanup actions, should the CDF be selected for those actions as an appropriate placement area through a separate removal or remedial action decision and provided the material is compatible with Terminal 4-specific sediment quality acceptance criteria. Currently, it is estimated that a total of approximately 105,000 cubic yards of contaminated sediment from 9.2 acres in Slip 3 and 28,000 cubic yards of sediment from beneath the containment berm will be placed in the CDF. An additional 542,000 cubic yards of non-Terminal 4 sediment will be placed in the CDF from separate dredge actions mentioned above. These volumes will be adjusted as necessary as the Prefinal (60 percent) Design progresses.

General conservation measures that will be applied to all activities include the following:

- In-water work for this project will comply with the timing restrictions specified in the in-water work window that has been specified by the Oregon Department of Fish and Wildlife (ODFW; ODFW 2000a), when salmonids are expected to be present in very low numbers. In the Lower Willamette River, the work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31. After the berm is built and Slip 1 is enclosed from the river, work in the CDF will not be bound by these windows.

[4] Figure 3 depicts a mix of dredging and/or capping and MNR in the area north of Berth 414, but does not define the exact boundaries of each component. This is because additional pre-construction data have been acquired for this area (Anchor 2006c *in prep*) and new dredging and/or capping areas for this area will be defined in the Prefinal (60 Percent) Design.

- Operations will be stopped temporarily if listed species are observed as injured, sick, or dead in the project area, to determine whether additional fish are present and to ensure that operations may continue without further impact. NMFS Law Enforcement will be notified, and fish will be handled with care to ensure effective treatment or analysis of cause of death or injury.
- The project will adhere to water quality protection conditions and monitoring found in the 401 Water Quality Certification (WQC) for this action. Because the WQC is not available at the time of submittal of this BA, it is understood that water quality monitoring stated in the WQC will be incorporated into the conservation measures of the Biological Opinion so that there are no inconsistent requirements between the Biological Opinion and WQC. Expected water quality monitoring details are provided in subsequent sections for each specific construction activity.
- Prior to entering the water, all equipment will be checked for leaks and completely cleaned of any external petroleum products, hydraulic fluid, coolants, and other deleterious materials.
- The contractor will establish an Environmental Protection Program which prevents environmental pollution and minimizes environmental degradation during and as a result of construction operations, including consideration of noise levels, air, water, and land. As part of the program, the contractor will submit an Environmental Protection Plan (EPP) that will establish and maintain quality control for environmental protection of all proposed actions. Erosion and turbidity control measures will also be included in the EPP.
- A spill containment and control plan will be present and will contain notification procedures, specific cleanup and placement instructions for different products, quick response containment and cleanup measures that will be available for the Removal Action, proposed methods for placement of spilled materials, and employee training for spill containment.

- If incidental demolition material drops into the water during demolition activities in Slip 3, the contractor will retrieve this material and remove it from the substrate using an "orange peel" bucket device[5]. Dropped demolition material in Slip 3 will not be allowed to remain on the substrate after construction is complete.

Details on technologies and construction measures for the proposed action follow in the next sections.

2.2.1 Timing of Activities and In-Water Construction Timing

The majority of the activities in the proposed Removal Action are anticipated to occur in 2007 and 2008 and will continue for some time post-2008 when the CDF is filled and the surficial layers are placed (Figure 6). The placement of non-Terminal 4 sediments into the CDF will occur following the CDF construction and placement of Terminal 4 sediments and before the surficial layer is placed.

As stated above, in-water work for this project will comply with the timing restrictions associated with the in-water work window that has been specified by the ODFW (2000a) to correspond to times when salmonids are expected to be present in very low numbers (Figure 6). In the Lower Willamette River, the work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31. After the berm is built and Slip 1 is enclosed from the river, in-water work schedules in the CDF will not be constrained by these windows (Figure 6).

2.2.2 Overwater Structure and Pile Demolition

Existing overwater structures in Slip 1, including Berths 405 and 408, will be demolished (Figure 7). Each berth structure includes wood and concrete piles and superstructure

[5] This device is a round grab bucket used for picking up material; the drop-bottom is divided into a number of multi-leaved sections that appear to peel back as the bucket opens. The bucket picks up material by closing partially and pinching the target item between the multi-leaved sections. The device may penetrate the substrate somewhat while picking up material, but the primary use of this device will be to remove errant debris material from the bottom.

with asphalt or concrete topping. At Berth 405, approximately 73,600 square feet of overwater structure and piling will be removed; at Berth 408, approximately 99,700 square feet will be removed, for a total of approximately 173,300 square feet (approximately 4.0 acres) of overwater structure and piling removal in Slip 1. There are wooden piles to be removed in the Wheeler Bay area just upstream from Slip 1, and numerous wooden piles to be demolished at Berth 412, and at Pier 5 located in Slip 3 (Figure 8). In addition, there are several piles located at the south end of Berth 401 that will be removed to facilitate berm construction. Work will be completed between the elevations of above the waterline to approximately -40 feet National Geodetic Vertical Datum (NGVD). This project element will require in-water work and is currently anticipated to span approximately 3 ½ months of the summer in-water work window in 2007 (Figure 6).

2.2.2.1 Construction Methods

Demolition work will be accomplished using typical heavy construction equipment based from barges and from shore. Barges will install spuds into the substrate and a crane barge will accomplish demolition of existing structures. Debris created will be removed, loaded onto a barge or truck, and hauled to an appropriate upland facility. Piles will be either pulled or cut at the mudline in a number of different locations as described below, and removed to an appropriate upland facility. All of the areas in which piles will be removed or cut at the mudline are slated for subsequent capping, either as a separate capping area or within the footprint of the CDF.

The piles at Berth 405 (mostly creosote-treated) will either be pulled out or cut at the mudline; this decision will be made after the contractor is selected. Piles at Berth 408 will be pulled and fully removed. The piles in Wheeler Bay and the Berth 412/Pier 5 area will be cut at the mudline; these piles will be cut (and not pulled) so that the pile length remaining below the mudline can continue to contribute to slope stability for that segment of the shoreline. Previous demolition activities at Terminal 4 that pulled old piles along steep slope shorelines resulted in slope failure due to the decreased structure and support below the mudline.

2.2.2.2 Conservation Measures

Conservation measures that will be applied to this work include:

- Visual monitoring will be conducted for potential turbidity plumes during demolition at the boundary of the construction zone which is expected to be no more than 100 meters from the mouth of either Slip 1 or Slip 3, depending on the location of demolition. In the event that construction-related plumes extend beyond the construction zone boundary for a period exceeding one hour, construction activities will be progressively slowed until plumes no longer extend beyond the construction zone, to minimize sediment suspension. This is similar to the measure of decreasing dredging cycle times to decrease turbidity plumes until the suspended sediment settles.
- A containment boom will be used to contain and collect any floating debris generated during demolition. Oil absorbent materials will be employed if visible sheens are observed floating during pile removal. The boom will remain in place until all oily material and floating debris have been collected.
- All treated wood debris removed during the project will be removed to an USEPA-approved upland facility. Once removed, any treated wood piling will not be left in the water or stacked on the streambank.
- Construction debris will be collected and removed from the project area to an appropriate upland facility.
- Construction barges will be placed at sufficient depth so as to not ground out during low water conditions.

2.2.3 Containment Berm Key Dredging

A new containment berm at the mouth of Slip 1 must be constructed to support the containment of sediment and fill material in the slip. To support the berm, an approximately 5- to 10-foot-deep key of approximately 28,000 cubic yards (this volume will be defined as necessary as the Prefinal [60 percent] Design progresses) will be mechanically dredged beneath the proposed containment berm location at the mouth of Slip 1 (Figure 9). This sediment will be removed from its current location and placed at the head of Slip 1 prior to containment berm construction. Chemical testing completed for the EE/CA showed little to no contamination in this sediment that will be dredged for the containment berm key[6]. This dredged sediment, when placed at the head of Slip 1, is lower in concentration than the existing surface sediments at that location. No new sediment surface area will be left exposed following dredging, as the berm will be created immediately atop the dredged key footprint. Dredging will occur at approximately -40 feet NGVD.

Containment berm key dredging and containment berm construction (Section 2.2.4) will require in-water work, and are currently anticipated to span approximately 4 months of the summer in-water work window in 2007 (Figure 6).

2.2.3.1 Construction Methods

To create the key, existing bottom material will be removed by clamshell bucket and will be deposited on a scow or bottom-dump barge. The material will be retained on the barge until the barge is approximately 85 to 90 percent full, or the dredging effort is complete, whichever is first. Material will be placed from the barge into the head of Slip 1 by bottom dump-barge, clamshell bucket lowered to the mudline, or by pushing off a flat deck barge by endloader. For stability during this work, barges will raise and lower spuds into the substrate. Any debris material encountered from the dredge prism will be removed to an approved upland landfill.

2.2.3.2 Conservation Measures

General conservation measures that will be applied to dredging include:

- To ensure material removal from the proper locations, a Global Positioning System (GPS) will be used for correct bucket or hydraulic dredge head location during dredging.
- Construction barges will be placed in areas of sufficient depth so as to not ground out during low water conditions.
- During dredging, the contractor will not be permitted to perform bottom stockpiling or multiple bites of the clamshell bucket.

[6] In testing completed for the EE/CA, sediment below the berm key did not exceed Probable Effects Concentrations (PEC; see Section 4.2.1) for any of the samples or depths tested, except one PAH result slightly elevated above the PEC for a sample from the 0-1 foot depth range (Appendix E in BBL 2005; sample VC-12).

- During dredging, barge scuppers will be sealed.

In addition to these measures, other conservation measures may be required during dredging. During dredging activities, the contractor and field crew will be required to monitor water quality standards in the project area to be compared against all applicable water quality standards, including turbidity and total suspended solids (TSS; standards will be defined more specifically in the WQC, but are expected to be compared to both pre-construction ambient water quality survey results and results from ongoing monitoring at the upstream background reference station). Areas where water quality will be measured will include areas at the boundary of the construction zone, which is expected to be no more than 100 meters from the mouth of Slip 1, and will also be monitored at "early warning areas" within the construction zone. If water quality measurements at the construction zone boundary during dredging exceed the criteria defined more specifically in the WQC, a sequence of responses will be initiated, including implementation of additional controls to be determined as needed. The details and sequence of the steps will be presented in the Water Quality Monitoring Plan for construction, but will generally include notifying USEPA and repeating measurements at specified time intervals after the exceedance is first detected, to confirm the exceedance or show that water quality criteria are no longer being exceeded. The construction contractor will then take corrective action as necessary in order to meet standards.

Due to deep water and vessel traffic at the mouth of Slip 1, operational controls (as opposed to a silt curtain or similar device) are considered the most effective measure for control of turbidity during key dredging. Examples of possible corrective actions are provided below:

- Reduce the velocity of the ascending loaded bucket through the water column, which reduces the potential to wash sediment from the bucket and reduces the sediment loading into the water column over a set period of time. Limiting the velocity of the descending bucket, on the other hand, may reduce the volume of sediment that is picked up by the bucket, which would require more total bites to remove the project material, increasing the overall project duration.

- Sediment resuspension can also be reduced by pausing the bucket at bottom after impact but before closing the bucket and pausing the bucket at the water line during the ascent, both of which increase cycle time and project duration.
- Use Closed or Environmental Bucket. This technology consists of specially constructed dredging buckets designed to reduce or eliminate increased turbidity from suspended solids from entering the water. Environmental buckets are not suitable in certain situations, including situations with sediments of medium or greater density.

2.2.4 Containment Berm Construction

The new containment berm will be created by placing approximately 160,000 cubic yards of material across the mouth of Slip 1 and parallel to the river banks (this volume will be further defined as necessary as the Prefinal [60 percent] Design progresses) (Figure 9 and Figure 5). The berm will be constructed across the existing mouth of Slip 1 and will extend between the existing north and south corners of the Slip 1 banks, for a total distance of approximately 600 horizontal feet. The height of the berm will be equivalent to the height of the adjacent river banks at an elevation of approximately 30 to 35 feet NGVD. The berm will be approximately 20 feet wide at the top and a maximum of 307 feet wide at the base. The berm will be constructed at a 2:1 side slope, with the exception of a more gently sloped bench (20 percent or 5:1) on the outside face of the berm that is incorporated into the design to reduce the net loss of shallow water habitat (the zone of water 0 to 6 feet in depth) in Slip 1. This bench will be approximately 30 feet wide, extending from approximately -3.2 to +2.8 NGVD. Placement of the containment berm material will occur from depths of about -40 feet NGVD extending to above water level. Containment berm key dredging and containment berm construction (Section 2.2.4) will require in-water work, and are currently anticipated to span approximately 4 months of the summer in-water work window in 2007 (Figure 6).

2.2.4.1 Construction Methods

The berm foundation over-excavation area will be backfilled with a select fill core consisting of free-draining, well-graded, sandy gravel or gravelly sand from a recognized and established borrow site, of 4-inch minus material with 45 to 65 percent gravel content and less than 4 percent passing the U.S. No. 200 sieve (wet screen). To build the berm, successive sets of two training dikes composed of quarry spalls or riprap will be constructed approximately 3 to 8 feet high at the base of the berm. These dikes will be filled with select fill and two more 3 to 8-foot-high dikes will be built. This process will be repeated until the berm has reached the specified height. The surface of the berm crest will be constructed for vehicle access and a crushed rock road will be constructed on top. The riprap training dike material will either be placed by clamshell bucket from a barge or placed by skip box (material placement device similar to a back end of dump truck); the berm select fill material will be either placed by bottom-dump barge or by clamshell bucket, and berm crest material will be placed by typical upland construction equipment.

Concurrent with berm construction, a weir and outfall structure will be installed in the berm that will be used later to drain water from the CDF as it is being filled with sediment. This structure will consist of a pipe and a weir structure through which effluent, when necessary, will outlet at the waterward face of the containment berm into the Willamette River.

During containment berm construction, approximately 16,000 cubic yards of rock (included in the approximate 160,000 total cubic yards to be placed for the containment berm) will be placed by clamshell bucket along the entire length and height of the riverward berm face to reinforce the berm and to preclude any river flow erosive effects (this volume will be adjusted as necessary as the Prefinal [60 percent] Design progresses (Figure 9).

2.2.4.2 Conservation Measures

Conservation measures that will be applied to this work include:

- Visual monitoring will be conducted for potential turbidity plumes during construction at the boundary of the construction zone which is expected to be no more than 100 meters from the construction activity. In the event that construction-related plumes extend beyond the construction zone boundary for a period exceeding one hour, construction activities will be progressively slowed until plumes no longer extend beyond the construction zone, to minimize sediment suspension. This is similar to the measure of decreasing dredging cycle times to decrease turbidity plumes until the suspended sediment settles.

- The use of coarser material with low fine content for berm select fill will minimize turbidity impacts associated with material placement.
- Construction barges will be placed in areas of sufficient depth so as to not ground out during low water conditions.
- Following berm construction, to minimize take of listed fish species and to ensure compliance with Oregon Revised Statutes (ORS) 509.585 regarding fish passage, an effort will be employed to remove as many listed species as practicable from within Slip 1 (Section 5.1.1.1).

2.2.5 Replacement Berth Construction and Dredged Material Offloading

Because Berth 405 will be removed (Section 2.2.2), a replacement berth for barge mooring will be constructed near the face of the new containment berm (Figure 10). The berth will include a pre-cast concrete platform supported by steel pipe piling with a vehicle access trestle from the shore. This platform will be capable of supporting a future grain unloading tower, as well as other future uses as required by the Port. Four ship berthing dolphins will be installed (two on either side of the berth), each with catwalk access from the main platform. The structure will require approximately 80 steel pipe piles and will include approximately 6,272 square feet of new overwater structure in the river (these numbers will be finalized during the Prefinal [60 percent] Design and Final [100 percent] Design). The overwater portion of the replacement berth will be located over the elevations of between approximately -10 and -20 feet NGVD, with the mooring location for barges located over the elevations of approximately -20 to -33 feet NGVD. An access trestle will be constructed over the shallow water portion of the area, leading from land to the berth. The pile caps for the new structure will be cast-in-place concrete, but construction of these caps will occur out-of-water and no uncured concrete will be in contact with the water at any time. This project element will require in-water work and is currently anticipated to span approximately 2½ months of the latter part of the in-water work window in 2007 (Figure 6).

Dredged material offloading (or the placement of non-Slip 3 dredge material in the CDF) is anticipated in future years following CDF construction and Slip 3 dredging. For this purpose, a system will likely be constructed at the replacement berth, and will likely consist of a suction and piping system or other conveyance system (e.g., conveyors or chutes) attached to the replacement berth designed to pump material from a barge berthed on the outer face of the containment bermover the containment berm into the CDF. Regardless of method, this system will be designed to directly place sediments into the CDF and will not allow sediments to fall onto the face of the berm or into the river. Construction of this piping system will not involve in-water work.

2.2.5.1 Construction Methods

The replacement berth will be constructed mostly by barge and some by land using typical pier construction methods. Heavy equipment will be used to place and build new structures. The berth and dolphins will be constructed of concrete cast-in-place materials with steel reinforcing bars as well as 24-inch diameter steel pipe piling. Access catwalks will be composed of prefabricated aluminum or steel. The steel pipe piling will be installed using the vibratory method and will be "proofed" using the impact hammer method. These two pile installation methods are described below:

- An impact hammer installs piling by striking them from above, driving them into the sediment from the downward force of the hammer on the top of a pile. Impact hammers have a lead that holds the hammer and a pile in place while a heavy rod moves up and down, striking the surface of the pile.
- The vibratory hammer method is a common technique used in steel pile installation where geologic conditions and load bearing requirements allow this method to be used. Installation of steel piling involves placing a choker around the pile and setting it in place at the mudline. The pile will be held steady while the vibratory hammer installs the pile to the required load bearing elevation. Once the pile has reached the required load bearing elevation, it may be "proofed" by striking it with an impact hammer. Proofing is a test method to ensure that the pile has met the design criteria.

Contractor staging will occur on barges and in existing upland areas on the north and east margins of Slip 1.

2.2.5.2 Conservation Measures

Conservation measures that will be applied to this work include:

- A containment boom will be used to contain and collect incidental floating debris potentially generated during construction. The boom will remain in place until all material and floating debris have been collected.
- Incidental construction waste and debris will be removed from the project area to an appropriate upland facility.
- Construction barges will be placed in areas of sufficient depth so as to not ground out during low water conditions.
- No cast-in-place concrete will be used in water.
- During pile driving with an impact hammer (e.g., proofing), a bubble curtain or other sound attenuation device capable of at least a 15 dB reduction in sound pressure level will be used, lowering the anticipated peak sound pressure level at the point of impact to 202 dB.

2.2.6 Stormwater and Outfall Structure(s) Relocation

The City of Portland and the Port currently have two and four stormwater collection routes, respectively, that drain upland areas on and in the vicinity of Terminal 4. The outlet pipes of these routes currently discharge to Slip 1 at elevations ranging from +8 to +12 feet NGVD. When the containment berm is completed, these discharge points will be cut off from the river; therefore, these pipes must be relocated to provide a new point of discharge for these flows into the Willamette River. It is the intent of the Port to keep the City- and Port-owned pipes separated, therefore requiring two parallel systems in the relocation program. Two new stormwater outfalls will be constructed to replace the existing outfalls (one new for the City route, and one new consolidated outfall for the existing Port routes) (Figure 11). The new outfalls are currently expected to discharge at approximately +6 feet NGVD (Port) and +10 feet NGVD (City). Shoreline conditions are similar in the locations of the new outfalls, the existing outfalls, and the existing shoreline slated for outfall placement, in that the shoreline in each of these areas currently exhibits a steep grade with substrate and armoring modifications such as piling, riprap, and debris. (An exception to this is one existing outfall that currently outlets under the overwater structure at Berth 408). The new consolidated Port outfall is expected to improve overall stormwater quality because the new conveyance system will include upgrades to reduce sediment and chemical loads, the specific elements of which will be determined during the Prefinal (60 percent) Design and Final (100 percent) Design.

This project element will require in-water work. Timing of this element is currently anticipated to require approximately 1½ months of non-in-water work prior to the summer in-water work window in 2007, and 2½ months of the first part of the work window in 2007 (Figure 6).

2.2.6.1 Construction Methods

To relocate the existing stormwater outfalls to separate outfalls, a trench will be dug in the upland area south of Slip 1, grading from existing grade to the outfall elevation of approximately -1 to +4 feet NGVD and ranging from 13 to 27 feet in depth. The relocated outfall pipes, consisting of 36-inch diameter high density polyethylene (HDPE) pipe, will be placed in the trench. Approximately 9 inches of crushed rock bedding will be placed in the trench, and then material excavated from the trench will be placed on top of the pipe to re-fill the trench. If necessary, a small amount of clean extra soil volume will be added on top of the pipe to bring the trench back to grade. The two outfall structures will be a pre-cast assembly with a riprap and crushed rock apron, spanning approximately 140 square feet of shore at each outfall location. For the construction of this trench and outfall structure, no significant amounts of riparian or upland vegetation will be disturbed or removed, as vegetation in this area is sparse and minimal.

All construction for the outfalls will occur from land using typical construction equipment for trench work and may include a trackhoe or dragline. Digging will begin starting from the lowest end of the proposed outfalls (at river edge) and will continue upland parallel to the Slip in the direction of the head of the Slip. If a trackhoe is used, the contractor may create a work platform for the device on the shore in the same place and future location of the riprap and crushed rock apron that will flank the new outfalls. This work platform is created by piling the same crushed rock bedding that will be used to fill the trench to create a solid platform for the device to sit. For safety reasons, engineered shoring will be required inside the trench for installation of pipe where trench depths exceed 20 feet deep. Shoring may also be required when existing utilities are located in proximity to the proposed storm drain alignments. This shoring may include a portable box, or field-installed sheet and strut trench safety systems.

2.2.6.2 Conservation Measures

Conservation measures that will be applied to this work include:

- Work at the shoreline will be completed during low water/low tide conditions.
- Material for the crushed rock bedding in the trench and the work platform (if this platform is necessary) will consist of low fine content backfill.
- During trench construction, material excavated from the trench will be piled in such a way as to preclude material falling into the river. Erosion control measures will be employed for this material and may include silt fences, geofabric, straw bale structures, jute mats, and coconut (coir) logs.

2.2.7 Slip 3 Dredging and Area North of Berth 414 Dredging and/or Capping

In accordance with the Action Memo, approximately 105,000 total cubic yards of contaminated sediment from 9.2 acres in Slip 3 will be dredged. The planned dredging spans almost the entire acreage of Slip 3 and will occur between the depths of approximately -40 to -55 feet NGVD, with the exception of the margins of the slip, which will be capped (Section 2.2.8). Final dredge yardage estimates, the expected dredge prism, and post-dredge bathymetry will be refined as necessary as the Prefinal (60 percent) Design progresses; however, information is presented here for the threshold effects concentrations (TEC) and probable effects concentrations (PEC) for the dredge area. The TEC is a low effects guideline that represents concentrations below which toxicity effects are unlikely to be observed in freshwater benthic invertebrates, while the PEC is a higher, probable effects guideline that represents concentrations above which toxicity effects are likely to be observed in freshwater benthic invertebrates. The PEC guidelines have been modified slightly to include lower concentrations for some constituents that may be regulated at lower levels in the Portland Harbor. Current estimates of the extent of sediment contamination as characterized by prevalent exceedances of PECs and TECs (called TEC and PEC neatline elevation) are shown in Figures 12 and 13[7].

In addition, material from the area north of Berth 414 may be dredged to a depth of 2 feet below the mudline[8]. Similar to Slip 3, final dredge yardage estimates, the expected dredge prism, and post-dredge bathymetry for the area north of Berth 414 dredging will be refined as necessary as the Prefinal (60 percent) Design progresses. Dredging at Berth 414 would occur between the depths of approximately -10 to -35 feet NGVD. The dredged area of the area north of Berth 414 may subsequently be capped and this cap would extend around the fringe of the dredge area, continue up to the shoreline, and intersect with the Pier 5 cap. Alternatively, the entire area could be capped and not dredged (Section 2.2.8 for capping details, if capped).

Dredging will require in-water work and is currently anticipated to span approximately 2 months of the first part of the in-water work window in 2008 (Figure 6).

2.2.7.1 Construction Methods

Dredge material includes soft organic silt and clay, with debris anticipated to be encountered during dredging. The construction method will be hydraulic dredging for the majority of Slip 3 sediments and mechanical clamshell bucket dredging for debris material. Dredged sediments will be transported by over-land or in-water pipe directly from Slip 3 to Slip 1 and will be deposited into the CDF. If an in-water pipe is used, the pipe will float in a portion of the dredge area and will rest on the bottom in other areas; the pipe will be placed so as not to cause navigational hazards. Any existing large debris encountered during dredging will be removed by clamshell, placed on a barge, and removed to an appropriate upland facility.

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[7] Figures 12 and 13 show TECs and PECs delineated using statistical interpolation.

[8] As stated previously, Figure 3 depicts a mix of dredging and/or capping and MNR in the area north of Berth 414, but does not define the exact boundaries of each component. This is because additional pre-construction data have been acquired for this area (Anchor 2006c *in prep*) and new dredging and/or capping areas for this area will be defined in the Prefinal (60 Percent) Design.

Dredged material from Slip 3 will not be placed into the CDF until after the construction of the berm and water in the CDF is completely isolated from the river. During the filling of Slip 1 with Slip 3 material, effluent is not expected to be discharged since this material will be the first material placed into the CDF. As the CDF is subsequently filled with non-Slip 3 material, more opportunity exists for the need to discharge effluent. If water within the CDF begins to approach a level at which discharge is necessary, water quality within the CDF will be sampled prior to discharge to confirm that water quality criteria will be achieved at the compliance boundary outside of the CDF, as described in more detail in Section 2.3.1.

For stability during dredging, material and derrick barges may lower spuds into the substrate. Following dredging, a bathymetric survey will be completed to document that the dredged area meets the specifications required. No aquatic or wetland vegetation currently exists in the area to be dredged.

2.2.7.2 Conservation Measures

General conservation measures that will be applied during dredging include:

- Dredged material from Slip 3 will be placed into the CDF following berm construction, when the CDF area is isolated from the river.
- To ensure material removal from the proper locations, a Global Positioning System (GPS) will be used for correct bucket or hydraulic dredge head location during dredging.
- Construction barges will be placed in areas of sufficient depth so as to not ground out during low water conditions.
- During hydraulic dredging, the cutterhead will be maintained in the substrate and will not be raised more than 3 feet above the river bottom when the dredge pumps are running, to prevent entrainment of salmonids.
- During mechanical debris removal, the contractor will not be permitted to perform bottom stockpiling or multiple bites of the clamshell bucket.
- If a barge is used, barge scuppers will be sealed.

In addition to these measures, other conservation measures may be required during dredging. During dredging activities, the contractor and field crew will be required to monitor water quality by comparing sample analysis results to applicable water quality standards, including turbidity/TSS standards, and acute chemical water quality criteria (as defined more specifically in the WQC). Water quality will be monitored at the boundary of the construction zone, which is expected to be no more than 100 meters from the mouth of Slip 3 for Slip 3 dredging and no more than 100 meters from the point of dredging for the area north of Berth 414, and at "early warning areas" within the construction zone. If an exceedance of water quality criteria is detected during dredging, a sequence of responses will be initiated, including implementation of additional controls to be determined as needed. The details and sequence of the steps will be presented in the Water Quality Monitoring Plan for construction, and may differ among turbidity or chemical contaminants, but will generally include notifying USEPA and repeating measurements at specified time intervals after the exceedance is detected, to confirm the exceedance or show that water quality criteria are no longer being exceeded. The construction contractor will then take appropriate corrective action as necessary in order to meet standards.

Due to water depths, vessel traffic, and the relatively confined nature of water movement expected inside Slip 3, operational controls (as opposed to a silt curtain or similar device) are considered the most effective measure for control of turbidity and contaminant dispersion during dredging. Examples of possible corrective actions that could be implemented during hydraulic dredging are provided below:

- Reduce cutterhead rotation speed. Reducing cutterhead rotation speed reduces the potential for side casting the excavated sediment away from the suction entrance and resuspending sediment.
- Reduce swing speed. Reducing the swing speed ensures that the dredge head does not move through the cut faster than it can hydraulically pump the sediment. Reducing swing speed reduces the volume of resuspended sediment. The goal is to swing the dredge head at a speed that allows as much of the disturbed sediment as possible to be immediately removed with the hydraulic flow. Typical swing speeds are 5 to 30 feet/minute.
- Eliminate bank undercutting. Removing sediment in maximum lifts equal to 80 percent or less of the cutterhead diameter reduces potential for side sloughing.

2.2.8 In-Situ Capping

In-situ capping is the proposed action selected for approximately 8.7 acres (this area will be defined as necessary as the Prefinal [60 percent] Design progresses) of the Removal Action Project Area. The in-situ cap is designed to resist typical vessel propeller wash; wind and vessel-induced waves for 100-year wind events; and water velocities and currents associated with a 100-year flood. In-situ capping will occur in the following areas (Figures 3, 14, 15, and 16):

- Berth 401 (37,000 square feet)
- Wheeler Bay, both bank and aquatic areas (75,000 square feet)
- Part of the area north of Berth 414 may be capped (27,500 square feet); part of this berth may also be dredged [Section 2.2.7])
- Under Berth 411 pier (34,400 square feet)
- Head of Slip 3 including behind the sheet pile bulkhead (13,000 square feet) and in front of the wooden bulkhead (11,000 square feet); side of Slip 3 adjacent to Pier 5 (84,000 square feet). The remainder of Slip 3 is slated for dredging.

This project element will require in-water work. In-situ capping work is anticipated to occur first at Berth 401 in the latter part of the summer/fall in-water work window of 2007; this cap can be placed after the containment berm key dredging is completed. Capping on the banks of Wheeler Bay may occur in 2007 and is currently anticipated to span 1½ months of the latter part of the summer/fall in-water work window; some shoreline capping in Wheeler Bay will occur above the ordinary high water (OHW) line and will not require in-water work. The remaining capping activities can begin following completion of Slip 3 dredging, and are currently anticipated to span approximately 2 months of the latter part of the summer/fall in-water work window in 2008 (Figure 6).

2.2.8.1 Construction Methods

The in-situ cap will consist of approximately 6 to 12 inches of select fill of fine/medium sand or gravel with low fines content free of large organic or other debris or waste. Cap materials will be placed mechanically from a barge using a clamshell bucket and capping under the piers will occur using a conveyor to send material back under the structures. For each lift, the bucket will be cracked above the water surface while moving side to side to spread the material. The material will be placed with sufficient control to meet the design thickness. An armor layer approximately 12 to 24 inches thick will also be placed atop the cap for cap stability. Taking into account the cap and armor layer, final elevations in capped areas will be approximately 1½ to 3 feet shallower than existing elevations. Following the placement of the cap, a bathymetric survey of capped aquatic areas will be completed to verify and document that the cover meets the specification.

2.2.8.2 Conservation Measures

Conservation measures that will be applied to this work include:

- Visual monitoring will be conducted for potential turbidity plumes during construction at the boundary of the construction zone which is expected to be no more than 100 meters from the point of capping. In the event that construction-related plumes extend beyond the construction zone boundary for a period exceeding one hour, construction activities will be progressively slowed until plumes no longer extend beyond the construction zone, to minimize sediment suspension. This is similar to the measure of decreasing dredging cycle times to decrease turbidity plumes until the suspended sediment settles. Following slowing of capping activities, monitoring will continue, and operations will be modified in this manner until the plume dissipates.
- To ensure proper cap placement, in-situ cap materials will be placed in a controlled and accurate manner. Set volume, tonnage, lead line measurements, cores, and bathymetry information will be used to verify adequate coverage during and following material placement.
- Cap select fill material will consist of fill with low fines content.
- Construction barges will be placed at sufficient depth so as to not ground out during low water conditions.

2.2.9 CDF Surficial Layer

Surficial layers will be placed on the CDF following the filling of the CDF to its approximately 700,000 cubic yard contaminated sediment capacity. This capacity includes sediments from Slip 3 as well as other sediment from other dredge projects.

The purpose of adding surficial layers is to complete the confinement of contaminated dredge material in the CDF and to raise the elevation of the CDF to the same as the surrounding area. The CDF surficial layering work will not require in-water work and is currently anticipated to occur post-2008.

2.2.9.1 Construction Methods

Surficial layer placement will consist of layering material atop the CDF to a thickness of approximately 20 feet, depending on existing CDF elevation at the time of layer placement. The first layer will be placed, composed of approximately 275,000 cubic yards of appropriate dredge or upland material[9], and then a second layer of approximately 270,000 cubic yards of imported fill material will be placed. The second layer will be placed atop the CDF surface from trucks or barges and graded to match surface elevation. In addition, as part of constructing the surficial layer, permanent monitoring well(s) to monitor groundwater quality will be installed (Section 2.3.2).

2.2.9.2 Conservation Measures

No specific conservation measures are specified here.

2.2.10 International Raw Materials Offloading

IRM (International Raw Materials) is an existing tenant at Berth 408 that currently transfers inert liquid bulk materials (e.g., molasses) between Berth 408 and adjacent upland storage tanks. The construction of the CDF in Slip 1 necessitates moving the offloading to an alternate location. The offloading structure at Berth 401 will be slightly modified to accommodate low access to barges that will dock at this location, and gangway ramps will be added to the existing structure. This work will not require in-water work and is currently anticipated to span approximately 1½ months prior to the summer in-water work window in 2007 (Figure 6).

[9] This material will be compatible with Terminal 4-specific sediment quality acceptance criteria.

2.2.10.1 Construction Methods

Four pre-manufactured 3-foot-wide steel or aluminum gangways will be installed below the deck surface of the berth as an access point between the berth and docked ships/barges. New piping will be routed from the IRM facility to berth 401, using the existing bridge to the dock. All construction will be conducted using typical construction equipment in upland areas or from barges.

2.2.10.2 Conservation Measures

Conservation measures that will be applied to this work include:

- Control structures will be employed to preclude upland material from entering the water during construction, and may include silt fences, straw bale structures, jute mats, and coconut (coir) logs.
- No in-water work will occur.

2.2.11 Compensatory Habitat Mitigation to Address Requirements of Clean Water Act Section 404(b)(1)

According to the Clean Water Act Section 404(b)1, the filling of aquatic areas in Slip 1 and capping of other areas will require mitigation for loss of habitat. The proposed mitigation project is as follows: The Port will provide $600,000 to the City of Portland for the Ramsey Refugia, Phase II project. The Port will not fund the entire project; the remaining portion would be funded by the City. Specifically, the Port will provide $450,000 toward construction of the project, and an additional $150,000 for post-construction monitoring. The payment to the City of Portland would be similar to an in-lieu-fee payment consistent with Clean Water Act Section 404 regulations and guidance for compensatory mitigation. A detailed description of the proposed project is provided in the following paragraphs.

This project proposes to restore the Ramsey Wetland Complex (located in the Columbia Slough) by re-establishing hydrologic connectivity to the Lower Columbia Slough to improve floodplain wetland functions and to increase the amount and quality of off-channel rearing and refuge habitat for ESA-listed juvenile Chinook, coho, and steelhead (Thompson 2006). Loss of tidally influenced, floodplain wetland habitats have been identified as a limiting factor for Columbia and Willamette River basin salmon. This project will incrementally return 5.0 acres of this lost habitat, thus helping to achieve restoration goals identified by regional resource managers (Thompson 2006).

Phase I of the project was recently successfully completed (City of Portland 2006) in an area that is nearby, but separate from, the Phase II location. The Phase II project would have no surface hydrologic connection to Phase I. Initial monitoring results indicate use of the Phase I area by juvenile Chinook, coho, chum, and steelhead.

A conceptual design of the backwater wetland and connected high-flow channel has been completed. This concept includes excavating two alcoves, connected to each other and the Columbia Slough through positively draining high-flow channels that would provide surface hydrological connection at seasonally high water levels. Anchored large woody debris (LWD) would be placed in submerged areas to improve habitat complexity and cover. The proposed project covers 5 acres of land, approximately 2 acres of which will be seasonally inundated and provide 0- to 6-foot shallow water depth range that is important to juvenile salmonids.

2.2.11.1 Construction Methods

Construction for the Mitigation Action will be conducted by the City of Portland. Methods will be described under a separate permitting and ESA consultation process led by the City. Obtaining $450,000 from the Port is necessary before the City of Portland can move forward with the project, including the permits and consultation process.

2.2.11.2 Conservation Measures

See section above (2.2.11.1).

2.3 Monitoring Overview

In accordance with requirements of the 401 Water Quality Certification obtained for this project and the Action Memo, water quality and sediment monitoring will be conducted to evaluate the short-term impacts and efficacy of the Removal Action. Archaeological monitoring will also be conducted concurrent with construction in necessary areas. Long-term monitoring will be conducted to assess the physical stability of the berm, groundwater quality of water passing through the berm, and the function of the habitat mitigation project. The frequency and locations of this monitoring will be determined in cooperation with USEPA. This section provides an overview of expected short-and long-term monitoring.

2.3.1 Short-Term Monitoring

The final monitoring plan to be implemented during the Removal Action will be finalized in the Prefinal (60 percent) Design (late 2006) and will include specific protocols, timelines, and decision processes for continuing monitoring as needed or required by USEPA. Currently, monitoring that is anticipated to occur includes several activities, as described in previous sections of this document and Appendix L of the EE/CA, as follows:

- Water quality monitoring will be conducted during activities expected to generate turbidity, as described in general above in Sections 2.2.2 – 2.2.10.
- Water quality monitoring will occur prior to discharging water from the CDF weir. As stated in Section 2.2.4.1, water within the CDF and effluent, (if present) will be monitored for turbidity, TSS, and acute water quality criteria (as defined more specifically in the WQC). Sample collection within the CDF will be limited to periods when the CDF is operational (receiving dredged material) and the ponded water elevation is such that overtopping of the weir is expected. The purpose of sampling within the CDF is to evaluate potential impacts of weir effluent on water quality in the river outside the CDF. Water quality within the CDF is not subject to compliance criteria. Should sample results from within the CDF indicate that there may be problems meeting water quality criteria outside the CDF, appropriate modifications to the operational controls of the CDF can be implemented to improve water quality, or to minimize the opportunity for effluent to be discharged to the river. Modifications may include adjusting outflow rate or weir height, slowing down production rates, and/or altering dredged material placement locations.
- Water samples from the CDF will also contribute to a better understanding of the relationship between water quality parameters that have been predicted from elutriate tests of the in-situ dredge material, and the actual concentrations

measured in the CDF once the slurried dredged material has settled in the isolated CDF.

- Post-dredging and capping confirmation sampling will be conducted following dredging and capping activities to confirm contaminant concentration in surface sediment layers is at acceptable levels as required in the Action Memo (USEPA 2006). Also, bathymetric surveys after dredging and capping will be performed in aquatic areas to confirm that the specified elevations were met.
- Appropriate monitoring will be conducted to confirm construction of the CDF according to the design drawings ("as-built" confirmation).
- During design, the procedures for the Archaeological Monitoring Protocol will be developed to ensure compliance with the National Historic Preservation Act (16 USC 470) and applicable Oregon statutes (ORS 97.740 et seq., 358.905 et seq., and 390.235 et seq.). These procedures will address potential inadvertent discoveries of cultural materials and deposits (including sacred objects, funerary objects, and objects of cultural patrimony as defined in ORS 358.905) and Indian burials and human remains (as defined in ORS 358.905) during ground-disturbing activities. The Archaeological Monitoring Protocol will include information regarding pre-action ceremonies, notification of ground disturbing work, the presence of a professional archaeologist and a tribal representative, and procedures in case of discovery. Continued coordination with the Oregon state historic preservation office is required.

2.3.2 Long-Term Monitoring

Long-term monitoring will evaluate the performance of the constructed CDF and for the habitat mitigation. For the CDF, monitoring will include evaluating physical stability of the CDF berm during and following high flow and flood events, and groundwater quality monitoring of the CDF and berm[10]. To facilitate groundwater monitoring of the CDF and berm, groundwater wells will be installed during final CDF capping activities. In addition to CDF evaluation, cap inspections will also be performed following certain natural events (earthquake or 100-year flood event) to confirm the integrity of the cap.

[10] Groundwater resources were described in the Site Characterization Report (BBL 2004b) and the EE/CA (BBL 2005).

The frequency of cap monitoring will be determined during detailed design of the selected remedy and may be modified based on performance.

For the Mitigation Action, appropriate monitoring will be conducted to survey physical components of construction that are linked to habitat characteristics known to be desirable for juvenile salmonid usage, and biological aspects such as vegetation survival and cover. As stated in the Action Memo, "the overall objective for the mitigation project as well as specific, quantitative performance standards for both the construction and long term monitoring of the mitigation project will be established in development of the final, approved mitigation plan" (USEPA 2006).

3 SPECIES ACCOUNTS AND USE OF THE ACTION AREA

This section describes species life history information and biological requirements, factors limiting the species, and information about the presence of each federally listed species that may occur in the Action Area.

3.1 Pacific Salmonids

Evolutionarily Significant Units (ESUs) and DPSs of Pacific salmonids that may occur in the Action Area were previously listed in Table 1. This section defines range-wide biological requirements of these salmonids as well as ESU- or DPS-specific information. Available historical and relatively recent species information is summarized from NMFS' coast-wide status reviews (Busby et al. 1996; Johnson et al. 1997; Weitkamp et al. 1995). Both adult and juvenile salmonids would be expected to use the Action Area, as described below.

In general, adult salmonids would be expected to occur in the deeper water of the main river channel of the Action Area. Adults of various ESA-listed species would be present during most months of the year during their respective upriver migration periods. Adults typically follow river margins when returning to their natal streams, moving rapidly through shallow water, and resting in deep pools and areas with habitat structure (Spence et al. 1996). Some adults may hold for periods of time within the Portland Harbor (NMFS 2002), but no spawning occurs in the Action Area.

Juveniles would be expected to be present in the Action Area year-round, and would be expected to use both the nearshore and offshore portions of the Action Area depending on fish size, with larger juveniles (yearlings) using offshore areas more often. General juvenile salmonid use of the Action Area is expected to vary by species and lifestage, as detailed below in the species-specific information.

3.1.1 Chinook Salmon

Chinook salmon mature between 2 and over 6 years of age (Myers et al. 1998). Fall-run Chinook salmon enter fresh water at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of fresh water entry (Healey 1991). Post-emergent fry seek shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. Chinook salmon spend between 1 and 4 years in the ocean before returning to their natal streams to spawn (Myers et al. 1998). Chinook salmon described in this BA typically exhibit an ocean-type life history, and smolts out-migrate predominantly as subyearlings, generally during April through July. Some Chinook salmon return from the ocean to spawn 1 or more years before full-sized adults return, and are referred to as jacks (males) and jills (females).

There is some evidence that subyearling Chinook hold in the Portland Harbor area over a longer period than other species of salmonids, attributed to their active feeding during migration (Knutsen and Ward 1991). Yearling Chinook may over-winter in the Lower Willamette River (NMFS 2002). ODFW (2005) observed that the median migration rate for yearling Chinook salmon during the study was 11.3 kilometers per day and median residence time in the study area was 3.4 days, and most tagged Chinook (76 percent) in the study were recovered in offshore, as opposed to nearshore, areas.

3.1.1.1 Lower Columbia River Chinook Salmon

The Lower Columbia River Chinook salmon ESU is currently listed as threatened under the ESA (Table 1). The ESU includes all naturally spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon east of the Hood River and the White Salmon River, and includes the Willamette River to Willamette Falls, Oregon, exclusive of spring-run Chinook salmon in the Clackamas River. The Lower Columbia River ESU of Chinook salmon includes both the fall-run and spring-run stocks. The majority of fish migrating through the Action Area are fall-run.

Factors listed in the decline of Lower Columbia River Chinook salmon include habitat loss due to hydropower development, urbanization, and other land uses that have reduced the function of riparian and in-stream habitat. Substantial impacts have occurred in the Lower Willamette Valley, including channelization and diking of rivers, filling and draining of wetlands, removal of riparian vegetation, and pollution (Kostow 1995).

The majority of Lower Columbia River Chinook salmon juveniles emigrate to the ocean as subyearlings, and there is some evidence that yearling migrants that do occur may be influenced by hatchery programs (Howell et al. 1985; Hymer et al. 1992; Myers et al. 1998; Olsen et al. 1994; Reimers and Loefell 1967; WDF et al. 1993). Adults return to tributaries in the Lower Columbia River at 3 and 4 years of age.

Migrating Lower Columbia River Chinook adults may be present in the Action Area starting in August and continuing through November, with peak migration occurring in September and October, and in November for "tule" Chinook (Kostow 1995; WDF et al. 1993). Juveniles in this ESU would be expected in the Action Area starting in March, continuing through July, with peaks occurring in April, May, and June.

3.1.1.2 Upper Willamette River Chinook Salmon

The Upper Willamette River Chinook salmon ESU is currently listed as threatened under the ESA by NMFS. This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River and its tributaries, above Willamette Falls, Oregon. Fall Chinook salmon above Willamette Falls were introduced and are not considered part of this ESU. Populations in this ESU have a life history that shares features of both the stream and ocean types of Chinook salmon.

Habitat blockage and degradation are listed as factors contributing to the decline of this ESU. Available habitat has been reduced by construction of dams in the Santiam, McKenzie, and Middle Fork Willamette River basins, and these dams have probably adversely affected remaining production via thermal degradation throughout the basin (Bottom et al. 1985; Kostow 1995).

Adult Upper Willamette River Chinook may occur in the Action Area concurrent with their upriver migration beginning in March and ending in July, with the peak between late April and early June (NMFS 2004). Smolts may pass through the Action Area from January through June, and from August through December, and some Upper Willamette River juveniles may over-winter in the Lower Willamette River.

3.1.2 Coho Salmon

Coho salmon typically mature at 3 years of age. Adult coho salmon typically enter rivers between September and February and spawning occurs from November to January (Hassler 1987), but occasionally as late as February or March (Weitkamp et al. 1995). Post-emergent fry move into shallow areas with vegetative or other cover, dispersing up- or downstream as they grow larger. In summer and during over-wintering, coho salmon fry prefer pools or other slower velocity areas such as alcoves, with woody debris or overhanging vegetation. Juveniles may rear in fresh water for up to 15 months then migrate to the ocean as smolts from March to June (Weitkamp et al. 1995). Coho salmon adults typically spend 2 years in the ocean before returning to their natal streams to spawn.

In a recent study, ODFW (2005) documented that the median migration rate for coho salmon in the Willamette River study area was 4.6 kilometers per day and median residence times in the study area were 8.7 days for coho salmon. In spring, coho salmon were found in higher abundance in areas with rock outcrops as compared to other habitats (ODFW 2005).

3.1.2.1 Lower Columbia River Coho Salmon

The Lower Columbia River ESU of coho is currently designated as threatened under the ESA. The ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side, including the Willamette River as far upriver as Willamette Falls. The Willamette River and its tributaries historically provided important spawning grounds for Columbia River basin coho salmon (Fulton 1970); however, most coho habitat in this area has been blocked by numerous tributary dams. Decline in the natural production of Lower Columbia River coho is primarily due to freshwater and estuarine habitat degradation and the ensuing problems related to artificial propagation and overharvest of the wild stocks as part of the hatchery-origin fishery (Johnson et al. 1991; Cramer and Cramer 1994).

The majority of Lower Columbia River coho return to spawn in the Columbia River between early December and March (NMFS 1991). In the Clackamas River, a tributary to the Willamette River, adult Lower Columbia River coho occur in two peaks: September (early run) and in January/February (late/native run) (Weitkamp et al. 1995). ODFW (2005) found that juvenile coho salmon in the Willamette River were found near shore more often than other species (43 percent) and were found more often near beaches and away from riprap and artificial fill. For these reasons, it is expected that adult and juvenile coho salmon are likely to be present in the Action Area as follows: adults are expected to occur in the deep water areas in the vicinity of the Action Area during these periods of their upstream spawning migration, and juveniles may occur in the shallow water portions of the Action Area during out-migration between February and July, peaking in May and early June (Cramer and Cramer 1994; Port of Portland and EES 2004a).

3.1.3 Chum Salmon

Chum salmon mature between 3 and 6 years of age. Adult chum salmon typically return to spawn between October and December (Salo 1991). The newly emerged fry typically begin downstream migration immediately, but a very small number of chum fry may reside in fresh water until the end of summer. Fry entering saltwater typically assemble in small schools close to shore and then gradually move to deeper waters as they grow and migrate toward open ocean waters. Chum salmon adults typically spend 3 to 5 years in the ocean before returning to their natal streams to spawn.

3.1.3.1 Columbia River Chum Salmon

The Columbia River ESU of chum salmon is currently listed as threatened under the ESA by NMFS. This ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries in Washington and Oregon. The effects of the mainstem Columbia River hydropower system have probably been more severe for chum salmon than for other salmon species. Bonneville Dam presumably continues to impede recovery of upriver populations. Substantial habitat loss in the Columbia River estuary and associated areas is identified as an important factor in their decline and also represents a significant continuing risk for this ESU.

The majority of Columbia River chum salmon from tributaries below Bonneville Dam spawn on the Washington side of the Columbia River; in the Portland vicinity, chum salmon have been reported to occur in October in the Sandy River (Salo 1991). Columbia River chum salmon do not spawn in the Willamette River or its tributaries. However, chum salmon may occur in the Action Area because adult Columbia River chum salmon must pass the mouth of the Willamette River during their upstream migration from late September through December, and out-migrating chum salmon fry may move into the Lower Willamette River for short periods during incoming tides (NMFS 2004; Johnson et al. 1997). Adults would be expected to use the deep water sections of the Action Area and juveniles would be expected in the shallow water.

3.1.4 Steelhead

Steelhead occur in two forms: 1) the anadromous steelhead and 2) the resident rainbow trout. The life histories of anadromous steelhead vary considerably, and adult steelhead spawners are divided into two races depending on the time of year they enter fresh water: summer-run and winter-run. Winter-run steelhead enter the rivers between November and April, whereas summer-run steelhead begin their migration from May to November (Busby et al. 1996). Summer-run steelhead generally enter fresh water between June and September, and spawn the following spring. Winter-run fish enter the rivers from December to February and spawn shortly thereafter. Steelhead adults typically spend 1 to 5 years in the ocean before returning to their natal streams to spawn. Steelhead spawn in cool, clear, and well-oxygenated streams with small to large gravel and suitable flow in conditions typical of upper tributaries of rivers (USFWS 1983). In a recent study, ODFW (2005) observed that the median migration rate for steelhead juveniles was 12.5 kilometers per day and median residence time in the Willamette River study area was 2.5 days.

3.1.4.1 Lower Columbia River Steelhead

The Lower Columbia River steelhead DPS is currently listed as threatened under the ESA. This DPS includes all naturally spawned populations of steelhead (and their progeny) in streams and tributaries to the Columbia River between the Cowlitz and Wind Rivers, Washington (inclusive) and the Willamette and Hood Rivers, Oregon (inclusive). Excluded are steelhead in the Upper Willamette River Basin above Willamette Falls and steelhead from the Little and Big White Salmon Rivers in Washington. This DPS includes both winter and summer runs of steelhead.

Most Lower Columbia River steelhead populations are in decline, primarily attributed to significant habitat blockages and degradation (NMFS 2003a). Summer- and winter-run Lower Columbia River steelhead adults may occur in the Action Area all year, but peak juvenile out-migration occurs from late April through May (Busby et al. 1995 and 1996; NMFS 2002). Use of the Action Area by Lower Columbia River smolts is expected to be limited as they are generally expected to pass through the Action Area in less than 1 day (NMFS 2002).

3.1.4.2 Upper Willamette River Steelhead

The Upper Willamette River steelhead DPS is currently listed as threatened under the ESA by NMFS. This DPS includes all naturally spawned populations of winter-run steelhead in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River, inclusive. Native Upper Willamette River steelhead of this basin are late-migrating winter-run, entering fresh water primarily in March and April (Oregon DEQ and USEPA 2002; Howell et al. 1985), whereas most other populations of west coast winter steelhead enter fresh water beginning in November or December.

Factors listed in the decline of Upper Willamette River steelhead include substantial habitat blockages on the Santiam and Willamette Rivers, as well as smaller dams or impassable culverts throughout the region (Oregon DEQ and USEPA 2002). In addition, habitat degradation is implicated, including changes in streamflow, temperature, riparian habitat, and instream habitat (Bottom et al. 1985).

Adult Upper Willamette River steelhead may occur in deeper waters of the Action Area from January through mid-May (NMFS 2004). Smolts may occur in shallow water areas from March through mid-July, with peaks occurring in May (NMFS 2002). There is no steelhead spawning in the Action Area. Use of the Action Area by Upper Willamette River smolts is expected to be limited, as juvenile steelhead have been observed to quickly migrate through the Portland Harbor area, spending less time in the area than other juvenile salmonids (Knutsen and Ward 1991; NMFS 2002).

3.2 Pacific Salmonids Critical Habitat

Critical habitat is defined under Section 3(5)(A) of the ESA as: "the specific areas within the geographical area occupied by the species, at the time it is listed on which are found those physical or biological features that are essential to the conservation of the species and which require special management consideration or protection; and specific areas outside the geographical area occupied by the species at the time it is listed…upon determination by the Secretary that such areas are essential for the conservation of the species." Once critical habitat is designated, Section 7 of the ESA requires federal agencies to ensure they do not fund, authorize, or carry out any action that will destroy or adversely modify that habitat. This requirement is in addition to the Section 7 requirement that federal agencies ensure their actions do not jeopardize the continued existence of listed species.

The Action Area is within designated critical habitat for each of the ESUs and DPSs discussed in this BA, except the Lower Columbia River ESU of coho salmon. For the Lower Columbia River coho salmon ESU, critical habitat has not been proposed or designated. Affected ESUs and DPSs include: Lower Columbia River Chinook, Upper Willamette River Chinook, Columbia River chum, Lower Columbia River steelhead, and Upper Willamette River steelhead. Critical habitat for these species includes the stream channels within the proposed stream reaches, and includes a lateral extent as defined by the ordinary high water mark (OHWM) (33 CFR 319.11). Table 2 describes the designated critical habitat for species covered in this BA.

Table 2
Designated Critical Habitat Information for Listed Species Covered in this BA

Lower Columbia River Chinook	1,300 miles of streams and 33 square miles of lakes	Lower Willamette River subbasin Lower Columbia River corridor; extends from the mouth of the Columbia River to the confluence with the Sandy River
Upper Willamette River Chinook	1,472 miles of streams and 18 square miles of lakes	Lower Willamette/Columbia River corridor; extends from the mouth of the Columbia upstream to the confluence of the Willamette and Clackamas Rivers
Columbia River chum	708 miles of streams	Lower Columbia corridor; extends from the mouth of the Columbia upstream to the confluence of the Washougal and Columbia Rivers
Lower Columbia River steelhead	2,324 miles of streams, and 27 square miles of lakes	Lower Willamette River subbasin
Upper Willamette River steelhead	1,276 miles of streams, and 2 square miles of lakes	Lower Willamette/Columbia River corridor; extends from the mouth of the Columbia River upstream to the confluence of the Clackamas and Willamette Rivers

Regarding these species, NMFS reviews the status of critical habitat affected by the proposed action by examining the condition and trends of primary constituent elements (PCEs) throughout the designated area. PCEs consist of the physical and biological elements identified as essential to the conservation of the species in the documents identifying critical habitat. The salmonid ESUs and DPSs considered in this BA share many of the same river reaches and have similar life history characteristics and requirements (and share the same PCEs). The PCEs potentially found in the Action Area include freshwater rearing and freshwater migration during the juvenile stage of the salmonid life cycle (Table 3).

Table 3
Sites and Essential Physical and Biological Features Designated as PCEs, and the Species Life Stage Each PCE Supports[1]

Freshwater rearing	Water quantity and floodplain connectivity	Juvenile growth and mobility
	Water quality and forage	Juvenile development
	Natural cover[2]	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover	Juvenile and adult mobility and survival

1 – This table adapted from NMFS 2005a.
2 – Shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

The condition of critical habitat PCEs in the Action Area for salmonids is limited by several factors: temperature of the Lower Willamette River in summer, the lack of floodplain connectivity, lack of shallow water habitat, altered hydrology, lack of complex habitat to provide forage and cover, and the presence of overwater structures. The filling of Slip 1 will result in the loss of a portion of critical habitat (Section 2.2.7); however, the existing habitat is poorly functioning and will be replaced by compensatory habitat mitigation (to satisfy CWA 404(b)(1) requirements) of higher quality (Section 2.2.11).

Critical habitat in the Action Area includes the aquatic areas affected by the Removal Action extending landward to the OHWM. Based on a historical analysis of U.S. Geological Survey (USGS) water level data from 1972 to 2004, water levels in the Action Area typically reach the OHWM less than 1 percent of the time from February to May, which overlaps the period that juvenile salmonids would be expected to be in the Action Area (Anchor 2006b).

3.3 Wildlife Species

The bald eagle is the only ESA-listed wildlife species that is expected to occur in the Action Area.

3.3.1 Bald Eagle

Bald eagles were listed as endangered in the contiguous United States under the ESA on March 6, 1967 (32 FR 4001). The population in the Pacific Northwest was later down-listed, on February 14, 1978, to threatened. On July 6, 1999, the USFWS proposed de-listing bald eagles from the ESA. Since its listing, population goals in eight of 10 recovery zones in Oregon have been met or exceeded. Typical behaviors for bald eagles in the region of the Lower Willamette River include nesting, foraging, perching, and wintering. The potential for the Removal Action to affect each of these behaviors is discussed in Section 5.2.1.1.

3.3.1.1 Nesting

The majority of nesting bald eagles in Oregon occur in the following areas: the Columbia River downstream of Portland, the Oregon coast and Coast Range, the High Cascades, Klamath Basin, and the upper Willamette River Basin. The majority of nest sites are within 0.5 mile of a body of water such as coastal shorelines, bays, rivers, lakes, farm ponds, and dammed rivers (i.e., beaver dams, log jams, etc.), and have an unobstructed view of the water (Anthony and Isaacs 1989). Bald eagle habitat typically occurs in undeveloped areas with little human activity. Nesting occurs from January 1 to August 15 (USFWS 1986).

The Pacific States Bald Eagle Recovery Plan (USFWS 1986) recommends limiting construction activities near bald eagle nests during critical wintering and nesting periods. The plan recommends construction and disturbance setbacks of 0.25 miles if the nest does not have a line of sight to the proposed construction activity, or 0.5 miles (2,640 feet) if the nest is within line of sight of construction. The closest nest sites to project activities are located at Smith Lake, approximately 1.9 miles east of the Terminal 4 project area and not in line of sight of the project, and on Ross Island, approximately 9 miles south of the Action Area (Anchor 2005).

3.3.1.2 Foraging

Bald eagle foraging is opportunistic and they are typically associated with water features such as rivers, lakes, and coastal shorelines where they prey upon fish, waterfowl, and seabirds. They prefer high structures for perching such as trees along the shoreline, but will also use other structures such as cliffs, piling, and open ground. They are usually seen foraging in open areas with wide views (Stalmaster and Newman 1979). Foraging could occur in the Action Area when eagles are present at nest sites.

3.3.1.3 Perching

Perch sites may be used for activities that include hunting, prey consumption, signaling territory occupation, and resting. Perches are most often associated with food sources near water and will have visual access to adjacent habitats (Stalmaster and Newman 1979). Suitable perch trees exist along sections of the Lower Willamette River corridor and in Forest Park, which is directly across the river from the Action Area, but no perch trees exist within or directly adjacent to the Action Area.

3.3.1.4 Wintering and Winter Roosting

Wintering bald eagles are found throughout Oregon, but concentrations occur in areas with dependable food supplies such as Klamath and Harney Basins and along the Snake and Columbia Rivers. Wintering activities for bald eagles occur from approximately November 1 through March 1. During the winter months, bald eagles forage, construct nests, and engage in courtship activities. There are no winter roosting areas in the Action Area and the closest winter roosting area is in Burlington Bottoms, approximately 4 miles to the northwest of the Action Area (J. Dillon, USFWS, personal communication 2004).

4 ENVIRONMENTAL BASELINE

This section describes the existing conditions in the Action Area, which includes the effects of past and ongoing human and natural factors leading to the current status of the species, their habitat, and ecosystems. In general, physical habitat conditions in the Action Area and vicinity are degraded for many habitat elements considered for listed species. The Action Area lies within a highly active area of the Portland Harbor and Portland metropolitan area, and is within the Industrial Sanctuary designated by the City of Portland's Comprehensive Plan. As a result, physical development (e.g., shoreline modification, dredging) and high disturbance (e.g., vessel traffic, ship wakes) that would be expected for these areas are present. The following sections provide more detail on the characteristics of the existing biological community and key indicators of Action Area habitat conditions.

4.1 General Information on Biological Communities in the Action Area

Compared to pre-European settlement, the general health of aquatic biota of the Lower Willamette River has been adversely affected by anthropogenic stresses including loss of habitat due to physical alterations, chemical impacts, and biological stresses from introduction of exotic species. Extirpations of sensitive species have occurred, and introductions of non-native species have resulted in increased competition for food and habitat for native species.

The existing fish community in the Lower Willamette River consists of warm-water, cool-water, and cold-water fish. There are several listed salmonid ESUs that may occur in the Action Area, as well as at least 33 other native and introduced species of both warm-water and cool-water fish that have been identified in the Lower Willamette River (ODFW 1994). These fish include white sturgeon, northern pikeminnow, smallmouth bass, peamouth chub, reticulated and prickly sculpin, common carp, largescale sucker, Pacific lamprey, threespine stickleback, pacific sculpin, yellow perch, American shad, smallmouth bass, grass carp, warmouth, and western mosquitofish (Farr and Ward 1993; EES 2003).

Previous BAs prepared for activities in Terminal 4 Slip 3 (Port of Portland and EES 2004a and 2004b) describe several benthic macroinvertebrates and zooplankton known to be present in the Lower Willamette River, listing oligochaetes, mysid shrimp, the amphipod

Corophium salmonis, chironomid (midge) larvae, crayfish, mollusks, several species of cladocera, copepods, hydracarina (water mites), and mayflies.

4.2 Aquatic Habitat

This section describes aquatic habitat characteristics typically considered for documenting environmental baseline conditions for Pacific salmonids. These characteristics that are suited to the type of habitat provided within the Action Area include adult migration and juvenile rearing habitat. No salmonid spawning habitat occurs within the Action Area.

Historically, floodplains, off-channel, and shallow water habitats existed in the Portland area, with large off-channel lakes such as Lake Guilds, Lake Doane, and Lake Ramsey (WRI 2004). In the last 150 years, the Lower Willamette River channel has deepened, narrowed, and simplified; banks have been hardened and lined (WRI 2004); floodplain, off-channel, and shallow water habitats have been filled; and banks have been steepened. Currently, the majority of the mainstem Willamette River channel, including mainstem areas bordering Terminal 4, is characterized by deep (greater than 20 feet NGVD 29) open-water areas in the navigation channel and relatively narrow strips of shallower areas (less than 20 feet NGVD 29) adjacent to shorelines. The shorelines are frequently broken by areas with seawalls or other structures that lack shallow water habitat.

As part of the CWA 404(b)(1) analysis, the habitat in the Removal Action Project Area was characterized based on physical features of the shoreline and riverbanks, as well as water depth. Table 4 summarizes the results of that characterization.

Table 4
Characteristics of Aquatic Habitat in the Removal Action Project Area

Less than 20 feet water depth (acres)	3.3	1.7	4.0	0.8	1.4	11.2
Greater than 20 feet water depth (acres)	10.9	11.7	1.2	1.4	1.2	26.4
Less than 20 feet water depth, less than 20 percent slope (acres)	0	0	3.2	0	0.6	3.8
Inundated pilings (acres)	3.5	3.0	0.0	0.0	0.8	7.3
Overhead pier structures (acres)	1.6	1.8	0	0	0.5	3.9
Total shoreline length (feet)	3,317	1,875	1,120	775	779	7,866
Bank Type[1]						
Structures length (feet)	2,776	1,523		696	432	5,427
Unclassified fill (feet)	425	352	766		347	1,890
Seawall (feet)				79		79
Riprap (feet)	116		354			470

1 – Bank Types as Classified by City of Portland (2001).

4.2.1 Surface Sediment Quality

The *Site Characterization Report* (BBL 2004b) evaluated surface sediment concentrations in the Removal Action Project Area and confirmed the degraded condition of sediment quality in the vicinity of Terminal 4. The EE/CA indicated that existing surface sediment contaminants have likely impacted wildlife by direct or indirect exposure due to direct contact, feeding, or bioaccumulation (BBL 2005).

In the *Site Characterization Report*, sediments were evaluated against two sediment quality guidelines: TECs and PECs. The TEC is a low effects guideline that represents concentrations below which toxicity effects are unlikely to be observed in freshwater benthic invertebrates. The PEC is a higher, probable effects guideline that represents concentrations above which toxicity effects are likely to be observed in freshwater benthic invertebrates. Dividing the chemical concentration by the PEC or TEC results in an exceedance ratio, which if greater than 1, indicates a concentration greater than the guideline. Additional details on TEC and PEC data collected in the Removal Action Project Area are available in the *Site Characterization Report*, but some information on the PEC as the higher guideline is presented here, for reference; the following PEC exceedances were reported in the *Site Characterization Report*:

- Some polycyclic aromatic hydrocarbons (PAHs) in some samples of Slip 1 surface sediment; the maximum PEC exceedance ratio for total PAHs was 2.
- Total DDT in one Slip 1 surface sediment sample, with a PEC exceedance ratio of less than 2.
- Total polychlorinated biphenyls (PCBs) in one Slip 1 surface sediment sample, with a PEC exceedance ratio of less than 2.
- Lead in one Wheeler Bay surface sediment sample, with a PEC exceedance ratio of less than 2.
- Some PAHs in one sample of Wheeler Bay surface sediment; the PEC exceedance ratio for total PAHs in that sample was less than 2.
- Lead in two samples and zinc in one sample of Slip 3 surface sediment; the lead PEC exceedance ratios were 2 and 5, and the zinc PEC exceedance ratio was less than 2.
- Some PAHs in some samples of Slip 3 surface sediment; the maximum PEC exceedance ratio for total PAHs was 26.

4.2.2 Water Quality

Water quality in the Willamette River is regulated by the State of Oregon and enforced by the Oregon DEQ, with both numeric and narrative standards designed to protect designated beneficial uses. According to these standards, the Willamette River, from its mouth at the Columbia River to Willamette Falls, exhibits the following designated beneficial uses: Public Domestic Water Supply, Private Domestic Water Supply, Industrial Water Supply, Irrigation, Livestock Watering, Fish and Aquatic Life, Wildlife and Hunting, Fishing, Boating, Water Contact Recreation, Aesthetic Quality, Hydro Power, and Commercial Navigation and Transportation.[11]

The sections below describe existing conditions at Terminal 4 for various water quality parameters.

4.2.2.1 Dissolved Oxygen

Dissolved oxygen (DO) in the Lower Willamette is not listed on Oregon DEQ's 303(d) list as a parameter of concern. In data collected between 1990 and 2001 in support of the Portland Harbor RI/FS Programmatic Work Plan, DO at the Spokane, Portland, and Seattle (SP&S) railroad bridge (RM 7; approximately 2.3 miles from Terminal 4) ranged from 6.4 to 14.2 milligrams per liter (mg/L) throughout the year (LWG 2004). Data collected in October and November of 2000 during ODFW's fish use study of the Lower Willamette River indicated that DO readings in the vicinity of Terminal 4 ranged from 10.9 to 11.2 mg/L during this period.

4.2.2.2 pH

Oregon DEQ's 303(d) list does not list pH in the Lower Willamette as a parameter of concern. Data collected in 1990 and 2001 to support the Portland Harbor RI/FS Programmatic Work Plan indicated that pH at the SP&S railroad bridge (RM 7) ranged from 6.8 to 8.3 throughout the year (LWG 2004).

4.2.2.3 Temperature

Oregon DEQ and USEPA have developed and approved new water quality standards for Oregon waters (Port of Portland and EES 2004a). The basis for the new Oregon DEQ temperature standard for the Lower Willamette River was the protection of cold-water species such as anadromous salmonids. The portion of the Willamette River that includes Terminal 4 is identified by the Oregon DEQ as providing migration habitat for salmon and steelhead. The temperature standard set for this area includes the stipulations that the 7-day-average maximum temperature may not exceed 68.0° F (20.0° C), and the waterbody must have cold-water refugia that is significantly distributed so as to allow salmon and steelhead migration without significant adverse effects from higher water temperatures elsewhere in the waterbody (OAR 340-041-0028(4)).

The Lower Willamette River (RMs 0 to 24.8) is on the Oregon 303(d) list as water quality limited for temperature during the summer months (Oregon DEQ 2003). The listing for the Willamette River was based on data collected by the Oregon DEQ at RMs 7.0 and 13.2 between water years 1986 and 1995 (Oregon DEQ 2003), wherein the temperature water column criterion was 68° F (20° C) and summer data from these years (except 1991) showed that 68 percent (34 of 50) of the samples recorded at

[11] OAR 340-041-0340, Table 340A

RM 7.0 exceeded the temperature standard (the maximum recorded was 26° C in July 1988).

More recent temperature data, collected by the Oregon DEQ laboratory (Oregon DEQ 2004) at the SP&S railroad bridge (RM 7.0) were reviewed by the Port of Portland and EES (2004a), for the time-period 1994 to 2004. They found that data were consistent with historic data, indicating that mid-summer temperatures continued to exceed the temperature standard.

4.2.2.4 Sediment/Turbidity

Existing Turbidity Levels

Average turbidity levels in the Lower Willamette River fluctuate throughout the year, but tend to be greater in fall and winter. Oregon DEQ (2004) collected turbidity information in the vicinity of the SP&S railroad bridge, at RM 7.0, 2.3 miles from Terminal 4. Average monthly turbidity in the months of December, January, and February (1995 to 2000) was 16, 39, and 47 nephelometric turbidity units (NTUs), respectively; maximum ambient turbidity levels were 24, 46, and 149 NTUs, respectively. Turbidity levels in this study were generally much lower during the summer and early autumn with average monthly turbidity ranging between 4 and 8 NTUs for the months of July through October; maximum turbidity levels during these months ranged from 4 to 18 NTUs.

Additional turbidity data in the vicinity of the Action Area were collected as part of the Removal Action Project Area characterization in Slip 3 over three periods between March 18 and May 17, 2004 (BBL 2004b), with typical turbidity of 6 NTUs with turbidity spikes ranging between 40 and 300 NTUs. Average turbidity at the inner portion of Slip 3 East ranged between 7.5 and 9 NTUs, while average values recorded at the outer portion of Slip 3 were 9, 15, and 23 NTUs for the months of March, April, and May, respectively.

Factors Affecting Turbidity

Ongoing river-induced sedimentation of suspended sediments occurs nearly continuously throughout the Action Area (BBL 2004b) and the periodic redistribution of this material affects long-term sediment accumulation patterns within the slips. In addition, the Willamette River experiences periodic high turbidity during flood events. Although historically the Willamette River may have had high periodic turbidity levels, the channelization of the Lower Willamette River has resulted in most of the sediment from high flows now discharging directly into the Columbia River.

As characterized under low-flow, low-rainfall conditions, the hydraulics and sedimentation in the Removal Action Project Area have the following attributes (BBL 2004b):

- Hydraulics within Slips 1 and 3 are affected by variations in river flow, stage, ship-induced currents, and, to a lesser extent, localized currents from stormwater discharge.
- River induced currents in the slips are low in velocity compared to river velocity.
- Current velocities in a majority of the Removal Action Project Area are dominated by propeller-induced currents, which result in increased circulation, velocities, and turbidity levels that extend beyond the paths that ships take in Slip 3. These currents also influence sediment transport in the Removal Action Project Area.
- Ongoing river-induced sedimentation of suspended sediments occurs nearly continuously throughout the Removal Action Project Area and periodic redistribution of this material affects long-term sediment accumulation patterns within the slips.

4.2.2.5 Chemical Contamination/Nutrients

Water quality data collected as part of the RI for Slip 3 (Hart Crowser 2000) indicated that metals, HPAHs, and phthalates were detected at three sampling locations, but concentrations did not exceed ambient water quality criteria in any of the samples. Table 5 provides a list and status of chemical contaminants and bacteria on Oregon

DEQ's 303(d) list because of impairment of one or more designated beneficial uses of water in the Lower Willamette River. These contaminants include mercury, fecal coliform, PAHs, iron, manganese, pentachlorophenol, and pesticides.

Table 5
Chemical Contaminants and Bacteria Information from Oregon DEQ 303(d) List in the Lower Willamette River, From RM 0 to RM 24.8

PCB	Fish tissue	Year-round	Oregon Health Division fish advisory issued November 21, 2001.
Mercury	Fish tissue	Year-round	Mercury concentrations have exceeded the criteria for fish tissue (0.35 pm) based on data collected since 1969. A public health advisory was issued for the consumption of fish tissue.
Fecal Coliform Bacteria	Water column geometric mean of 200, no more than 10% of samples >400	Year-round	Oregon DEQ data show that 39% (20 of 51) of samples at RM 7.0 and 31% (20 of 65) of samples (fall, winter, spring) at RM 13.2 exceed fecal coliform standard, between water years 1986 to 1995.
PAH	Water column criterion = 2,800 pg/L	Year-round	USGS site at RM 6: 35 day average concentration of 52,900 pg/L.
Iron	Water column criterion = 300 µg/L	Year-round	Oregon DEQ data at RM 6.9 show that two of four samples exceed criterion.
Manganese	Water column criterion = 50 µg/L	Year-round	Oregon DEQ data at RM 13.1 show that two of five samples exceed criterion.
Pentachlorophenol	Sediment criterion = 1.01 mg	Year-round	Oregon Health Division alert regarding fishing and swimming in the area of McCormick and Baxter due to soils and sediment contaminated by creosote.
Pesticides (Dieldrin, Aldrin, DDE/DDT)	Fish tissue	Year-round	Oregon Health Division fish advisory issued November 20, 2001.
DDT	Water column	Year-round	USGS data at RM 12.7 show that two of nine samples exceeded the criterion of 0.000024 µg/L.

Source: Port of Portland and EES 2004b

4.2.3 Habitat Access

4.2.3.1 Physical Barriers

There are no physical barriers to migration of adult or juvenile salmon in the Action Area. However, in the Willamette River, there is one mainstem dam at Willamette Falls and 13 tributary dams that largely regulate flows and present barriers to salmonid migration, despite fish passage facilities at some of these locations (Port of Portland and EES 2004a). Other physical barriers on Willamette River tributaries include undersized culverts and other developments that block access to historically available habitat (Foster 1991).

4.2.4 Habitat Elements

4.2.4.1 Substrate

Benthic habitats in the Action Area can be generally divided into three types: (1) unconsolidated sediments (sands and silts) in the deeper water and lower channel slopes; (2) unconsolidated sediments (sands and silts) in shallower areas; and (3) developed underwater structures such as rock riprap, sheet pile, and bulkheads. The deeper habitat with typically unconsolidated sediment tends to be in the center of Slips 1 and 3 and the outer portions of Wheeler Bay. Shallow water areas are found at the margins of the slips and Wheeler Bay and under docks and piers. Most of the shallow areas also contain concrete and wooden piling, riprap, and other debris.

Grain sizes in parts of the Action Area have been characterized as follows (BBL 2004a; Hart Crowser 2000):

- Under Berth 401 and in Slip 1: silty clay
- Wheeler Bay: sandy clayey silt
- North of Berth 414: various mixtures of sand, clay, and silt
- Slip 3: silty sands and clayey silts

4.2.4.2 Large Woody Debris

No comprehensive survey data of LWD frequency has been conducted for the Lower Willamette River or in the vicinity of the Action Area (Port of Portland and EES 2004a). However, LWD recruitment potential in the Action Area is low due to removal of riparian vegetation, river channelization, and the river's reduced flood plain access. The shoreline of the Action Area is characterized primarily by industrial facilities, docks, and remnant piling.

4.2.4.3 Shallow Water Habitat

Shallow water salmonid habitat in the Lower Willamette River has been reduced and degraded (primarily steep-sloped riprap shoreline) due to channelization, diking, dredging, and filling. High quality shallow water habitat typically exhibits gently sloped shoreline with fine-grained substrate and in-water and overwater cover.

4.2.4.4 Off-channel Habitat

Off-channel salmonid habitat in the Lower Willamette River has been reduced and degraded due to channelization, diking, dredging, and filling. High quality off-channel habitat typically exhibits riparian cover and reduced velocities relative to the main channel; this habitat is lacking in the Action Area.

4.2.4.5 Refugia

Refugia habitat (e.g., thermal refuge, velocity refuge, and high quality holding and rearing habitat) has been degraded or lost in the Lower Willamette River. In the Action Area, habitat has been significantly altered by industrial development and high quality refugia is lacking. However, current velocity in slip areas is lower than in the mainstem river during higher flow events.

4.2.5 Channel Conditions and Dynamics

4.2.5.1 Streambank Condition

Most of the banks in the Action Area typically contain piling, sheet pile, riprap, vertical cement walls, metal debris, and docking facilities. As noted in Table 4, of the 7,866 linear feet of bank habitat in the Removal Action Project Area, 5,427 feet are bordered by an overwater pier structure, 79 feet are armored by seawalls, and 470 feet contain riprap armoring. Riparian vegetation in the Action Area is sparse and limited, consisting chiefly of immature black cottonwood, with a few Oregon white ash, red alder, and willow. This vegetation exists in the areas of Slip 1 and along the east side of Slip 3, and mostly occurs among shoreline debris and piling. Bank erosion west of Berth 409 and Slip 1 and in Wheeler Bay was recognized in the EE/CA as a historical and ongoing source of localized sediment contamination to the Action Area; however, its contribution to contamination was identified as non-significant (BBL 2005).

4.2.5.2 Floodplain Connectivity

Floodplain connectivity has been lost or reduced in the Action Area and in the vicinity of the Lower Willamette River due to flood control projects, dams, and urbanization.

4.2.6 Flow/Hydrology

4.2.6.1 Peak/Base Flows

Patterns of flow in the vicinity of the Action Area have been altered by water management projects and dams that have minimized rapid periodic increases in peak flow, which would have previously been typical to the Willamette River. Annual minimum flows in the vicinity of the Action Area typically occur in August, and rapidly increase from October to December, peaking in December and January (NMFS 2004).

4.2.6.2 Drainage Network

The Action Area within the Lower Willamette Basin exhibits an anthropogenic drainage network that conveys runoff from developments and roadways.

4.2.7 Watershed Conditions

4.2.7.1 Road Density and Location

Road density in the vicinity of the Action Area is high due to the high population densities and developments.

4.2.7.2 Disturbance History

The Lower Willamette River channel morphology, streambanks, and floodplain areas have been substantially modified by development and urbanization within the channel, floodplains, and adjacent areas. Habitat connectivity has been lost both longitudinally along the river and laterally from the vegetated riverbanks to the upland forests (City of Portland 2004).

4.2.7.3 Riparian Reserves

Riparian vegetation in the Lower Willamette River is limited, and riparian functions, such as shade, organic inputs, and recruitment of LWD, have been reduced or do not occur.

4.3 Summary of Existing Conditions

In summary, habitat in the vicinity of the Action Area currently exhibits degraded habitat conditions in many of the characteristics discussed above. The shoreline of Terminal 4 contains many of the abundant anthropogenic structures and facilities typical of the surrounding area in the Willamette River. The context of the Action Area within the larger landscape is a highly developed zone within an industrial area with a long history and legacy of anthropogenic activities.

5 EFFECTS OF THE PROPOSED ACTION AND EFFECTS DETERMINATIONS

In Sections 3 and 4, the biological requirements of listed species and the environmental baseline of habitat in the Action Area were defined. This section addresses direct, indirect, interrelated, interdependent, and cumulative effects of the proposed action on listed species and designated critical habitat. Potential direct effects are those effects that occur at or very close to the time of the action. Indirect effects are those that are caused by the proposed action and occur later in time, but still are reasonably certain to occur. Interrelated actions are those that are associated with a larger action and depend on the larger action for their justification. Interdependent actions are those with no independent utility apart from the proposed action. Cumulative impacts are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the Action Area of the proposed project subject to consultation.

Although some individual organisms may experience adverse effects, the proposed project will provide long-term benefits for listed species by removing contamination in the Removal Action Project Area and providing enhancements of critical habitat elements as part of the mitigation project. The overall impact of the completed project on listed species and habitats is anticipated to be a net benefit.

5.1 Pacific Salmonids

5.1.1 Removal Action Effects

5.1.1.1 Direct and Indirect Effects

Potential direct and indirect effects on Pacific salmonids assessed for this project incorporate those potentially resulting from noise, disturbance to food sources, entrainment, water quality impacts, and alteration of nearshore habitat.

5.1.1.1.1 Hydroacoustic Impacts

Impact pile driving (i.e., proofing) is the construction noise of greatest concern associated with the proposed activity. Peak sound pressure levels from impact pile driving are known to cause injury to fish. Based on the practical spreading model used by NMFS, peak sound pressure levels will decrease to the NMFS expected 180 dB limits of potential harm (Hastings 2002) within 293 meters (958 feet) of a steel pile that is installed with an impact hammer, with the use of a bubble curtain or other sound attenuation device. There is potential for sustained pile driving noise within this range to induce salmonid avoidance behavior, interrupt feeding, delay migration, and reduce growth. Beyond this range, pressure waves are expected to stop at the bends in the river at 1.7 miles downstream (RM 3) and 1.3 miles upstream (RM 6) from the sound pressure source. If uninterrupted, these levels would return to ambient levels within approximately 18 miles of the pressure source. However, the duration of the effect will not extend beyond the time required to complete the pile driving, which will occur during the in-water work window when salmonids are expected to be present in very low numbers. In addition, piles will be driven with a vibratory hammer and pile driving will be limited to "proofing" the piles (Section 2.2.5.1).

5.1.1.1.2 Food Source

Construction of the CDF in Slip 1 will result in a loss of existing benthic organisms and habitat and dredging and capping in Slip 3 will temporarily disturb benthic habitat. However, impaired benthic habitat will be restored in Slip 3 after completion of dredging and capping. As described in Section 4 of this BA, the substrate in most shallow areas of both slips is highly modified and exhibits an abundance of overwater structures, concrete and wooden piling, riprap, and other debris, resulting in less area for production of epibenthic salmonid prey on bottom substrates in shallow water in these locations. Also, there is some evidence that juvenile Chinook and coho diets may more be tied to pelagic food webs rather than epibenthic prey items (ODFW 2005). Thus, while disturbances to benthic habitat will occur during project activities, due to existing compromised habitat (for all salmonids) and diet preferences (for Chinook), it is expected that impacts to salmonids via disturbance of the epibenthic prey community will be minimal.

Direct impacts to pelagic invertebrate species could result during dredging activities as a result of short-term increases in turbidity, decreases in DO, and resuspension of contaminants that may occur as a result of the project. Studies on *Daphnia spp.* reveal that there is evidence for photo-induced adverse effects of PAHs, but results have varied. In one study, *Daphnia* were documented to biotransform 50 percent of some accumulated PAHs in between 0.4 and 0.5 hours (Southworth et al. 1978); another study showed daphnids accomplished a 21 percent loss of benzo(a)pyrene in 18 hours. Whitman and Miller (1982) found that naphthalene completely inhibited the phototactic response of *D. magna* at 2.0 mg/L and depressed the response at 1.0 mg/L. Further, *Daphnia* spp. are expected throughout the water column in many areas of the project vicinity, and impacts resulting from exposure to contaminants are not expected to be at a level that would affect the abundance of these ubiquitous prey items.

For these reasons, it is anticipated that any impacts to the prey community as a result of the proposed action will have little effect on salmonids. Moreover, the purpose of conducting the removal of sediment contamination in the Removal Action Project Area is to reduce exposure to existing contaminants and to provide long-term benefits to prey species, as well as salmonids, by significantly improving overall benthic habitat conditions at Terminal 4.

5.1.1.1.3 Entrainment

Entrainment due to Dredging

The dredging operations planned for the proposed project are not expected to entrain juvenile salmonids. Pressure waves created as the bucket (mechanical dredging) or hydraulic pump (hydraulic dredging) descends through the water column will forewarn salmonids present within the area, and will allow individuals time to avoid the mechanism. In addition, for mechanical dredging, the clamshell jaws are open during descent, which should reduce the likelihood of entrapping or containing fish (NMFS 2003b). The U.S. Army Corps of Engineers (Corps) conducted extensive sampling within the Columbia River in 1985 through 1988 (Larson and Moehl 1990). In the study, no juvenile salmon were entrained. McGraw and Armstrong (1990) examined fish entrainment rates outside of peak migration times in Grays Harbor from 1978 to 1989 and found that one juvenile salmon was entrained.

For hydraulic dredging, the intake will be operated at or below the surface of the bed material being removed, but may be raised briefly by a maximum of 3 feet to flush the intake system. The depth at which material removal will occur in Slip 3, as well as the intake operation procedure itself, will reduce the probability that fish will become entrained. NMFS developed a methodology to estimate the magnitude of take as a result of hydraulic maintenance dredging operations on the Lower Columbia River up to RM 125.3 (NMFS 2005b). Based upon this methodology, NMFS found that up to 583 juvenile salmonids could be entrained per year between RM 106.5 and 125.3 due to dredging in the mainstem navigation channel; however, NMFS concluded that "the magnitude of effect on ESA-listed juvenile salmonids from entrainment is likely to be small at the population and ESU scales" (NMFS 2005b). For adults, NMFS concluded that "based upon migration behavior of adult salmonids, and the proposed dredging operation and depths, the probability of entraining adult salmonids in the navigation channel, RM 4.4 to RM 125.3, is extremely low" (NMFS 2005b).

Entrainment due to CDF

In order to minimize take of listed fish species and to ensure compliance with ORS 509.585 regarding providing fish passage[12], an effort will be made to remove fish from Slip 1 prior to Slip 3 dredged material placement in the CDF. Fish removal will occur following initial berm construction when the height of the berm isolates water from the CDF from the river, and prior to Slip 3 dredged sediment placement in the CDF, and is expected to span 3 to 5 fishing days near the second half of the summer in-water work window in 2007. This removal is intended to minimize impact to listed fish, but will also have the effect of minimizing impacts to other fish species that are collected with the listed fish. Following this work, the absence (or near absence) of fish from the CDF area should minimize or eliminate the potential contact of piscivorous birds with potentially affected water, sediments, or prey from Slip 1.

[12] ORS 509.585 states that "Except as otherwise provided by this section or ORS 509.645, a person owning or operating an artificial obstruction may not construct or maintain any artificial obstruction across any waters of this state that are inhabited, or historically inhabited, by native migratory fish without providing passage for native migratory fish."

Based upon typical juvenile salmonid behavior, fish removal efforts will be focused on shallow water habitat and the top portion of the water column (NMFS 2005c). Methods were selected that should be reasonably effective for the areas where juvenile salmonids and other fish are expected to be located, and are consistent with the provisions in the NMFS fish collection guidance (NMFS 2000), typical methods used for fish collection (Murphy and Willis 1996), and with previous successful methods used to capture salmonids and other fish in the Terminal 4 vicinity (Gasco Removal Action; Anchor 2006a; and *Portland Harbor Remedial Action/Feasibility Study*; Striplin et al. 2003). These methods are listed in order of expected catch effectiveness, and this order will be used in sequencing the effort, as follows:

1. Boat electrofishing at the head and sides of Slip 1 (including Berths 405 and 408)
2. Beach seines (if possible) in the open shore of the shallow water at the head of Slip 1
3. Research-size purse seines deployed by boat on sides of Slip 1
4. Fyke nets extending from shallow to deeper water on sides of Slip 1

During sampling, shifts in priority for the methods or concurrent use of two or more methods in this list may occur depending on observed effectiveness of these methods and actual catch rates, in order to maximize potential for catching and removing as many fish as possible.

The target removal proportion is 80 percent of the salmonids expected to inhabit the slip at the time of removal. To estimate number of expected salmonids, catch rates were evaluated from other studies sampling fish in and nearby Terminal 4 at the same time of year (fall months) in which fish removal is expected to occur for this project (Striplin et al. 2003; Anchor 2006a). In the Portland Harbor work, three to 12 subyearling Chinook were typically caught per beach seine set, with total catches of 15 Chinook for each station (one station was directly across the river from Slip 1). For comparison with this work, it is estimated that approximately 15 beach seine and/or purse seine sets could occur at Slip 1. At a collection of approximately 15 juvenile salmonids per set, that would equate to approximately 225 juveniles. Fyke netting in the under-pier areas and in shoreline areas potentially not fishable by beach seine may account for approximately another 100 juveniles, for a total estimate of 325 juvenile salmonids. The Gasco Biological Opinion (NMFS 2005a) estimated incidental take at 50 juvenile and five adult salmonids for the 0.5 acre site along the shore of the Willamette River. The Slip 1 shoreline acreage is approximately 3 acres, or six times the size of the Gasco project shoreline. Thus, based on the incidental take amount used in the Gasco Biological Opinion, an approximate number of salmonids that could be encountered at Slip 1 during fish removal is six times this amount, or 300 juvenile salmonids and 30 adult salmonids. These two differing approaches yield similar estimates, and therefore, it is recommended that take levels be established at 325 juvenile salmonids and 50 adult salmonids. Coordination will be ongoing with NMFS during this effort regarding actual catch per unit effort (CPUE) efficiencies encountered. As stated previously, this removal would be expected to span approximately 3 to 5 fishing days in the fall of 2007.

Once fish are captured, water quality conditions within fish transport systems (e.g., buckets or tanks) will be maintained as sufficient to promote fish recovery, including using brief holding times, aerators, and clean, cold, circulated water. Collected fish will be released into the river as quickly as possible in shallow water near the shore on the opposite side of the containment berm. The selection of release sites will be coordinated with NMFS prior to the fish removal effort. In the event of mortalities, federally listed fish will be transferred to the Services if requested.

All fish removal activity will be conducted in close coordination with NMFS to determine the removal effort duration and evaluate effectiveness of the activity. The entire collect-and-release operation will be conducted by the Port's consultant team of experienced fishery biologists to ensure the safe and appropriate capture and handling of all fish. During the entire process, the substantive requirements of ODFW Scientific Taking Permits will be met. Collection and release information will be reported to the USEPA and NMFS in a brief memorandum following the fish removal effort, including the means of fish removal, the number and species of fish removed, the condition of all fish released, and any incidence of observed injury or mortality.

5.1.1.1.4 Water Quality

Potential water quality impacts will occur as a result of construction during the Removal Action. Conservation measures (Section 2.2.7.2) and water quality monitoring will be applied for these events. The Port will be in active communication with USEPA to ensure close coordination in the event of exceedances.

The following actions will be conducted that will minimize water quality effects on fish:

- All removed sediments will be placed in the CDF and any new cover or capping materials will be clean, which will sustain a healthier invertebrate community and improve foraging opportunities for salmonids.
- Water quality in the action area will be monitored during dredging activities and additional actions will be taken to reduce water quality impacts, if unacceptable water quality is observed (Section 2.2.7.2).

Water quality elements and potential effects are discussed in detail below.

Dissolved Oxygen

During dredging of the containment berm key and dredging in Slip 1, suspension of anoxic sediment compounds may result in reduced DO in the water column as the sediments oxidize, but any reduction in DO beyond background is expected to be limited in extent and temporary in nature. Based on a review of four studies on the effects of dredging on DO levels, LaSalle (1988) showed little or no measurable reduction in DO around dredging operations[13].

[13] Bucket dredge operation in channel in New York; cutterhead dredge operation in Grays Harbor, Washington; hopper dredge operation in Oregon tidal slough; bucket dredging operation in widened portion of lower Hudson River, New York.

In addition, impacts to listed fish due to any potential DO depletion around dredging activities is expected to be minimal for several reasons: 1) the relatively low levels of suspended material generated by dredging operations; 2) counterbalancing factors in the area, such as tidal or current flushing; 3) DO depletion typically occurs low in the water column; and 4) high sediment biological oxygen demand created by suspended sediment in the water column is not common (LaSalle 1988; Simenstad 1988). A model by LaSalle (1988) showed a DO depletion of no more than 0.1 mg/L at depth[14] at the point of the upper limit of suspended sediment concentrations in typical hydraulic dredging operations. A reduction in DO during the dredging activities at Terminal 4 is expected to be minimal as the carbon content (surrogate for biological oxygen demand) is low—approximately 0.8 percent (BBL 2005).

During capping, material placed for capping is not expected to result in a change in sediment oxygen demand (and resulting DO reduction) during transport through the water column. There may be minor resuspension at the point of impact of the cap materials; however, this condition is expected to be temporary and localized, and the capping activity will be monitored by water quality testing. Based on the above information, DO is not expected to drop to a level that will detrimentally impact salmonids that may occur in the area.

Exposure to Contaminants

Short-term exposure of fish to contaminants may occur during dredging when suspended sediment and/or a portion of the chemical mass associated with the suspended sediment becomes dissolved in the water column. Direct contact and ingestion of suspended sediment, as well as uptake of dissolved chemicals in the water column across the gills, can result in increased burdens of bioaccumulative chemicals in tissue (see Appendix C) or acute effects. However, exposure is a function of concentration and duration, and any suspended sediment increases that may occur during dredging of contaminated sediments are expected to be short term and localized; dredging these sediments is expected to span approximately 2 months of the in-water work window in 2007 (Figure 6). Due to

[14] Estimates of DO demand used over the range expected for estuarine sediments.

this short-term and localized nature of operations potentially causing suspension of contaminated sediments, the potential for bioaccumulation or acute increases are expected to be minimal.

During Slip 3 dredging and dredging in the area North of Berth 414 (if dredged), contaminants will be tested for as part of water quality monitoring using chemical testing (Section 2.2.7.2). There is a significant long-term benefit of removing chemicals in contaminated sediment from the sediment environment, which must be taken into consideration when evaluating the potential short-term risks of some exposure during the proposed Removal Action. As stated previously, the overall objective in completing the project is to reduce the long-term risk of contaminant exposure for listed species.

Fish could also be exposed to contaminants as a result of accidental spills from construction equipment. However, spills and accidental releases of dredged material during handling and filling into the CDF will be minimized and mitigated by implementing standard and appropriate material handling and containment procedures. Using the CDF at Slip 1 to place dredged materials from Slip 3 reduces the potential for off-site spills and contamination.

Turbidity

There may be temporary increases in turbidity due to dredging activities. However, as described in Section 4.2.2.4, periodic spikes in turbidity do presently occur during low water conditions in the Terminal 4 area concurrent with normal operating conditions of the existing slips.

Research has shown that turbidity increases due to dredging are typically short term and localized in nature. Mechanical clamshell dredging causes increased suspended sediment concentrations due to the impact and withdrawal of the bucket from the substrate, the washing of material out of the bucket as it moves through the water column, and the loss of water as the sediment is loaded onto the barge (Hayes et al. 1984, Nightingale and Simenstad 2001). However, this turbidity is typically very limited, short term, and localized, and should not result in any long-term effects as a result of the proposed action (NMFS 2003b). For a hydraulic dredge operation, exclusive of overflow, the turbidity source at the point of contact with the sediments has little, if any, plume at the surface (Hayes et al. 1984). With both dredging methods, suspended sediment concentrations vary throughout the water column, with larger plumes typically occurring at the bottom closer to the point of dredging. Even without suspended sediment controls, plume size decreases exponentially with movement away from the point of dredging both vertically and horizontally. Increases in turbidity that result from dredging activities will be short term and localized, and are typically of much less magnitude than increases caused by natural storm events (Nightingale and Simenstad 2001).

The potential effects of increased turbidity on salmonids have been investigated in a number of dredging studies (Servizi and Martens 1987 and 1992, Emmet et al. 1988, Simenstad 1988, Redding et al. 1987, Berg and Northcote 1985, Noggle 1978, Mortensen et al. 1976). There are several mechanisms by which suspended sediment can affect juvenile salmonids including direct mortality, gill tissue damage, physiological stress, and behavioral changes. Each of these potential effects is discussed below.

Direct Mortality

Direct mortality from extremely high levels of suspended sediment has been documented at concentrations far exceeding those caused by typical dredging operations. Laboratory studies have consistently found that the 96-hour median lethal concentration (LC50) for juvenile salmonids occurs at levels above 6,000 mg/L (Stober et al. 1981, Salo et al. 1980, LeGore and DesVoigne 1973). However, typical samples collected adjacent to dredge locations (within approximately 150 feet) contain suspended sediment concentrations between 50 and 150 mg/L (Palermo et al. 1990, Havis 1988, Salo et al. 1979). Based on an evaluation of seven clamshell dredge operations, LaSalle (1988) determined that suspended sediment levels of 700 mg/L and 1,100 mg/L at the surface and bottom, respectively, would represent the upper limit concentration expected adjacent to the dredge source (within approximately 300 feet). Concentrations of this magnitude could occur at locations with fine silt or clay substrates. Much lower concentrations (50 to 150 mg/L at 150 feet) are expected at locations with coarser sediment. Because direct mortality occurs at turbidity levels that far exceed typical dredging operations, direct mortality from suspended sediment is not expected to occur during this project.

Gill Tissue Damage

Studies indicate that suspended sediment concentrations occurring near dredging activity are generally not high enough to cause gill damage in salmonids. Servizi and Martens (1992) found that gill damage was absent in underyearling coho salmon exposed to concentrations of suspended sediments lower than 3,143 mg/L. Redding et al. (1987) also found that the appearance of gill tissue was similar for control fish and those exposed to high, medium, and low concentrations of suspended topsoil, ash, and clay. Based on the results of these studies, juvenile and subadult salmonids, if present, are not expected to experience gill tissue damage even if exposed to the upper limit of suspended sediment concentrations expected during dredging.

Physiological Stress

Suspended sediments have been shown to cause physical stress in salmonids, but at concentrations higher than those typically caused by 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). Exposure to approximately 500 mg/L of suspended sediment for 2 to 8 consecutive days also caused stress, but to a much lesser degree (Redding et al. 1987, Servizi and Martens 1987). At 150 to 200 mg/L of glacial till, no significant difference in blood plasma glucose (a stress indicator) concentrations were observed. These results indicate that upper limit suspended sediment conditions near dredging activity (700 to 1,100 mg/L) can cause stress in juveniles if exposure continues for an extended period of time. Continued exposure is unlikely, however, due to the tendency for unconfined salmonids to avoid areas with elevated suspended sediment concentrations (Salo et al. 1980). Typical sediment plumes caused by dredging do not create suspended sediment concentrations high enough to cause stress in juvenile salmonids (Contaminated Sediments Task Force 2003).

Behavioral Effects

Behavioral responses to elevated levels of suspended sediment include feeding disruption and changes in migratory behavior (Servizi 1988, Martin et al. 1977). Several studies indicate that salmonid foraging behavior is impaired by high levels of suspended sediment (Bisson and Bilby 1982; Berg and Northcote 1985). Redding et al. (1987) demonstrated that yearling coho and steelhead exposed to high levels (2,000 to 3,000 mg/L) of suspended sediment did not rise to the surface to feed. Yearling coho and steelhead exposed to lower levels (400 to 600 mg/L), however, actively fed at the surface throughout the experiment. In these instances, the thresholds at which feeding effectiveness was impaired greatly exceeded the upper limit of expected suspended solids during dredging.

Adult migration may also be subject to disruption from suspended sediment. Adult salmonids are not necessarily closely associated with the shoreline and are less vulnerable to adverse impacts if they encounter turbid conditions. Whitman et al. (1982) used volcanic ash from the eruption of Mt. St. Helens to recreate highly turbid conditions faced by returning adult salmon. This study showed that, despite very high levels of ash, adult male Chinook were still able to detect natal waters through olfaction even when subjected to 7 days of total suspended sediment levels of 650 mg/L. Therefore, migratory or feeding disruptions are not expected to occur from dredging activities.

5.1.1.1.5 Alteration of Nearshore Habitat

The Lower Willamette River is a migratory corridor for juvenile and adult salmonids discussed in this BA; habitat use of this area was discussed in Section 3. Nearshore habitat will be affected during demolition of overwater structures in Slip 1; however, following demolition, the nearshore of Slip 1 will be converted to upland and compensatory habitat mitigation will be required to mitigate for lost habitat functions to comply with the Clean Water Act Section 404(b)(1). In Slip 3, nearshore areas will be capped with clean sediment. In addition, following construction of the replacement berth, a new nearshore area will be created at the waterward face of the berm, to include a habitat bench along this face. As described in Section 2, conservation measures will be taken to avoid unnecessary impacts and minimize the negative effects of these actions. The overall effect of alteration of these shoreline areas is expected to be minimal because existing conditions in Slip 1 are already heavily industrialized, fish use of the area is compromised, and lost habitat functions will be mitigated per Clean Water Act Section 404(b)(1) as described in Section 2.2.9. In addition, the habitat in Slip 1 that is being removed and the habitat in Slip 3 that is being altered is contaminated and is located adjacent to active berths with vessel traffic, which may limit function as nearshore habitat. The clean cap surface will provide improved habitat benefits for benthic and salmonid species relative to existing conditions. The overall effect of the completed project is a net benefit to listed species.

5.1.1.2 Effects on Critical Habitat

Designated critical habitat within the Action Area for the ESA-listed salmonids considered here consists of freshwater rearing sites, freshwater migration corridors, and certain associated essential physical and biological features. The status of these features was previously described in Section 4 and the potential effects on these features are shown in Table 6.

Table 6
Potential Effects on Sites and Biological Features Designated as PCEs

Freshwater rearing	Water quantity and floodplain connectivity	No effect on water quantity or flows. Floodplain connectivity is already limited in the project reach by industrial activities and urbanization, and will not undergo change due to the proposed project.
	Water quality and forage	Significant short-term effects to water quality will occur related to dredging and resuspension of sediments and contaminants may occur during in-water work, but these increases are expected to dissipate following these activities. The proposed vessel berth at the outer face of the containment berm will be constructed in deeper water than its current location, resulting in less overall turbidity in the vicinity of Slip 1. Construction of the CDF in Slip 1 will result in a loss of existing benthic organisms and habitat, (which will be mitigated for in accordance with Clean Water Act, Section 404(b)1). Dredging and capping in Slip 3 will temporarily disturb benthic habitat. However, impaired benthic habitat will be restored in Slip 3 after completion of dredging and capping. Existing conditions indicate that there is poor production of epibenthic salmonid prey in these areas. Thus, Removal Action activities, including compensatory habitat mitigation, are not expected to affect the abundance or availability of typical prey/forage organisms. In addition, in-water work for the project will comply with the timing restrictions specified in the in-water work window, when salmonids are expected to be present in very low numbers. In the Lower Willamette River, the work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31.
	Natural cover[1]	Natural cover is absent in the Removal Action Project Area; no effect on availability of natural cover.
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover	Passage will be impeded in the Removal Action Project Area during in-water work; project effects are likely to delay migration periodically for a period of hours, but will be limited to the duration of in-water work during dredging and construction of the CDF, which will occur during the in-water work window when salmonids are expected to be present in very low numbers. Passage will not be impeded during the filling of the CDF following

Site	Essential Physical and Biological Features	Effect from Proposed Action
		initial construction. Significant short-term effects to water quality will occur related to dredging and resuspension of sediments and contaminants may occur during in-water work, but these increases are expected to dissipate following these activities. The proposed vessel berth at the outer face of the containment berm will be constructed in deeper water than its current location, resulting in less overall turbidity in the vicinity of Slip 1. No effect on water quantity or flows. Natural cover is absent in the Removal Action Project Area; no effect on availability of natural cover. In addition, in-water work for the project will comply with the timing restrictions specified in the in-water work window, when salmonids are expected to be present in very low numbers. In the Lower Willamette River, the work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31.

1 Shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

Sections 3 and 4 of this BA indicate that existing habitat conditions for rearing and migration are already of low quality. The effects of the Removal Action will reduce water quality and fish passage in the Action Area over the short term, but will not affect the value of the Action Area to overall salmonid critical habitat over the long term. Given the context of the Action Area in an industrialized reach of the river, although short-term effects are likely, the long-term effect of the proposed action on critical habitat PCEs is likely to be beneficial. The Removal Action is not expected to appreciably reduce the conservation value of critical habitat. Moreover, the project will serve to increase the habitat value of the area by removing contaminated sediments from the environment and also providing habitat benefits through the planned Mitigation Action.

5.1.2 Mitigation Action Effects

5.1.2.1 Direct and Indirect Effects

Effects to listed fish species due to the construction of the Mitigation Action will be considered as part of the City of Portland's ESA consultation process for the Mitigation Action at the Ramsey Refugia, Phase II. Post-construction benefits to listed fish species are expected to include the re-establishment of hydrologic connectivity to the Lower Columbia Slough to reclaim and improve floodplain wetland functions (forested wetland and soft bottom, mud backwater sloughs) and to increase the amount and quality of off-channel rearing and refuge habitat for juvenile Chinook, coho, and steelhead. These fish would be expected to use habitat in Ramsey Refugia Phase II because the City of Portland's Ramsey Refugia Phase I project has already identified juvenile Chinook, coho, and steelhead using the Phase I project area (City of Portland 2006).

5.1.2.2 Effects on Critical Habitat

Effects to critical habitat due to the construction of the Mitigation Action will be considered as part of the City of Portland's ESA consultation process for the Mitigation Action at the Ramsey Refugia, Phase II. Similar to the effects on listed fish, post-construction benefits to critical habitat are expected to include the re-establishment of hydrologic connectivity to the Lower Columbia Slough to reclaim and improve floodplain wetland functions (forested wetland and soft bottom, mud backwater sloughs) and to increase the amount and quality of off-channel rearing and refuge habitat for juvenile salmonids. These fish would be expected to use habitat in Ramsey Refugia Phase II area because the City of Portland's Ramsey Refugia Phase I project has already identified juvenile Chinook, coho, and steelhead using the Phase I project area (City of Portland 2006).

5.1.3 Interrelated/Interdependent and Cumulative Effects

The capacity of the CDF for contaminated dredge material will exceed the volume to be dredged from the Removal Action Project Area. This excess capacity may be filled with materials accepted from other dredging projects in the Lower Willamette River or other nearby areas; the potential sources of dredged material are not currently known. However, placement of such materials in the CDF would be subject to evaluation and controls pursuant to a USEPA-approved operation and maintenance plan. Once the CDF is at-grade, the capped surface may be used for a purpose similar to uses in the surrounding area. Potential future uses are not known; however, any future use would be consistent with existing Port and agency requirements. Providing a CDF for contaminated sediments near the Portland Harbor Superfund Site could provide a net benefit by facilitating cleanup of contaminated sediments. As described earlier, the (404[b][1]) compensatory mitigation project will provide higher quality habitat for listed species. In addition, one goal of the project is to provide enhanced connectivity of local habitat areas, thereby increasing overall habitat function in the area.

The Mitigation Action, Ramsey Refugia Phase II, will have the interrelated and cumulative effect of providing increased long-term habitat opportunities for listed fish species foraging, rearing, and migrating through the Lower Willamette River. As stated previously, some of these fish would be expected to use habitat in Ramsey Refugia Phase II area because the City of Portland's Ramsey Refugia Phase I project has already identified juvenile Chinook, coho, and steelhead using the Phase I project area (City of Portland 2006).

5.1.4 Effects Determination

The long-term effects of exposure to contaminants will be significantly reduced after completion of the Removal Action. However, short-term adverse effects may occur to varying degrees, associated with construction activities, as discussed above. Thus, based on the potential for short-term effects for listed fish species associated with project implementation, it is concluded that the proposed action **may affect, and is likely to adversely affect, Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Lower Columbia River coho salmon, Columbia River chum, Lower Columbia River steelhead, and Upper Willamette River steelhead.**

For critical habitat, it is concluded that this project **may affect, but is not likely to adversely affect, designated critical habitat for Lower Columbia River Chinook salmon, Upper Willamette River Chinook salmon, Columbia River chum, Lower Columbia River steelhead, and Upper Willamette River steelhead.** It is further concluded that this project **will not adversely modify proposed critical habitat, and if**

listed, may affect, but is not likely to adversely affect designated critical habitat for coho salmon.

5.2 Wildlife Species

ESA-listed wildlife species in the Action Area are limited to bald eagle.

5.2.1 Bald Eagle

5.2.1.1 Removal Action Effects

Potential direct and indirect effects to the bald eagle from this project include short-term impacts to behaviors such as nesting, foraging, perching, and wintering. In addition, potential impacts to food chain transfer are addressed in this section.

5.2.1.1.1 Nesting

At approximately 2 miles away, the nearest nest is significantly farther away from the project vicinity than the protective 0.5 mile construction setback; therefore, the effects of project activities on nesting are minimal, based upon location. Nesting activities occur from January 1 to August 15 and may overlap with the summer/fall work window, which is open from July 1 to October 15; however, the distance to the closest nest from the project vicinity will minimize potential noise effects.

5.2.1.1.2 Foraging

Foraging could occur in the Lower Willamette River area when eagles are present; however, there are many alternative opportunities for this behavior in the vicinity and along the Lower Willamette River, so adverse effects on foraging are not likely to be significant.

5.2.1.1.3 Perching

Suitable perch trees exist along sections of the Lower Willamette River corridor and likely in the adjacent Forest Park. However, there are no perching trees in the Action Area and, as with foraging areas, opportunities exist for selecting alternate perching trees in the vicinity; therefore, adverse effects on perching are not likely to be significant.

5.2.1.1.4 Wintering

The closest winter roosting area is in Burlington Bottoms, approximately 4 miles to the northwest. At this distance, the nearest winter roosting area is significantly farther away from the project vicinity than the protective 0.5 mile construction setback; therefore, effects of project activities on winter roosting are not expected based upon timing and location.

5.2.1.1.5 Food Chain Transfer

A focused ecological risk assessment (EcoRA, Appendix C) was conducted to provide a conservative evaluation of risks to the piscivorous bird, bald eagle, during and following the Terminal 4 Removal Action. The EcoRA discusses concerns about exposure to organochlorine contaminants (DDE, PCBs, and dioxin/furans) that could be released during the proposed action and potentially impact bald eagles via food chain transfer (discussed in this document in Section 5.1.1.1.4 – Exposure to Contaminants, and in detail in the EcoRA in Appendix C). The EcoRA concluded that for bald eagle, some risk was indicated from total PCBs under the modeled reasonable maximum exposure scenario for the Removal Action. However, bald eagle exposure to PCBs and DDE due to the project was determined unlikely to increase over the baseline exposure to PCBs and DDE in the Willamette River. Implementation of conservation measures during dredging (Section 2.2.7.2) should have the effect of eliminating bald eagle foraging from the project area. The conservative assumptions made in the model, as well as the implementation of the conservation measures, suggest that risk to bald eagles via food chain bioaccumulation associated with the removal of sediments as part of the Terminal 4 Removal Action would be minimal.

5.2.1.2 Mitigation Action Effects

Effects to bald eagles due to the Mitigation Action will be considered as part of the ESA consultation process led by the City of Portland for the Ramsey Refugia Phase II Mitigation Action.

5.2.1.3 Interrelated/Interdependent and Cumulative Effects

The Mitigation Action would have the cumulative and interrelated effect of increasing open space for bald eagle habitat as well as supporting listed fish species that provide a foraging base for bald eagles in the vicinity.

5.2.1.4 Effects Determination

Based on the limited use of the Action Area by bald eagles, historic disturbance regimes, and anticipated impacts, it is concluded that the proposed project **may affect, but is not likely to adversely affect** bald eagle.

5.3 Incidental Take Analysis

Activities necessary to complete the proposed project will take place within and adjacent to the active channel of the Willamette River when juvenile and/or adult salmonid individuals may be present. The activities will cause temporary increases in turbidity and contaminants. However, the potential for incidental take of ESA-listed species will be reduced by adherence to the timing restrictions in the work window for the project area at the time of construction and the use of specific conservation measures during construction activities. Fish removal from the CDF area will be conducted in accordance with the substantive requirements of ODFW Scientific Taking Permits. The presence of a bubble curtain or other sound attenuation device, and implementation of other conservation measures described in Section 2.2 will reduce the likelihood of potential effects due to dredging and pile driving. Further, this project will remove substantial contamination from the river to provide long-term habitat benefits. As a result, incidental take due to disruption of normal behavior patterns or mortality is not expected to be significant and, while the survival and protection of individual organisms is an important factor, the overall impact of the completed project on listed species is anticipated to be a net benefit.

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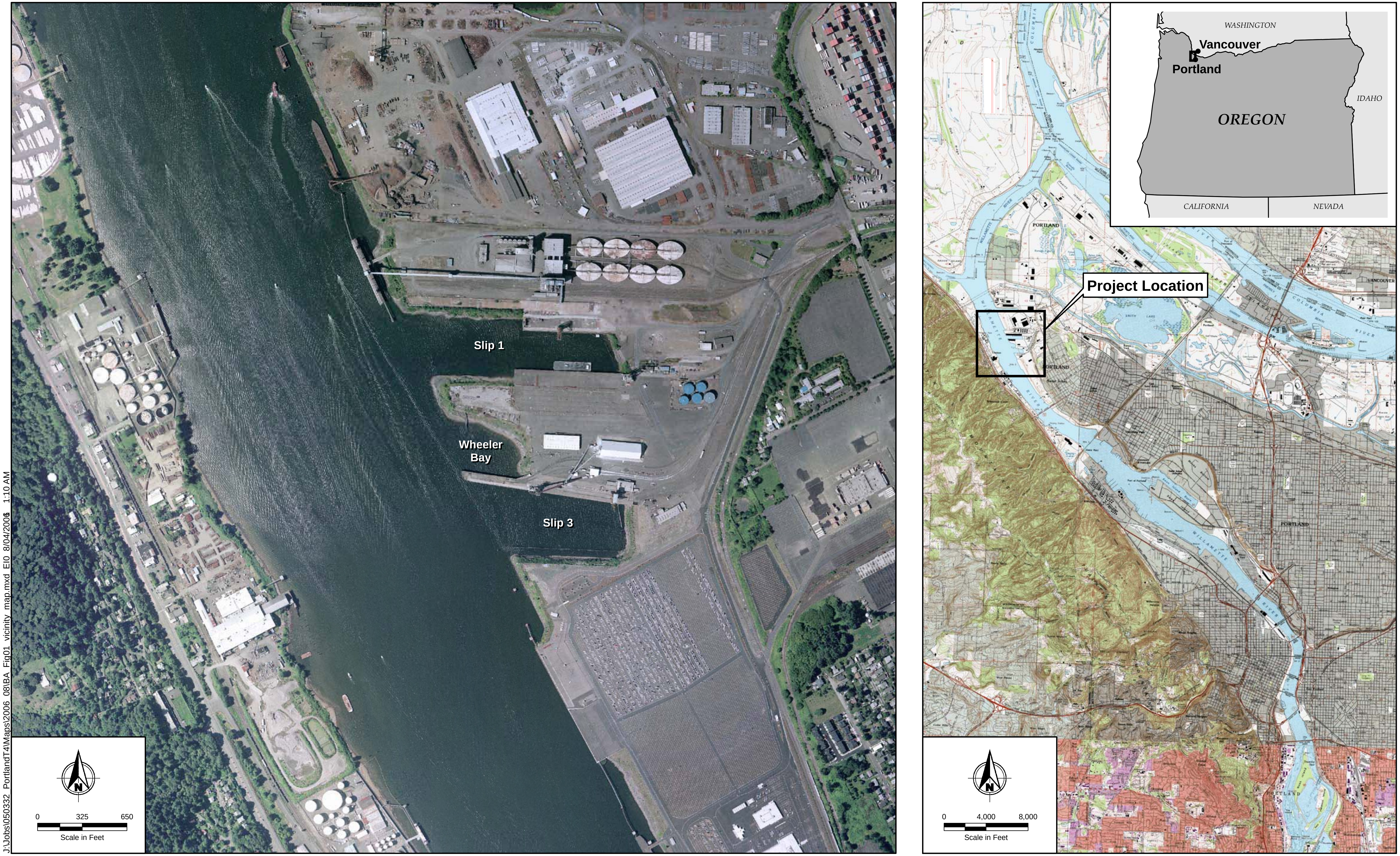
FIGURES



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ANCHOR ENVIRONMENTAL, L.L.C.

Notes:
1. High resolution imagery dated July 2005.

Figure 1
Vicinity Map
Terminal 4 Early Action Biological Assessment
Port of Portland

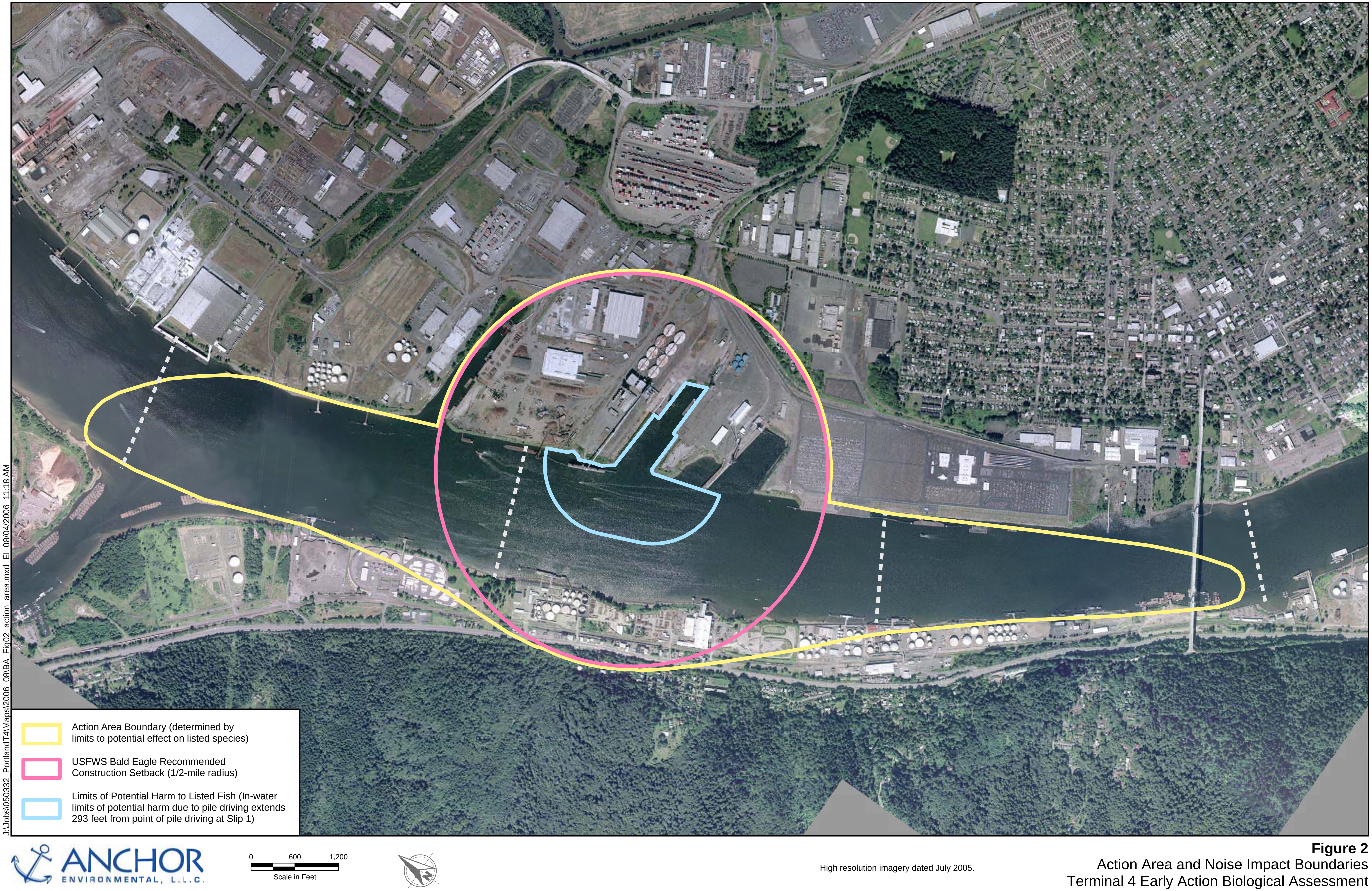

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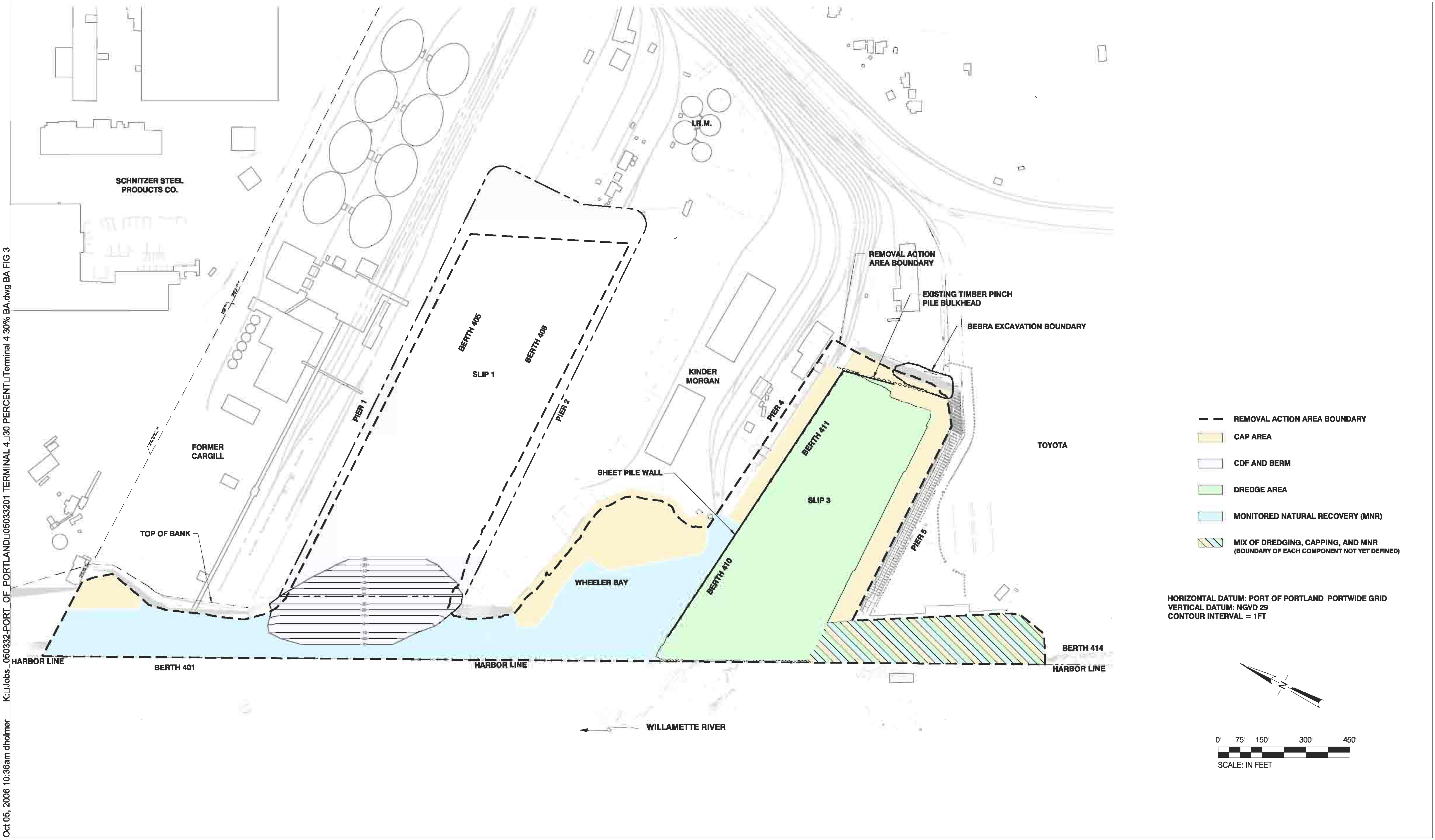
Figure 2
Action Area and Noise Impact Boundaries
Terminal 4 Early Action Biological Assessment
Port of Portland



Oct 05, 2006 10:36am dholmer K:\Jobs\050332-PORT OF PORTLAND\05033201 TERMINAL 4\30 PERCENT\Terminal 4 30% BA.dwg BA FIG 3

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3
Summary of Removal Action
Terminal 4 Early Action Biological Assessment
Port of Portland

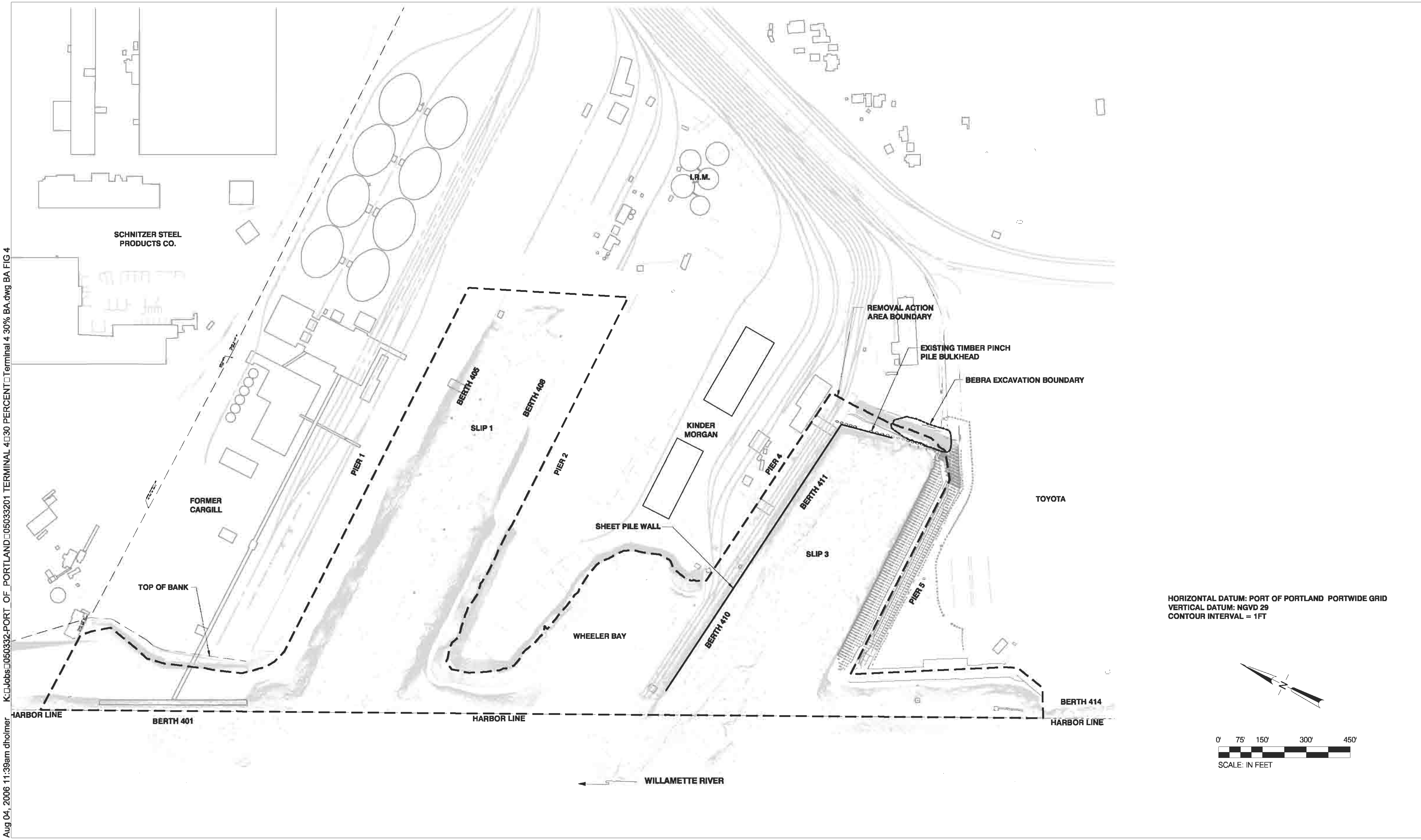


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Figure 4
Summary of Physical Conditions
Terminal 4 Early Action Biological Assessment
Port of Portland

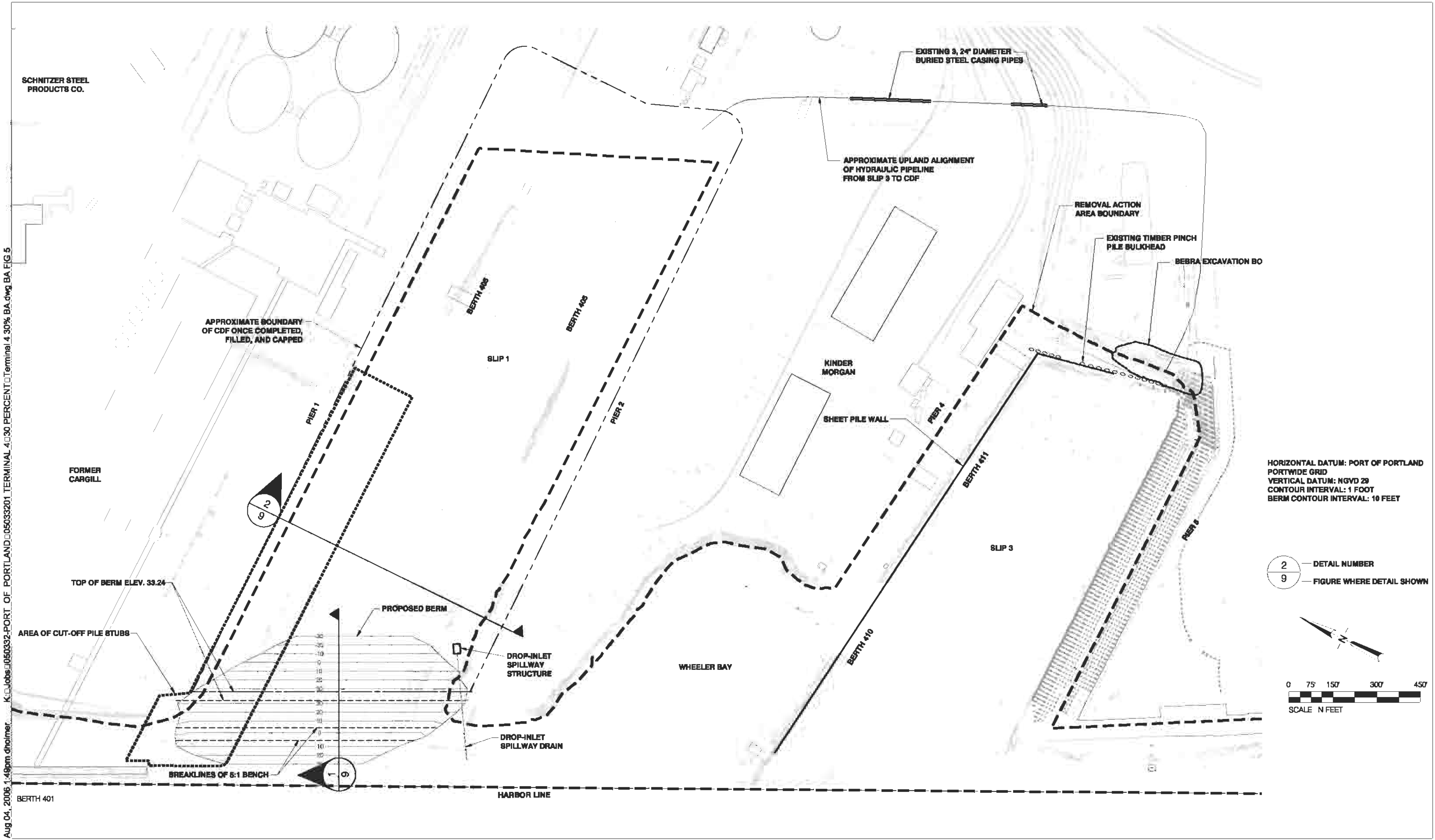

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Figure 5
Confined Disposal Facility Plan
Terminal 4 Early Action Biological Assessment
Port of Portland

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
			Summer In-water Work Window									
2007												
IRM Materials Offloading												
Overwater Structure and Pile Demolition												
Containment Berm Key Dredging and Construction												
Replacement Berth Construction and Dredge Material Offloading				?								
Stormwater and Outfall Structure(s) Relocation					?							
Capping on Banks of Wheeler Bay (2007?)					?							
2008												
Slip 3 Dredging					?							
In Situ Capping				?								
Post-2008												
Non-Terminal 4 Contaminated Sediment Placement												
Imported FIll Material Placement for CDF Surfical Layer												
Completion of CDF Surfical Layer												

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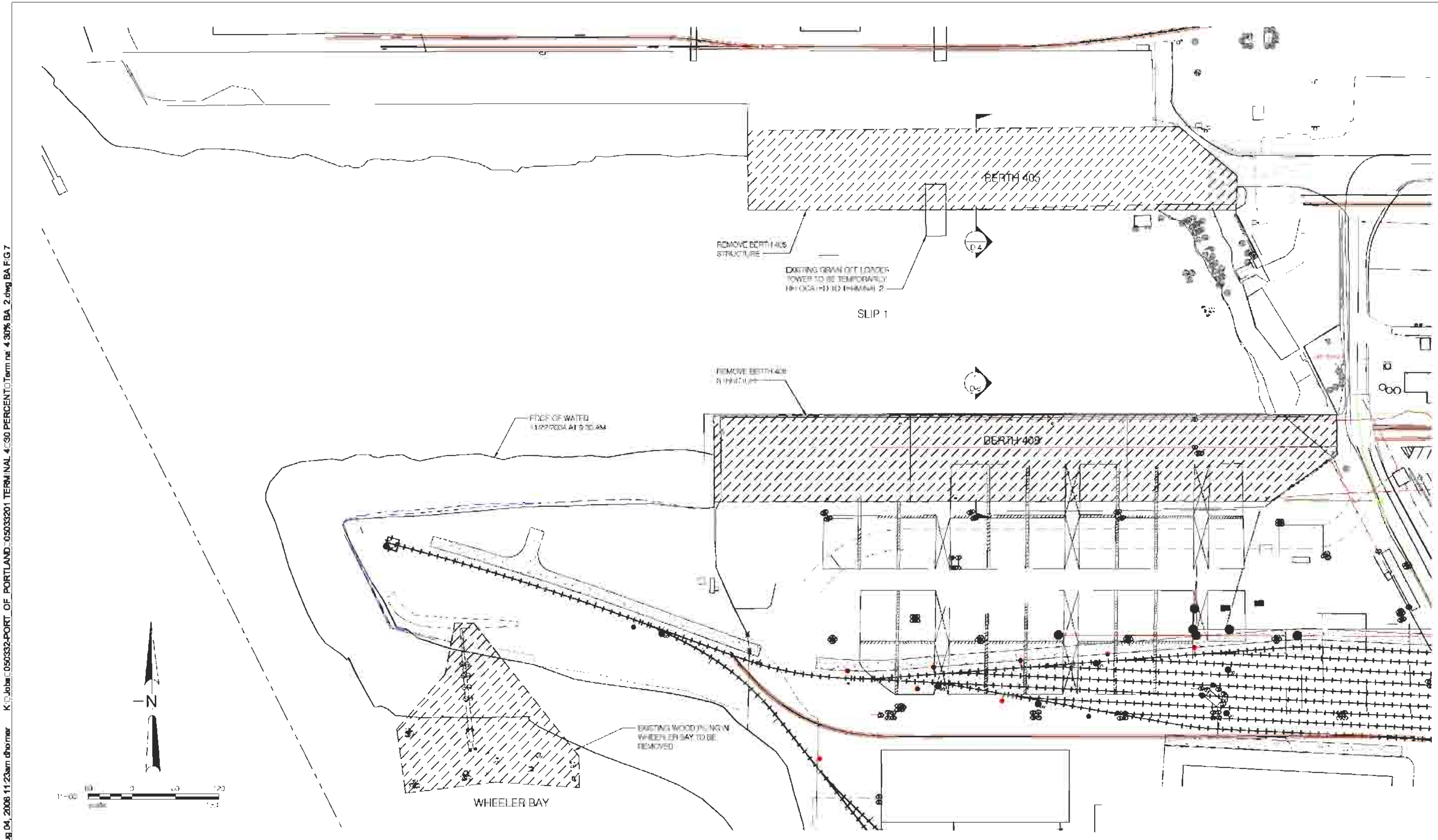
Figure 6
Conceptual Terminal 4 Early Action Construction Schedule and Sequencing
Terminal 4 Early Action Biological Assessment
Port of Portland



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BERGER/ABAM

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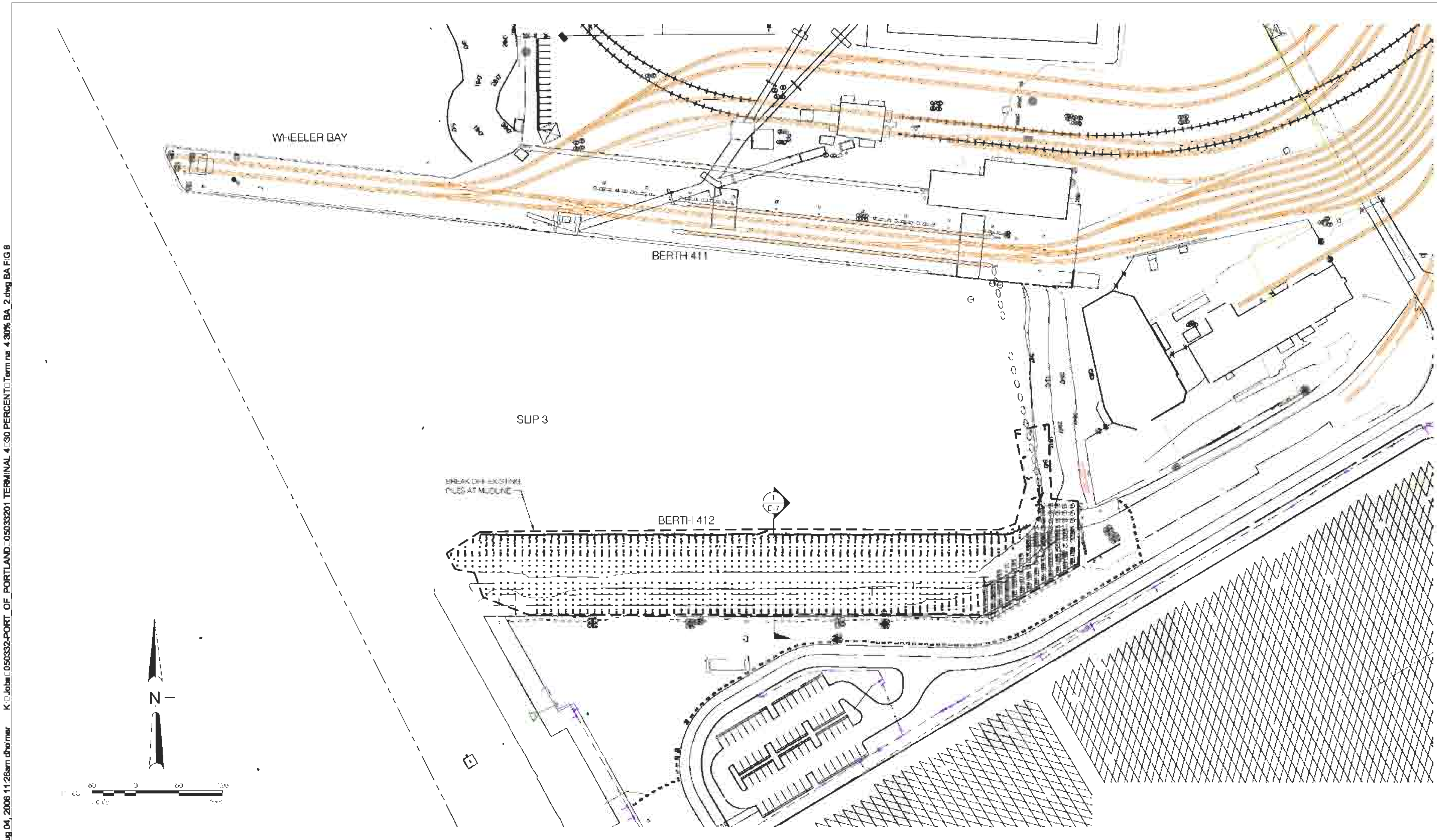
Figure 7
Slip 1 and Wheeler Bay Demolition Plan
Terminal 4 Early Action Biological Assessment
Port of Portland



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BERGER/ABAM ENGINEERS INC.

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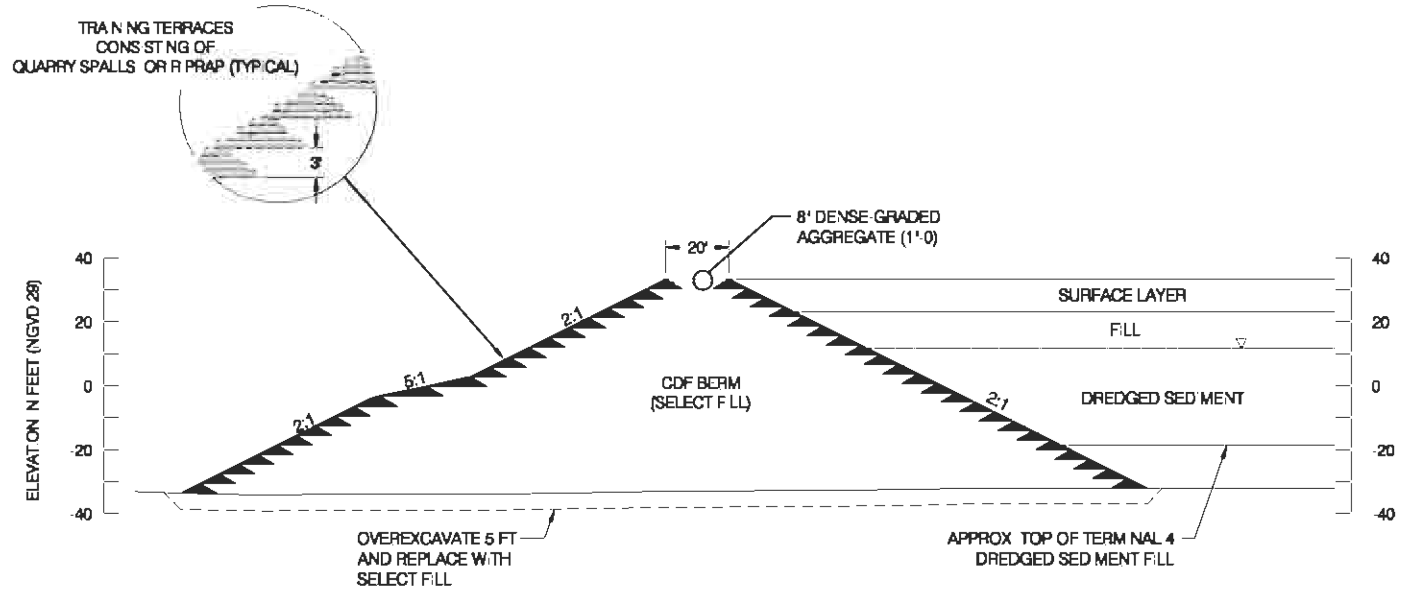
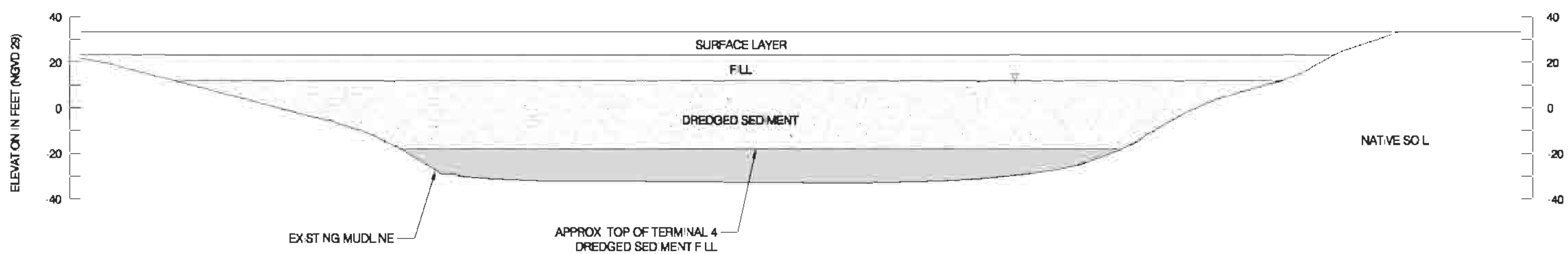
Figure 8
Slip 3 Demolition Plan
Terminal 4 Early Action Biological Assessment
Port of Portland



BERM CROSS SECTION 1/9
NO VERTICAL EXAGGERATION



CDF CROSS SECTION 2/9
NO VERTICAL EXAGGERATION

HORIZONTAL DATUM: PORT OF PORTLAND PORTWIDE GRID
VERTICAL DATUM: NGVD 29

NOTE: BOUNDARY ELEVATIONS BETWEEN DIFFERENT UNITS ARE CONCEPTUAL AND WILL BE FINALIZED DURING DRAFT FINAL DESIGN.

0' 15 30 60 90
SCALE IN FEET

Aug 04, 2006 1:51pm dholmer K:\Jobs\050332-PORT OF PORTLAND\05033201 TERMINAL 4\30 PERCENT\Terminal 4 30% BA.dwg BA FIG 9

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Figure 9
Confined Disposal Facility Sections
Terminal 4 Early Action Biological Assessment
Port of Portland

Aug 04, 2006 11:28am dhorner K:\Jobs\050332-PORT_OF_PORTLAND\05033201 TERMINAL 4\30 PERCENT\Terminal 4 30% BA_2.dwg BA FIG 10

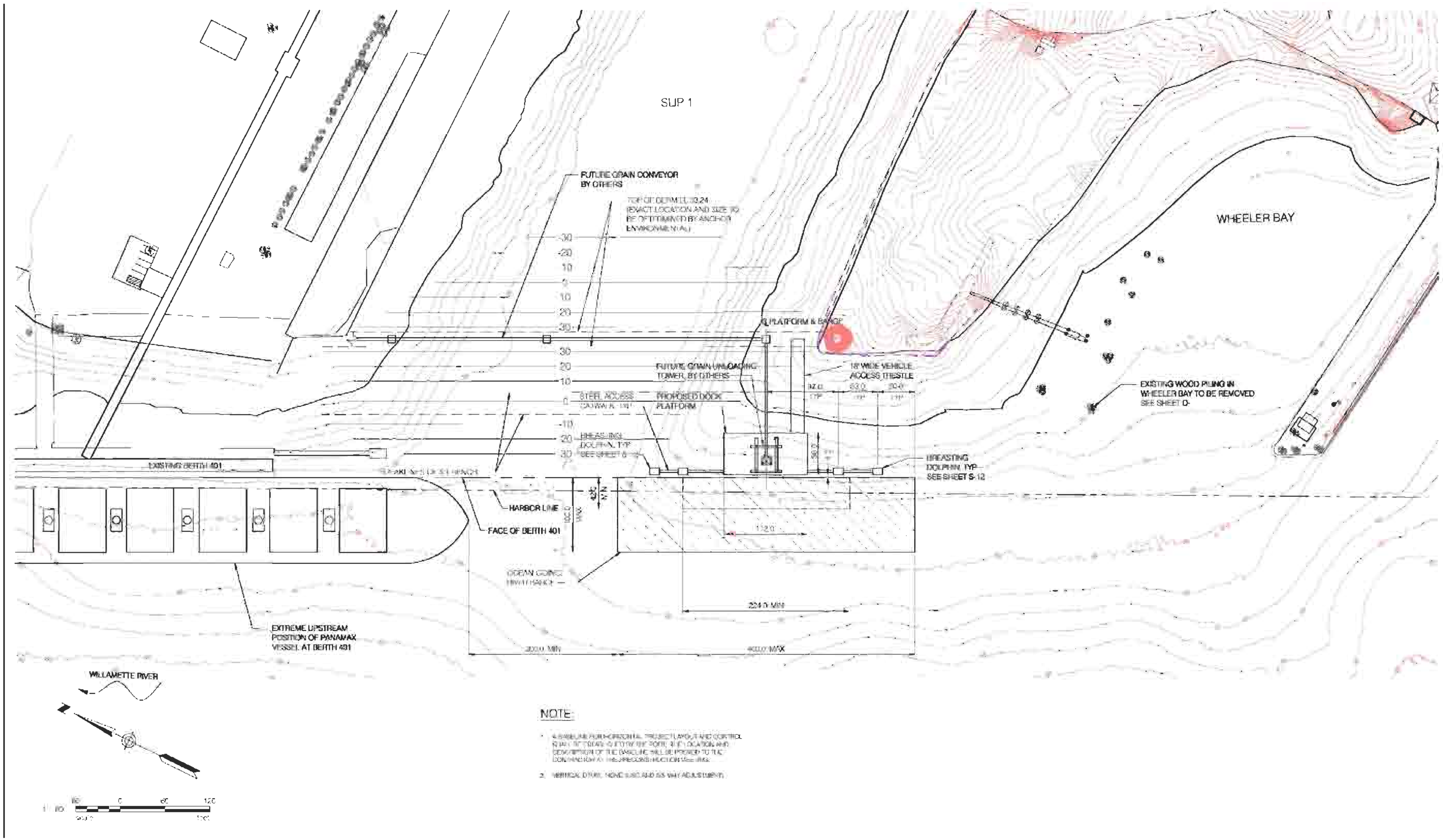

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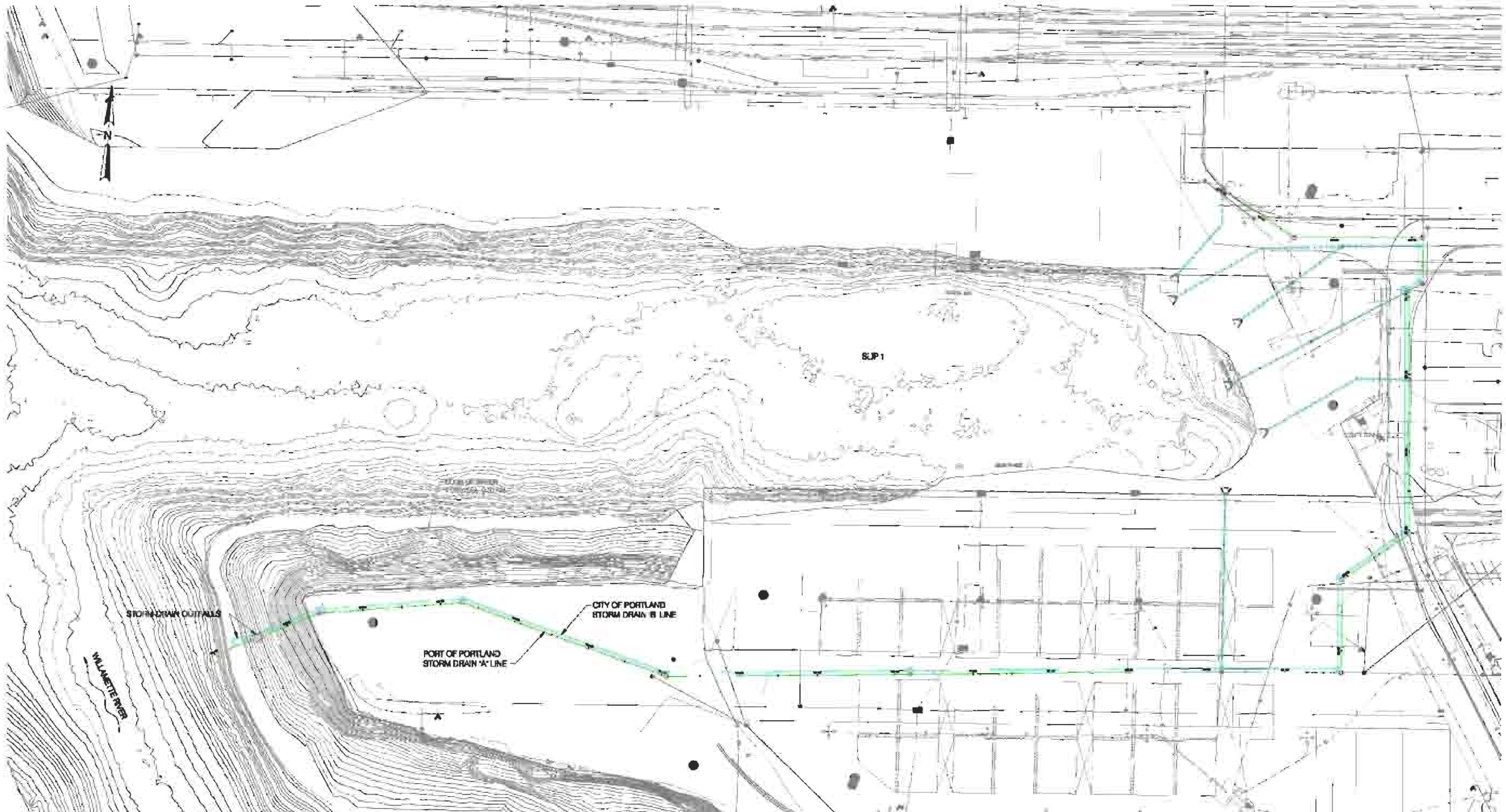
Figure 10
Berth 405 Structure Relocation
Terminal 4 Early Action Biological Assessment
Port of Portland



Aug 04, 2006 11:29am dhomer K:\Jobs\050332-PORT_OF_PORTLAND\05033201 TERMINAL 4\30 PERCENT\Terminal 4 30% BA_2.dwg BA FIG 11

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BERGER/ABAM ENGINEERS INC.

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Figure 11
Slip 1 Stormwater Reroute Locations
Terminal 4 Early Action Biological Assessment
Port of Portland

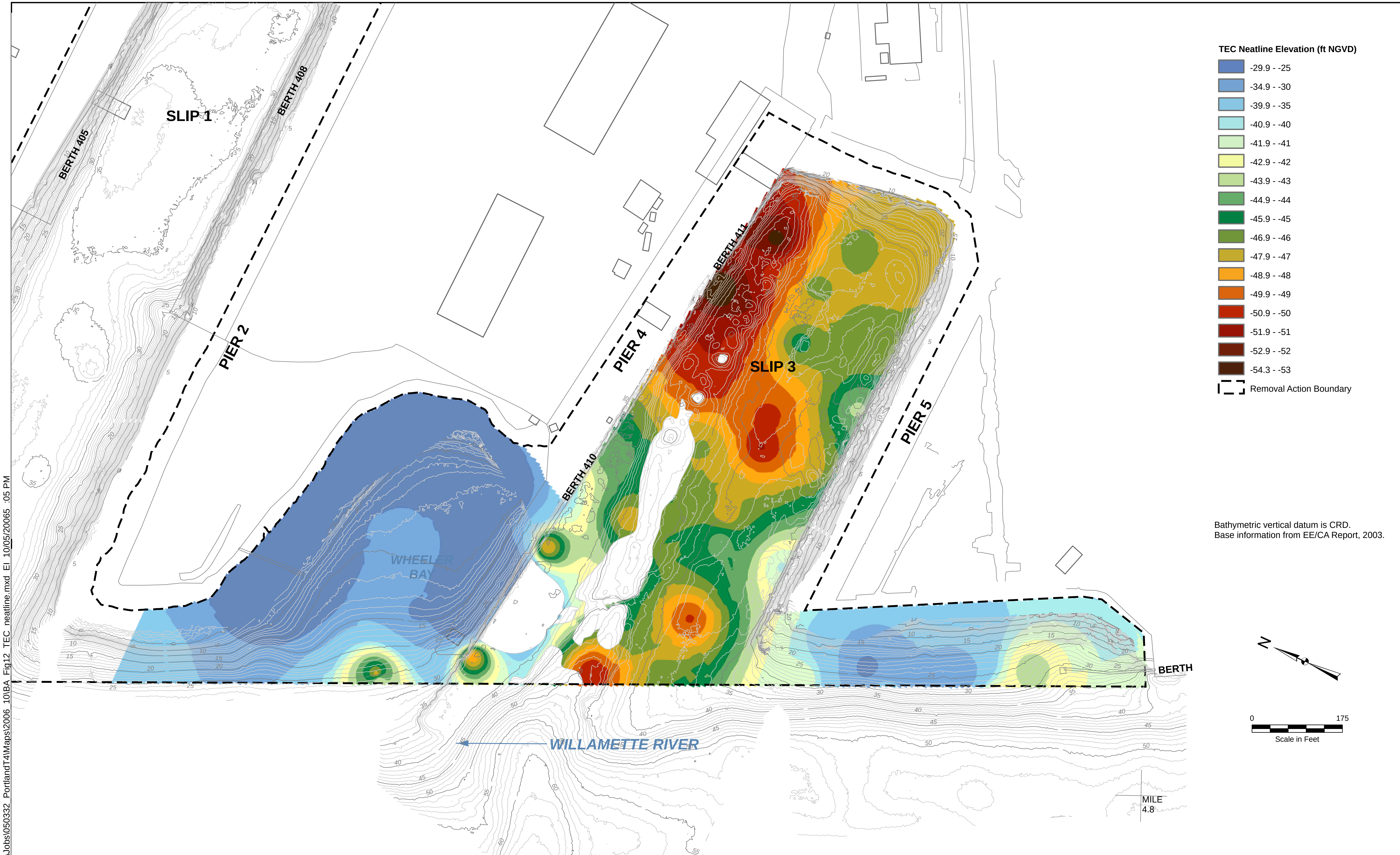

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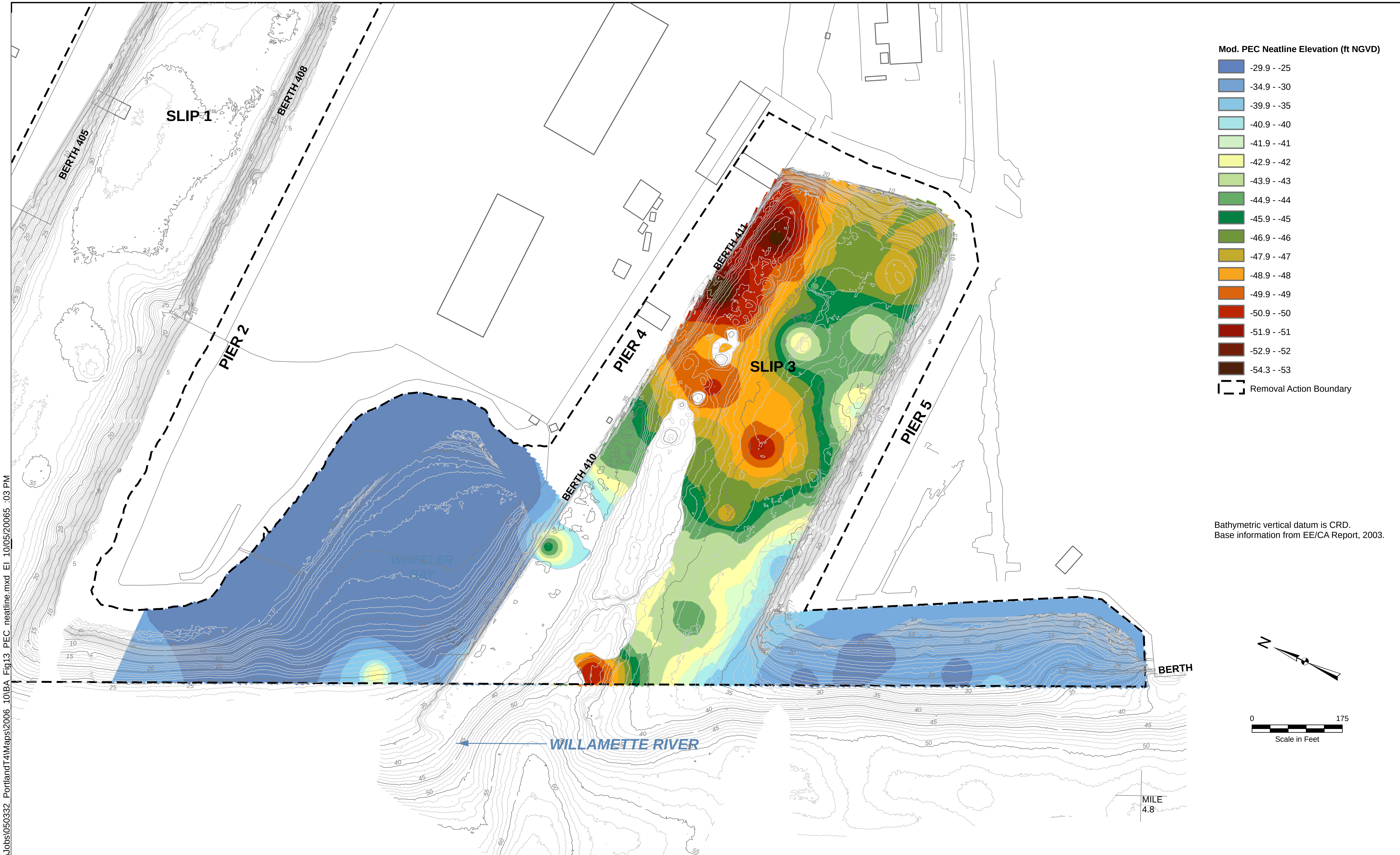
Figure 12
TEC Neatline Elevation
Terminal 4 Early Action Biological Assessment
Port of Portland



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ANCHOR ENVIRONMENTAL, L.L.C.

Figure 13
PEC Neatline Elevation
Terminal 4 Early Action Biological Assessment
Port of Portland

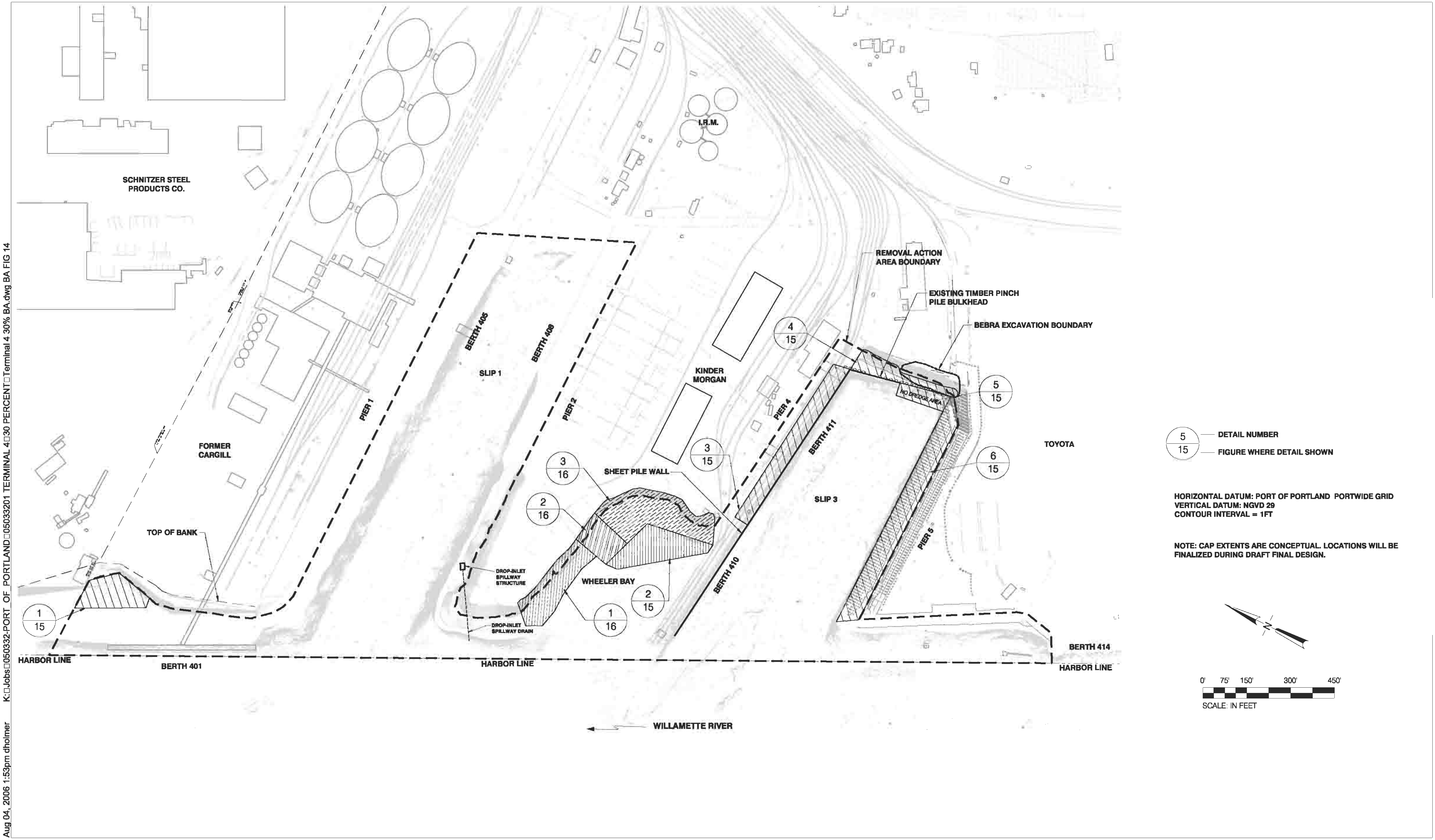

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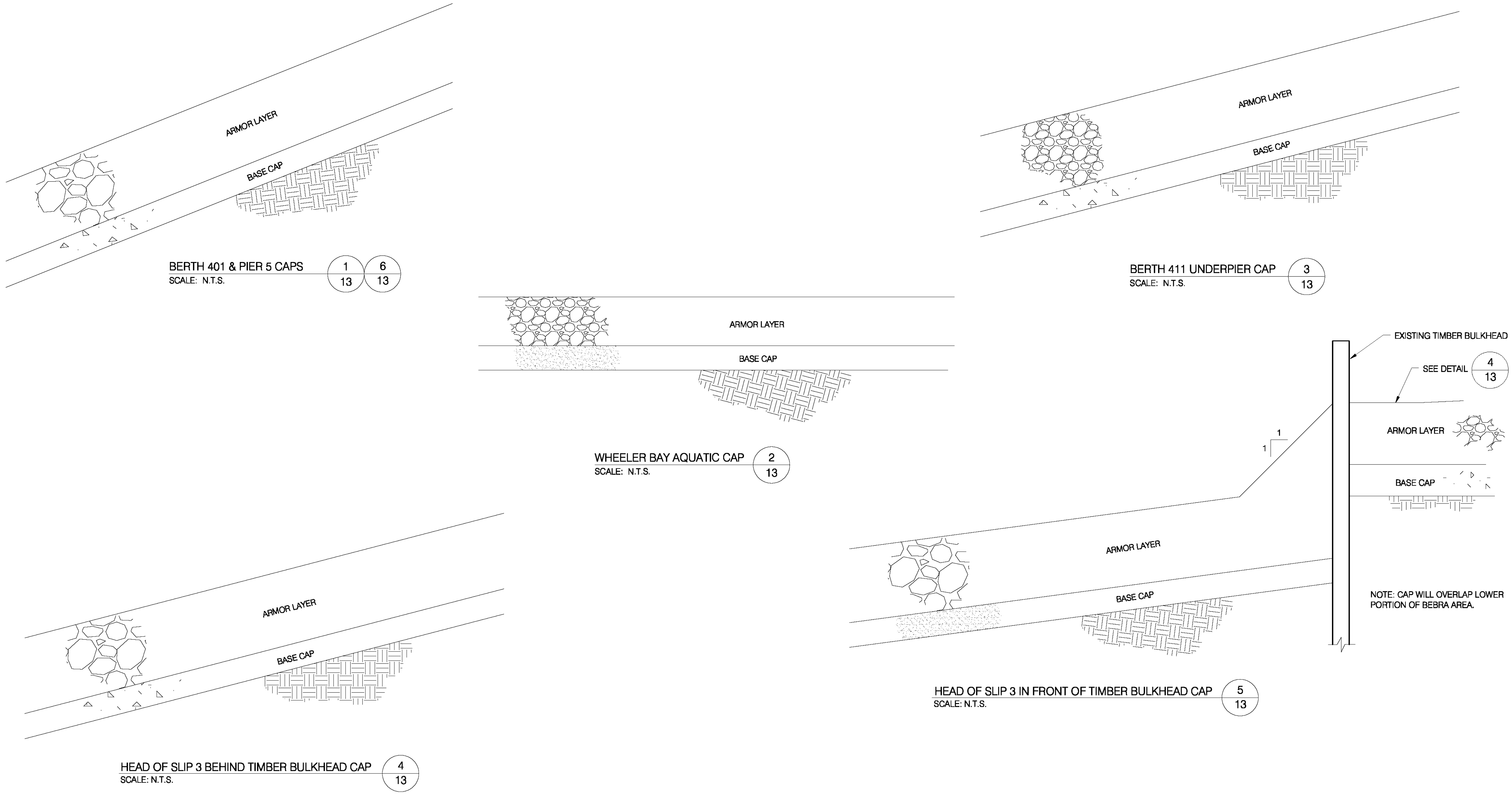
Figure 14
Cap Plan
Terminal 4 Early Action Biological Assessment
Port of Portland

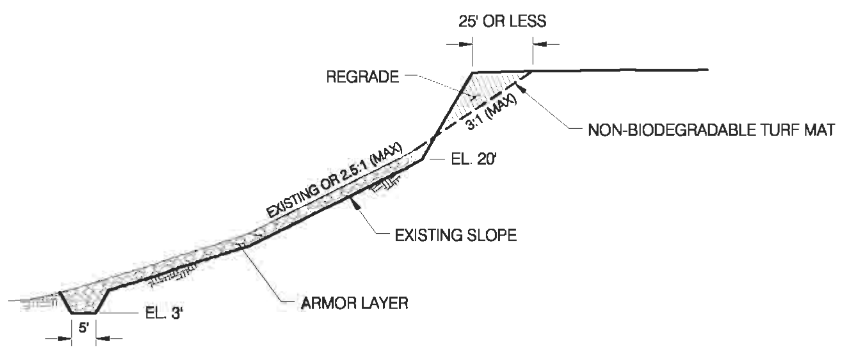


NOTE: GRADATIONS AND DIMENSIONS OF BASE CAP AND ARMOR LAYER ARE CONCEPTUAL AND WILL BE FINALIZED DURING DRAFT FINAL DESIGN.

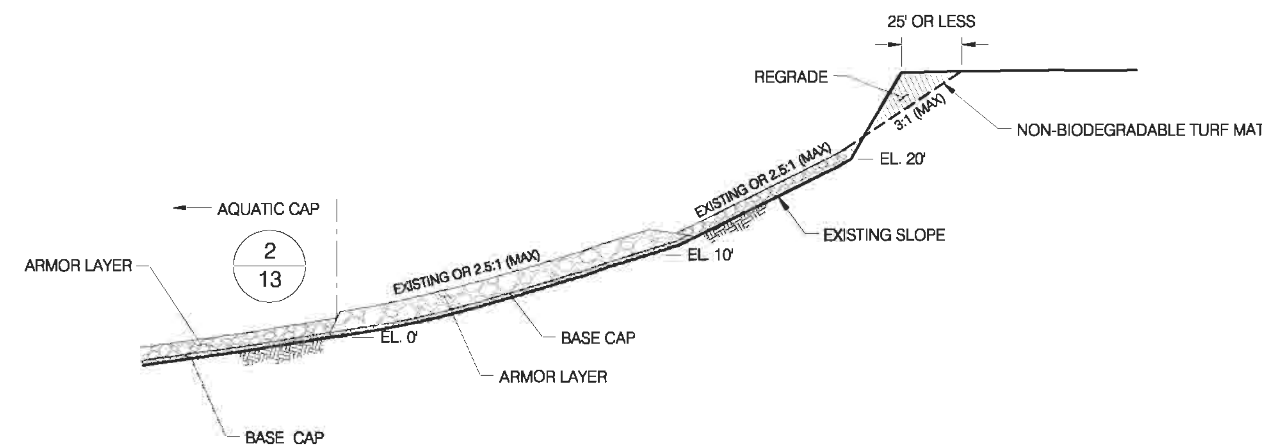
ANCHOR ENVIRONMENTAL, L.L.C.

Figure 15
Aquatic Cap Sections
Terminal 4 Early Action Biological Assessment
Port of Portland

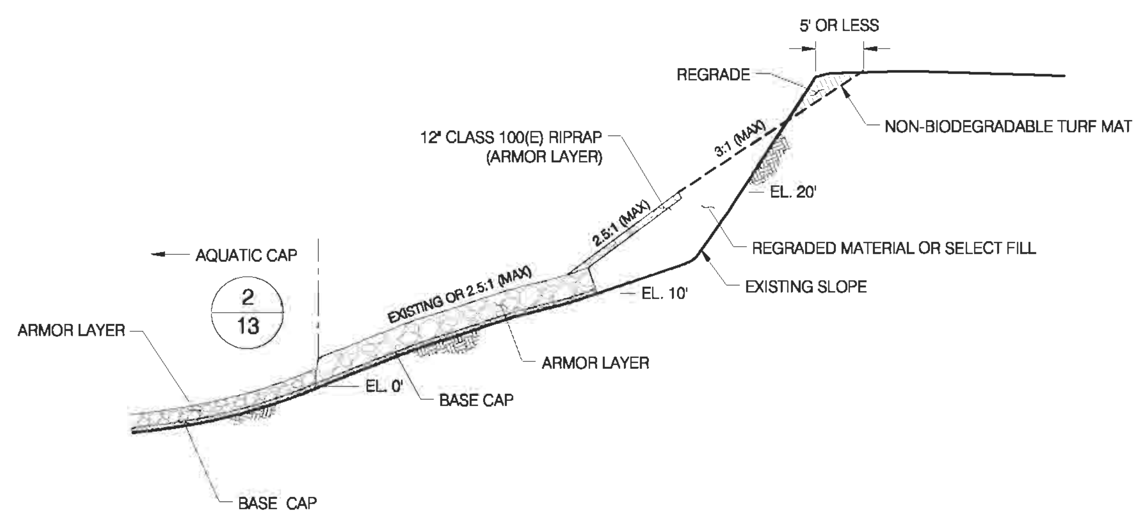
Aug 04, 2006 11:42am dholmer K:\Jobs\050332-PORT OF PORTLAND\05033201 TERMINAL 4\30 PERCENT\Terminal 4 30% BA.dwg BA FIG 15



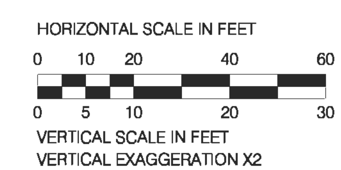
TYPICAL SHORELINE CAP CROSS SECTION IN WHEELER BAY (1/14)
TYPE A - UNRESTRICTED SLOPE GRADING
(WITHOUT AQUATIC CAP)



TYPICAL SHORELINE CAP CROSS SECTION IN WHEELER BAY (2/14)
TYPE A - UNRESTRICTED SLOPE GRADING
(WITH AQUATIC CAP)



TYPICAL SHORELINE CAP CROSS SECTION IN WHEELER BAY (3/14)
TYPE B - RESTRICTED SLOPE GRADING



NOTES:
1. SAND DRAINAGE BLANKET REQUIRED ONLY WHERE AQUATIC CAP IS SPECIFIED.
2. ALL ELEVATIONS REFERENCED TO NGVD 29.

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Figure 16
Wheeler Bay Shoreline Cap Sections
Terminal 4 Early Action Biological Assessment
Port of Portland

APPENDIX A

ESSENTIAL FISH HABITAT CONSULTATION

ESSENTIAL FISH HABITAT

Pursuant to the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) and the 1996 Sustainable Fisheries Act (SFA), an Essential Fish Habitat (EFH) evaluation of impacts is necessary for activities that may adversely affect EFH. EFH is defined by the MSFCMA in 50 CFR 600.905-930 as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" and is designated for groundfish, Pacific salmon, and coastal pelagic composites.

Identification of EFH in the Action Area

The Action Area for the proposed project includes habitats that have been designated as EFH for the groundfish and Pacific salmon EFH composites. The groundfish composite species that may occur in the Action Area is starry flounder (*Platichthys stellatus);* starry flounder have been captured in shallow water habitat areas in the lower Willamette River near St. Johns Bridge (EES 2003). Pacific salmon EFH composite species that may occur in the action area include Chinook and coho salmon. There are no coastal pelagic fish found in the vicinity of the proposed project.

Designated EFH for groundfish composite species encompasses all waters from the mean high water line and upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon, and California, seaward to the boundary of the Unites States exclusive economic zone (370.4 kilometers) (PFMC 1998a, 1998b). Groundfish EFH is discussed in detail in the *Final Environmental Assessment/Regulatory Review for Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan* (PFMC 1998a) and National Marine Fisheries Service's (NMFS') *Essential Fish Habitat for West Coast Groundfish Appendix* (NMFS 1998).

Freshwater EFH for Pacific salmon includes those streams, lakes, ponds, wetlands, and other waterbodies currently or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable constructed barriers (as identified by the Pacific Fisheries Management Council [PFMC]), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years; PFMC 1999). Salmonid EFH is discussed in detail in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). EFH and life history stages for species that may occur in the Action Area are listed in Table A-1.

Table A-1
MSFCMA Managed Species and Life History Stages
with Designated EFH that May Occur in the Project Vicinity

Starry flounder	X	X	X	X	X
Chinook salmon	X		X		
Coho salmon	X		X		

Effects of the Proposed Action and Effects Determination

The assessment of potential impacts from the proposed project to the species' EFH is based on information in previous sections of this Biological Assessment (BA). Impacts may occur as a result of the Removal Action and the Mitigation Action, as considered below.

Removal Action Effects

Direct and Indirect Effects

Direct and indirect effects on groundfish and Pacific salmon EFH, and the conservation measures that avoid and minimize impacts, are identified in Table A-2.

Table A-2
Affected EFH by Project Element and Proposed Conservation Measures

Benthic habitat in Slip 1 would be altered.	Construction of the Confined Disposal Facility (CDF) in Slip 1 will result in a loss of existing benthic organisms and habitat, (which will be mitigated for in accordance with Clean Water Act 404(b)1) and dredging and capping in Slip 3 will temporarily disturb benthic habitat. However, impaired benthic habitat will be restored in Slip 3 after completion of dredging and capping. Existing conditions indicate that there is poor production of epibenthic and benthic prey in these areas. Thus, Removal Action activities, including compensatory habitat mitigation, are not expected to affect the abundance or availability of typical prey/forage organisms for salmonids and groundfish. Therefore, potential impacts to the benthic community may not be linked to EFH for these species.	In-water work for the project will comply with the timing restrictions specified in the in-water work window, when salmonids are expected to be present in very low numbers. The goal of the proposed dredging and capping actions is to significantly reduce exposure to existing contamination in sediments, which will improve overall aquatic ecosystem health.

Table A-2
Affected EFH by Project Element and Proposed Conservation Measures

Affected EFH	Impact	
	Further, groundfish and salmonids are mobile and generally able to distinguish and avoid areas where prey are less abundant. If available, groundfish species could selectively use undisturbed or recolonized areas in the project vicinity for foraging.	
Suspended sediment concentrations in water column EFH could be temporarily elevated.	Significant short-term effects to water quality will occur related to dredging, but conservation measures will be implemented to minimize effects on water quality. Resuspension of sediments and contaminants may occur during in-water work, but are expected to dissipate following these activities. The proposed vessel berth at the outer face of the containment berm will be constructed in deeper water than its current location, resulting in less overall turbidity in the vicinity of Slip 1. Because groundfish and salmonid species in the Willamette River are mobile, they would be expected to avoid areas where unsuitably turbid conditions exist. For this reason, the adverse effects of turbidity on water column EFH are expected to be minimal.	In-water work for the project will comply with the timing restrictions specified in the in-water work window, when salmonids are expected to be present in very low numbers. Water quality monitoring will occur concurrent with dredging and capping activity in accordance with the 401 Water Quality Certification issued for the project.
Suspension of sediment has the potential to adversely affect water column EFH by reducing dissolved oxygen (DO).	High concentrations of suspended sediments have the potential to reduce DO levels by exposing nutrients to bacterial breakdown (Mortensen et al. 1976). A model created by LaSalle (1988) demonstrated that even in a situation where the upper limit of expected suspended sediment is reached during dredging operations, DO depletion of no more than 0.1 mg/L would occur at depth. LaSalle (1988) concluded that based on the relatively low levels of suspended material generated by dredging operations, and considering factors such as flushing, DO depletion around these activities should be minimal.	In-water work for the project will comply with the timing restrictions specified in the in-water work window, when salmonids are expected to be present in very low numbers. Water quality monitoring will occur concurrent with dredging and capping activity in accordance with the 401 Water Quality Certification issued for the project.
Water column EFH could be adversely affected by spills from construction equipment.	There is a nominal chance that an unintentional release of fuel, lubricants, or hydraulic fluid from the construction equipment could lead to adverse impacts to groundfish or salmonid EFH.	Surface booms, oil-absorbent pads, and similar materials will be on site for any accidental construction equipment spills. Water quality monitoring will occur concurrent with dredging and capping activity in accordance with the 401 Water Quality Certification issued for the

Table A-2
Affected EFH by Project Element and Proposed Conservation Measures

Affected EFH	Impact	
	In addition, because groundfish and salmonid species in the Willamette River are mobile, they would be expected to avoid areas where unsuitable conditions exist. For this reason, the adverse effects of these substances on water column EFH are expected to be minimal.	project. In-water work for the project will comply with the timing restrictions specified in the in-water work window, when salmonids are expected to be absent or present in very low numbers.

Cumulative Effects

Following implementation of the project, substrate quality in the Removal Action Project Area would be substantially improved relative to existing conditions. The loss of habitat associated with the CDF, in terms of the relative function and value of the habitat, will be evaluated and mitigated for in accordance with applicable federal and state Applicable or Relevant and Appropriate Requirements (ARARs), for a net gain of habitat quality.

Mitigation Action Effects

Direct and Indirect Effects

Effects to EFH due to the construction of the Mitigation Action will be considered as part of the Endangered Species Act (ESA) consultation process led by the City of Portland for the Ramsey Refugia Phase II Mitigation Action. Post-construction benefits to EFH are expected to include the re-establishment of hydrologic connectivity to the Lower Columbia Slough to reclaim and improve floodplain wetland functions (forested wetland and soft bottom, mud backwater sloughs) and to increase the amount and quality of off-channel rearing and refuge habitat for juvenile Chinook, coho, and steelhead.

Cumulative Effects

The Mitigation Action would have the cumulative effect of increasing the amount and quality of EFH occurring in the vicinity of the Ramsey Refugia Phase II Mitigation Action.

Effects Determination

Effects to EFH include impacts to freshwater rearing sites and migration corridors. Short-term and localized effects include increased turbidity and resuspension of sediments and loss of prey production in dredged and capped areas. Long-term effects include permanent loss of prey production in Slip 1; however, this habitat is currently low quality and loss will be mitigated in accordance with applicable federal and state ARARs. Based on this information, it is concluded that the effects of the proposed action **may adversely affect Pacific Coast Salmon EFH and West Coast Groundfish EFH**. Long-term effects to EFH in the Removal Action Project Area are expected to be beneficial based on the reduction of sediment contamination.

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APPENDIX B

SPECIES LISTS

Endangered Species Act Status of West Coast Salmon & Steelhead

(Updated June 6, 2006)

Species[1]			Current Endangered Species Act Listing Status[2]	ESA Listing Actions Under Review
Sockeye Salmon (*Oncorhynchus nerka*)	1	Snake River	***Endangered***	
	2	Ozette Lake	***Threatened***	
	3	Baker River	*Not Warranted*	
	4	Okanogan River	*Not Warranted*	
	5	Lake Wenatchee	*Not Warranted*	
	6	Quinalt Lake	*Not Warranted*	
	7	Lake Pleasant	*Not Warranted*	
Chinook Salmon (*O. tshawytscha*)	8	Sacramento River Winter-run	***Endangered***	
	9	Upper Columbia River Spring-run	***Endangered***	
	10	Snake River Spring/Summer-run	***Threatened***	
	11	Snake River Fall-run	***Threatened***	
	12	Puget Sound	***Threatened***	
	13	Lower Columbia River	***Threatened***	
	14	Upper Willamette River	***Threatened***	
	15	Central Valley Spring-run	***Threatened***	
	16	California Coastal	***Threatened***	
	17	Central Valley Fall and Late Fall-run	***Species of Concern***	
	18	Upper Klamath-Trinity Rivers	*Not Warranted*	
	19	Oregon Coast	*Not Warranted*	
	20	Washington Coast	*Not Warranted*	
	21	Middle Columbia River spring-run	*Not Warranted*	
	22	Upper Columbia River summer/fall-run	*Not Warranted*	
	23	Southern Oregon and Northern California Coast	*Not Warranted*	
	24	Deschutes River summer/fall-run	*Not Warranted*	
Coho Salmon (*O. kisutch*)	25	Central California Coast	***Endangered***	
	26	Southern Oregon/Northern California	***Threatened***	
	27	Oregon Coast	*Not Warranted*	
	28	Lower Columbia River	***Threatened***	• Critical habitat
	29	Southwest Washington	*Undetermined*	
	30	Puget Sound/Strait of Georgia	***Species of Concern***	
	31	Olympic Peninsula	*Not Warranted*	
Chum Salmon (*O. keta*)	32	Hood Canal Summer-run	***Threatened***	
	33	Columbia River	***Threatened***	
	34	Puget Sound/Strait of Georgia	*Not Warranted*	
	35	Pacific Coast	*Not Warranted*	
Steelhead (*O. mykiss*)	36	Southern California E	***Endangered***	
	37	Upper Columbia River	***Threatened***	
	38	Central California Coast	***Threatened***	
	39	South Central California Coast	***Threatened***	
	40	Snake River Basin	***Threatened***	
	41	Lower Columbia River	***Threatened***	
	42	California Central Valley	***Threatened***	
	43	Upper Willamette River	***Threatened***	
	44	Middle Columbia River	***Threatened***	
	45	Northern California	***Threatened***	
	46	Oregon Coast	***Species of Concern***	
	47	Southwest Washington	*Not Warranted*	
	48	Olympic Peninsula	*Not Warranted*	
	49	Puget Sound [3]	*Proposed Threatened*	• Critical habitat • Protective regulations
	50	Klamath Mountains Province	*Not Warranted*	
Pink Salmon (*O. gorbuscha*)	51	Even-year	*Not Warranted*	
	52	Odd-year	*Not Warranted*	

1 The ESA defines a "species" to include any distinct population segment of any species of vertebrate fish or wildlife. For Pacific salmon, NOAA Fisheries Service considers an evolutionarily significant unit, or "ESU," a "species" under the ESA. For Pacific steelhead, NOAA Fisheries Service has delineated distinct population segments (DPSs) for consideration as "species" under the ESA.

2 Updated final listing determinations for 16 salmon species were issued on June 28, 2005 (70FR37160). Updated final listing determinations for 10 West Coast steelhead species were issued on Jan. 5, 2006 (71FR834). The final "not warranted" listing determination for Oregon Coast coho salmon was announced on Jan. 19, 2006 (71FR3033). On Sept. 2, 2005, NOAA Fisheries Service issued final critical habitat designations for 19 West Coast salmon and steelhead species (70FR52488 and 52630).

3 Puget Sound steelhead was proposed for listing as threatened on Mar. 29, 2006 (71FR15666). A final determination, if one is warranted, should occur within a year.

APPENDIX C

ASSESSMENT OF POTENTIAL EXPOSURE OF BALD EAGLES TO BIOACCUMULATIVE CHEMICALS IN THE REMOVAL ACTION PROJECT AREA

FINAL

APPENDIX C

ASSESSMENT OF POTENTIAL EXPOSURE OF BALD EAGLES TO BIOACCUMULATIVE CHEMICALS IN THE REMOVAL ACTION PROJECT AREA

TERMINAL 4 EARLY ACTION

PORT OF PORTLAND, PORTLAND, OREGON

Prepared for

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October 2006

List of Tables

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1 INTRODUCTION

This report addresses a request by the United States Fish and Wildlife Service (USFWS) regarding the Biological Assessment (BA) for the Terminal 4 Early Action at the Port of Portland, Oregon (Port). USFWS has requested additional information regarding potential bald eagle (*Haliaeetus leucocephalus)* exposure to organochlorine contaminants that could be released during the proposed action. This assessment is being submitted as an appendix to the BA.

This report describes the methods and results of a focused ecological risk assessment (EcoRA) that was conducted to provide a conservative evaluation of risks to the piscivorous bird, bald eagle, during and following the Removal Action at the Terminal 4 Site on the Willamette River in Portland, Oregon. The assessment presented herein was based on an earlier assessment that was conducted in support of the Gasco Site Removal Action project BA at the request of USFWS to address concerns about exposure to organochlorine contaminants (DDE, PCBs, and dioxin/furans) that could be released during the proposed action and potentially impact bald eagles via food-chain transfer (Anchor 2005). The Gasco modeling effort was initiated by Anchor and, through a cooperative effort with the USFWS reviewer, Jeremy Buck, Senior Environmental Contaminant Specialist, was updated to be more consistent with work conducted by USFWS on bald eagle. Because dioxin/furan data were not collected in support of the remedial design and the available data for these compounds are not from samples within the project area, only DDE (the breakdown product of the pesticide DDT that is most toxic to raptors) and total PCBs were evaluated herein. The potential for food chain transfer of sediment-associated PCBs and DDE to the bald eagle was evaluated using the Gobas steady-state uptake model included as part of the U.S. Army Corps of Engineers Trophic Trace (Version 4; November 2003) software developed by the Waterways Experiment Station (WES; http://el.erdc.usace.army.mil/trophictrace/).

2 PROBLEM FORMULATION

The problem formulation of an EcoRA establishes the ecotoxicological connections between receptors of concern (ROCs) and chemicals of potential concern (COPCs) within a site conceptual model and describes the environmental setting, ecological resources, ROCs, COPCs, the conceptual site model, and assessment endpoints and measures of exposure and effects. The conceptual site model was based primarily on trophic transfer of the COPCs through the food chain from sediment and water → invertebrates → forage species → piscivorous species, as generally framed by the Trophic Trace model. When bedded sediment is removed by dredging, a portion of sediment becomes suspended in the water column. In addition, a portion of the chemical mass associated with the suspended sediment becomes dissolved in the water column. Direct contact and ingestion of suspended sediment, as well as uptake of dissolved chemicals in the water column across the gills, can result in increased burdens of bioaccumulative chemicals in tissue. Suspended sediment will also redeposit, and sediment-associated chemicals can be incorporated into the tissue of benthic infauna living in or feeding on sediment deposits. Associated increases of bioaccumulative chemical concentrations in benthic invertebrates and fish prey species can result in increased tissue burdens in the higher trophic level aquatic predators that are, in turn, prey for bald eagle.

Two dietary pathways were evaluated, a sediment-based pathway and a water-based pathway. Pathways were selected as follows: at the beginning of the food chain were the two invertebrates, a benthic mollusc (clam) to represent the sediment-based diet pathway, and a benthic crustacean (crayfish) to represent the water-based diet pathway. In this model, one invertebrate-eating fish (largescale sucker [*Catostomus macrocheilus*]) was selected to model the sediment-based diet pathway, modeled to feed equally on crayfish and clam. One piscivorous fish, northern pikeminnow (*Ptychocheilus oregonensis*), was selected to model the water-based pathway, modeled to feed entirely on largescale sucker. One piscivorous bird species (bald eagle) was selected to complete the water-based pathway, and modeled to feed exclusively on northern pikeminnow.

The assessment endpoints for bald eagle were survival, growth, and reproduction. Toxicity reference values (TRVs) provided the risk-based levels on which potential effects of exposure to the COPCs were measured. TRVs are the exposure concentrations associated with either no observable apparent effects levels (NOAEL) or lowest observable apparent effects levels

(LOAEL) and provide a basis for judging the potential effects of measured or predicted exposures that are above or below these levels (vonStackelberg and Burmistrova 2003). The process for selecting TRVs is described in more detail in Section 3. The approaches to evaluating risk were modeled dietary exposure comparisons (for adults) and modeled tissue-residue comparisons (for eggs).

3 EXPOSURE AND EFFECTS ASSESSMENT

Three parameters describing chemical behavior in the food chain were used in this evaluation, Kow, Koc, and a biota-sediment accumulation factor (BSAF) (Table 1). The Kow values for total PCBs, DDT, DDE, and DDD were obtained from the toxicological profiles on the Agency for Toxic Substances and Disease Registry (ATSDR) website (http://www.atsdr.cdc.gov/toxpro2.html). Koc was calculated from Kow using the Connell and Hawker equation as cited in the Trophic Trace users manual (VonStakelberg and Burmistrova 2003). The BSAF values applied were for bivalves as reported in Wong et al. 2001. The BSAFs of 2.8 applied herein were based on the median BSAF for bivalves and hydrophobic organic compounds using all data reported (Wong et al. 2001). Per USFWS recommendations made during the Gasco modeling effort, the median BSAF value for all data (2.8) was applied for determining risk for both total PCBs and DDE under the reasonable maximum exposure (RME) scenario (Jeremy Buck, personal communication 2005)

Table C-1
Summary of Chemical Parameters for Contaminants of Potential Concern

PCBs (Total)	6.301	6.197	2.8
DDE	6.51	6.400	2.8

The parameters used in the Trophic Trace model to define the environment of the Willamette River at the Terminal 4 site were surface water temperature, total organic carbon (TOC) in sediment, and the concentrations of COPCs in sediment and surface water. The water temperature (20°C) used in the model was taken from the U.S. Geological Service (USGS) gauge at Portland and approximates the upper quartile of annual temperatures. The TOC and COPC dataset used in the model included all surface and subsurface sediment samples evaluated during the Blasland Bouck and Lee (BBL 2005) sampling effort and reported in the EE/CA that are still relevant (i.e., have not been subsequently dredged) (Table C1-1). For TOC, two values were used in the model: the mean of all data and the mean of the detected data. The sediment COPC concentrations used in the model were the 95% upper confidence limit (UCL) of the mean estimate using the method recommended by ProUCL[1]. The RME scenario applied the

[1] UCL values were calculated using U.S. EPA's ProUCL software (version 3.0; http://www.epa.gov/nerlesd1/tsc/images/proucl3.pdf). Please see Table A-3 and A-4 for the ProUCL.

95% UCL COPC concentration and the mean TOC concentration based on the detected sample data.

The sediment analytical chemistry dataset used to estimate exposure to bald eagle was confined to samples within areas to be dredged. Specifically these include the berm area of Slip 1 and Slip 3 (see Figure 7.3.4 in the EE/CA, Alternative C, from BBL 2005). To ensure a conservative estimate of the remaining sediment surface after the Removal Action, the 95% UCL was calculated under the assumption that all sediment data within the dredge areas would contribute equally to remaining residuals. The DDE concentrations used in the model was 4,4'-DDE. The total PCB concentrations used in the model were calculated as the sum of Aroclor 1248, Aroclor 1254, and Aroclor 1260, the three Aroclor mixtures detected in samples from the action area. Undetected values in the sums were calculated using one half the detection limit (U = ½). Table C-2 provides a summary of the analytical chemistry statistical values (minimum, mean, 95% UCL, and maximum) used in the model. Summary tables with the complete analytical chemistry data, ProUCL output files, temperature data, and lipid data are provided in the Attachment C-1.

The maximum total PCB value was more than six times greater than the 95% UCL. The second highest total PCB value was 227 μg/kg. The median total PCB concentration was 10 μg/kg. Typical of many sediment chemistry datasets, these data exhibit a log-normal distribution. The total PCB 95% UCL, calculated using EPA's ProUCL software, is a conservative estimate of the average exposure from the dredge residuals.

Table C-2
Statistical Summary of Analytical Chemistry Results for Samples within Early Action EE/CA Area

4,4'-DDE	0.2	1.34	2.68	6.0	62	μg/kg
Total PCBs - Detected Aroclors*	7.4	63.1	155	1000	59	μg/kg
TOC	0.02	1.33	1.75	5.71	44**	%

* Aroclors A-1248, A-1254, and A-1260
** Total number of TOC analyses including non-detects was 62; mean of data set was 0.94 percent TOC

As noted above, for TOC, the mean value was applied to the model instead of the 95% UCL to ensure the exposure estimates were conservative. The TOC data were log-normally distributed. Because the median (0.73 percent) and mean were similar, using the mean provides an accurate exposure estimate. In other words, the TOC data are not substantially skewed. Further, the mean is likely to best represent the sediment residuals concentration during and after dredging.

Exposure is a function of concentration and duration, and the duration is short for dredging of contaminated sediment, which is expected to span approximately two months of the in-water work window in 2007 (see Figure 6 of the Biological Assessment to which this document is an appendix) (In the Lower Willamette River, the in-water work window is in the summer and early fall, from July 1 through October 31, and in the winter, from December 1 through January 31. As an additional conservation measure for this project, in-water work will be limited to the late summer and fall in-water work window, from July 1 to October 31 [see Figure 6 of the Biological Assessment].)

The freely dissolved surface water concentrations of COPCs were calculated by the Trophic Trace model from the sediment and TOC data using equilibrium partitioning. This approach is conservative because it essentially estimates the dissolved porewater concentration without dilution. It is important to note that the modeled water concentrations are expected to be lower than the actual dissolved surface water concentrations during the Removal Action because of the dilution of sediment porewater that would occur from river water.

Organism parameters applied in the model included percent lipids for invertebrates; percent lipids, weight, food prey items and percent of diet, and site use factors for fish; and weight, food ingestion rate, food prey items and percent of diet, and site use factors for wildlife. These values were selected based on available information from various life history data sources and attempted to approximate the biological and ecological features of the species likely to be found at the site. Site-specific lipid content data for the invertebrates and fish were taken from the LWG Round 1 tissue dataset (Table C-3). Wildlife exposure assumptions for bald eagle were taken from the studies summarized in USEPA's Wildlife Exposure Factors Handbook as cited by VonStakelberg and Burmistrova (2003). The eagle body weight was 5.1 kilograms (kg), the food ingestion rate was 0.65 kg/day, and the site use factor applied was 1. The site use factor is likely conservative given the shoreline home range of eagles is substantially larger than the project area.

Table C-3
Summary of Invertebrate and Fish Model Parameters

Benthic mollusc (clam)	1.1	Mean LWG Round 1	n/a	Sediment
Benthic crustacean (crayfish)	0.8	Mean LWG Round 1	n/a	Water
Largescale sucker	7.3	Mean LWG Round 1	40	50% crayfish 50% clam
Northern pikeminnow	4.8	Mean LWG Round 1	500	100% largescale sucker

ww= wet weight

Dietary and tissue-based TRVs and biomagnification factors (BMFs) were selected from existing reports including: the EPA-reviewed final risk assessments of the Duwamish River Superfund site (Windward 2003); the DRAFT Portland Harbor RI/FS Technical Memorandum: Provisional Toxicity Reference Values Selection for Preliminary Ecological Risk Assessment (Windward 2004); and research on bald eagles in the lower Columbia River watershed (USFWS 1999 and 2004; Buck et al 2005). Where readily available, the original publications cited in the above reports were consulted.

The TRVs applied in this assessment are summarized in Table C-4. For PCBs and eagle, the NOAEL value for dietary effects (0.41 mg/kg day) was taken from a study of ringed turtle dove hatching success by Peakall et al. (1972). The dietary and egg effect LOAEL data (0.94 mg/kg and 16 mg/kg, respectively) were taken from a study with screech owls by McLane and Hughes (1980). The total PCB egg NOAEL, 4.0 mg/kg, was taken from a field study of bald eagle by Wiemeyer et al. (1984) as cited in USFWS (1999).

For DDE, the dietary NOAEL and LOAEL (0.12 and 1.2 mg/kg day) were taken from a study by Lincer (1975) on the reproduction of American kestrel. The DDE egg NOAEL, 3.6 mg/kg, was taken from a field study of bald eagle by Wiemeyer et al. (1993), as cited by USFWS (1999). The PCB egg LOAEL taken from McLane and Hughes (1980) identified above was applied to provide additional information to evaluate TRV uncertainty.

Table C-4
Summary of Bird Toxicity Reference Values

DDE	0.12	1.2	3.6	
Total PCBs	0.41	0.94	4	16

During the GASCO site evaluation (Anchor 2005), BMFs from three sources, Giesy et al (1995), Henny et al. (2003), and USFWS (2004) were evaluated (Table C-5). In addition, the geometric means of the DDE BMFs and total PCB BMFs were calculated. The differences in BMFs ranged from 4-fold for DDE to 10-fold for total PCBs. The geometric mean values were applied as the RME scenario for the risk determinations.

Table C-5
Summary of Relevant Egg Biomagnification Factors for Bald Eagle

Giesy et al. 1995	22	28	Michigan Rivers	Bald eagle
Henny et al. 2003	87	11	Willamette River, OR	Osprey
USFWS 2004	75	113	Lower Columbia River, WA and OR	Bald eagle
Geometric Mean	52	33	--	--

4 RISK CHARACTERIZATION AND UNCERTAINTY EVALUATION

Risk to the ROCs from exposure to the COPCs in the sediments was assessed using toxicity quotients (TQs). TQs are calculated as the dietary- or tissue-based exposure concentration divided by the effects concentration (dietary- or tissue-based NOAEL or LOAEL). Trophic Trace has the ability to provide a range of TQs based on the fuzzy math calculation of input values (trapezoidal fuzzy numbers), allowing the user to characterize parameter uncertainty. For the risk determination step, risk was indicated if the TQ associated with the RME scenario was greater than 1; in other words, if the RME exposure (i.e., 95% UCL sediment concentration, median BSAF for all data, and geometric mean BCF) exceeded the selected TRV.

Uncertainties in the problem formulation and the exposure and effects measure have the potential to affect the conclusions of a risk assessment. The selection of COPCs was based on a specific request by USFWS and the available sediment data. It is unlikely that the selection of COPCs would result in changes to the risk conclusions. The receptor evaluated for the risk assessment was selected to represent the listed species (bald eagle) with the greatest likelihood of having a complete pathway to sediment-associated COPCs, bald eagle. It is unlikely that species not represented have greater exposure potential or are significantly more sensitive than the species evaluated. Less conservative, but appropriate and defensible, TRVs could result in predictions of even lower risk. Uncertainties for exposure measures are discussed in the risk summary (Section 5).

The dietary NOAEL TQs for DDE and total PCBs were below 1 under the RME scenario. The egg NOAEL TQ for PCBs was 9.98 for the RME scenario and the egg NOAEL TQ for DDE was 2.25 for the RME scenario.

One model run was completed, using the mean TOC from both detected and non-detected samples in the data set with a BSAF value of 2.8 as well as using the mean TOC from only detected values in the data set and a BSAF of 2.8 and the RME BMFs (Table C-6 and Attachment C-2). The purpose of completing this evaluation of the data was to assess the sensitivity of the TOC primary input values in determining the risk to bald eagle reproduction. Overall, by including the mean TOC values for both the detected and non-detected samples increased the risk determinations.

Table C-6
Summary of Risk Assessment Modeling Results for DDE and PCBs in Bald Eagle Eggs

Model Run #1	RME sediment; mean TOC with and without nondetected values; and; RME BMFs	TQ>1 for RME	TQ>1 for RME

In addition to the work described above to evaluate potential risk, the modeled fish prey tissue concentrations and fish tissue samples collected from the Willamette River within 2,000 meters of the Terminal 4 Removal Action Site were compared to the threshold fish concentrations (TFCs). Table C-7 presents the modeled data and empirical fish tissue data collected in the Willamette River near the Terminal 4 Removal Action Site in comparison to TFCs calculated using the RME BAFs and TRVs identified above. The TFC values for DDE and total PCBs are 70 µg/kg and 120 µg/kg, respectively.

Table C-7
Summary of Calculated Fish Tissue Concentrations compared to USFWS Threshold Fish Concentrations (USFWS 2004)

Northern Pikeminnow	DDE	RME	160	300	2.29	4.29
	Total PCBs-Det. Aroclor	RME	1,210	1,435	10.1	11.9
Largescale Sucker	DDE	RME	86	139	1.23	1.98
	Total PCBs-Det. Aroclor	RME	670	790	5.58	6.58

*Station within 2,000 meters of Terminal 4 Removal Action Area

Table C-8
Summary of Non-Modeled Fish Tissue Concentrations from Samples Collected in the Vicinity of Terminal 4

Black Crappie	FZ0306	LWG01FZ0306TSBCWBC10	4,4'-DDE	38	0.54
			Total PCB	85	0.71
		LWG01FZ0306TSBCWBC20	4,4'-DDE	37	0.53
			Total PCB	90	0.75
Brown Bullhead	FZ0306	LWG01FZ0306TSBBWBC10	4,4'-DDE	32	0.46
			Total PCB	67	0.56
		LWG01FZ0306TSBBWBC20	4,4'-DDE	70	1.00
			Total PCB	90	0.75
		LWG01FZ0306TSBBWBC30	4,4'-DDE	42	0.60
			Total PCB	125	1.04
Carp	FZ0306	LWG01FZ0306TSCPWBC10	4,4'-DDE	81	1.16
			Total PCB	300	2.50
		LWG01FZ0306TSCPWBC20	4,4'-DDE	260	3.71
			Total PCB	6500	54.17
		LWG01FZ0306TSCPWBC30	4,4'-DDE	105	1.50
			Total PCB	230	1.92
Peamouth	05R006	LWG0105R006TSPMWBC00	4,4'-DDE	110	1.57
			Total PCB	174	1.45
Sculpin	04R002	LWG0104R002TSSPWBC00	4,4'-DDE	16	0.23
			Total PCB	156	1.30
	04R003	LWG0104R003TSSPWBC00	4,4'-DDE	14	0.20
			Total PCB	196	1.63
Smallmouth Bass	04R023	LWG0104R023TSSBWBC10	4,4'-DDE	220	3.14
			Total PCB	1280	10.67
		LWG0104R023TSSBWBC20	4,4'-DDE	140	2.00
			Total PCB	470	3.92
		LWG0104R023TSSBWBC30	4,4'-DDE	99.5	1.42
			Total PCB	590	4.92
	05R006	LWG0105R006TSSBWBC00	4,4'-DDE	108	1.54
			Total PCB	390	3.25

Based on the RME, the calculated DDE TQ for northern pikeminnow was 2.29 and the total PCBs TQ was 10.1. For largescale sucker, the DDE TQ was 1.2 and for total PCBs, the TQ was 5.6. The lower TQ values for largescale sucker are consistent with the model which placed largescale sucker at a lower trophic level as an intermediate prey item for northern pikeminnow. The Willamette River fish tissue data were evaluated from Station 03R014 and

05R006, the closest stations to the T-4 Removal Action area sediments with northern pikeminnow or largescale sucker tissue samples. Aroclor 1260 was the only PCB detected in these samples. For northern pikeminnow, the average PCB and DDE TQs were 12 and 4.3, respectively. For largescale sucker, the PCB and DDE TQs were 6.6 and 2.0, respectively. The fact that the measured fish tissue concentrations at Station 03R014 and 05R006 are slightly higher than the conservatively modeled fish tissue concentrations detailed herein indicates that the potential risk to bald eagle associated with the Terminal 4 Removal Action Area sediments is minor. In addition, fish tissue from species that were not included in the model, black crappie, brown bullhead, carp, peamouth, sculpin, and smallmouth bass, were compared to the DDE and total PCB TFCs (Table C-8). For these species, DDE TQs ranged from less than 1 to 3.7.and total PCB TQs ranged from less than 1 to 54. Based on Willamette River tissue samples, risk thresholds for prey items for bald eagles are already exceeded. Because additional operations that increase contaminants in the food chain can enhance biomagnification that may lead to reproductive problems in bald eagles, conservation measures to control additional exposure are important. Conservation measures include those discussed in Section 2.2.7.2 of the Biological Assessment. With these in place for the sediment removal action, bald eagle exposure to PCBs and DDE via the food chain is unlikely to increase over the baseline exposure to PCB and DDE in the Willamette River.

5 RISK SUMMARY AND CONCLUSIONS

This risk assessment evaluated the potential for adverse effects to bald eagle during and following the Removal Action dredging at the Terminal 4 site. The exposure of the ROCs to sediment-associated COPCs was evaluated for food chain transfer of contaminants from sediment and/or water → invertebrates → forage species → piscivorous species, as generally framed by the Trophic Trace model. Bioaccumulation modeling of the COPCs was used to evaluate whether food chain accumulation would result in tissue burdens or dietary doses greater than selected TRVs. The exposure assumptions for the risk assessment were conservative, as highlighted by the assumptions below:

- The modeled fish tissue concentrations are likely to overestimate the tissue burdens in fish prey for bald eagles because:
  - The modeled water exposure was based on equilibrium partitioning and essentially estimates the dissolved porewater concentration without dilution. These modeled water concentrations are likely to significantly overestimate the actual dissolved surface water concentrations generated during the remedial action.
  - The site use factor for fish was 1.
- The site use factor for bald eagle was 1. The home range and foraging areas required by bald eagle are significantly larger than the area of the proposed Removal Action. Applying a site use factor of 1 is likely to significantly overestimate the modeled dose to bald eagle.

In conclusion, for bald eagle, some risk was indicated from total PCBs, under the modeled RME scenario. However, bald eagle exposure to PCBs and DDE due to the project is unlikely to increase over the baseline exposure to PCB and DDE in the Willamette River. Given the conservative assumptions made in the model, as well as the implementation of best management practices, risk to bald eagle via food chain bioaccumulation of PCBs or DDTs associated with removal of sediments as part of the Terminal 4 Removal Action is expected to be minimal. Overall, the Terminal 4 Removal Action project is not likely to adversely affect bald eagle.

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ATTACHMENT C-1

SUMMARY DATA TABLES

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Table C1-1
Summary of Surface Analytical Chemistry Results for Samples within Tar Body Removal Action Area

Location ID	HC-S-16		HC-S-28		HC-S-36			T4-UP14		T4-VC04		T4-VC11		T4-VC22		T4-VC23		T4-VC24		T4-VC25		T4-VC26		T4-VC27		T4-VC29		T4-VC32		WR-PG-09	
Sample ID	HC-S-16		HC-S-28		HC-S-36			T4-UP14		T4-VC04-0-1		T4-VC11-0-1		T4-VC22-0-1		T4-VC23-0-1		T4-VC24-0-1		T4-VC25-0-1		T4-V26-0-1		T4-VC27-0-1		T4-VC29-0-1		T4-VC32-0-1		WR-PG-09	
Sample Date	10/14/1998		10/14/1998		10/15/1998			4/21/2004		3/16/2004		3/18/2004		3/11/2004		3/3/2004		3/3/2004		3/11/2004		3/4/2004		3/9/2004		3/5/2004		3/4/2004		5/26/2005	
Depth Interval	0-10 cm		0-10 cm		0-10 cm			0-0 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30.48 cm		0-30 cm	
Sample Matrix	SE		SE		SE			SE		SE		SE		SE		SE		SE		SE		SE		SE		SE		SE		SE	
Sample Class	surface		surface		surface			surface		surface		surface		surface		surface		surface		surface		surface		surface		surface		surface		surface	
Conventionals																															
Total organic carbon (%)	**2.5**		**2.35**		**0.69**			**1.53**		**1.92**		**1.85**		0.08	U	**0.7**		**2.28**		**0.19**		**1.71**		**0.15**		**1.89**		**2.73**		**2.04**	J
PCBs (µg/kg)																															
Aroclor 1016	--		--		--		U	50	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5.2	U	5	U	3	U
Aroclor 1221	--		--		--		U	100	U	10	U	10	U	10	U	9.9	U	11	U	10	U	10	U	10	U	11	U	10	U	3	U
Aroclor 1232	--		--		--		U	50	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5.2	U	5	U	3	U
Aroclor 1242	--		--		--		U	50	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5.2	U	5	U	3	U
Aroclor 1248	--		--		--		U	50	U	5	U	**6.4**		5	U	5	U	5.1	U	5	U	**6**		5	U	**11**		**11**	J	3	U
Aroclor 1254	--		--		--		U	50	U	5	U	14	U	5	U	5	U	5.1	U	5	U	15	U	5	U	19	U	28	U	**12**	
Aroclor 1260	--		--		--			50	U	**8.9**		**15**		5	U	**12**		**53**		5	U	**16**		**6.8**		**31**		**46**		**12**	
Aroclor 1262	--		--		--		U	50	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5.2	U	5	U	3	U
Aroclor 1268	--		--		--		U	50	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5.2	U	5	U	3	U
Pesticides (µg/kg)																															
2,4'-DDD	--		--		--		U	**4.7**		**1.4**	J	**1.6**	J	0.4	U	**1.1**		**3**		0.4	U	**1.2**		**1.2**		**2.4**		**2.8**		2	U
2,4'-DDE	--		--		--		U	4	U	0.4	U	0.4	U	0.4	U	0.44	U	0.72	U	0.4	U	0.4	U	**0.3**	J	**0.75**		0.93	U	0.53	U
2,4'-DDT	--		--		--		U	4	U	**0.43**		**0.28**	J	0.4	U	**1.1**	J	0.84	U	0.4	U	**0.74**		0.49	U	0.63	U	**1.4**	J	**0.68**	J
4,4'-DDD	**8**	G	**8**	G	**3**	G	U	**13**		**1.6**		**2.1**		0.4	U	**2**		**5.6**		0.4	U	**2.5**		**2**	J	**3.4**		**5.4**		**0.9**	J
4,4'-DDE	**5**	G	**5**	G	**2**	G	U	**3.4**	J	**2.7**		**3**		0.4	U	**2.1**		**6**		0.4	U	**3.5**		**0.64**	J	**2.2**		**2.9**		**2**	
4,4'-DDT	**26**	G	**10**	G	20	UG		**14**		0.4	U	0.4	U	0.4	U	**1.8**	J	**6.5**		0.4	U	**2**	J	**0.63**		**2.8**	J	**9.8**		**1.9**	

Table C1-1
Summary of Subsurface Analytical Chemistry Results for Samples within Tar Body Removal Action Area

Location ID	T4-VC04		T4-VC04		T4-VC04		T4-VC04		T4-VC11		T4-VC11		T4-VC11		T4-VC11		T4-VC11	
Sample ID	T4-VC04-1-3		T4-VC04-3-5		T4-VC04-5-7		T4-VC04-7-9		T4-VC11-1-3		T4-VC11-3-5		T4-VC11-5-7		T4-VC11-7-9		T4-VC11-9-11	
Sample Date	3/16/2004		3/16/2004		3/16/2004		3/16/2004		3/18/2004		3/18/2004		3/18/2004		3/18/2004		3/18/2004	
Depth Interval	30.48-91.44 cm		91.44-152.4 cm		152.4-213.4 cm		213.4-274.3 cm		30.48-91.44 cm		91.44-152.4 cm		152.4-213.4 cm		213.4-274.3 cm		274.3-335.3 cm	
Sample Matrix	SE		SE		SE		SE		SE		SE		SE		SE		SE	
Sample Class	subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf	
Conventionals																		
Total organic carbon (%)	**2.03**		**1.05**	**J**	0.15	U	**0.22**		**1.97**		**0.46**		**0.03**	**J**	**0.02**	**J**	**0.02**	**J**
PCBs (µg/kg)																		
Aroclor 1016	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5	U	5	U
Aroclor 1221	10	U	10	U	10	U	11	U	10	U	10	U	10	U	10	U	10	U
Aroclor 1232	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5	U	5	U
Aroclor 1242	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5	U	5	U
Aroclor 1248	**5.9**		5	U	5	U	5.1	U	**10**		**10**		5	U	5	U	5	U
Aroclor 1254	18	U	5	U	5	U	5.1	U	20	U	20	U	5	U	5	U	5	U
Aroclor 1260	**12**		**3.7**	**J**	5	U	5.1	U	**16**		**64**		5	U	5	U	5	U
Aroclor 1262	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5	U	5	U
Aroclor 1268	5	U	5	U	5	U	5.1	U	5	U	5	U	5	U	5	U	5	U
Pesticides (µg/kg)																		
2,4'-DDD	**1.4**	**J**	0.4	U	0.4	U	0.41	U	**2.2**	**J**	**1.3**		0.4	U	0.4	U	0.4	U
2,4'-DDE	0.4	U	0.4	U	0.4	U	0.41	U	0.75	U	0.4	U	0.4	U	0.4	U	0.4	U
2,4'-DDT	0.4	U	0.4	U	0.4	U	0.41	U	1.1	U	0.98	U	0.4	U	0.4	U	0.4	U
4,4'-DDD	**2.9**		**0.34**	**J**	0.4	U	0.41	U	**3**		**1.4**		0.4	U	0.4	U	0.4	U
4,4'-DDE	**4.1**		**0.35**	**J**	0.4	U	0.41	U	**3.9**		**0.89**		0.4	U	0.4	U	0.4	U
4,4'-DDT	**13**		**0.53**	**J**	0.4	U	**0.087**	**J**	**2**	**J**	**2.9**		**0.07**	**J**	0.4	U	0.4	U

Table C1-1
Summary of Subsurface Analytical Chemistry Results for Samples within Tar Body Removal Action Area

Location ID	**T4-VC22**		**T4-VC22**		**T4-VC22**		**T4-VC22**		**T4-VC22**		**T4-VC23**		**T4-VC23**		**T4-VC23**		**T4-VC23**		**T4-VC23**		**T4-VC24**		**T4-VC24**		**T4-VC24**	
Sample ID	**T4-VC22-1-3**		**T4-VC22-3-5**		**T4-VC22-5-7**		**T4-VC22-7-9**		**T4-VC22-9-11**		**T4-VC23-1-3**		**T4-VC23-3-5**		**T4-VC23-5-7**		**T4-VC23-7-9**		**T4-VC23-9-11**		**T4-VC24-11-13**		**T4-VC24-1-3**		**T4-VC24-3-5**	
Sample Date	**3/11/2004**		**3/11/2004**		**3/11/2004**		**3/11/2004**		**3/11/2004**		**3/3/2004**		**3/3/2004**		**3/3/2004**		**3/3/2004**		**3/3/2004**		**3/3/2004**		**3/3/2004**		**3/3/2004**	
Depth Interval	**30.48-91.44 cm**		**91.44-152.4 cm**		**152.4-213.4 cm**		**213.4-274.3 cm**		**274.3-335.3 cm**		**30.48-91.44 cm**		**91.44-152.4 cm**		**152.4-213.4 cm**		**213.4-274.3 cm**		**274.3-335.3 cm**		**335.3-396.2 cm**		**30.48-91.44 cm**		**91.44-152.4 cm**	
Sample Matrix	**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**	
Sample Class	**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**	
Conventionals																										
Total organic carbon (%)	0.06	U	0.06	U	0.06	U	0.06	U	0.05	U	**0.05**		**0.05**		**0.27**		**0.08**		**5.71**		**0.49**		**0.86**		**0.75**	
PCBs (µg/kg)																										
Aroclor 1016	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	5	U	5	U
Aroclor 1221	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	10	U	12	U	11	U	9.9	U	9.9	U
Aroclor 1232	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	5	U	5	U
Aroclor 1242	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	5	U	5	U
Aroclor 1248	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	5	U	5	U
Aroclor 1254	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	**11**		5	U
Aroclor 1260	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	**10**	**J**	5	U
Aroclor 1262	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	5	U	5	U
Aroclor 1268	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	6	U	5.4	U	5	U	5	U
Pesticides (µg/kg)																										
2,4'-DDD	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.48	U	0.43	U	**1**		0.4	U
2,4'-DDE	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.48	U	0.43	U	0.4	U	0.4	U
2,4'-DDT	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.63	U	0.43	U	**0.61**	**J**	0.4	U
4,4'-DDD	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.55	U	0.48	U	0.43	U	**1.5**		0.4	U
4,4'-DDE	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.48	U	0.43	U	**1.2**		0.4	U
4,4'-DDT	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	**0.24**	**J**	0.43	U	0.4	U	0.4	U

Table C1-1
Summary of Subsurface Analytical Chemistry Results for Samples within Tar Body Removal Action Area

Location ID	T4-VC24		T4-VC24		T4-VC24		T4-VC25		T4-VC25		T4-VC25		T4-VC25		T4-VC25		T4-VC26		T4-VC26		T4-VC26		T4-VC26		T4-VC27	
Sample ID	T4-VC24-5-7		T4-VC24-7-9		T4-VC24-9-11		T4-VC25-1-3		T4-VC25-3-5		T4-VC25-5-7		T4-VC25-7-9		T4-VC25-9-11		T4-V26-1-3		T4-VC26-3-5		T4-VC26-5-7		T4-VC26-7-9		T4-VC27-1-3	
Sample Date	3/3/2004		3/3/2004		3/3/2004		3/11/2004		3/11/2004		3/11/2004		3/11/2004		3/11/2004		3/4/2004		3/5/2004		3/5/2004		3/5/2004		3/9/2004	
Depth Interval	152.4-213.4 cm		213.4-274.3 cm		274.3-335.3 cm		30.48-91.44 cm		91.44-152.4 cm		152.4-213.4 cm		213.4-274.3 cm		274.3-335.3 cm		0-91.44 cm		91.44-152.4 cm		152.4-213.4 cm		213.4-274.3 cm		30.48-91.44 cm	
Sample Matrix	SE		SE		SE		SE		SE		SE		SE		SE		SE		SE		SE		SE		SE	
Sample Class	subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf		subsurf	
Conventionals																										
Total organic carbon (%)	**0.83**		**0.56**		**1.32**		0.08	U	0.07	U	0.06	U	0.08	U	**0.12**		**2.05**		**3.71**		**0.73**		0.09	U	0.07	U
PCBs (µg/kg)																										
Aroclor 1016	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5.1	U	5.1	U	5	U
Aroclor 1221	9.9	U	9.9	U	10	U	10	U	10	U	10	U	10	U	10	U	11	U	10	U	11	U	11	U	10	U
Aroclor 1232	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5.1	U	5.1	U	5	U
Aroclor 1242	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5.1	U	5.1	U	5	U
Aroclor 1248	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	**13**		**53**		**18**		5.1	U	5	U
Aroclor 1254	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	29	U	88	U	33	U	5.1	U	5	U
Aroclor 1260	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	**28**		**130**		**26**		5.1	U	5	U
Aroclor 1262	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5.1	U	5.1	U	5	U
Aroclor 1268	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5	U	5.1	U	5	U	5.1	U	5.1	U	5	U
Pesticides (µg/kg)																										
2,4'-DDD	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	**2.1**		**4.2**	**J**	**2.1**	**J**	0.41	U	0.4	U
2,4'-DDE	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.62	U	0.4	U	0.41	U	0.41	U	0.4	U
2,4'-DDT	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	**0.93**	**J**	**3.1**	**J**	**1**		0.41	U	0.4	U
4,4'-DDD	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	**3.1**		**3.3**		**1.8**		0.41	U	0.4	U
4,4'-DDE	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	**3.7**		**4.7**	**J**	**2.2**	**J**	0.41	U	0.4	U
4,4'-DDT	0.4	U	**0.12**	**J**	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	0.4	U	**1.7**		**13**		**1.5**		0.41	U	0.4	U

Table C1-1
Summary of Subsurface Analytical Chemistry Results for Samples within Tar Body Removal Action Area

Location ID	**T4-VC27**		**T4-VC27**		**T4-VC27**		**T4-VC29**		**T4-VC29**		**T4-VC29**		**T4-VC29**		**T4-VC29**		**T4-VC32**		**T4-VC32**		**T4-VC32**		**T4-VC32**	
Sample ID	**T4-VC27-3-5**		**T4-VC27-5-7**		**T4-VC27-7-9**		**T4-VC29-1-3**		**T4-VC29-3-5**		**T4-VC29-5-7**		**T4-VC29-7-9**		**T4-VC29-9-11**		**T4-VC32-7-9**		**T4-VC32-1-3**		**T4-VC32-3-5**		**T4-VC32-5-7**	
Sample Date	**3/9/2004**		**3/9/2004**		**3/9/2004**		**3/5/2004**		**3/5/2004**		**3/5/2004**		**3/5/2004**		**3/5/2004**		**3/3/2004**		**3/4/2004**		**3/4/2004**		**3/4/2004**	
Depth Interval	**91.44-152.4 cm**		**152.4-213.4 cm**		**213.4-274.3 cm**		**30.48-91.44 cm**		**91.44-152.4 cm**		**152.4-213.4 cm**		**213.4-274.3 cm**		**274.3-335.3 cm**		**213.4-274.3 cm**		**30.48-91.44 cm**		**91.44-152.4 cm**		**152.4-213.4 cm**	
Sample Matrix	**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**		**SE**	
Sample Class	**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**		**subsurf**	
Conventionals																								
Total organic carbon (%)	0.04	U	0.04	U	0.05	U	**2.06**		**0.86**		0.15	U	**0.65**		**0.35**		**4.55**		**2.25**		**1.68**		**0.05**	
PCBs (µg/kg)																								
Aroclor 1016	5	U	5.1	U	5	U	50	U	5	U	5	U	5	U	5	U	5.7	U	5.1	U	5	U	5.1	U
Aroclor 1221	10	U	11	U	10	U	100	U	10	U	10	U	10	U	10	U	12	U	11	U	10	U	11	U
Aroclor 1232	5	U	5.1	U	5	U	50	U	5	U	5	U	5	U	5	U	5.7	U	5.1	U	5	U	5.1	U
Aroclor 1242	5	U	5.1	U	5	U	50	U	5	U	5	U	5	U	5	U	5.7	U	5.1	U	5	U	5.1	U
Aroclor 1248	5	U	5.1	U	5	U	50	U	**6.7**		5	U	5	U	5	U	5.7	U	**24**		**22**		5.1	U
Aroclor 1254	5	U	5.1	U	5	U	240	U	22	U	5	U	5	U	5	U	5.7	U	45	U	33	U	5.1	U
Aroclor 1260	5	U	5.1	U	5	U	**1000**		**17**		5	U	5	U	5	U	5.7	U	**64**		**29**		5.1	U
Aroclor 1262	5	U	5.1	U	5	U	50	U	5	U	5	U	5	U	5	U	5.7	U	5.1	U	5	U	5.1	U
Aroclor 1268	5	U	5.1	U	5	U	50	U	5	U	5	U	5	U	5	U	5.7	U	5.1	U	5	U	5.1	U
Pesticides (µg/kg)																								
2,4'-DDD	0.4	U	0.41	U	0.4	U	**16**		**1.8**	**J**	0.4	U	0.4	U	0.4	U	0.46	U	**3**		**2.5**		0.41	U
2,4'-DDE	0.4	U	0.41	U	0.4	U	0.67	U	0.4	U	0.4	U	0.4	U	0.4	U	0.46	U	0.79	U	0.69	U	0.41	U
2,4'-DDT	0.4	U	0.41	U	0.4	U	24	U	0.4	U	0.4	U	0.4	U	0.4	U	0.46	U	**1.3**	**J**	0.66	U	0.41	U
4,4'-DDD	0.4	U	0.41	U	0.4	U	**64**	**J**	**2.5**		0.4	U	0.4	U	0.4	U	0.46	U	**4.5**		**3.7**		0.41	U
4,4'-DDE	0.4	U	0.41	U	0.4	U	**4.1**		**1.8**		0.4	U	0.4	U	0.4	U	0.46	U	**4.9**		**3.6**		0.41	U
4,4'-DDT	0.4	U	0.41	U	0.4	U	**90**		**1.6**		0.4	U	0.4	U	0.4	U	0.46	U	**4**		**2.8**		0.41	U

Table C1-2
Summary of Percent Lipid Data from Phase 1 Tissue Results, Lower Willamette Group

Species	Tissue	n	Min	Max	Mean	Std Err
clam	body without shell	4	0.66	1.7	1.1	0.23
crayfish	whole body	27	0.16	1.3	0.8	0.05
largescale sucker	whole body	10	5	8.7	7.3	0.40
northern pikeminnow	whole body	11	2.3	8.1	4.8	0.56

Table C1-3
Summary Statistics Generated by ProUCL (Version 3.0): Sum Total PCBs

Data File | Variable: **Total PCBs**

Raw Statistics

Number of Valid Samples	59
Number of Unique Samples	23
Minimum	7.4
Maximum	1000
Mean	46.115254
Median	10
Standard Deviation	133.34634
Variance	17781.246
Coefficient of Variation	2.8915885
Skewness	6.6040741

Gamma Statistics

k hat	0.6757523
k star (bias corrected)	0.6526914
Theta hat	68.242842
Theta star	70.653993
nu hat	79.738766
nu star	77.017586
Approx.Chi Square Value (.05)	57.798053
Adjusted Level of Significance	0.0459322
Adjusted Chi Square Value	57.381543

Log-transformed Statistics

Minimum of log data	2.00148
Maximum of log data	6.9077553
Mean of log data	2.9323743
Standard Deviation of log data	1.0285507
Variance of log data	1.0579166

Normal Distribution Test

Lilliefors Test Statisitic	0.3857796
Lilliefors 5% Critical Value	0.1153474
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)

Student's-t UCL	75.133764

Gamma Distribution Test

A-D Test Statistic	9.1790204
A-D 5% Critical Value	0.7992039
K-S Test Statistic	0.3253558
K-S 5% Critical Value	0.120987
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL		61.449917
Adjusted Gamma UCL		61.895958

Lognormal Distribution Test

Lilliefors Test Statisitic	0.3230532
Lilliefors 5% Critical Value	0.1153474
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	43.523643
95% Chebyshev (MVUE) UCL	53.305176
97.5% Chebyshev (MVUE) UCL	62.767922
99% Chebyshev (MVUE) UCL	81.355653

95% Non-parametric UCLs

CLT UCL	74.670266
Adj-CLT UCL (Adjusted for skewness)	90.618824
Mod-t UCL (Adjusted for skewness)	77.621417
Jackknife UCL	75.133764
Standard Bootstrap UCL	74.104697
Bootstrap-t UCL	153.04163
Hall's Bootstrap UCL	177.53156
Percentile Bootstrap UCL	79.359322
BCA Bootstrap UCL	94.142373
95% Chebyshev (Mean, Sd) UCL	121.78667
97.5% Cl	154.52976
99% Chebyshev (Mean, Sd) UCL	218.84721

RECOMMENDATION
Data are Non-parametric (0.05)

Use 97.5% Chebyshev (Mean, Sd) UCL

Table C1-4

Summary Statistics Generated by ProUCL (Version 3.0): Sum 4,4'-DDE

Data File

Variable: **4,4'-DDE**

Raw Statistics

Number of Valid Samples	62
Number of Unique Samples	22
Minimum	0.2
Maximum	6
Mean	1.3432258
Median	0.2
Standard Deviation	1.6879532
Variance	2.8491861
Coefficient of Variation	1.2566415
Skewness	1.1975841

Gamma Statistics

k hat	0.6898268
k star (bias corrected)	0.6672008
Theta hat	1.9471927
Theta star	2.0132257
nu hat	85.538528
nu star	82.732901
Approx.Chi Square Value (.05)	62.767202
Adjusted Level of Significance	0.046129
Adjusted Chi Square Value	62.353964

Log-transformed Statistics

Minimum of log data	-1.6094379
Maximum of log data	1.7917595
Mean of log data	-0.5828037
Standard Deviation of log data	1.3313523
Variance of log data	1.772499

Normal Distribution Test

Lilliefors Test Statisitic	0.3476618
Lilliefors 5% Critical Value	0.1125221
Data not normal at 5% significance level	

95% UCL (Assuming Normal Distribution)

Student's-t UCL	1.7012711

Gamma Distribution Test

A-D Test Statistic	8.2150906
A-D 5% Critical Value	0.7979344
K-S Test Statistic	0.3766351
K-S 5% Critical Value	0.1180292
Data do not follow gamma distribution at 5% significance level	

95% UCLs (Assuming Gamma Distribution)

Approximate Gamma UCL	1.7704942
Adjusted Gamma UCL	1.7822278

Lognormal Distribution Test

Lilliefors Test Statisitic	0.3764568
Lilliefors 5% Critical Value	0.1125221
Data not lognormal at 5% significance level	

95% UCLs (Assuming Lognormal Distribution)

95% H-UCL	2.1191666
95% Chebyshev (MVUE) UCL	2.5775716
97.5% Chebyshev (MVUE) UCL	3.1218021
99% Chebyshev (MVUE) UCL	4.1908375

95% Non-parametric UCLs

CLT UCL	1.6958335
Adj-CLT UCL (Adjusted for skewness)	1.7306717
Mod-t UCL (Adjusted for skewness)	1.7067052
Jackknife UCL	1.7012711
Standard Bootstrap UCL	1.7009318
Bootstrap-t UCL	1.7275838
Hall's Bootstrap UCL	1.7242607
Percentile Bootstrap UCL	1.695
BCA Bootstrap UCL	1.7427419
95% Chebyshev (Mean, Sd) UCL	2.2776442
97.5% CI	2.6819678
99% Chebyshev (Mean, Sd) UCL	3.4761831

RECOMMENDATION

Data are Non-parametric (0.05)

Use 97.5% Chebyshev (Mean, Sd) UCL

Data Info:

The data that was used to generate this is provided on the workbook I:\Projects\Port of Portland\CONFIDENTIAL Terminal 4\Data0501106 Working Screened Sediment Results.xls

Total PCBs and Total DDTs were calculated using U=0.

Table C1-5
Fish Tissue Datafrom Station 03R014 and 05R006

Location	X	Y	Species	Tissue	Matrix	SampleID	Method	Analysis Date	Analyte	Detectflag	Value	Qualifiers	Units
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8081A	37726	2,4'-DDE	N	4	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8081A	37732	4,4'-DDE	Y	200		µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1260	Y	620	J	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1254	N	1500	UJ	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1268	N	38	UJ	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1221	N	38	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1232	N	38	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1248	Y	1400	J	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1016	N	38	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1262	N	38	UJ	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8082	37755	Aroclor 1242	N	38	UJ	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8270C	38080	2,4'-DDE	N	7.5	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC10	SW8270C	38080	4,4'-DDE	Y	120		µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8081A	37727	2,4'-DDE	N	4	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8081A	37727	4,4'-DDE	Y	93		µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1260	Y	180		µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1254	N	310	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1268	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1221	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1232	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1248	Y	170		µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1016	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1262	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	largescale sucker	whole body	tissue	LWG0103R014TSLSWBC20	SW8082	37748	Aroclor 1242	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8081A	37751	2,4'-DDE	N	9.9	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8081A	37751	4,4'-DDE	Y	240		µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1260	Y	560		µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1254	N	400	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1268	N	19	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1221	N	19	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1232	N	19	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1248	Y	150		µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1016	N	19	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1262	N	19	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8082	37753	Aroclor 1242	N	19	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8270C	38085	2,4'-DDE	N	7.5	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC10	SW8270C	38085	4,4'-DDE	Y	210		µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8081A	37751	2,4'-DDE	N	4	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8081A	37755	4,4'-DDE	Y	240		µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1260	Y	220		µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1254	N	280	U	µg/kg

Table C1-5
Fish Tissue Datafrom Station 03R014 and 05R006

Location	X	Y	Species	Tissue	Matrix	SampleID	Method	Analysis Date	Analyte	Detectf lag	Value	Qualifiers	Units
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1268	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1221	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1232	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1248	Y	150		µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1016	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1262	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8082	37753	Aroclor 1242	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8270C	38085	2,4'-DDE	N	7.5	U	µg/kg
03R014	7616007.73	720392.7	northern pikeminnow	whole body	tissue	LWG0103R014TSNPWBC20	SW8270C	38085	4,4'-DDE	Y	180		µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8081A	37751	2,4'-DDE	N	1	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8081A	37755	4,4'-DDE	Y	120		µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1260	Y	68		µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1254	N	120	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1268	N	1.9	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1221	N	1.9	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1232	N	1.9	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1248	Y	79		µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1016	N	1.9	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1262	N	1.9	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8082	37753	Aroclor 1242	N	1.9	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8270C	38085	2,4'-DDE	N	7.5	U	µg/kg
03R014	7616007.73	720392.7	peamouth	whole body	tissue	LWG0103R014TSPMWBC00	SW8270C	38085	4,4'-DDE	Y	98		µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8081A	37727	2,4'-DDE	N	4	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8081A	37732	4,4'-DDE	Y	180		µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1260	Y	320		µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1254	N	660	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1268	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1221	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1232	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1248	Y	460		µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1016	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1262	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8082	37748	Aroclor 1242	N	7.6	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8270C	38080	2,4'-DDE	N	7.5	U	µg/kg
03R014	7616007.73	720392.7	smallmouth bass	whole body	tissue	LWG0103R014TSSBWBC00	SW8270C	38080	4,4'-DDE	Y	110		µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8081A	37757	2,4'-DDE	N	1	U	µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8081A	37757	4,4'-DDE	Y	79		µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1260	Y	50		µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1254	N	61	U	µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1268	N	1.9	U	µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1221	N	1.9	U	µg/kg

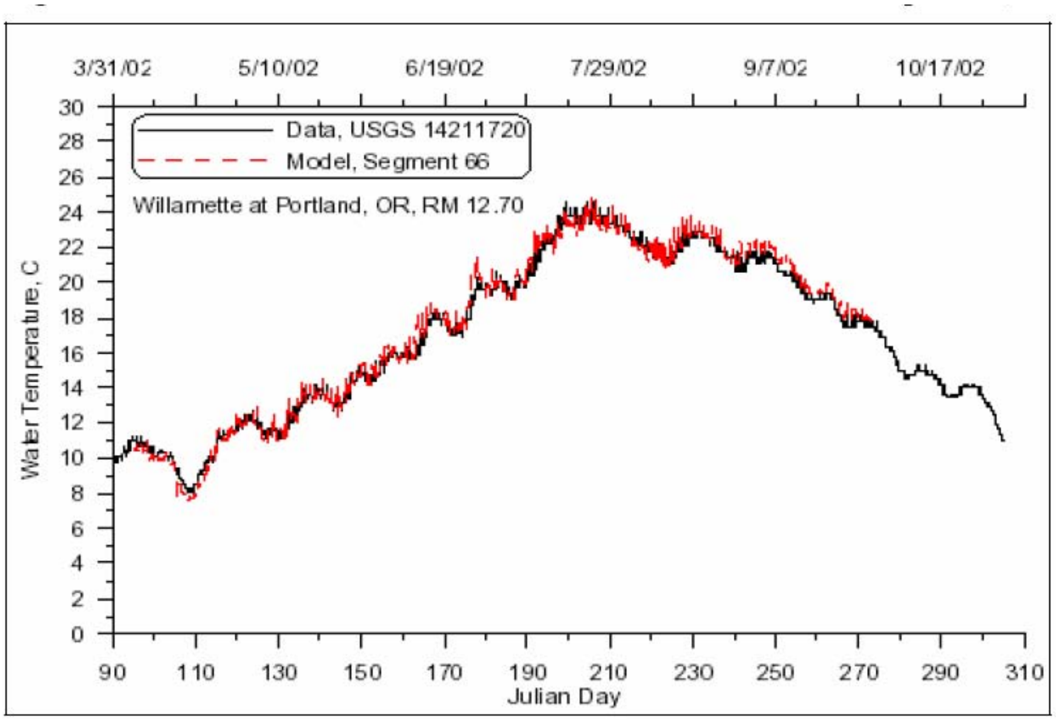
Table C1-5
Fish Tissue Datafrom Station 03R014 and 05R006

Location	X	Y	Species	Tissue	Matrix	SampleID	Method	Analysis Date	Analyte	Detectflag	Value	Qualifiers	Units
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1232	N	1.9	U	µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1248	Y	45		µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1016	N	1.9	U	µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1262	N	1.9	U	µg/kg
05R006	7619740.39	711395.18	largescale sucker	whole body	tissue	LWG0105R006TSLSWBC00	SW8082	37752	Aroclor 1242	N	1.9	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8081A	37751	2,4'-DDE	N	4	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8081A	37755	4,4'-DDE	Y	360		µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1260	Y	280		µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1254	N	460	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1268	N	7.6	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1221	N	7.6	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1232	N	7.6	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1248	Y	160		µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1016	N	7.6	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1262	N	7.6	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8082	37753	Aroclor 1242	N	7.6	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8270C	38085	2,4'-DDE	N	7.5	U	µg/kg
05R006	7619740.39	711395.18	northern pikeminnow	whole body	tissue	LWG0105R006TSNPWBC00	SW8270C	38085	4,4'-DDE	Y	250		µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8081A	37751	2,4'-DDE	N	1.7	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8081A	37755	4,4'-DDE	Y	110		µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1260	Y	110		µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1254	N	110	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1268	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1221	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1232	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1248	Y	64		µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1016	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1262	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8082	37785	Aroclor 1242	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8270C	38085	2,4'-DDE	N	7.5	U	µg/kg
05R006	7619740.39	711395.18	peamouth	whole body	tissue	LWG0105R006TSPMWBC00	SW8270C	38085	4,4'-DDE	Y	110		µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8081A	37740	2,4'-DDE	N	1.5	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8081A	37750	4,4'-DDE	Y	120	J	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1260	Y	270	J	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1254	N	190	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1268	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1221	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1232	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1248	Y	120		µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1016	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1262	N	9.5	U	µg/kg

Table C1-5
Fish Tissue Datafrom Station 03R014 and 05R006

Location	X	Y	Species	Tissue	Matrix	SampleID	Method	Analysis Date	Analyte	Detectflag	Value	Qualifiers	Units
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8082	37764	Aroclor 1242	N	9.5	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8270C	38080	2,4'-DDE	N	7.5	U	µg/kg
05R006	7619740.39	711395.18	smallmouth bass	whole body	tissue	LWG0105R006TSSBWBC00	SW8270C	38080	4,4'-DDE	Y	96		µg/kg

Figure C1-1. Temperature for Willamette River at Portland



ATTACHMENT C-2

TROPHIC TRACE MODEL OUTPUT FILES

TrophicTrace *Version 4.0 6/23/2006 9:49 AM*

Eco-Risk Assessment for Eagle

Body Weight, kg: 5.10E+00
Ingestion Rate, kg/day: 6.50E-01
Site Use Factor: 1.00E+00

Fuzzy number components: a=minimum possible,b=minimum probable,c=maximum probable,d=maximum possible

Risk Table

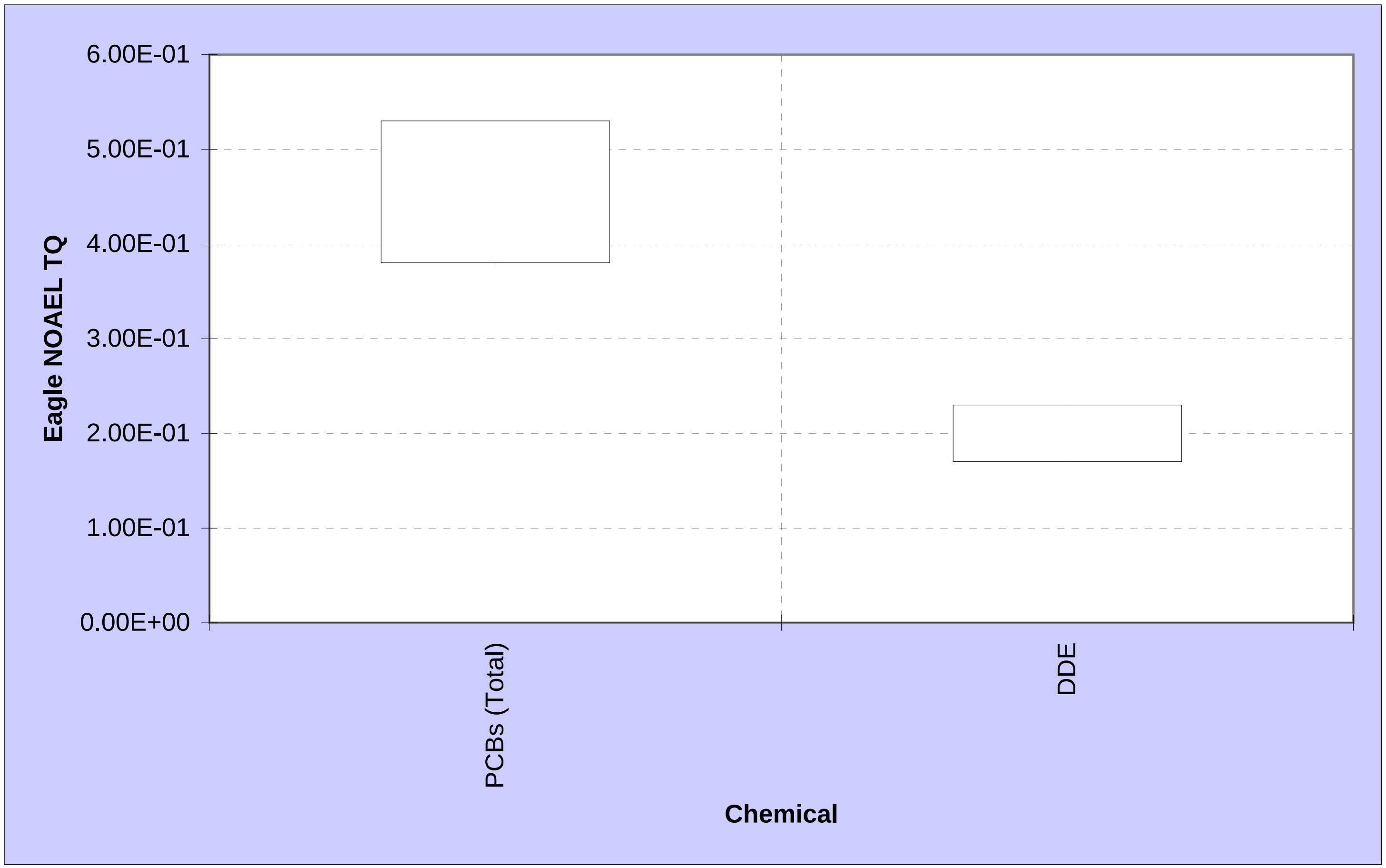
Chemical	Method of Risk Calculation	NOAEL TQ	LOAEL TQ	NOAEL TQ for Eggs	LOAEL TQ for Eggs	
PCBs (Total)	Equilibrium Partitioning	3.80E-01	1.60E-01	9.98E+00	2.49E+00	<---a
		3.80E-01	1.60E-01	9.98E+00	2.49E+00	<-b
		5.30E-01	2.30E-01	1.41E+01	3.53E+00	<-c
		5.30E-01	2.30E-01	1.41E+01	3.53E+00	<---d
DDE	Equilibrium Partitioning	1.70E-01	1.70E-02	2.25E+00		<---a
		1.70E-01	1.70E-02	2.25E+00		<-b
		2.30E-01	2.30E-02	3.18E+00		<-c
		2.30E-01	2.30E-02	3.18E+00		<---d

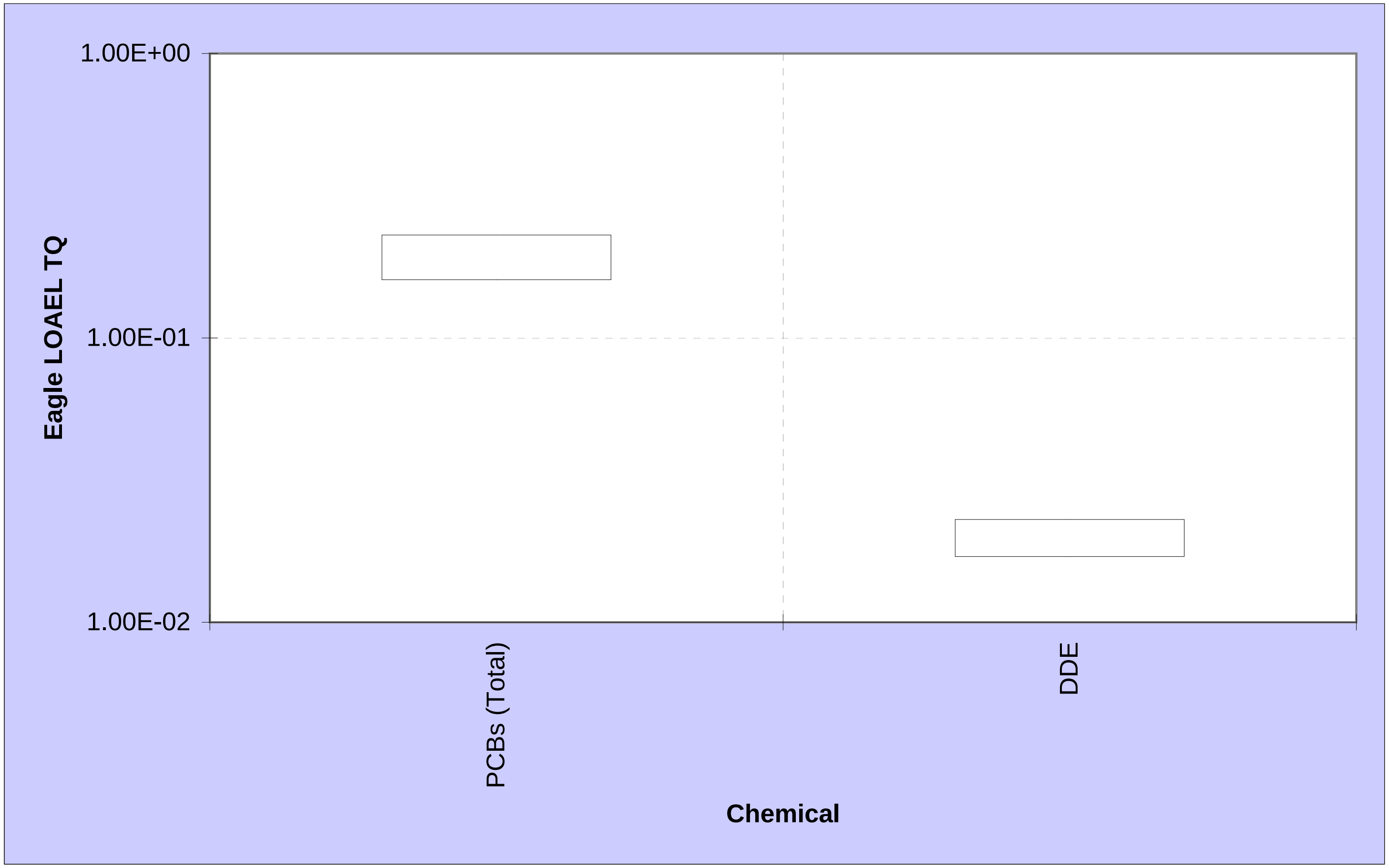
Exposure Concentrations Table

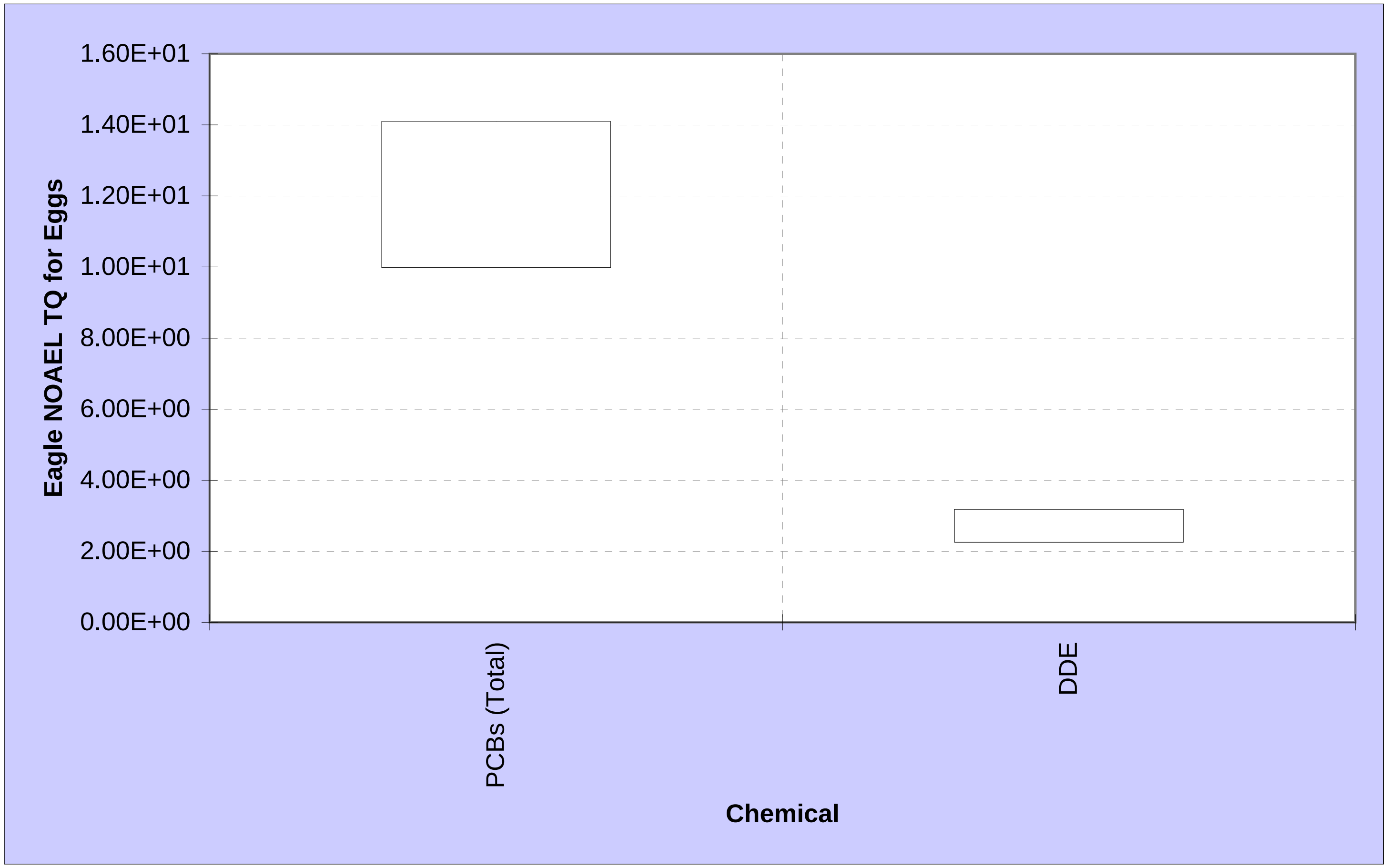
Diet	Diet Site	Diet Percent	Chemical	Concentration, mg/kg	
Northern Pikeminnow	Port of Portland - Terminal 4	1.00E+02	PCBs (Total)	1.21E+00	<---a
				1.21E+00	<-b
				1.71E+00	<-c
				1.71E+00	<---d
			DDE	1.60E-01	<---a
				1.60E-01	<-b
				2.20E-01	<-c
				2.20E-01	<---d

Fish Food Chain Table

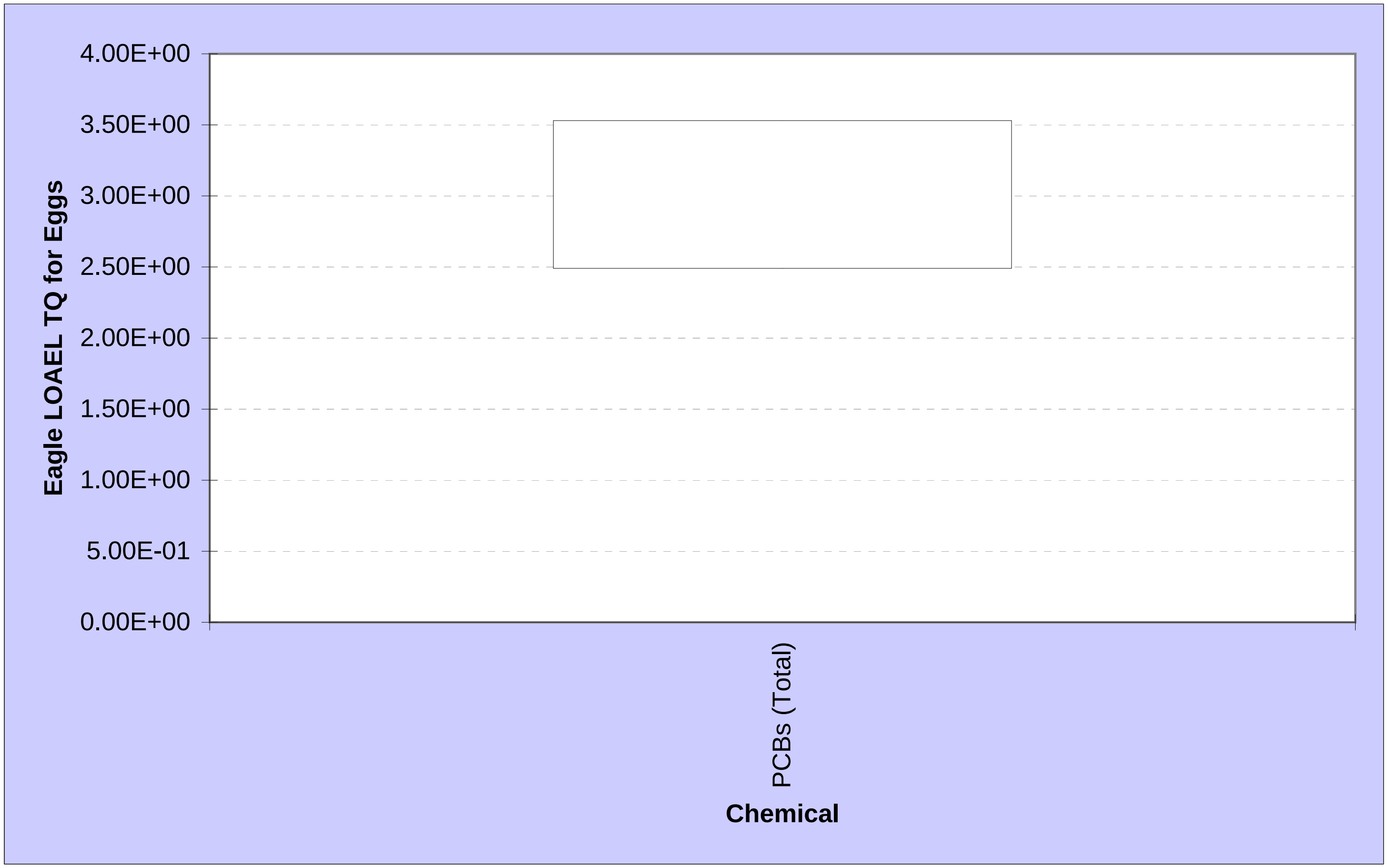
Fish	Environment	Reference Invertebrate	Reference Invertebrate Environment	Diet Item	Diet Item Environment
Northern Pikeminnow	Port of Portland - Termi			Largescale Sucker	Port of Portland - Termi
Largescale Sucker	Port of Portland - Termi			Clam	Port of Portland - Termi
				Crayfish	Port of Portland - Termi




1.00E+00
1.00E-01
1.00E-02
Eagle LOAEL TQ
PCBs (Total)
DDE
Chemical



Eagle NOAEL TQ for Eggs
1.60E+01
1.40E+01
1.20E+01
1.00E+01
8.00E+00
6.00E+00
4.00E+00
2.00E+00
0.00E+00
PCBs (Total)
DDE
Chemical



4.00E+00
3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
Eagle LOAEL TQ for Eggs
PCBs (Total)
Chemical

TrophicTrace

Version 4.0 6/23/2006 9:49 AM

Eco-Risk Assessment for Largescale Sucker

Weight, g: 4.00E+01
Lipid Percent: 7.30E+00
Site Use Factor: 1.00E+00

Fuzzy number components: a=minimum possible,b=minimum probable,c=maximum probable,d=maximum possible

Risk Table

Chemical	Method of Risk Calculation	NOAEL TQ	LOAEL TQ	NOAEL TQ for Eggs		LOAEL TQ for Eggs		
PCBs (Total)	Equilibrium Partitioning							<---a
								<-b
								<-c
								<---d
DDE	Equilibrium Partitioning							<---a
								<-b
								<-c
								<---d

Exposure Concentrations Table

Diet	Diet Site	Diet Percent	Chemical	Concentration, mg/kg	
Clam	Port of Portland - Terminal 4	5.00E+01	PCBs (Total)	4.20E-01	<---a
				4.20E-01	<-b
				6.00E-01	<-c
				6.00E-01	<---d
			DDE	5.70E-02	<---a
				5.70E-02	<-b
				8.10E-02	<-c
				8.10E-02	<---d
Crayfish	Port of Portland - Terminal 4	5.00E+01	PCBs (Total)	3.10E-01	<---a
				3.10E-01	<-b
				4.30E-01	<-c
				4.30E-01	<---d
			DDE	4.10E-02	<---a
				4.10E-02	<-b
				5.90E-02	<-c
				5.90E-02	<---d

TrophicTrace

Version 4.0   6/23/2006   9:48 AM

Eco-Risk Assessment for   Northern Pikeminnow

Weight, g: 5.00E+02
Lipid Percent: 4.80E+00
Site Use Factor: 1.00E+00

Fuzzy number components: a=minimum possible,b=minimum probable,c=maximum probable,d=maximum possible

Risk Table

Chemical	Method of Risk Calculation	NOAEL TQ	LOAEL TQ	NOAEL TQ for Eggs		LOAEL TQ for Eggs		
PCBs (Total)	Equilibrium Partitioning							<---a
								<-b
								<-c
								<---d
DDE	Equilibrium Partitioning							<---a
								<-b
								<-c
								<---d

Exposure Concentrations Table

Diet	Diet Site	Diet Percent	Chemical	Concentration, mg/kg	
Largescale Sucker	Port of Portland - Terminal 4	1.00E+02	PCBs (Total)	6.70E-01	<---a
				6.70E-01	<-b
				9.40E-01	<-c
				9.40E-01	<---d
			DDE	8.60E-02	<---a
				8.60E-02	<-b
				1.20E-01	<-c
				1.20E-01	<---d

Fish Food Chain Table

Fish	Environment	Reference Invertebrate	Reference Invertebrate Environment	Diet Item	Diet Item Environment
Largescale Sucker	Port of Portland - Termi			Clam	Port of Portland - Termi
				Crayfish	Port of Portland - Termi

TrophicTrace

Version 4.0 6/23/2006 9:48 AM

Input for the site: *Port of Portland - Terminal 4 OR*

Surface Water Temperature, C: 2.00E+01
Total Organic Carbon in Sediment, %: [.94, 1.33]
Particulate Organic Carbon, mg/L: 6.00E-02
Dissolvwd Organic Carbon, mg/L: 1.20E+00

Chemical of Concern Table

Chemical	Type of Water Concentration	Water (ng/L)	Sediment Bulk Dry Weight (ng/g)	
PCBs (Total)	Dissolved	8.84E+00	1.82E+02	<---a
		8.84E+00	1.82E+02	<-b
		1.25E+01	1.82E+02	<-c
		1.25E+01	1.82E+02	<---d
DDE	Dissolved	7.40E-01	2.46E+01	<---a
		7.40E-01	2.46E+01	<-b
		1.04E+00	2.46E+01	<-c
		1.04E+00	2.46E+01	<---d

TrophicTrace

Version 4.0 6/23/2006 9:48 AM

Input for the Fish: Northern Pikeminnow Port of Portland - Terminal 4

Lipid, %: 4.80E+00
Weight, g: 5.00E+02
Site Use Factor, unitless: 1.00E+00
Reference Invertebrate: None

Fish Diet

Species	% in Diet
LargescaleSucker	1.00E+02

TrophicTrace *Version 4.0 6/23/2006 9:48 AM*

Input for the Fish: Largescale Sucker Port of Portland - Terminal 4

Lipid, %: 7.30E+00
Weight, g: 4.00E+01
Site Use Factor, unitless: 1.00E+00
Reference Invertebrate: None

Fish Diet

Species	% in Diet
Clam	5.00E+01
Crayfish	5.00E+01

TrophicTrace

Version 4.0   6/23/2006   9:48 AM

Input for the Invertebrate: Crayfish   Port of Portland - Terminal 4

Diet Pathway:	Sediment
Lipid, %:	8.00E-01

TrophicTrace

Version 4.0 6/23/2006 9:48 AM

Input for the Invertebrate: Clam Port of Portland - Terminal 4

Diet Pathway:	Sediment
Lipid, %:	1.10E+00

TrophicTrace

Version 4.0 6/23/2006 9:48 AM

Input for the Organic Substances

Chemical	Log10(Kow) (unitless)	Log10(Koc) (unitless)	Cancer Slope Factor (1/(mg/kg-day))	Reference Dose (mg/kg-day)	Benthic-Sediment Accumulation Factor	
PCBs (Total)	6.30E+00	6.19E+00	2.00E+00	2.00E-05	2.80E+00	<---a
	6.30E+00	6.19E+00	2.00E+00	2.00E-05	2.80E+00	<-b
	6.30E+00	6.19E+00	2.00E+00	2.00E-05	2.80E+00	<-c
	6.30E+00	6.19E+00	2.00E+00	2.00E-05	2.80E+00	<---d
DDE	6.51E+00	6.40E+00	3.40E-01	5.00E-04	2.80E+00	<---a
	6.51E+00	6.40E+00	3.40E-01	5.00E-04	2.80E+00	<-b
	6.51E+00	6.40E+00	3.40E-01	5.00E-04	2.80E+00	<-c
	6.51E+00	6.40E+00	3.40E-01	5.00E-04	2.80E+00	<---d

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There are no metals in the Model