TACOMA HARBOR, WA
FEASIBILITY STUDY
PIERCE COUNTY, WASHINGTON

APPENDIX C – SUPPLEMENTAL INFORMATION ON THE AFFECTED ENVIRIONMENT

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US Army Corps of Engineers®
Seattle District

Port of Tacoma

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Supplemental Information on the Affected Environment

This appendix provides supplemental and background information that was used during the analysis of potential environmental effects.

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1. Water Quality

The Washington Department of Ecology tests water quality to comply with the Clean Water Act and to place waters of concern on the Section 303(d) list. The study area contains water bodies that are listed as Category 5 on the Washington State 2012 303(d) list (Figure 1) that was approved by the Environmental Protection Agency in 2016. Inner Commencement Bay is listed for Bis(2-Ethylhexyl)phthalate, polychlorinated biphenyls (PCBs); within the inner bay, Thea Foss Waterway is listed for PCBs and Hylebos Waterway is listed for dieldrin, PCBs, chlorinated pesticides, dichlorodiphenyltrichloroethane (DDT), and high molecular weight polycyclic aromatic hydrocarbons (HPAH). The Blair Waterway is not on the 303(d) list, but it is listed under "waters of concern" for benzene, tetrachloroethylene, and trichloroethylene. Outer Commencement Bay is listed for bacteria, DO, PCBs, and Bis(2-Ethylhexyl)phthalate.

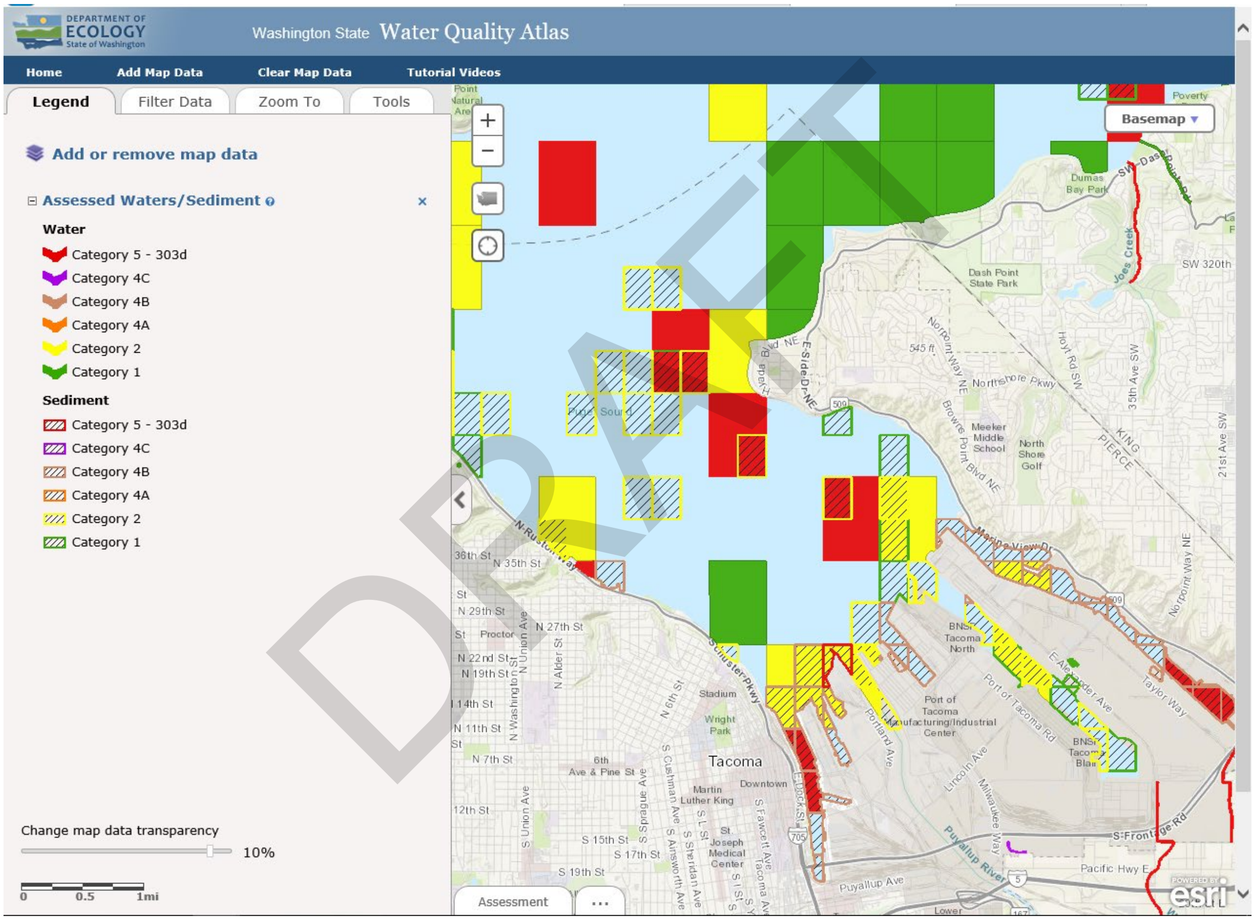

Figure 1. Map of assessed waters and 303(d) listing status (Ecology 2012).

2. Vegetation

Commencement Bay has limited eelgrass and kelp beds. There is a small patch of eelgrass to the east of Saltchuk. There is little information on eelgrass beds prior to 1941, but historically eelgrass grew in several locations along the western shores of Commencement Bay.

3. Beneficial Use of Dredged Material

The shorelines of Commencement Bay have been highly altered using riprap and other materials to provide bank protection. Blair Waterway comprises seven percent of the total of armored shoreline that cover 71 percent of the length of the Commencement Bay shoreline. Based on shoreline surveys and aerial photo interpretation of the area, approximately five miles, or 20 percent of the Commencement Bay shoreline, is covered by wide over-water structures (Kerwin 1999). The existing project area is presently altered using riprap that provides low to medium quality feeding and refuge habitat for juvenile salmon (Spence et al. 1996).

At present, the small amount of functional salmonid habitat within Commencement Bay shorelines is gradually increasing in acreage because of habitat restoration projects and natural processes. The importance of nearshore marine habitat, as part of a restoration strategy for habitat function within the estuary, has been emphasized by the Salmon Habitat Protection and Restoration Strategy for the Puyallup Watershed (Pierce County 2012) and is an important step toward improving the overall ecological functionality of the area.

Per ER 1105-2-100, U.S. Army Corps of Engineers (USACE) encourages consideration of placement options that provide opportunities for aquatic ecosystem restoration. Where environmentally beneficial use of dredged material is the least cost, environmentally acceptable method of disposal, it is cost shared as a navigation cost. The Saltchuk site is approximately 64 acres of low quality or degraded habitat. Of the 64 acres, approximately 8 acres (13%) is covered in wood waste. The wood waste present at Saltchuk is the result of historic logging practices that utilized waterways for storage and transport timber products. The wood waste present at Saltchuk is not known to be chemically treated, and thus not a suspected source of Hazardous, Toxic, and Radiological Waste (HTRW). This study evaluates the potential for beneficial us of dredged material at Saltchuk with the objective to restore nearshore intertidal and subtidal habitat substrate conditions for several fish and wildlife species, including ESA-listed species. The target species to benefit from the proposed project include juvenile and adult Chinook salmon, steelhead, and bull trout. Restoration actions aim to improve habitat conditions for these species and their prey species, such as forage fish and epibenthic and benthic invertebrates. The Saltchuk site is mostly (60.7 acres) deep water habitat that does not benefit the target species as much as shallower habitat. This action would potentially improve the quality of feeding and refuge habitat in the Commencement Bay area (Pierce County 2012) by increasing the amount of shallower nearshore habitat through placement of dredged material. See Section 4.3.2 in the draft Feasibility Report/Environmental Assessment (FR/EA) for more detail on the Saltchuk site. See section 4.11 in the draft FR/EA for discussion of Saltchuk in relation to HTRW.

3.1 Cost Effectiveness and Incremental Cost Analysis

The Saltchuk site is not the least cost placement site and is not the base plan. However, USACE is evaluating environmentally beneficial use of dredged material at the Saltchuk site for consideration of this as a multiple purpose project, including also ecosystem restoration. For environmentally beneficial disposal methods with incremental federal costs that exceed 25% of total base plan disposal costs or $300,000, USACE guidance requires the incremental costs be justified by demonstrating that the monetary and non-monetary benefits (outputs) of the ecosystem restoration project justify its incremental costs above the Base Plan. Analysis must demonstrate that the environmental resources restored by the placement method are valuable, describe and quantify the environmental outputs, and show federal and state resource agencies support for the environmentally beneficial disposal method.

This section describes the model inputs for performing the cost effectiveness and incremental cost analyses using the USACE Institute for Water Resources (IWR) Planning Suite, version 2.0.9.1 (USACE certified model). The USACE IWR developed this software to assist with the formulation and comparison of alternative plans. The software can assist with plan formulation by combining solutions to planning problems and calculating the additive effect of each combination, or "plan", by utilizing inputs on outputs (Average Annual Habitat Units, or AAHUs), costs, and rules (combinability and dependency relationships) for combining solutions into plans. Plans are then compared in IWR Planning Suite by conducting cost effectiveness and incremental cost analyses (CE/ICA), identifying the plans which are the best financial investments, and displaying the effects of each on a range of decision variables. The Puget Sound Nearshore Habitat Valuation (NHV) Model that was developed by the National Marine Fisheries Service (NMFS) in 2015 (Ehinger et al. 2015). Additional background on the NHV and why it was chosen appears in Section 3.6.2.1 of the draft FR/EA.

The NHV model uses a checklist scoring system to define habitat value, based primarily on elevation, vegetation, substrate conditions, anthropogenic impacts, and landscape context to provide a criteria-based and repeatable method for establishing habitat value (Table 1 and Table 2). The USACE used this model to establish base habitat values for the two elevation zones within the assessment area: Lower Shore Zone (LSZ; +5 to -10 MLLW) and Deeper Critical Habitat Zone (DZ; below -10 MLLW).

The evaluation of habitat units (HU) will takes into consideration changes over the 50-year period of analysis for the Tacoma Harbor feasibility study with analysis of years 0, 3, and 50. The LSZ indicators are about submerged aquatic vegetation (SAV; e.g., kelp and eelgrass) and shallow water habitat (which includes foraging habitat, i.e., benthic invertebrates). Depth, water quality, and sediment are all immediately functioning. The time to establishment for benthic invertebrates is estimated to take 3 years in the LSZ and DZ. The DZ indicators are similar to LSZ with 3 years for the establishment of benthic invertebrates. The NHV model will be expanded to include quality scores (i.e. normalized habitat quality scores between 0 and 1) for each year and scenario analyzed. The maximum quality score is 0.3 for DZ and 1.0 for LSZ. Results of scoring each zone appear in Table 3 and Table 4. The Riparian Zone (RZ) and Shallow Subtidal Zone (SSZ) portions of the model will not be used due to real estate limitations and the scope of this proposed beneficial use. The HUs are then used to calculate AAHUs, for use in the EC/ICA. This beneficial use analysis is very preliminary and will continue to be evaluated.

Scenario A (No-Action), Scenario B (Bench 1 placement to -20 MLLW), Scenario C (Bench 1 plus Bench 2 placement to -10 MLLW), Scenario D (Benches 1 and 2 plus placement to -5 MLLW), and Scenario E (Benches 1, 2, and 3 plus island creation to +5 MLLW). Scenarios are additive, building upon the material placed in preceding scenarios. These scenarios are described in the draft FR/EA in Section 3.6.1.2.

Table 1. Deep Zone (DZ) Excel Worksheet.

				Scenario A (No Action)			Scenario B					
				Years 0, 3, and 50			Year 0			Years 3, 50		
#	Indicator of Physical Habitat	Question	Maximum Possible Points	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category
Shallow Water Habitat												
1	Water Habitat, Accessibility and Presence	What water area [in sqft] is lost to Chinook use? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill.	3.00	0	3.00	3.00	0.00	3	3.00	0	3	3.00
Primary Production												
	Primary Productio	Primary production from algae. Assumed always present.	1		1	1		1	1		1	1
Water Quality												
6a	Water Quality, select one (y/n)	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	2	n	0.00		n	0.00		n	0.00	
6b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horshead Bay, Gig Harbor, choose "yes".	1	n	0.00		n	0.00		n	0.00	
6c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0	y	0.00	0.00	y	0.00	0.00	y	0.00	0.00
Sum		Sum of maximum possible points	6.00		Total	4.00		Total	4.00		Total	4.00
NHV					NHV	0.20		NHV	0.20		NHV	0.20
						14	Number added to divisor to set maximum possible					

	Scenario C						Scenario D						Scenario E					
	Year 0			Years 3, 50			Year 0			Years 3, 50			Year 0			Years 3, 50		
#	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category	Site Condition	Project Points	Summary Project Points by Category
Shallow Water Habitat																		
1	0	3	3.00	0	3	3.00	0	3	3.00	0	3	3.00	0	3	3.00	0	3	3.00
Primary Production																		
		1	1		1	1		1	1		1	1		1	1		1	1
Water Quality																		
6a	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00	
6b	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00	
6c	y	0.00	0.00	y	0.00	0.00	y	0.00	0.00	y	0.00	0.00	y	0.00	0.00	y	0.00	0.00
Sum		Total	4.00		Total	4.00		Total	4.00		Total	4.00		Total	4.00		Total	4.00
NHV		NHV	0.20		NHV	0.20		NHV	0.20		NHV	0.20		NHV	0.20		NHV	0.20

Table 2. Lower Shore Zone (LSZ) Excel Worksheet.

				Scenario A (No Action)			Scenario B						Scenario C						Scenario D						Scenario E					
				Years 0, 3, and 50			Year 0			Years 3, 50			Year 0			Years 3, 50			Year 0			Years 3, 50			Year 0			Years 3, 50		
#	Indicator of Physical Habitat	Question	Maximum Possible Points	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by	Site Condition	Project Points	Summary Project Points by
Submerged Aquatic Vegetation (SAV)																														
1a	**SAV condition, select one (y/n)**	Aquatic vegetation value high	4	n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0	
1b		Aquatic vegetation value medium, incl. native oyster beds	3	n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0		n	0	
1c		Aquatic vegetation value medium low	2	n	0		n	0		y	2		n	0		y	2		n	0		y	2		n	0		y	2	
1d		Aquatic vegetation value very low	1	y	1		y	1		n	0		y	1		n	0		y	1		n	0		y	1		n	0	
1e		Aquatic vegetation value none	0	n	0	1	n	0	1	n	0	2	n	0	1	n	0	2	n	0	1	n	0	2	n	0	1	n	0	2
Shallow Water Habitat																														
2a	**Shallow Water Habitat, Accessibility and Presence**	What shallow water area [in sqft] is lost to juvenile rearing? This loss could be the result of the construction of three-dimensional structures that result in the loss of shallow water habitat during some tides. Such structures include piles, bulkheads, and fill, or the conversion of shallow water habitat to deep water habitat via dredging. Not included as impacts to this habitat parameter are low profile structures like boat ramps, rails, and low concrete rubble. The effect of boat ramps and debris are considered with the Substrate rating below.	1.00	0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00		0	1.00	
2b	**Dredging**	Is habitat loss dredging related? Y or N. If so, NHV for LSZ gets multiplied with 0.3, because maximum habitat value for deeper habitat is 0.3.		n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00	n	1.00	1.00
Sediment																														
3a	**Substrate Size select one (y/n)**	Is the surface substrate in the littoral zone of the action area >25% mud or mixed fines?	0.5	y	0.50		y	0.50		y	0.50		y	0.50		y	0.50		n	0.00		n	0.00		n	0.00		n	0.00	
3b		Is the surface substrate in the littoral zone of the action area >25% sand or larger grained gravels?	1	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		y	1.00		y	1.00		y	1.00		y	1.00	
3c		Is the surface substrate in the littoral zone of the action area >25% rocky?	1	n	0.00	0.50	n	0.00	0.50	n	0.00	0.50	n	0.00	0.50	n	0.00	0.50	n	0.00	1.00	n	0.00	1.00	n	0.00	1.00	n	0.00	1.00
	Habitat Loss from Developme	**Sediment lost to low and high structures:** What area [in sqft] is lost to structures including boat ramps, riprap, concrete rubble, jetties, and bulkheads.		36,100	0.37		36,100	0.37		36,100	0.37		36,100	0.47		36,100	0.47		0	1.00		0	1.00		0	1.00		0	1.00	
3d	**Habitat Degradation Resulting from Development**	**Habitat Reduction:** % for entire affected area not covered up by low structures. Is the substrate in the affected area unnaturally compacted or coarsened as a result of a bulkhead or riprap; has the beach grade lowered? Consider effects within the affected area, only, like downdrift part of drift cell. This is the area calculated by dividing habitat loss from development (sq ft) by total area (sq ft).		0.25	0.37	0.37	0.25	0.37	0.37	0.25	0.37	0.37	0.06	0.47	0.47	0.06	0.47	0.47	-	1.00	1.00	-	1.00	1.00	-	1.00	1.00	-	1.00	1.00
Water Quality																														
4a	**Water Quality Condition, select one**	Is water quality in action area optimal? Use location as surrogate if no data. If action area is in undeveloped part of Puget Sound choose "yes".	1	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00	
4b		Is water quality in action area free of major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location as surrogate if no data. If action area is in little to medium developed part of Puget Sound, like Wollochet Bay, Horshead Bay, Gig Harbor, choose "yes".	0.5	n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00		n	0.00	
4c		Is WQ impacted by major contaminants associated with industrial and urban development like harbors, water treatment plants, and untreated storwater inputs? Use location, as surrogate if no data. If action area is very developed and has WQ effects from industrial sources, like Commencement Bay, Duwamish, choose "yes".	0	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**	y	0.00	**0.00**
		Sum of maximum possible points	**7.00**		**Total**	**2.37**		**Total**	**2.37**		**Total**	**3.37**		**Total**	**2.47**		**Total**	**3.47**		**Total**	**3.00**		**Total**	**4.00**		**Total**	**3.00**		**Total**	**4.00**
					NHV	**0.34**		NHV	**0.34**		NHV	**0.48**		NHV	**0.35**		NHV	**0.50**		NHV	**0.43**		NHV	**0.57**		NHV	**0.43**		NHV	**0.57**

Table 3. Deep Zone NHV Scores by Alternative and Year.

		Scenario A (No-Action)		Scenario B		Scenario C		Scenario D		Scenario E	
Indicator of Physical Health	**Max. Score**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**
Shallow Water Habitat											
1: Shallow Water Habitat accessibility and presence - Shallow water area lost to Chinook use (sq. ft.)	**3**	0	0	0	0	0	0	0	0	0	0
Shallow Water Habitat Score		***3***	***3***	***3***	***3***	***3***	***3***	***3***	***3***	***3***	***3***
Primary Production											
Primary Production	**1**	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***
Water Quality											
6a-6c: Water quality condition	**2**	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Total Scores	**6**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
NHV (Total Score divided by 20)		**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**

Table 4. Lower Shore Zone Scores by Alternative and Year.

		Scenario A (No-Action)		Scenario B		Scenario C		Scenario D		Scenario E	
Indicator of Physical Health	**Max. Score**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**	**Years 0, 3**	**Year 50**
Submerged Aquatic Vegetation											
1a-1e: SAV Condition	**4**	***1***	***1***	***1***	***2***	***1***	***2***	***1***	***2***	***1***	***2***
Shallow Water Habitat											
2a: Shallow Water Habitat accessibility and presence - Shallow water area lost to juvenile rearing (sq. ft.)	**1**	0	0	0	0	0	0	0	0	0	0
2b: Dredging (y/n)		n	n	n	n	n	n	n	n	n	n
Shallow Water Habitat Score		***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***	***1***
Sediment											
3a-3c: Substrate Size	**1**	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	1
Habitat Loss from development (sq. ft.)		36,100	36,100	36,100	36,100	36,100	36,100	0	0	0	0
3d: Habitat degradation resulting from development		25%	25%	25%	25%	6%	6%	0%	0%	0%	0%
Sediment Score		***0.37***	***0.37***	***0.37***	***0.37***	***0.47***	***0.47***	***1***	***1***	***1***	***1***
Water Quality											
4a-4c: Water quality condition	**1**	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***	***0***
Total Scores	**7**	**2.37**	**2.37**	**2.37**	**3.37**	**2.47**	**3.47**	**3**	**4**	**3**	**4**
NHV		**0.34**	**0.34**	**0.34**	**0.48**	**0.35**	**0.50**	**0.43**	**0.57**	**0.43**	**0.57**

HUs are quantity multiplied by quality of habitat, where quantity is the acres for a given zone and quality is the NHV quality score. HUs were computed for each scenario, year, and habitat zone (Table 5). The NHV quality scores reference the computations in their respective sheets in the Excel file on the 'DZ' and 'LSZ' tabs (Adapted from Ehinger et al. 2015; Table 1 and Table 2).

Table 5. Average Annual Habitat Unit (AAHU) Inputs: Saltchuk NHV Quantity and Quality Scores.

	Scenario A (No-Action)		**Scenario B**		**Scenario C**		**Scenario D**		**Scenario E**	
Metric	**DZ**	**LSZ**	**DZ**	**LSZ**	**DZ**	**LSZ**	**DZ**	**LSZ**	**DZ**	**LSZ**
Acreage	60.7	3.3	60.7	3.3	49.8	14.2	49.3	14.7	23.1	40.9
Year 0 NHV	0.20	0.34	0.20	0.34	0.20	0.35	0.20	0.43	0.20	0.43
Year 3 NHV	0.20	0.34	0.20	0.48	0.20	0.50	0.20	0.57	0.20	0.57
Year 50 NHV	0.20	0.34	0.20	0.48	0.20	0.50	0.20	0.57	0.20	0.57

The total HU for a scenario and year is the sum of HUs for DZ and LSZ, as shown in the following formula.

$$Total\ HUs_{year\ x} = (DZ\ acres_{year\ x} \times DZ\ NHV_{year\ x}) + (LSZ\ acres_{year\ x} \times LSZ\ NHV_{year\ x})$$

For example, computation of Scenario D HUs for year 0 is as follows:

$$Scenario\ D\ HUs_{year\ 0} = (Scenario\ D\ DZ\ acres_{year\ 0} \times Scenario\ D\ DZ\ NHV_{year\ 0}) + (Scenario\ D\ LSZ\ acres_{year\ 0} \times Scenario\ LSZ\ NHV_{year\ 0})$$

$$= (49.3 \times 0.2) + (14.7 \times 0.57) = 16.2$$

Table 6 displays AAHUs that are calculated from NHV quality scores that are carried forward for the computation of HUs and AAHUs. Total HU values for each scenario and year are used for computing AAHU using the IWR Planning Suite Annualizer Tool. Years 0, 3, and 50 Total HU values shown in the green cells from Table 5 are input for a given scenario (or Annualization Set). Linear interpolation between years is assumed.

Table 6. Saltchuk Habitat Unit Inputs and Average Annual Habitat Units.

Year	Scenario A (No-Action)			Scenario B			Scenario C			Scenario D			Scenario E		
	DZ	**LSZ**	**Total, by Year**	**DZ**	**LSZ**	**Total, by Year**	**DZ**	**LSZ**	**Total, by Year**	**DZ**	**LSZ**	**Total, by Year**	**DZ**	**LSZ**	**Total, by Year**
0	12.1	1.1	**13.3**	12.1	1.1	**13.3**	10.0	5.0	**15.0**	9.9	6.3	**16.2**	4.6	17.5	**22.1**
3	12.1	1.1	**13.3**	12.1	1.6	**13.7**	10.0	7.0	**17.0**	9.9	8.4	**18.3**	4.6	23.4	**28.0**
50	12.1	1.1	**13.3**	12.1	1.6	**13.7**	10.0	7.0	**17.0**	9.9	8.4	**18.3**	4.6	23.4	**28.0**
AAHU			***13.3***			***13.7***			***16.9***			***18.2***			***27.8***
Total Output			***0.0***			***0.4***			***3.6***			***4.9***			***14.5***

3.2 Inputs

Traditional benefit-cost analysis is not possible for the beneficial use placement evaluation because costs and benefits are expressed in different units. Rather, cost effectiveness and incremental cost analysis (CE/ICA) is used to assist the process of determining what project features and design alternatives should be built based on comparison of quantified habitat benefits (outputs) and estimated costs of alternative feature designs. Cost effectiveness analysis is conducted to ensure that the least cost plan is identified for each possible level of environmental output; and that for any level of investment, the maximum level of output is identified. Subsequent incremental cost analysis of the cost effective plans is conducted to reveal changes in costs as output levels are increased. Output, or net AAHU gain over the No-Action (Scenario A), and average annual cost in $1,000s are the two inputs to the cost effectiveness and incremental cost analysis. Five scenarios at Saltchuk were input for the cost effectiveness and incremental cost analysis, including Scenario A (No-Action), Scenario B (Bench 1 placement to -20 MLLW), Scenario C (Bench 1 plus Bench 2 placement to -10 MLLW), Scenario D (Benches 1 and 2 plus placement to -5 MLLW), and Scenario E (Benches 1, 2, and 3 plus island creation to +5 MLLW). Alternative scenarios are additive, building upon the material placed in preceding scenarios.

Costs of the beneficial use placement are the incremental costs above the base plan, or disposal at Commencement Bay for the -57' MLLW alternative for purposes of navigation improvements. Table 7 summarizes the base plan costs and the incremental costs of the five scenarios. The incremental average annual equivalent (AAEQ) costs are used for the CE/ICA.

Table 7. Beneficial Use Incremental Costs ($1000, October 2019 prices, 2.75% discount rate).

Plan	Project First Costs	IDC	LSF	Total Economic Cost	Total OMRR&R	AAEQ Cost
Base Plan						
Scenario A (No-Action)	$0	$0	$0	$0	$0	$0
Scenario B	$1,240	$52	$0	$1,292	$0	$48
Scenario C	$2,352	$99	$0	$2,451	$0	$91
Scenario D	$2,839	$119	$0	$2,958	$0	$110
Scenario E	$10,631	$4456	$0	$11,076	$0	$410

3.3 Results

Section 3.6.1.2 provides a summary of incremental costs and benefits associated with each scenario.

There were three best buy plans identified from the incremental analysis: Scenario A (No-Action), Scenario D (Benches 1-3), and Scenario E (Saltchuk full build-out with benches and islands; Figure 2). Additional details of the model results are in Section 3.6.1.2 of the draft FR/EA.

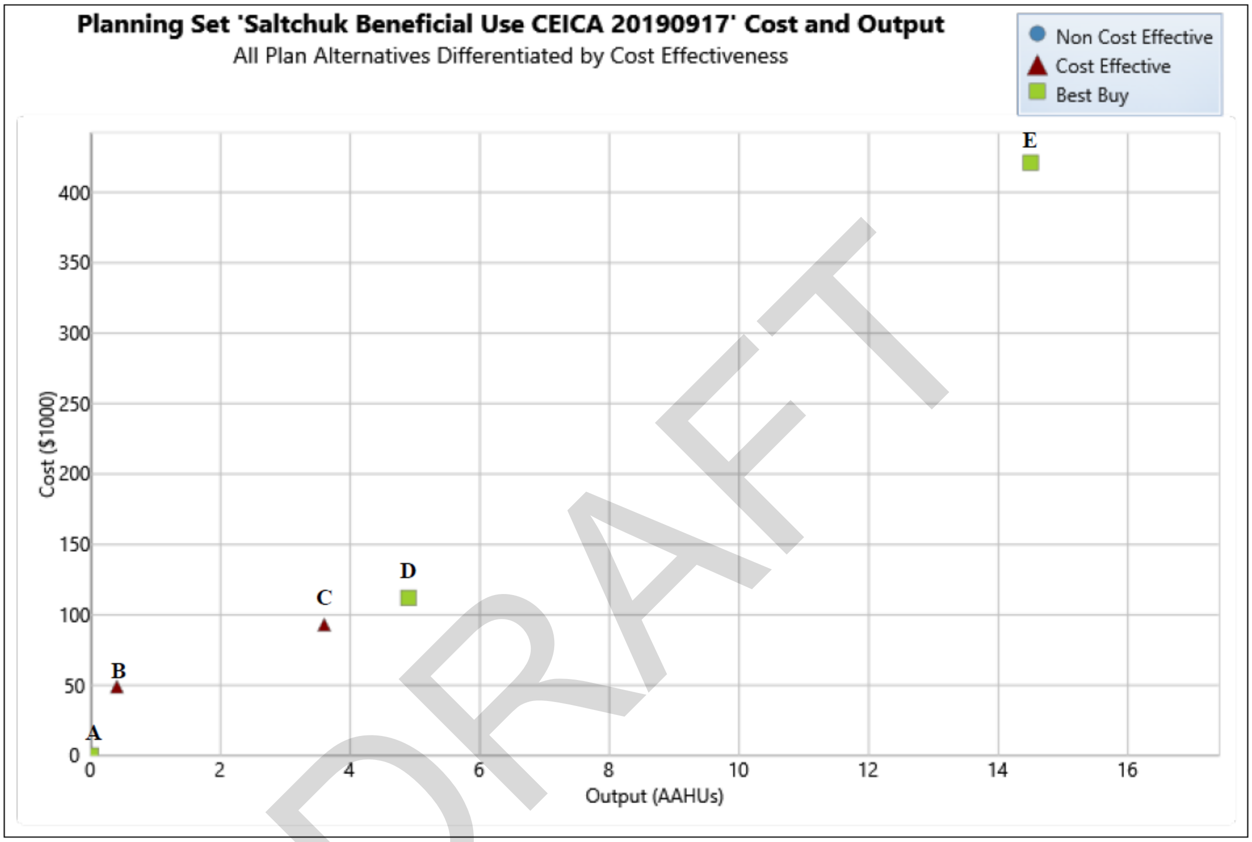

Figure 2. Saltchuk Alternative Cost and Output Plot

The objective of beneficial use of dredged material at Saltchuk is to restore nearshore intertidal and subtidal habitat substrate conditions for several fish and wildlife species, including ESA-listed species. The target species to benefit from the proposed project include juvenile and adult Chinook salmon, steelhead, and bull trout. Restoration actions aim to improve habitat conditions for these species and their prey species, such as forage fish and epibenthic and benthic invertebrates.

The incremental cost of the beneficial use disposal alternative to create nearshore habitat at Saltchuk site is reasonable in relation to the environmental benefits it achieves. Natural shorelines provide many important functions for PS Chinook salmon. In addition to the strictly vegetation related functions, addressed in the riparian assessment, the shallow water along natural shorelines in the upper shore zone provides refuge from predators and a migratory corridor. Stabilized shorelines, to varying degrees, cut off the shallow water regions of the beach. Further, hard bank stabilization has been shown to frequently result in modified wave regime, beach degradation including lowering of beach profile, and coarsening of substrate (Sobocinski 2003; Dugan et al. 2008; Shipman 2010; Dugan et al. 2011). All three effects from shoreline stabilization, harsher wave regime, lowered beach profile, and coarser substrate, reduce the suitability for forage fish spawning and their reproductive success. Fewer forage fish mean a reduce food base for salmon in Puget Sound.

Natural shorelines include bluffs, woody vegetation, and wetlands/saltmarshes. Regardless of which geology/vegetation combination is present, literature shows that highly stabilized shorelines provide significantly lower habitat values (Tonnes 2008; Holsman and Willing 2007; Sobocinsk 2003; Brennan 2007; MacDonald 1994).

4. Air Quality

Ambient air quality standards as adopted by the State of Washington (WAC 173-476) are in Table 8.

Table 8. NAAQS as adopted by the State of Washington**.

Pollutant		Averaging Time	Level	Remarks	Measurement Method	Interpretation Method
Particle Pollution	PM-10	24-hour	150 $\mu g/m^3$	Not to be exceeded more than once per year averaged over 3 years	40 C.F.R. Part 50, Appendix J	40 C.F.R. Part 50, Appendix K
	PM-2.5	Annual	12.0 $\mu g/m^3$	Annual mean, averaged over 3 years	40 C.F.R. Part 50, Appendix L	40 C.F.R. Part 50, Appendix N
		24-hour	35 $\mu g/m^3$	98th percentile, averaged over 3 years		
Lead		Rolling 3-month average	0.15 $\mu g/m^3$	Not to be exceeded	40 C.F.R. Part 50, Appendix G	40 C.F.R. Part 50, Appendix R
Sulfur Dioxide		Annual*	0.02 ppmv	Not to be exceeded in a calendar year	40 C.F.R. Part 50, Appendix A-1 or A-2	WAC 173-476-130(3)
		24-hour*	0.14 ppmv	Not to be exceeded more than once per year		
		3-hour	0.5 ppmv	Not to be exceeded more than once per year		
		1-hour	75 ppbv	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years		
Nitrogen Dioxide		Annual	53 ppbv	Annual Mean	40 C.F.R. Part 50, Appendix F	40 C.F.R. Part 50, Appendix S
		1-hour	100 ppbv	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years		
Ozone		8-hour	0.070 ppmv	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years	40 C.F.R. Part 50, Appendix D	40 C.F.R. Part 50, Appendix P
Carbon Monoxide		8-hour	9 ppmv	Not to be exceeded more than once per year	40 C.F.R. Part 50, Appendix C	WAC 173-476-160(3)
		1-hour	35 ppmv			

*Annual and 24-hour SO2 standards have a "sunset provision". They will no longer apply to those areas that have been in attainment status (designated by EPA) for the one-hour SO2 standard for one year. (See WAC 173-476-130 and 40 C.F.R. 50.17 for additional details.)
**Table taken from http://apps.leg.wa.gov/WAC/default.aspx?cite=173-476-900
ppmv – parts per million (ppm) by volume, ppbv – parts per billion (ppb) by volume, μg/m^3 – micrograms per cubic meter of air

Emissions of air pollutants were estimated by the following methodology:

engine power rating * hours of engine operation * emissions factor = emissions

Engine power ratings are typically expressed in terms of kilowatts (kW). Emission factors are specific to the pollutant and type of engine for which the emission estimate is being made and are typically expressed in terms of metric tons of pollutant emitted per kilowatt hour. Emissions are typically express in terms of metric tons of pollutant.

Short-term, direct impacts to air quality from construction activities air emissions were estimated for each project alternative. Air emissions estimates for construction activities considered the emissions for off-road diesel equipment and harborcraft, such as tug boats and the clamshell dredge. Emissions factors for off-road diesel equipment were obtained from the website of the South Coast Air Quality Management District (SCAQMD 2016). Emissions factors for harborcraft operations were derived from the Harborcraft, Dredge and Barge Emission Factor Calculator from the Sacramento Metropolitan Air Quality Management District (SMAQMD). Equipment and harborcraft types, engine power ratings, and hours of operation were provided by the cost engineering analysis for the project. Trucks would be used under all alternatives to transport dredged material not suitable for open water disposal to an upland disposal site. The analysis assumes that the upland disposal site would be the LRI Landfill in Graham, Washington, which is approximately 30 miles from the project location.

Long-term, indirect impacts to air quality consisting of air emissions due to port activities (local transit, maneuvering, and hoteling of ocean going vessels (OGVs)) were estimated for each project alternative.

The number of vessel calls used for the estimate of long-term, indirect air quality effects was based on the vessel traffic information presented in Appendix A – Economics, and Section 4.4 of the document.

5. Greenhouse Gas Emissions

GHGs have differing abilities to reflect infrared radiation and therefore have differing potentials to alter Earth's greenhouse effect. GHG emissions are typically standardized to metric tons of carbon dioxide (CO_2) equivalent by multiplying the tons of GHG by its 100-year global warming potential (IPCC 2013). For standardizing the estimate of methane (CH_4) emissions, the 100-year global warming potential incorporating climate carbon feedbacks was selected (IPCC 2013).

Greenhouse gas (GHG) emissions were estimated by the following methodology:

engine power rating * hours of engine operation * emissions factor = emissions

Engine power ratings are typically expressed in terms of kilowatts (kW). Emission factors are specific to the GHG and type of engine for which the emission estimate is being made and are typically expressed in terms of metric tons of GHG emitted per kilowatt hour. Emissions are typically express in terms of metric tons of GHG.

Greenhouse gas emissions were modeled for short-term sources during construction and considering the following three components: off-road diesel equipment emissions, harborcraft emissions, and locomotive emissions. The results appear in Section 4.9 of the draft FR/EA.

An estimate of CO_2 and CH_4 emissions under the various proposed alternatives was performed. These are the two primary GHGs produced by diesel engines in construction equipment, marine vessels, and locomotives. Nitrous oxide (N_2O) is a greenhouse gas that is produced by the combustion of fossil fuels in internal combustion engines. However, N_2O emissions from diesel powered engines are much lower than those from gasoline engines. The equipment and marine vessels used to construct the maximum extent proposal is assumed to be all diesel powered. The associated N_2O emissions are assumed to be negligible and therefore were not calculated.

Emissions factors for off-road diesel equipment used during construction were obtained from the website of the South Coast Air Quality Management District (SCAQMD 2015). Number of vessels and types of equipment, along with estimated operating hours were used from the cost estimate to provide the most conservative estimate of emissions. Emissions factors for clamshell dredge and tugboat operations (i.e. harborcraft) were derived using the Harborcraft, Dredge, and Barge Emission Factor Calculator from the Sacramento Metropolitan Air Quality Management District (SMAQMD 2017). It is assumed that dredged material not suitable for open water disposal would be transported via truck to the LRI Landfill in Graham, Washington. The number of vessel calls used for the estimate of long-term, indirect GHG emissions was based on the vessel traffic information presented in Appendix A – Economics, and Table 4-9 of the document.

6. Underwater Noise

To analyze the proposed action's potential effects of underwater noise on aquatic resources, some fundamental characteristics of sound and the existing conditions (i.e., the status of underwater noise in Puget Sound) are laid out here for a basic understanding for the analysis.

Sources of Sound

Ambient noise is the combination of all sound sources, which creates a steady background noise. Underwater sound source categories are biological (caused by marine life), hydrodynamic (caused by wind, waves, and rain), marine vessel traffic, and seismically produced such as during earthquakes or seismic surveys for oil exploration. Ambient noise conditions underwater in Puget Sound have many contributors including shipping traffic to the Ports of Everett, Seattle, and Tacoma, U.S. Navy activities, the Washington State ferry routes across Puget Sound with up to 23 vessels operating at a time, cruise ships, commercial fishing vessels, and recreational boats. As one example location, permanent ambient underwater noise in Admiralty Inlet, a major route for shipping traffic near Port Townsend, is around 98 dB (1 µPa @ 1 m; Bassett 2010). Mean ambient level in most marine waters is 80 to 100 dB (Richardson et al. 1995).

Sources of sound are intermittent as well as ambient. Some temporarily occurring noises include dredging, ships passing nearby, naval sonar testing, and pile driving or other construction-related activities. For example, in addition to the ambient noise in Admiralty Inlet, the Washington state ferry vessel in the Port Townsend-Coupeville route emits roughly 179 dB (1 µPa @ 1 m; Bassett 2010). Small ships around 100 to 150 feet long are common in Puget Sound and their engines emit broadband sound (20 Hz to 1 kHz) at 150 to 170 dB (1 µPa @ 1 m; Richardson et al. 1995). Larger commercial vessels emit lower frequency noise as loud as 170 to nearly 200 dB (1 µPa @ 1 m). Naval active sonar testing is likely the loudest sound produced emitting 230 dB (1 µPa @ 1 m) in the range of 2 to 5 kHz.

Animals in Puget Sound Potentially Affected by Underwater Noise

The major groups of animals in Puget Sound that can be affected by underwater noise are fish, diving birds, pinnipeds (seals, sea lions, and sea otters), and the two types of whales, mysticetes (baleen whales) and odontocetes (toothed whales). The species of focus for this analysis are identified as significant biological resources or are otherwise protected by the Marine Mammal Protection Act.

Fish can be harmed in different ways, particularly through their swim bladder because of the large difference in impedance between the gas-filled bladder and the surrounding water-filled body tissues (Nedwell et al. 2004). Intense sound pressure waves can cause physical harm and mortality. Fishes' sensitivity to hearing varies, but most exhibit a response to sounds in the range of 50 Hz to 2 kHz, with a minimum threshold around 70 dB (Hastings 1995). Herring, a forage fish with declining populations, have high sensitivity to sound due to their specialization of pressure-sensing mechanisms (Blaxter and Hoss 1981); this is in contrast to Cottids (sculpins), which have no swim bladder and are therefore not sensitive to sound waves (Nedwell et al. 2004).

Diving birds, such as marbled murrelets, are vulnerable to excessive underwater noise because it affects their ability to catch prey while diving, and can cause disorientation and injury. Excessive noise can cause a range of problems including aborted feeding attempts, disorientation, and even injury if the sound pressure wave is strong enough.

Marine mammals use vocalizations to identify themselves, their location, territory, or reproductive status and communicate with each other about presence of prey, another animal, or danger. Loudness, frequency, duration, and types of sounds vary widely among the species, and can be compared to the audiogram for the species if one has been developed. Audiograms are the graphic display of hearing sensitivity, which plot frequency against hearing threshold. Available data show that whales' auditory thresholds can extend as low as 10Hz for the mysticetes and as high as 500kHz for some odontocetes (Gordon and Moscrop 1996). California sea lions are most sensitive to sounds between 1 kHz and 28 kHz with peak sensitivity around 16 kHz (Schusterman et al. 1972). Harbor seals have a slightly broader range with ability to hear up to about 50 kHz for sounds over 60 dB (1 µPa @ 1 m; Richardson et al. 1995). The Steller sea lion hearing range is 500 Hz to 32 kHz with less sensitivity at the low and high frequencies.

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals (Ford 1989). Noise pollution from marine vessel traffic is one of the main concerns with decline in the endangered Southern Resident killer whale population because of how it may affect their vocalizations and hearing. Excessive noise levels may mask echolocation and other signals the species use, as well as temporarily or permanently damage hearing sensitivity (NMFS 2005). Vessel traffic negatively affects foraging behavior of the Southern Resident killer whales, which can have biologically significant consequences and is likely a factor in their low population level (Lusseau et al. 2009).

For a determination on whether construction related noise would affect marine mammals, fish, and birds, one must consider the frequency, location, intensity, and duration of the sound source as well as the audiogram of the recipient species. If an audiogram is available for a species, then using that audiogram helps to analyze the effects of noise on important biological resources; otherwise, the hearing frequency range may be the best available information. Effects analysis requires calculating the sound exposure level (SEL) that the animal receives. Table 9 displays data collected on hearing capabilities of potentially affected species in the project area.

Table 9. Hearing capabilities of aquatic species and sound threshold for continuous and pulsed noise that can cause behavioral disruption and injury.

Species	Audible Frequencies	Level B harassment (continuous)	Level B harassment (pulsed)	Level A injury
Fish (general)[2]	50Hz – 2kHz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Herring[2]	70Hz – 200Hz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Salmonids[2,7]	10Hz – 600Hz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Rockfish[8]	50Hz – 2kHz	150 dB_{RMS}	187 dB_{RMS}	206 dB_{RMS}
Pinnipeds[5]	500Hz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
California sea lions	1kHz – 28kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Harbor seals	1kHz – 50kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Steller sea lions	500Hz – 32kHz	120 dB_{RMS}	160 dB_{RMS}	190 dB_{RMS}
Mysticete whales[4]	10Hz – 8kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Minke whale[4]	10Hz – 500Hz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Odontocete whales[4]	100Hz – 500kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Killer Whale (orca)[3]	500Hz – 105kHz	120 dB_{RMS}	160 dB_{RMS}	180 dB_{RMS}
Diving birds[9] (developed for marbled murrelet)	Not available, presumed at 1kHz – 5kHz	150 dB_{RMS} (guideline)	183 dB_{RMS} (onset of injury)	202 dB_{RMS}

[1] square root of the mean of the squares of the values recorded over a given time interval [2]Blaxter and Hoss 1981; [3] Hall and Johnson 1971, Bain et al. 1993, Szymanski et al. 1999; [4] Gordon and Moscrop 1996; [5] Schusterman et al. 1972; [6] Bailey et al. 2010; [7] Knudsen et al. 1992; [8] Skalski et al. 1992; [9] SAIC 2011

The National Marine Fisheries Service (NMFS) has provided technical guidance on the effects of underwater noise on the hearing of marine mammal species. The hearing ranges and acoustic thresholds at which marine mammals are predicted to experience changes in hearing due to non-impulsive anthropogenic underwater noise, such as dredging, are summarized in Table 4. There are different thresholds for temporary (TTS) and permenant threshold shifts (PTS) of hearing sensitivity. For non-impulsive sounds the thresholds are presented using the cumulative sound exposure level (SEL_{cum}) (NMFS 2016).

Table 10. Generalized Hearing Ranges, PTS, and TSS Thresholds for Non-impulsive Sounds

Hearing Group	Generalized Hearing Range	PTS Onset Acoustic Thresholds (received level)	Weighted TTS onset acoustic threshold (SEL_{cum})
Low frequency (LF) cetaceans (baleen whales)	7 Hz to 35 kHz	$L_{E,LF,24h}$: 199 dB	179 dB
Mid-frequency (MF) cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	105 Hz to 160 kHz	$L_{E,MF,24h}$: 198 dB	178 dB
High-frequency cetaceans (true porpoises, *Kogia*, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger* & *L. australis*)	275 Hz to 160 kHz	$L_{E,HF,24h}$: 173 dB	153 dB
Phocid pinnipeds (PW) (underwater) (true seals)	50 Hz to 86 kHz	$L_{E,PW,24h}$: 201 dB	181 dB
Otariid pinnipeds (PW) (underwater) (sea lions and fur seals)	60 Hz to 39 kHz	$L_{E,OW,24h}$: 219 dB	199 dB

NMFS 2016. In the PTS column, L_E is the cumulative sound exposure level, other abbreviations, like LF, represent the auditory weighting function for that group of marine mammals, and the accumulation period is 24 hours.

A 2018 BiOP issued to USACE for eight maintenance dredging projects assumed dB_{RMS} and dB_{SEL} to be equal for continuous noise (NMFS 2018). Behavioral changes from noise avoidance are the most likely impacts to marine mammals. Few marine mammals, other than seals and sea lions, frequent inner Commencement Bay or waterways, so the impacts within the bay itself are predicted to be low. The sound exposure level (SEL), the threshold that causes a temporary shift in hearing ability, is 181 dB and 199 dB for seals and sea lions, respectively, which is above the level of noise generated by studies cited in NMFS 2016. Additionally, sound would attenuate quickly with distance from the dredge and would not cause any greater harm than avoidance of the immediate dredging area.

Overall, the dredge is not expected to cause more than the usual amount of disturbance that occurs to birds or marine mammals in Commencement Bay; however, the constant noise from the dredge may cause wildlife to avoid the immediate project area during the approximately 6 months of dredging and disposal. They would return to normal habits once the dredging is complete. No long-term significant impacts to wildlife populations are anticipated.

Impacts related to noise are likely to occur but should be temporary, and behavioral changes related to avoiding the noise are the most likely response by fish. High intensity underwater noise can result in temporary threshold shifts (TTS), non-injurious temporary reduction in hearing sensitivity. No permanent hearing loss has been documented in fish (NOAA 2016). Hearing varies depending upon the species of fish, however most react to sounds in the range of 50 Hz to 2 kHz with a minimum threshold around 70 dB (Hastings, 1995). Noise generated by hydraulic dredges are characterized as continuous (or non-pulsed), since the elevated sound pressure occurs over seconds (not milliseconds, as is the case with pulsed noise; Agness, NMFS, personal comm., July 23, 2013). The following are noise thresholds for various forms of effects on salmonids for both impact and vibratory pile driving (note that, like dredging, vibratory pile driving is considered continuous):

- 150 dB_{RMS}[1] for harassment for continuous noise for fish of all sizes (Hastings 2002)
- 187 dB cumulative SEL[2] for injury of fish ≥ 2 grams[3] (NMFS et al. 2008)
- 183 dB cumulative SEL for injury of fish < 2 grams (NMFS et al. 2008)
- 206 dB_{peak}[4] for injury of fish of all sizes (NMFS et al. 2008)

A more recent study lists the following continuous noise[2] thresholds based on Popper et al. 2014:

- For fish with swim bladders that are involved in hearing (e.g. herring, sardines, and anchovies)
  - 170 dB_{RMS} for 48 hours for recoverable injury
  - 158 dB_{RMS} for 12 hours for TTS (Temporary Threshold Shift, or complete recovery of hearing loss)
- There is no direct evidence for mortality or potential mortal injury for continuous noise
- There are no continuous noise thresholds set for fish without swim bladders (sculpins) or those with bladders that are not involved in hearing (salmonids)

The operation of most large marine vessels, including tugs that would have the barges for open-water sediment disposal, produce up to 180 dB. While the operation of the tug and barge would increase ambient noise levels along the immediate travel route, impacts of any sound disturbance would likely result in temporary, short-range displacement of animals rather than injury. A 2010 study recorded a tugboat with peak sound pressure levels in the range of 148-168 dB with the hydrophone placed 350 m away from the tugboat. This study also reported measurements of noise levels from clamshell dredging in the Snohomish River as high as 164 dB re µP (dB_{peak}) and 164 dB_{RMS} for a clamshell dredge when the bucket hits the bottom (Pentec Environmental 2010). Another study in Cook Inlet recorded a peak sound level of 124 dB re µP (dB_{peak}) when the clamshell hit a coarse substrate bottom (Dickerson et al. 2001). It is likely that the dB_{RMS} noise levels for this study were lower than the peak noise levels, although they were not reported. This Cook Inlet study also found that softer substrates are more effective at absorbing sound from the impact of the dredge bucket, and the peak sound measurements in these softer substrates did not exceed thresholds for continuous sound. The sound levels generated in the Snohomish River study exceeded the NMFS harassment (all fish) and Popper TTS (fish with swim bladders used for hearing) thresholds, but no injury thresholds for fish. The substrate in Commencement

[1] Decibels root mean square over a period of time
[2] Decibels sound exposure level over a 24 hour period (cumulative)
[3] Injury thresholds are based on pile driving (pulsed noise)
[4] Peak sounds in decibels

Bay is similar to that of the Snohomish River (mostly sand). Therefore, sound levels (both in dB_{peak} and $_{RMS}$) are likely to be lower than the Snohomish study and thresholds are not expected to be exceeded.

Data for how continuous sound affects fish is limited and in the technical report of sound exposure guidelines prepared by Popper et al. (2014), they rank the level of risk of injury as high, moderate, or low for most categories of fish instead of presenting number thresholds for harm. According to Popper, the risk of mortality for continuous sound such as this is low for all categories of fish at all distances from the sources of sound; the risk of recoverable injury is the same except for fish with a swim bladder used for hearing. Their threshold for recoverable injury is 170 dB rms, and 158 dB_{RMS} for a temporary threshold shifts. The peak sound level during the Snohomish River study falls between these thresholds. The risk of temporary threshold shift for the other groups of fish, those without swim bladders and those with swim bladders that do not use them for hearing, is moderate near the source of the sound but low for intermediate or far distances (Popper 2014).

Seals and sea lions in the area are likely accustomed to a higher level of underwater noise due to the heavy vessel traffic around Commencement Bay. Large shipping vessels can generate noise levels well above harassment and injury thresholds depending on variables like vessel speed, oceanic conditions, water temperatures, and bathymetry (McKenna et al. 2013; Richardson et al. 1995). Many commercial and recreational vessels transit the area multiple times a day.

According to the Washington Department of Fish and Wildlife's Atlas of Seal and Sea Lion Haulout Sites in Washington (Jeffries et al. 2000), the nearest harbor seal and sea lion haulout sites are in northeast Commencement Bay on buoys, floats, and discontinued log booms. Commencement Bay is not considered a major pupping and nursing site and although the number of haul outs and sightings of pups were increasing in 2009, the discontinuation of log booms removed a major haul out location in Commencement Bay.

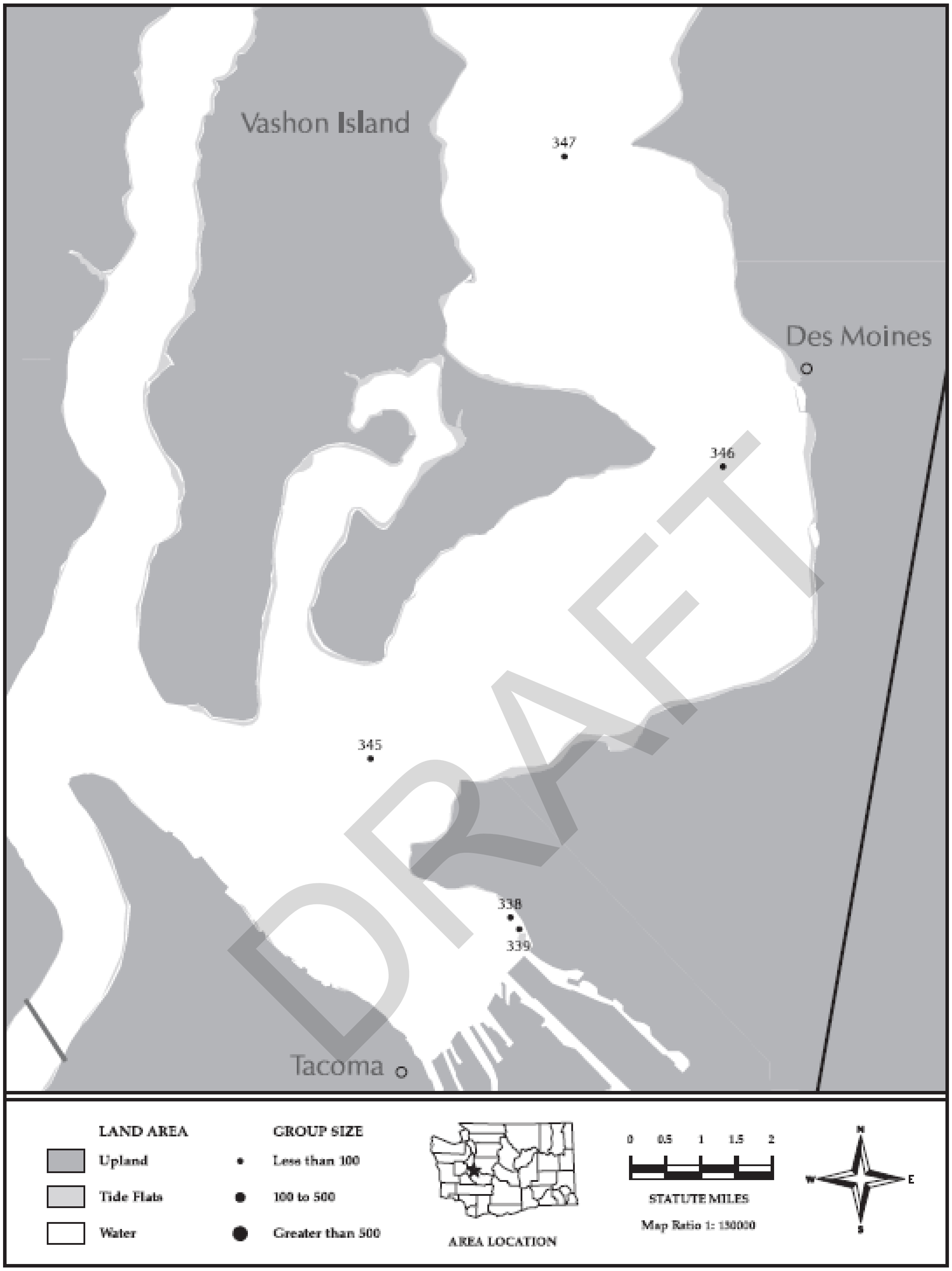

Figure 3. Seal and sea lion haulout sites in central Puget Sound from WDFW (Jeffries et al. 2000). Harbor seals and sea lions have historically hauled out onto buoys, floats, and the discontinued log booms in northeast Commencement Bay.

7. Invasive Species

The relevant vectors for invasive species are transport in shipping containers, ship fouling, and exchange of ballast water. It is assumed trade routes, container ship sizes, and number of containers will not change, so the risk of introducing species that may be transported via hull or ballast water biofouling or in containers such as Asian gypsy moth would not change. A check was performed to determine whether the New Zealand mudsnail (NZMS) has been documented within the project area. The site and surrounding areas are not listed in the most recent NZMS action summary (WDFW 2015 as cited in Anchor QEA 2019).

8. Recreation Resources

The Port of Tacoma provides public access to Commencement Bay as required by the City of Tacoma Shoreline Master Program. Public access to launch boats, sit along the water, or access the shoreline are available at the Dick Gilmur Shoreline Restoration and Kayak Launch along Marine View Drive north of the Hylebos Waterway, Balfour Dock and Youth Marine Foundation on the Foss Waterway, and Observation Tower at the head of Sitcum Waterway. Some access sites around Commencement Bay have been combined with habitat restoration, such as at Gog-Le-Hi-Te 1 &2 on the Puyallup River, and along the Hylebos Waterway with Julia's Gulch to the north and Place of Circling Waters at the mouth of Hylebos Creek. On the Blair Waterway, there is a public overlook with views of the Rhone-Poulenc saltmarsh and mudflat habitat site without direct shoreline access.

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